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**Assessment of Areas Impacted by Floods, Landslides,
and Debris**

Contract No: NDRRMA/RFP-AFL/01/2082-083

Final Report

**Report Submitted To
National Disaster Risk Reduction and Management Authority
Singhadurbar, Kathmandu**

Report Submitted By



Nithin

**GHC-Paragon-Bhugol JV
Chapagau, Lalitpur, Nepal**

Project Declaration

Government of Nepal
Ministry of Home Affairs
National Disaster Risk Reduction and Management Authority
Singhadurbar, Kathmandu, Nepal

Assessment of Areas Impacted by Floods, Landslides, and Debris (Contract No.: NDRRMA/RFP-AFL/01/2082-083)

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This document is the Final Report of work, for “Assessment of Areas Impacted by Floods, Landslides, and Debris (Contract No.: NDRRMA/RFP-AFL/01/2082-083)” undertaken by the Government of Nepal, Ministry of Home Affairs, National Disaster Risk Reduction and Management Authority, Singhadurbar, Kathmandu, Nepal. At this stage, the consultant has completed all the task assigned in the ToR. This final report provides all the requirements demanded by ToR provided by the client and the technical proposal submitted by the consultant.

Project Information

Project Information

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Name of the Consultant	Geo Hydro Consult Pvt. Ltd. Chapagau, Lalitpur, Nepal Paragon Engineering Consultancy and Research Center Pvt. Ltd. Bakhundol, Lalitpur, Nepal Bhugol Engineering Consultant Pvt. Ltd. Kalanki, Kathmandu, Nepal
Contact of the Consultant	Address: Chapagau, Lalitpur, Nepal Email: ghcnepal@gmail.com , info@ghc.com.np Website: www.ghc.com.np Phone: 977016218146, 9841970426
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Executive Summary

1. Background and Objective

The National Disaster Risk Reduction and Management Authority (NDRRMA) commissioned a rapid geohazard assessment of settlements affected by floods, landslides, debris flows, erosion, and related hazards to support evidence-based disaster risk reduction planning, mitigation prioritization, and relocation decision-making. Initially, the assessment was planned for 81 settlements identified by NDRRMA across various provinces of Nepal. However, based on field verification, requests from local governments, emerging hazard conditions, and the identification of additional highly vulnerable settlements during the assessment process, the scope was expanded to include 95 settlements. The final assessment covered 95 settlements located in seven districts across four provinces of Nepal, namely Koshi, Bagmati, Gandaki, and Karnali Provinces. The assessment aimed to characterize existing geo-hazards, evaluate exposure and vulnerability, determine the feasibility of mitigation measures, identify households requiring relocation, and provide technical recommendations for short-term and long-term disaster risk reduction interventions.

2. Assessment Methodology

The rapid geohazard assessment employed an integrated multidisciplinary approach combining desk study, remote sensing, field investigation, GIS analysis, and socio-economic assessment. Baseline information was compiled from NDRRMA, DMG, DHM, ICIMOD, and local governments, along with spatial datasets such as DEMs, geological maps, land-use data, and infrastructure inventories. Satellite imagery and GIS analyses were used to identify hazard features and support preliminary assessments, which were subsequently verified through detailed field investigations and stakeholder consultations. Hazard inventories, exposure, vulnerability, and mitigation feasibility were evaluated using field observations and spatial analysis. Based on hazard severity, risk level, and treatability, settlements were categorized according to the NDRRMA framework (CAT-I, CAT-II, and CAT-III), and appropriate mitigation, risk reduction, and relocation recommendations were formulated.

Table 1 Summary of Assessed Settlements

Province	District	Number of Settlements
Koshi	Ilam	53
Koshi	Dhankuta	1
Bagmati	Dhading	4
Gandaki	Parbat	2
Karnali	Rukum West	2
Karnali	Kalikot	5

Executive Summary

Karnali	Surkhet	28
Total	7 Districts	95

3. Assessment Results

The assessment identified multiple geohazard processes including active landslides, debris flows, riverbank erosion, gully erosion, flash floods, and complex slope failures. Most hazards are strongly influenced by monsoon rainfall, weak geological formations, steep terrain, toe erosion, and anthropogenic slope disturbances.

Table 2 Hazard Categorization and their number of settlements

Category	Description	Number of Settlements
CAT-I	Relatively safe settlements requiring routine monitoring	16
CAT-II	Settlements requiring mitigation measures	51
CAT-II (Partial Relocation)	Settlements requiring mitigation and relocation of highly exposed households	18
CAT-III	Settlements requiring relocation due to severe hazards	10
Total		95

4. Priority Assessment and Relocation Needs

Based on hazard severity, exposure, vulnerability, and urgency of intervention, settlements were prioritized for action.

Table 3 Priority Classification

Priority Level	Number of Settlements
Very High	13
High	33
Medium	35
Low	14
Total	95

A total of 222 households were identified for immediate relocation due to severe geohazard exposure and limited feasibility of engineering stabilization.

Table 4 District-wise Summary of Relocation Requirements

Province	District	Households Recommended for Relocation
Koshi	Ilam	56
Bagmati	Dhading	1
Gandaki	Parbat	12
Karnali	Rukum West	8
Karnali	Kalikot	114
Karnali	Surkhet	31
Total		222

The highest relocation requirements were identified in Kalikot, Surkhet, Ilam, and Rukum West districts, where active and progressive landslide processes pose significant risks to life and property.

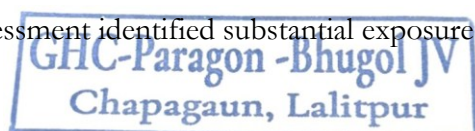
Table 5 Municipality-wise Summary of Immediate Relocation Households

Municipality / Rural Municipality	Number of Settlements Requiring Relocation	Households for Immediate Relocation
Mai Municipality	1	8
Phakphokthum Rural Municipality	1	16
Sandakpur Rural Municipality	2	9
Mangsebung Rural Municipality	2	9
Suryodaya Municipality	10	13
Dhunibesi Municipality	1	1
Phalebas Municipality	1	12
Aathbisakot Municipality	1	8
Palata Rural Municipality	1	94
Narharinath Rural Municipality	1	20
Gurbhakot Municipality	6	32
Total	27	222

The rapid assessment identified 222 households across 27 relocation-priority settlements (28 settlement clusters/sites) requiring immediate relocation due to unacceptable levels of geohazard risk. The highest relocation demand was observed in Palata Rural Municipality, Kalikot (94 households), followed by Narharinath Rural Municipality, Kalikot (20 households) and Phakphokthum Rural Municipality, Ilam (16 households).

5. Exposure and Vulnerability Assessment

The assessment identified substantial exposure of:



Mitlenad

- Residential settlements and households;
- Schools and health facilities;
- Roads and bridges;
- Drinking water systems;
- Agricultural land and irrigation infrastructure;
- Public buildings and community facilities.

Vulnerability is further exacerbated by fragile geological conditions, inadequate drainage systems, increasing anthropogenic disturbances, limited access to mitigation resources, and recurring monsoon-induced hazards.

6. Recommended Interventions

Short-Term Measures

- Surface and subsurface drainage management;
- Emergency slope stabilization;
- Toe protection and river training works;
- Bioengineering measures;
- Community awareness and preparedness;
- Hazard monitoring and early warning systems.

Long-Term Measures

- Detailed geotechnical investigations;
- Permanent slope stabilization measures;
- Watershed and catchment management;
- Land-use zoning and regulation;
- Community resilience strengthening;
- Planned relocation and resettlement programs.

7. Conclusions

The rapid geohazard assessment confirms that many settlements across Nepal's hill and mountain regions remain highly vulnerable to landslides and related hazards due to fragile geological conditions, steep topography, intense monsoon rainfall, and anthropogenic disturbances.

Of the 95 assessed settlements, 69 settlements require engineering and risk reduction interventions, while 10 settlements have been identified as requiring relocation due to severe and largely uncontrollable hazard conditions. Immediate relocation of 222 households is recommended to reduce life safety risks

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CHAPTER 1: INTRODUCTION

1.1 Background

Nepal is one of the most geologically dynamic and hazard-prone countries in the world. Situated along the active Himalayan orogenic belt formed by the ongoing collision between the Indian and Eurasian tectonic plates, the country is characterized by young, fragile, and highly fractured rock formations, steep mountainous terrain, deeply incised river valleys, and complex geomorphological processes. These natural characteristics, combined with intense monsoonal rainfall, frequent seismic activity, climate change–induced extremes, and increasing anthropogenic pressure on land resources, have made Nepal exceptionally vulnerable to a wide range of geophysical and hydro-meteorological hazards.

Among the various disaster types affecting Nepal, landslides constitute one of the most frequent, destructive, and recurrent hazards, particularly in the mid-hills and mountainous regions. Landslides are commonly triggered by prolonged and intense monsoon rainfall, earthquakes, river undercutting, unplanned road construction, deforestation, slope modification, and inadequate drainage management. These events frequently cause loss of life, displacement of households, destruction of settlements, agricultural land degradation, and severe damage to critical infrastructure such as rural roads, highways, bridges, hydropower projects, drinking water systems, irrigation canals, schools, and health facilities.

According to disaster records published by the Ministry of Home Affairs (MoHA), between 1971 and 2016 Nepal experienced more than 22,000 disaster events. Landslides alone accounted for over 3,200 recorded events, ranking among the top three most frequent hazards in the country. During this period, disasters collectively resulted in more than 40,000 fatalities, approximately 80,000 injuries, and displacement of over 1.3 million people, while affecting nearly 6 million individuals nationwide.

Landslides have contributed significantly to these impacts, causing repeated economic losses, disruption of livelihoods, and long-term development setbacks, particularly in rural and remote areas.

The monsoon season, typically extending from June–July to September–October, represents the most critical period for landslide occurrence. During this time, saturation of soil and rock masses, increased groundwater pressure, surface runoff concentration, toe erosion by rivers and streams, and reactivation of old landslide scars significantly elevate the probability of slope failure. In many cases, landslides also generate cascading and compounding hazards, such as river damming and subsequent outburst flooding, debris flows, isolation of communities due to road blockages, and prolonged interruption of essential services.

The Government of Nepal, through the National Disaster Risk Reduction and Management Authority (NDRRMA) under the Ministry of Home Affairs Nepal, has established a clear institutional mandate to lead national efforts in disaster risk reduction and management. Under the provisions of the Disaster Risk Reduction and Management Act 2017, NDRRMA is responsible for conducting national risk assessments, facilitating risk communication, coordinating disaster risk reduction investments, and guiding the development of evidence-based policies, strategies, and plans aimed at reducing Nepal's exposure to geophysical hazards. Recognizing the increasing frequency and impacts of disasters such as floods, landslides, and debris flows, the Government of Nepal has placed disaster risk reduction and management at the center of its national development agenda. In recent years, NDRRMA has received a growing number of requests from District Disaster Management Authorities (DDMAs), municipalities, and local communities seeking technical support to assess areas impacted by floods, landslides, and debris and recommend appropriate risk reduction interventions.

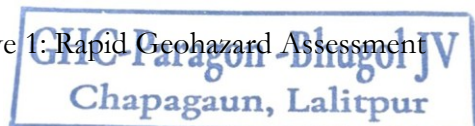
In response to growing requests from District Disaster Management Authorities, municipalities, and local communities for technical support, NDRRMA plans to undertake field-based assessments of areas affected by floods, landslides, and debris. Several impacted sites have been identified based on submissions from local governments and DDMMAs, and these locations are included under the present assignment. The objective of this consulting service is to generate reliable technical evidence to support informed decision-making and targeted risk reduction measures. Accordingly, NDRRMA has initiated this assignment, focusing on the pre-identified sites listed in Annex 1 of the Terms of Reference (TOR).

1.2 Objectives of the Study

The overall objective of the consulting services is to conduct a comprehensive assessment of areas impacted by floods, landslides, and debris, and to provide actionable recommendations for disaster risk reduction and the enhancement of community resilience.

The specific objectives of the consulting services are to:

Objective 1: Rapid Geohazard Assessment



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To conduct a systematic rapid geohazard assessment of all 81 pre-identified landslide-, debris-flow-, and flood-affected sites listed in Annex 1 of the Terms of Reference, producing scientifically rigorous, site-specific hazard characterizations that detail the type, magnitude, activity state, triggering factors, and spatial extent of the geohazard phenomena at each location

Objective 2: Geological, Engineering Geological, and Geomorphological Studies

To conduct comprehensive geological, engineering geological, and geomorphological investigations at all study sites, correlating observed instabilities with causal factors, and performing hydrological assessments to document the influence of surface and subsurface water dynamics on hazard initiation and propagation

Objective 3: Elements-at-Risk Mapping

To prepare comprehensive elements-at-risk maps for each study site, integrating the complete inventory of human settlements, residential and public buildings, transportation networks, utilities, agricultural lands, cultural and religious sites, and economic assets located within or potentially exposed to identified hazard footprints.

Objective 4: Recommendations on Urgency, Mitigation, and Relocation

To provide technically rigorous, evidence-based recommendations for each study site on the urgency and prioritization of interventions; the necessity and feasibility of partial or complete community relocation where mitigation is insufficient; and the requirements for further detailed engineering or geotechnical investigations, including the implementation of other geotechnically and geologically feasible mitigation measures.

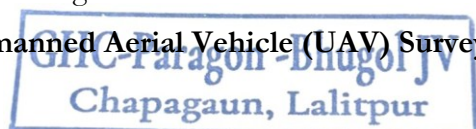
1.3 Scope of Work

The consulting services comprised a comprehensive, multidisciplinary program involving remote sensing analysis, field investigation, community engagement, geospatial mapping, and technical assessment of areas affected by landslides, debris flows, floods, and related geohazards. The major activities undertaken are summarized below

1. Remote Sensing and Desk-Based Analysis

- ✓ Freely available satellite imagery, including historical Google Earth archives, Sentinel-1, and Sentinel-2 datasets, were analyzed to identify landslide, debris-flow, and flood-affected areas.
- ✓ Existing reports and records from NDRRMA, DMG, DHM, DoS, local governments, and other relevant sources were reviewed to understand the geological, hydrological, and historical disaster contexts of each site
- ✓ Pre-field site information sheets were prepared for all study locations to support field investigations with baseline information on hazards, exposure, and socio-economic conditions.

2. Unmanned Aerial Vehicle (UAV) Surveys



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- ✓ UAV surveys were conducted using RTK-GPS-enabled drones to document terrain characteristics and hazard features.
- ✓ High-resolution orthophotos were generated for detailed site analysis.
- ✓ All UAV operations were carried out in compliance with the regulations and guidelines of the Civil Aviation Authority of Nepal (CAAN)..

3. Geological, Engineering Geological, and Geomorphological Field Investigations

- ✓ Detailed geological, engineering geological, and geomorphological field investigations were conducted to characterize lithology, soil conditions, geological structures, slope processes, and failure mechanisms.
- ✓ Landslides, debris flows, erosion features, and flood impacts were documented using standard classification systems.
- ✓ Longitudinal and transverse cross-sections were prepared for selected priority sites.
- ✓ Field-based assessments of slope stability and cascading hazard interactions were carried out where multi-hazard conditions were identified..

4. Hydrological Assessment

- ✓ Surface and subsurface hydrological features, including streams, springs, seepage zones, drainage conditions, and groundwater influences, were documented.
- ✓ Available rainfall and hydrological records from DHM stations were analyzed to assess potential triggering mechanisms and hazard recurrence characteristics.

5. Stakeholder Consultations and Socio-Economic Assessment

- ✓ Structured community consultations, including key informant interviews, focus group discussions, and participatory assessments, were conducted.
- ✓ Socio-economic information, including demographic characteristics, livelihoods, assets, and vulnerability indicators, was compiled and analyzed

6. Elements-at-Risk Inventory and Mapping

- ✓ Detailed inventories of buildings, settlements, roads, bridges, schools, health facilities, utilities, agricultural land, irrigation systems, and cultural assets exposed to geohazards were prepared and mapped.

7. Risk Assessment and Recommendations

- ✓ Risk assessments were carried out based on hazard characteristics, exposure conditions, vulnerability levels, and potential consequences, and each site was assigned a priority level of Very High, High, Medium, or Low.
- ✓ The technical feasibility of mitigation measures and the necessity for relocation were evaluated.

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- ✓ Practical recommendations were formulated, including immediate actions, short-term and long-term mitigation measures, responsible implementing agencies, requirements for further investigation, and monitoring and early warning strategies

1.4 Study Area and District Coverage

The project covers 81 settlements across six districts in four provinces of Nepal, representing a cross-section of the country's most geohazard-prone communities. These sites span diverse terrains, from the eastern subtropical hills to the mid- and high-hill regions of western Nepal, encompassing a wide range of hazard exposure, geological settings, and socio-economic contexts. In Koshi Province, approximately 52 sites are included, primarily in Ilam district, with one site in Dhankuta district. In Karnali Province, around 38 sites are covered across Surkhet (approximately 30 sites), Kalikot (5 sites), and Rukum Paschim (2 sites) districts. Bagmati Province contributes 3 sites within the Dhunibesi Municipality of Dhading district, while Gandaki Province includes a single site in the Phalebas Municipality of Parbat district.

Table 6 Settlements and locations to be assessed for flood, landslide, and debris flow risks

S.N.	Province	District	Municipality / (Rural Municipality)	Ward No.	Settlement (Basti)
1	Koshi	Ilam	Mai Municipality	2	Purbe, Kharpani
2				9	Rangapani
3			Phakphokthum Rural Municipality	1	Panchami Bazar
4				6	Simsara
5			Sandakpur Rural Municipality	1	Ahale
6				2	Todke
7				2	Kamere
8				3	Gairigaun
9				4	Gumba
10			Mangsebung Rural Municipality	3	Bhanjyang
11				3	Lamitar
12				6	Chisopani
13				6	Setikhare
14			Deumai Municipality	1	Maidane
15			Suryodaya Municipality	1	Paireni Tol
16				1	Shreekhola Chhare (Shreekhola Tol)
17				1	Bilaune Pakha (Durgabhawani Tol)
18				1	Ghising Gaun (Makarjung)
19				1	Teenghare (Purbeli Tol)
20				1	Chhare Jirel (Sagarmatha Tol)
21				1	Khadka Gaun (Indreni Tol)
22				1	Manebhanjyang (Sunakhari Tol)
3				2	Siddhikhola Area
24				2	Manedanda Tol
25				2	Arubotar Tol
26				2	Deurali Tol

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27				2	Mayukhola Area
28				2	Makhamali Tol
29				3	Mehelbote
30				4	Sadakate (Unitary Tol)
31				4	Salleri
32				4	Shreebung
33				4	Thalukhola Khand
34				5	Sudung
35				5	Ambitar
36				5	Mechi Bagar
37				7	Ambe Tol
38				9	Dhode
39				9	Rai Gaun
40				9	Adarsha Tol
41				11	Bhalu Khop
42				12	Rong Tol Khahare Khola Malim
43				12	Seti Devi Tol
44				12	Deurali Tol
45				12	Sundarbasti Tol
46				12	Sundar Khola
47				12	Triveni Tol
48				12	Lumke Tol
49				13	Doctor Gaun Kolbote Tol
50				14	Thulo Bardu Tol
51				14	Simle Sahakale Tol
52		Dhankuta	Dhankuta Municipality	5	Tudikhel (Mathillo Kopche)
53	Bagmati	Dhading	Dhunibesi Municipality	2, 8, 9	Jugedi, Khatripauwa
54	Gandaki	Parbat	Phalebas Municipality	8	Khalte and Okhani Kalamuda
55		Rukum	Musikot Municipality	10	-----
56		West	Aathbisakot Municipality	13	Kalo Pahiro
57				8, 9	Thulo Madu, Bade, Buase
58	Karnali			9	Bade, Buase
59		Kalikot	Palata Rural Municipality	6	Kam Basti
60				3	Jogkhola, Dalit Basti and Bhita
61			Narharinath Rural Municipality	5	Rupsa
62				2	Gharti Base and Khahare
63				3	Atak and Hile Dhariseta
64				3	Lekhhkhure
65				4	Jhalepahar and Nauly
66				4	Aaptakura
67				7	Naule Khola and Sano Thagleni
68				8	Bhedawari
69		Surkhet	Gurbhakot Municipality	8	Gaigate Khola
70				9	Nadekot and Dapcha
71				9	Simghat Votachaur
72	Karnali			9	Bhulke and Thakhokhoriya
73				10	Bhedawari Mathillo Tamitale Tol
74				10	Hanuman Umepani
75				11	Barmagar

76				11	Awalurma
77				11	Simkhola and Khahare
78				12	Sunadaha
79				12	Wallo Beteni
80				12	Lamidanda
81				14	Hileni Samuregaun and Kapase

1.5 Methodology

This study has adopted a multidisciplinary and integrated approach combining remote sensing, GIS analysis, engineering geological investigation, geomorphological assessment, hydrological evaluation, UAV-based terrain mapping, socio-economic assessment, and stakeholder consultation to rapidly assess geohazards and associated risks in the identified disaster-affected areas.

The methodology was designed to systematically identify hazard processes, evaluate their causative factors, assess vulnerability and exposure of communities and infrastructures, and recommend appropriate mitigation, stabilization, and relocation measures. The study was conducted in close coordination with NDRRMA, concerned local governments, district authorities, and local communities to ensure technical reliability and practical applicability of the recommendations.

The assessment was carried out in five major phases:

- Desk Study and Data Collection
- Detailed Field Investigation
- Hazard and Risk Assessment
- Remote Sensing and GIS Analysis
- Preparation of Mitigation and Relocation Recommendations

1.5.1 Phase I: Desk Study and Collection of Secondary Information

The study was commenced with comprehensive collection and review of available information relevant to the project areas. Existing reports, hazard inventories, geological maps, topographic maps, hydrological records, meteorological information, satellite imagery, disaster databases, and previous assessment reports were collected from government agencies, academic institutions, and development partners.

Particular emphasis was given to reviewing previous geological and geotechnical investigations, landslide and flood inventory databases; publications from NDRRMA, Department of Mines and Geology, Department of Hydrology and Meteorology; Existing hazard maps; topographic maps and DEM datasets; road and infrastructure development plans; municipal disaster management plans, historical disaster records etc. The collected information was organized within a GIS database to facilitate spatial analysis and field planning.

The desk study has provided preliminary understanding regarding regional geology, geomorphology, tectonic setting, drainage characteristics, historical disaster events, existing settlements and infrastructure, potential hazard-prone locations etc. The findings from the desk study guided the consultant the planning of field investigations and identification of priority assessment sites.

1.5.2 Remote Sensing, GIS and UAV-Based Assessment

1.5.2.1 *Satellite Image Interpretation*

The consultant has analyzed high-resolution freely available satellite imagery to identify existing and potential geohazard features. The interpretation was focused on landslide scars, debris flow channels, riverbank erosion, flood affected zones, tension cracks, surface deformation indicators, drainage obstructions, slope instability features etc.

1.5.2.2 *Digital Elevation Model Analysis*

Digital Elevation Models (DEM) were processed to generate slope maps, aspect maps, hillshade maps, relative relief maps, curvature maps, drainage network maps etc. These datasets supports the consultant understanding of terrain conditions controlling hazard occurrence.

1.5.2.3 *UAV Survey and Terrain Mapping*

Drone surveys were conducted on all given sites to generate high-resolution terrain information. The UAV survey has produced orthomosaic images and three-dimensional terrain models. The UAV-generated products were allowed the consultant accurate mapping of hazard boundaries, geomorphological features, damaged infrastructure, and potential future failure zones.

1.5.3 Phase III: Detailed Field Investigation

Field investigations constitute the core component of the assessment. A multidisciplinary team comprising engineering geologists, geologists, hydrologists, GIS experts, and surveyors were undertaken detailed site investigations.

1.5.3.1 *Geological Assessment*

Rapid geological assessments were conducted to characterize lithology, geological contacts, structural discontinuities, faults and fractures, weathering conditions and rock mass characteristics. Geological observations assisted determine geological controls influencing hazard development.

1.5.3.2 *Engineering Geological Assessment*

Engineering geological investigations were focused on assessing slope materials, soil characteristics, rock strength conditions, weathering grades, groundwater conditions, seepage patterns and instability indicators. Particular attention was given to identifying active deformation features such as tension cracks, differential settlements, tilting structures, surface ruptures and ground subsidence.

1.5.3.3 *Geomorphological Assessment*

Geomorphological mapping was undertaken to understand terrain evolution and active geomorphic processes. Assessment parameters were including slope morphology, drainage characteristics, erosional processes, depositional environments, debris accumulation zones, river channel dynamics, alluvial fan development etc. Geomorphological interpretation assists in determining hazard mechanisms and future hazard evolution.

1.5.3.4 *Hydrological and Drainage Assessment*

The consultant evaluates hydrological investigations and their influence of water on slope instability and flooding. The assessment was including surface drainage mapping, watershed characterization, flow concentration analysis, stream morphology assessment, riverbank erosion assessment, drainage obstruction identification, seepage and groundwater observations etc. Hydrological triggers associated with past hazard events were identified and analyzed.

1.5.3.5 *Engineering Survey*

Topographic and engineering surveys were conducted to prepare longitudinal sections (L-Sections) and cross sections (T-Sections), hazard profiles, settlement profiles etc. Survey information were used in hazard characterization and design of mitigation measures.

1.5.4 *Community Consultation and Socio-Economic Assessment*

Community consultation forms an essential component of rapid geohazard assessment. Consultations were conducted with chief district officer, municipal authorities, ward representatives, community leaders, disaster management committees, affected households, local stakeholders etc. From the consultations the consultant has gathered information regarding, historical disaster events, frequency of hazard occurrence, local perception of risks, previous damage records, emergency response experiences, community coping mechanisms etc. A socio-economic assessment on each affected settlement were carried out to evaluate population at risk, household vulnerability, livelihood dependence, social infrastructure exposure, economic losses, community resilience capacity etc. The collected information supports the consultant realistic risk assessment and recommendation development.

1.5.5 *Hazard Assessment and Analysis*

1.5.5.1 *Hazard Characterization*

Each identified hazard was characterized based on type of hazard, activity status, magnitude, spatial extent, triggering factors and potential future evolution. Hazards were classified into categories like active landslide, dormant landslide, debris flow, rockfall, flood hazard, riverbank erosion and complex hazard

1.5.5.2 Causative Factor Analysis

The study has evaluated both natural and anthropogenic factors contributing to hazard occurrence. Natural factor includes geological conditions, slope geometry, rainfall, drainage patterns, river erosion and weathering. Anthropogenic factor includes road excavation, unplanned construction, poor drainage, quarrying activities and land use changes.

1.5.5.3 Hazard Probability Assessment

The probability of future hazard occurrence was assessed based on current activity level, historical recurrence, triggering mechanisms, geological conditions and geomorphological indicators. The likelihood of future failures was categorized into qualitative classes of very high, high, moderate and low.

1.5.6 Exposure and Elements-at-Risk Assessment

The study has identified and mapped all exposed elements within hazard influence zones. These includes residential buildings, schools, health facilities, government offices, roads and bridges, water supply systems, irrigation systems, transmission lines, agricultural lands, forest, commercial establishments etc. Spatial overlay analysis in GIS were used to determine the degree of exposure of these elements to identified hazards. Elements-at-risk maps were prepared for each study area.

1.5.7 Risk Assessment

Risk assessment were integrated hazard characteristics, exposure, and vulnerability information. The assessment has evaluated human risk, infrastructure risk, economic risk, and environmental risk. A qualitative analysis approach was applied to classify risks into very high risk, high risk, moderate risk and low risk. Risk maps were generated using GIS-based analysis to support decision-making. The study has also assessed potential cascading hazards where one hazard may trigger another, such as landslides blocking rivers and causing flash floods.

1.5.8 Mitigation and Relocation Assessment

Based on field observations and hazard analysis, site-specific recommendations were developed. Which includes:

1.5.8.1 Structural Mitigation Measures

The consultant has included potential structural interventions, such as construction of retaining structures, gabion walls, check dams, river training works, slope protection measures, bioengineering solutions, surface drainage systems, and subsurface drainage systems.

1.5.8.2 *Non-Structural Measures*

The consultant has included potential non-structural interventions, such as land use regulation, community awareness programs, early warning systems, monitoring systems, development control measures, and emergency preparedness planning.

1.5.8.3 *Relocation Assessment*

Where hazards are determined to be untreatable or pose unacceptable risks, relocation options were evaluated. Relocation assessment were recommended considering safety conditions, availability of suitable land, accessibility, basic infrastructure, social acceptance and environmental suitability

Each site was categorized by safe or area will be stable naturally, suitable for mitigation, suitable for mitigation with monitoring, and need for complete relocation.

1.5.9 GIS Database Development and Report Preparation

All collected spatial and non-spatial information were integrated into a comprehensive GIS database. The final outputs include engineering geological maps, elements-at-risk maps, orthomosaic maps, UAV products, risk maps, longitudinal sections and cross sections etc. The study findings were compiled into Draft Reports in accordance with the requirements of NDRRMA. The reports were presented detailed analyses, field observations, hazard assessments, risk evaluations, mitigation options, relocation recommendations, and implementation priorities to support disaster risk reduction and resilient reconstruction planning.

1.6 Limitations of the Study

The consultant faced following limitations during the project period:

- This rapid assessment was conducted under a highly constrained timeframe. As per the contract requirements, the report was required to be submitted within approximately two months from project commencement. Considering the large geographical coverage, challenging terrain conditions, and extensive field investigations required, the available time for detailed fieldwork and data acquisition was limited.
- Although the Terms of Reference (ToR) originally identified 81 landslide sites for assessment, a total of 95 landslide sites were ultimately investigated during the course of the study. The increase in the number of sites significantly expanded the scope of work, requiring additional field visits, data collection, mapping, drone surveys, and analysis within the same project duration.
- To expedite field activities, three separate field teams were mobilized simultaneously in different regions. However, the dispersed nature of the landslide sites, difficult accessibility, rugged mountainous terrain, and long travel times between locations posed considerable logistical

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challenges. Consequently, the time available for detailed site investigations at individual locations was often limited.

- The project also encountered substantial technical challenges related to UAV (drone) operations. During fieldwork, three drones were damaged in separate incidents while conducting aerial surveys in difficult mountainous environments. Following each incident, replacement drones had to be dispatched from Kathmandu to the field sites to maintain continuity of data acquisition. These unforeseen equipment failures resulted in interruptions to survey schedules and increased operational difficulties.
- Furthermore, field investigations in eastern Nepal, particularly in Ilam District, coincided with the early onset of the pre-monsoon season. Many landslide sites were located on steep mountain ridges and upper slope positions where drone surveys were essential for mapping and hazard assessment. Frequent fog formation, especially during afternoon hours (typically from 1:00 PM onwards), significantly reduced visibility and restricted UAV flights. These adverse weather conditions frequently delayed or limited aerial survey operations and affected the efficiency of field data collection.

Despite these challenges; including the expanded number of assessment sites, limited project duration, difficult terrain, adverse weather conditions, and repeated UAV equipment failures; the study team successfully completed the required field investigations, analyses, and reporting activities within the stipulated project schedule. Every effort was made to ensure that the assessment findings, hazard characterization, and recommendations presented in this report are technically sound and representative of the site conditions observed during the study period.

CHAPTER 2: REGIONAL SETTING

2.1 Regional Geology

The study districts of Kalikot, Jajarkot, Rukum West, Parbat, Dhading, Dhankuta, and Ilam are located within different physiographic and tectonic zones of the Nepal Himalaya. These districts collectively encompass the Siwalik, Lesser Himalaya, Higher Himalaya, and locally the Sub-Himalayan transition zones. The geological setting of the study area is primarily controlled by the ongoing convergence between the Indian and Eurasian plates, which has produced a complex assemblage of sedimentary, metasedimentary, metamorphic, and unconsolidated Quaternary deposits. Major tectonic structures including the Main Central Thrust (MCT), Main Boundary Thrust (MBT), and several regional thrusts and faults exert significant control on slope stability, river incision, erosion, and geohazard occurrence. The geological complexity of these districts contributes directly to the widespread occurrence of landslides, debris flows, rockfalls, riverbank erosion, and flood-related hazards.

2.1.1 Kalikot District

Kalikot District lies predominantly within the Lesser Himalayan Zone of western Nepal. The district is characterized by low- to medium-grade metamorphic rocks consisting of phyllite, slate, quartzite, schist, metasandstone, limestone, and dolomite. These rocks belong mainly to the Precambrian to Paleozoic metasedimentary successions of the Lesser Himalaya. The area is highly deformed by folding, faulting, and thrusting associated with Himalayan tectonic activity. Numerous structural discontinuities, shear zones, and weathered rock masses are present throughout the district.

The deeply incised valleys of the Karnali River and its tributaries expose extensive bedrock sections, demonstrating strong tectonic uplift and active erosion. The combination of steep slopes, fractured

Regional Setting

bedrock, intense monsoonal rainfall, and river undercutting has created favorable conditions for recurrent landslides and debris flow events. Weathered phyllitic and schistose rocks are particularly susceptible to slope failures during prolonged rainfall periods.

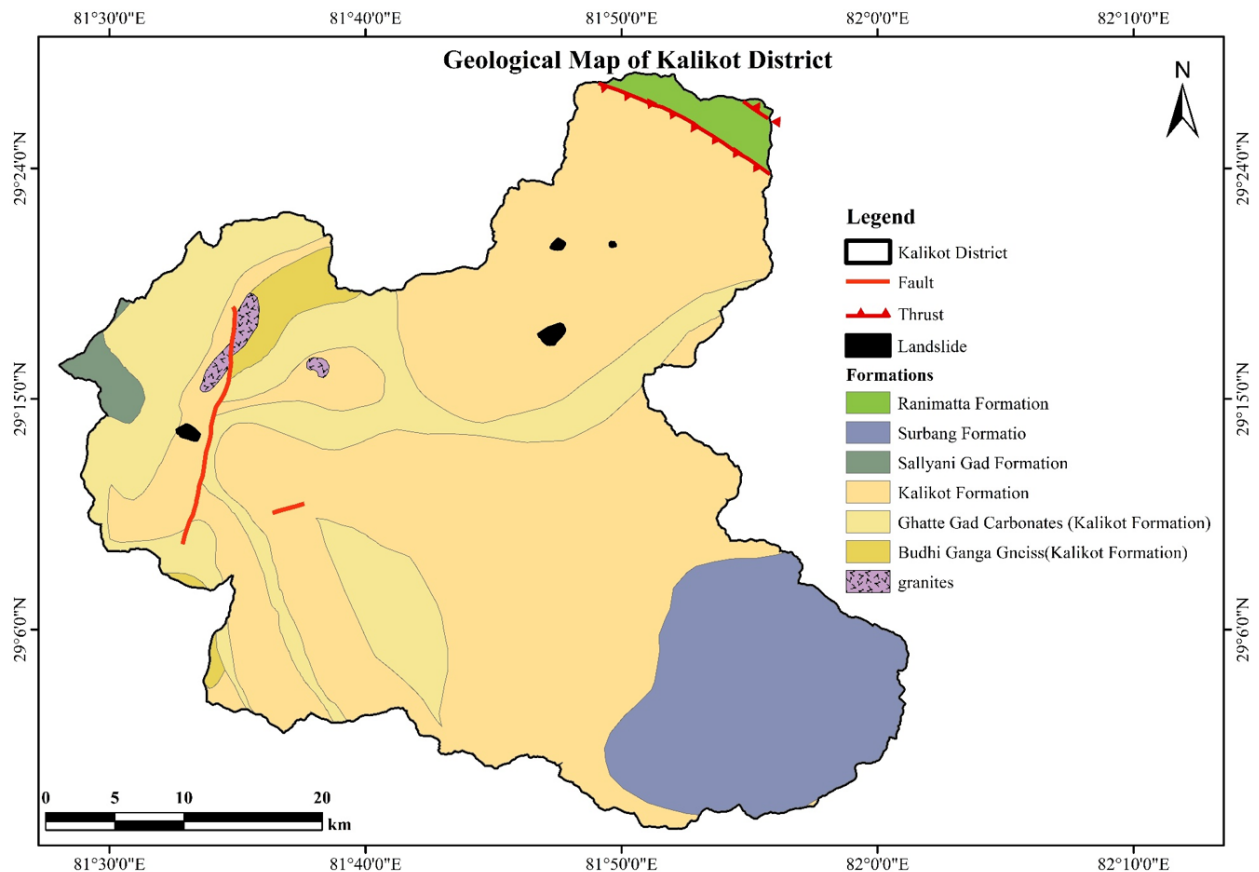


Figure 1 Geology of the Kalikot District (after DMG, 2020; Geological Map of Karnali Province)

2.1.2 Surkhet District

Surkhet District is situated within the western Siwalik and Lesser Himalaya and contains a complex geological assemblage of sedimentary rocks and low- to medium-grade metamorphic rocks. Dominant lithologies include sandstone to conglomerate in Siwalik and phyllite, quartzite, schist, slate, limestone, and dolomite in Lesser Himalaya. The district is affected by several regional thrust systems and fold structures that have significantly influenced the present-day topography and slope conditions.

The geological setting is characterized by highly weathered and fractured rock masses, particularly along major river valleys such as the Bheri and Babai and their tributaries. The district also contains extensive colluvial and residual soil deposits derived from weathered bedrock. These geological conditions, combined with steep slopes and intense rainfall, contribute to widespread slope instability. Numerous active and dormant landslides occur throughout the district, especially in areas underlain by weak Siwalik rocks and phyllitic Lesser Himalayan rocks and along road corridors where slope excavation has disturbed natural equilibrium.

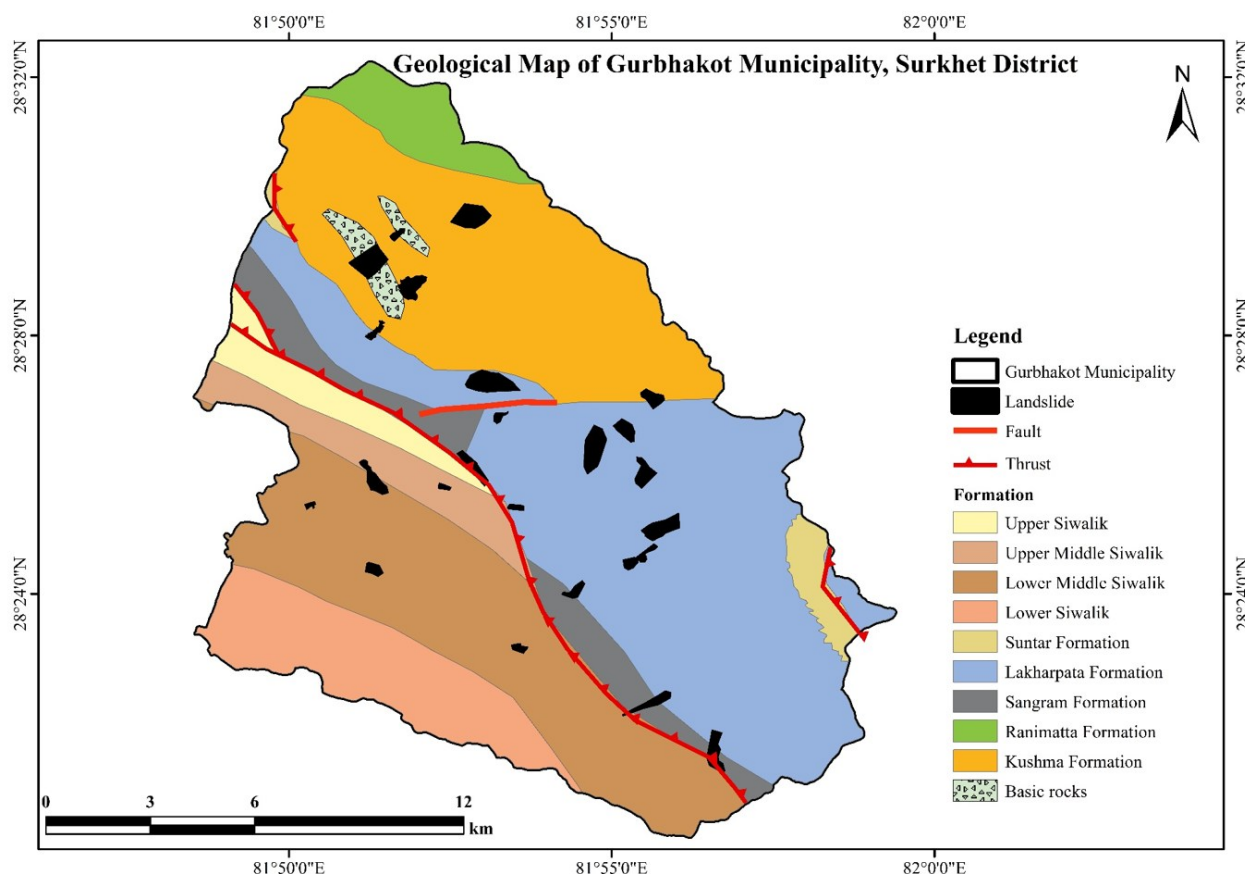


Figure 2 Geology of Gurbhakot Municipality, Surkhet District (after DMG, 2020; Geological Map of Karnali Province).

2.1.3 Rukum West District

Rukum West occupies a transitional position between the Lesser Himalayan and Higher Himalayan geological domains. The district contains a diverse assemblage of metamorphic rocks including schist, gneiss, quartzite, phyllite, and marble. Tectonic activity has resulted in the development of numerous folds, faults, and shear zones that strongly influence slope morphology and drainage patterns.

The rugged mountainous terrain reflects active uplift and erosion processes. Rock masses in many areas exhibit moderate to high degrees of weathering and fracturing. Large-scale landslides are common along steep valley slopes, particularly where highly weathered schist and phyllite are exposed. River incision by tributaries of the Bheri River has produced steep relief and unstable valley walls. The geological conditions, combined with monsoonal precipitation and seismic activity, make the district highly susceptible to geohazards.

2.1.4 Parbat District

Parbat District is located within the central-western Lesser Himalaya to Higher Himalaya and is characterized by metasedimentary rocks of the Nawakot Complex and associated geological formations. Dominant lithologies include quartzite, phyllite, metasandstone, schist, and gneiss. Along major river corridors such as the Kali Gandaki and Modi Khola, extensive Quaternary terrace deposits are present.

Regional Setting

The geological structure is controlled by regional folds, thrust faults, and metamorphic fabrics. Deep river incision by the Kali Gandaki system has generated steep slopes and high local relief. The district contains numerous landslide-prone areas where weathered phyllite and schist occur on steep slopes. River erosion, toe cutting, and intense monsoonal rainfall further aggravate slope instability. The presence of extensive terrace deposits and unconsolidated sediments also contributes to localized erosion and mass movement processes.

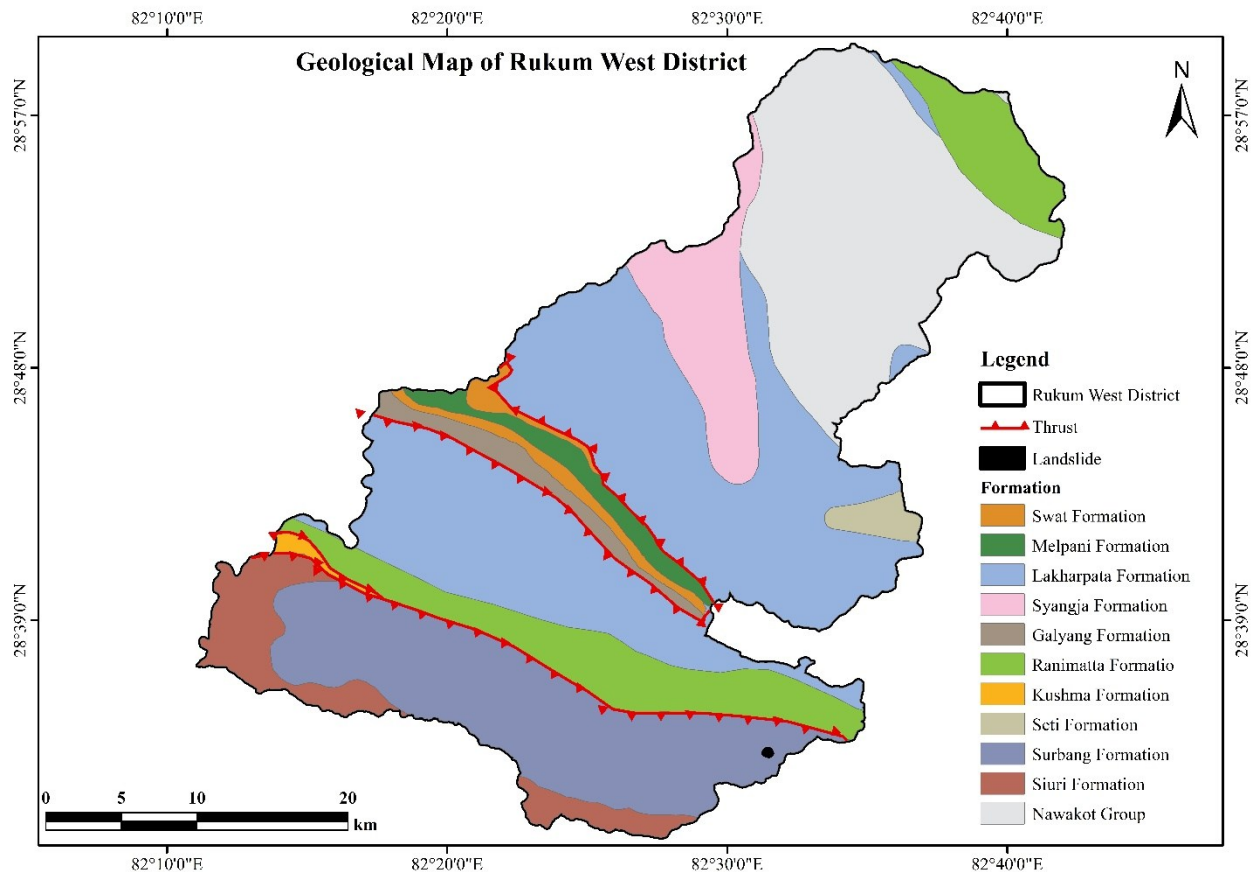


Figure 3 Geology of Rukum West District (after DMG, 2020; Geological Map of Karnali Province)

2.1.5 Dhading District

Dhading District occupies a significant portion of the central Nepal Himalaya and spans multiple geological zones from the Lesser Himalaya toward the Higher Himalaya. The district contains well-developed successions of the Nawakot Group, including formations such as the Kunchha Formation, Fagfog Quartzite, Dandagaon Phyllite, Nourpul Formation, and Dhading Dolomite.

The geology is characterized by low-grade metamorphic rocks that have undergone extensive folding and faulting. Major thrust systems and structural discontinuities traverse the district. The Trishuli River and its tributaries have deeply dissected the terrain, exposing various geological formations and creating steep unstable slopes. Weathered phyllites, schists, and colluvial deposits are particularly vulnerable to

Regional Setting

landsliding. The district's geological setting played a major role in the extensive landslide activity observed during the 2015 Gorkha Earthquake and subsequent monsoon seasons.

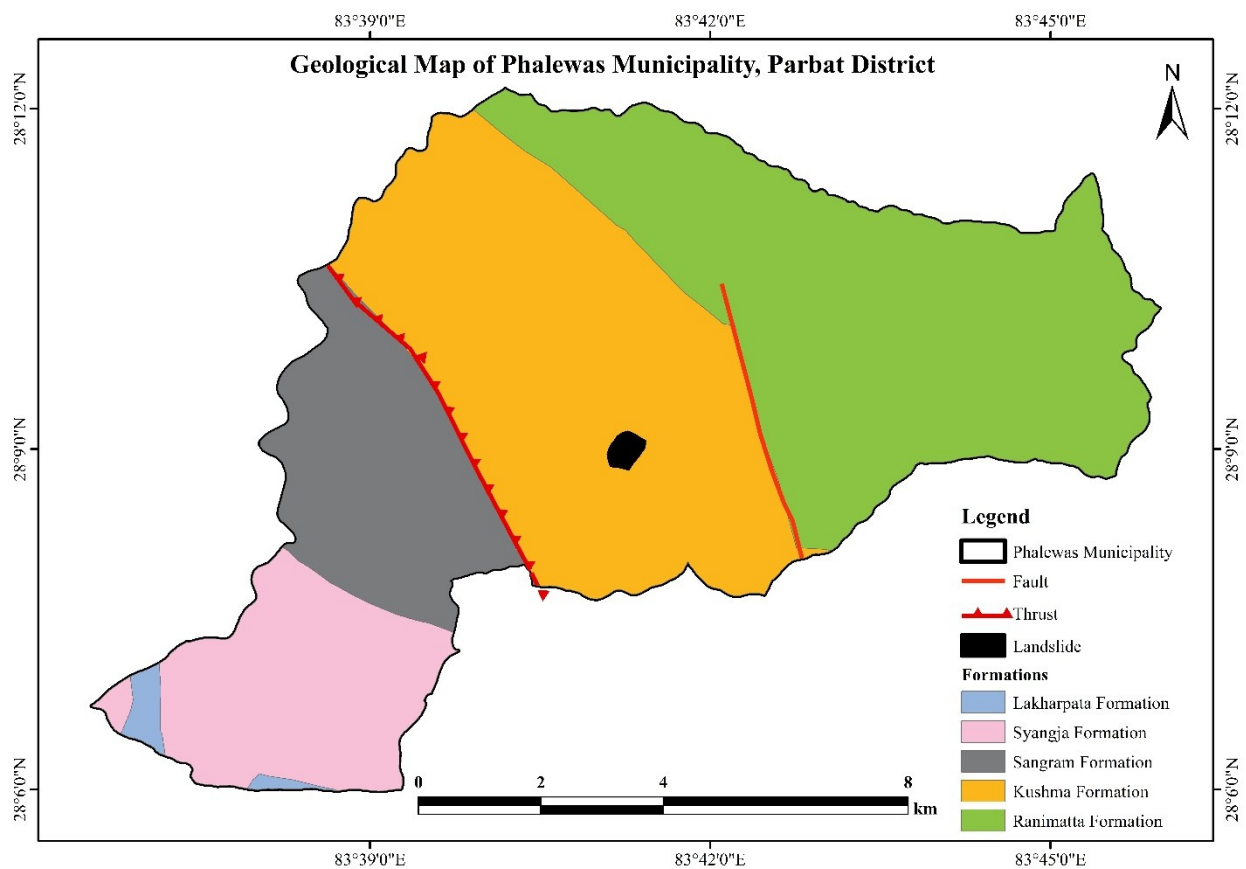


Figure 4 Geology of Phalewas Municipality, Parbat District (after DMG, 2020; Geological Map of Gandaki Province)

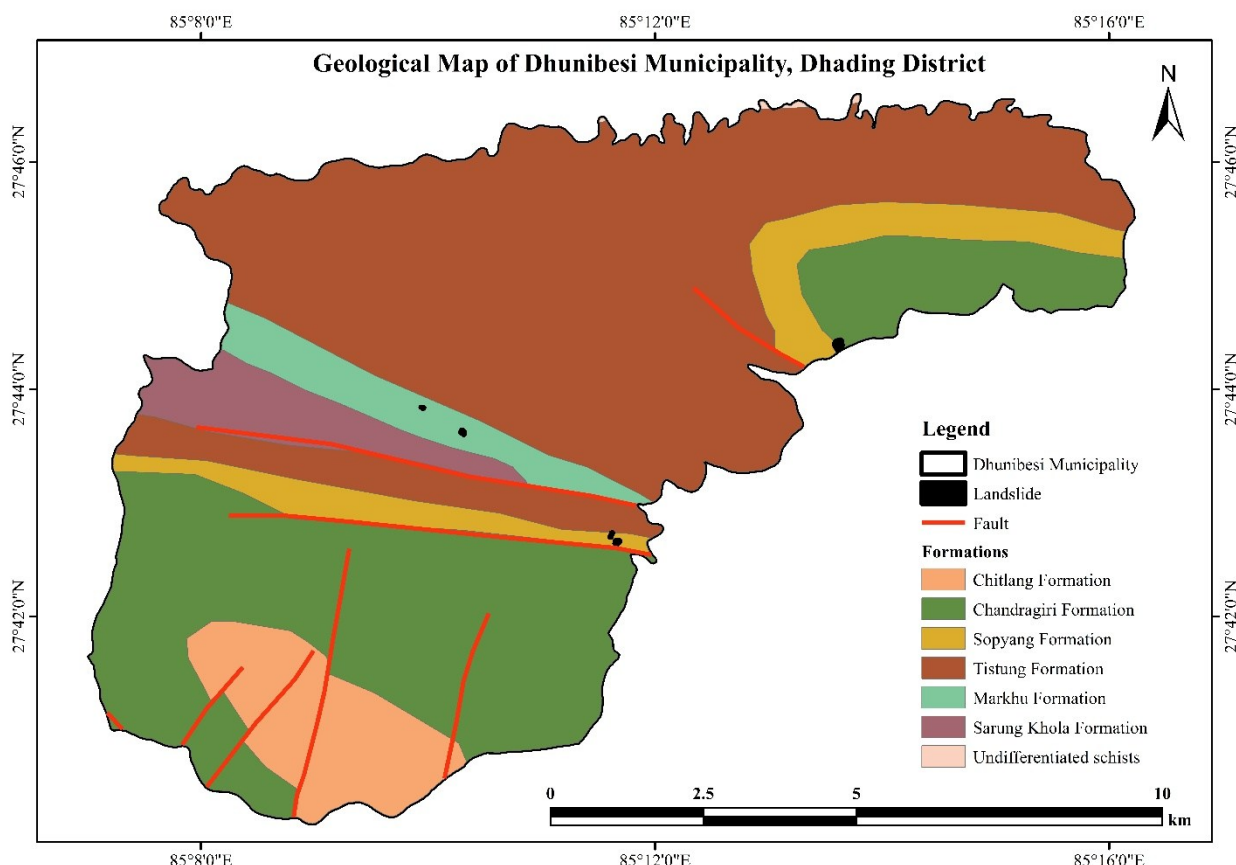


Figure 5 Geology of Dhunibeshi Municipality, Dhading District (after DMG, 2020; Geological Map of Bagmati Province)

2.1.6 Dhankuta District

Dhankuta District lies within the eastern Lesser Himalaya and exhibits a geological framework dominated by metasedimentary and metamorphic rocks. The district contains phyllite, quartzite, schist, slate, and locally carbonate-bearing units. The terrain is characterized by steep slopes, deeply incised river valleys, and highly weathered rock masses.

The geological formations have undergone multiple phases of deformation resulting in complex structural patterns. Weathering and fracturing are widespread, particularly along ridge slopes and drainage channels. These conditions, combined with intense monsoon precipitation, create favorable conditions for shallow landslides, debris flows, and gully erosion. Road construction and land-use modifications have further increased slope instability in several parts of the district.

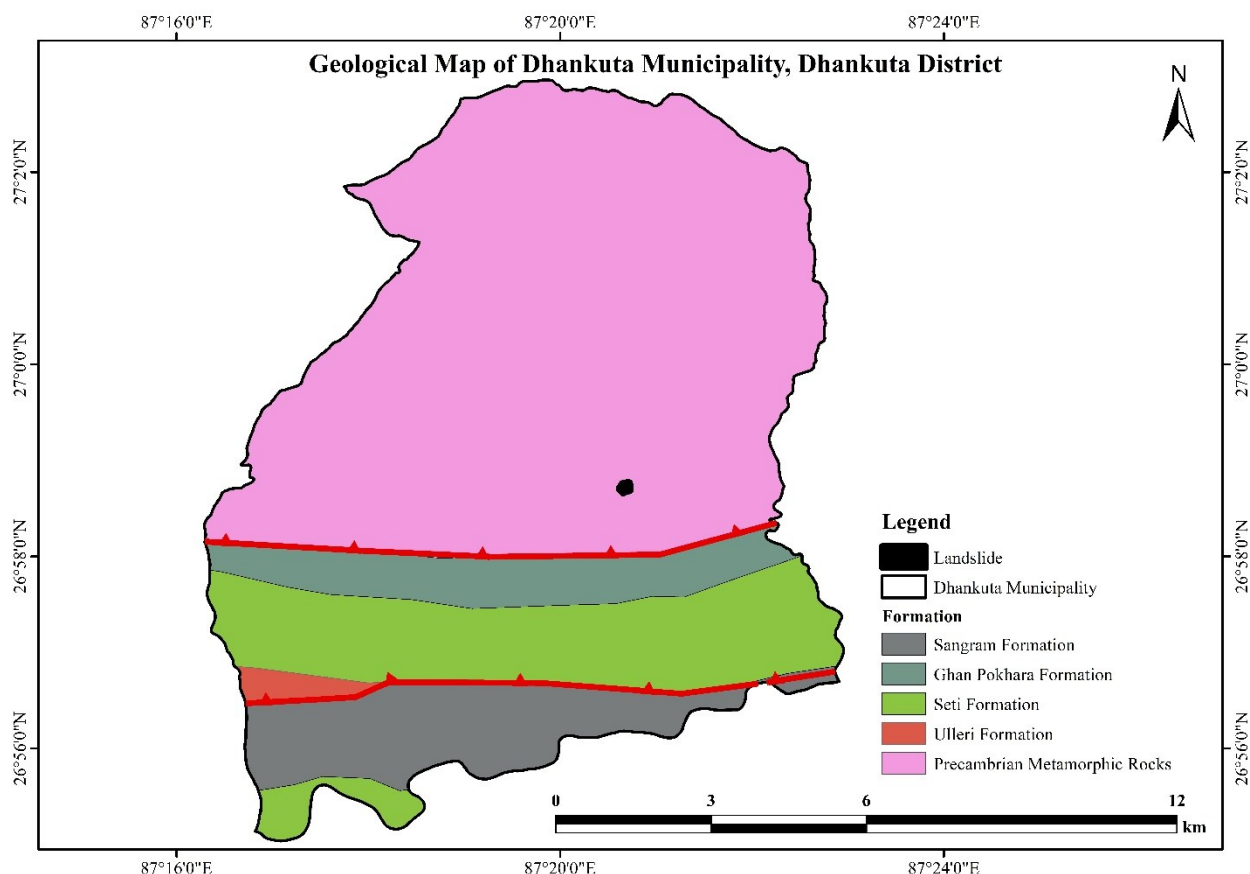


Figure 6 Geology of Dhunibeshi Municipality, Dhading District (after DMG, 2020; Geological Map of Bagmati Province)

2.1.7 Ilam District

Ilam District is situated in the eastern Nepal Himalaya and occupies predominantly Siwalik and Lesser Himalayan terrain. The district consists of thin succession of mudstone to sandstone bearing Siwalik rock and low- to medium-grade metamorphic rocks including phyllite, schist, quartzite, slate, and gneiss. In addition, extensive colluvial deposits and weathered residual soils occur on hill slopes.

The geological setting is characterized by highly dissected terrain with dense drainage networks and steep valley sides. Rock masses are often intensely weathered and structurally weakened by joints, fractures, and foliation planes. Due to high annual rainfall and prolonged monsoon influence, the district experiences frequent landslides, debris flows, and slope erosion. Tea plantation areas, road corridors, and settlements located on steep slopes are particularly vulnerable to geologically induced hazards. The combination of fragile geology, steep topography, and heavy rainfall makes Ilam one of the most landslide-prone districts in eastern Nepal.

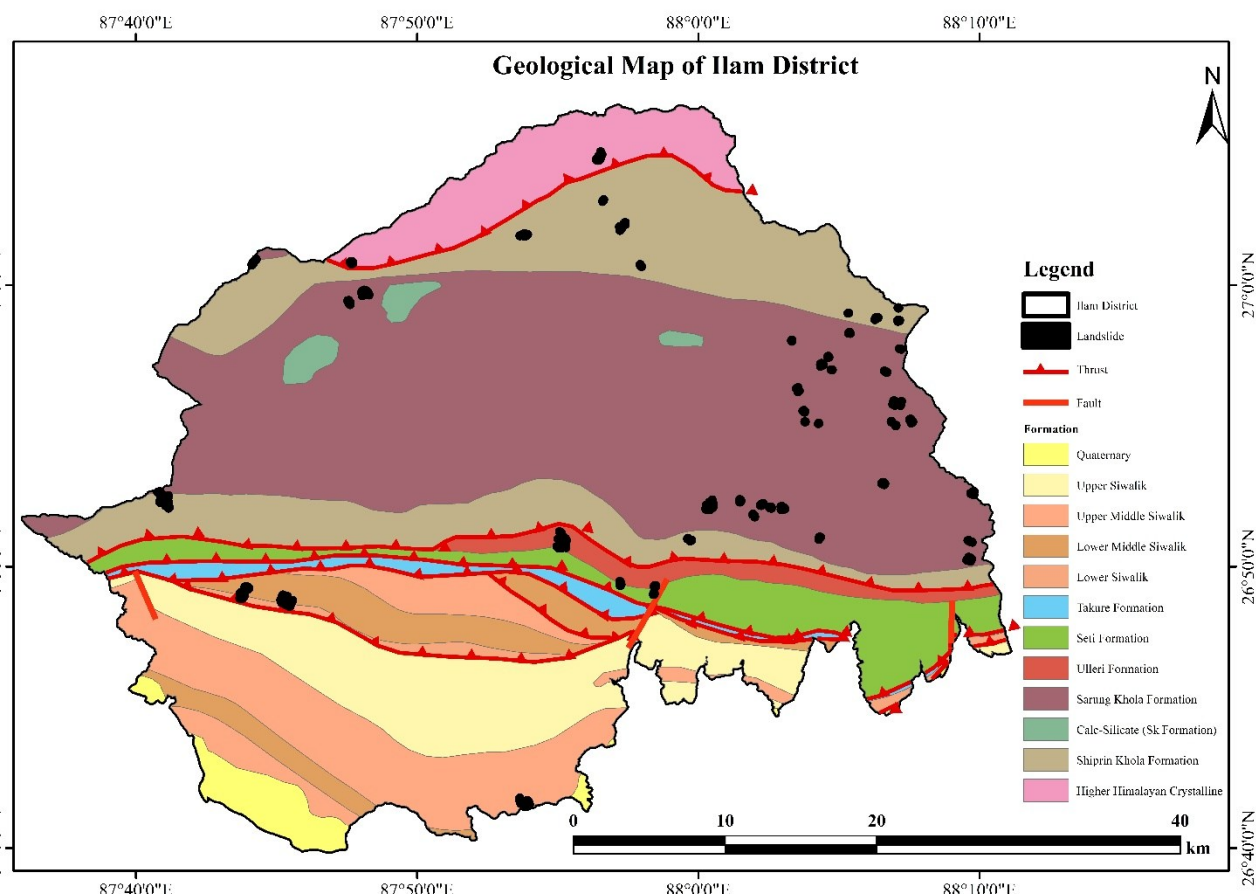


Figure 7 Geology of Ilam District (after DMG, 2020; Geological Map of Koshi Province)

2.2 Geomorphology

The study districts of Kalikot, Surkhet, Rukum West, Parbat, Dhading, Dhankuta, and Ilam encompass a wide range of geomorphological environments within the Nepal Himalaya. These districts are characterized by rugged mountain terrain, steep river valleys, active fluvial systems, deeply dissected hillslopes, and highly dynamic geomorphic processes resulting from the combined effects of tectonic uplift, intense monsoonal precipitation, weathering, erosion, and mass wasting.

The geomorphology of the study area has evolved under the influence of ongoing Himalayan mountain-building processes associated with the convergence of the Indian and Eurasian tectonic plates. Continuous uplift and river incision have produced steep topographic gradients and unstable slopes, making these districts highly susceptible to landslides, debris flows, riverbank erosion, flash floods, and other geohazards.

Geomorphological processes within the study area are predominantly controlled by geology, structural discontinuities, slope gradient, drainage density, climatic conditions, and anthropogenic modifications such as road construction, deforestation, and unplanned settlement expansion. The resulting landscape consists of deeply incised valleys, narrow ridges, river terraces, colluvial slopes, alluvial fans, and active erosion zones.

2.2.1 Kalikot District

Kalikot District is characterized by highly rugged mountainous terrain with elevations ranging from approximately 700 m to over 4,000 m above sea level. The district lies within the Karnali River Basin and exhibits intense topographic relief resulting from rapid tectonic uplift and river incision.

The dominant geomorphic features include steep mountain slopes, narrow ridge systems, deeply incised river valleys, active gullies, and extensive colluvial deposits. The Karnali River and its tributaries have carved deep valleys and gorges, producing relief differences exceeding several hundred meters within short horizontal distances. Such steep terrain facilitates rapid surface runoff and increases susceptibility to erosion and slope instability.

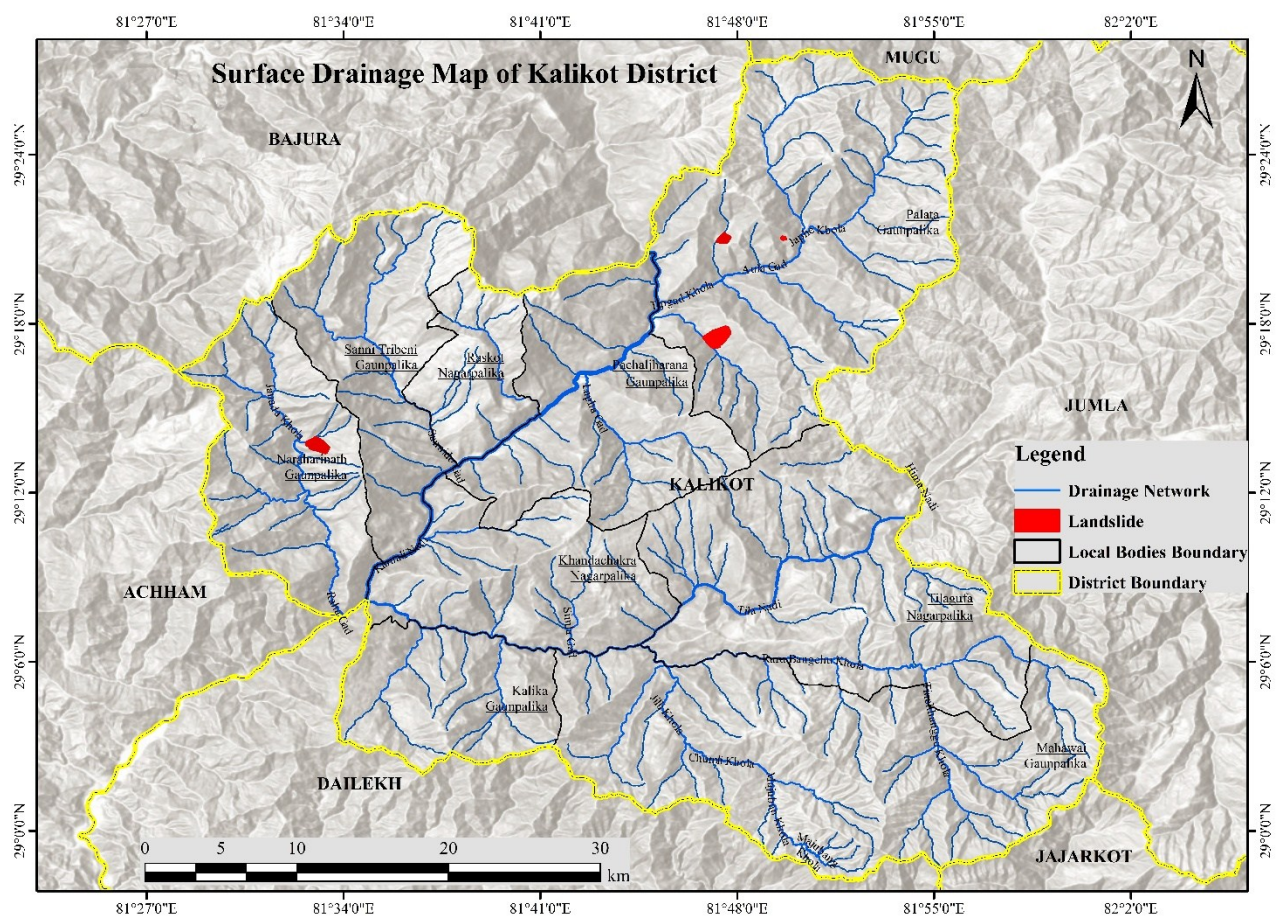


Figure 8 Geomorphological setting of Kalikot District

The district contains numerous landslide scars, debris accumulation zones, and active erosion channels. Weathered rock masses and thick colluvial deposits commonly occur on middle and lower slopes. Riverbank erosion is particularly significant along the Karnali River and major tributaries where lateral erosion continuously destabilizes valley-side slopes.

Several geomorphic processes actively shape the landscape, including:

- Fluvial incision

Regional Setting

- Hillslope erosion
- Debris flow activity
- Rockfall processes
- Gully erosion
- Riverbank undercutting

The combination of high relief, steep slopes, weak geological formations, and intense monsoon rainfall contributes to the widespread occurrence of geomorphological hazards throughout the district.

2.2.2 Surkhet District

The geomorphology of Jajarkot District is characterized by highly dissected mountainous terrain dominated by steep slopes, narrow ridges, and deeply incised river systems. Elevations range from approximately 300 m to over 4,400 m above sea level, creating significant variation in geomorphic processes across the district.

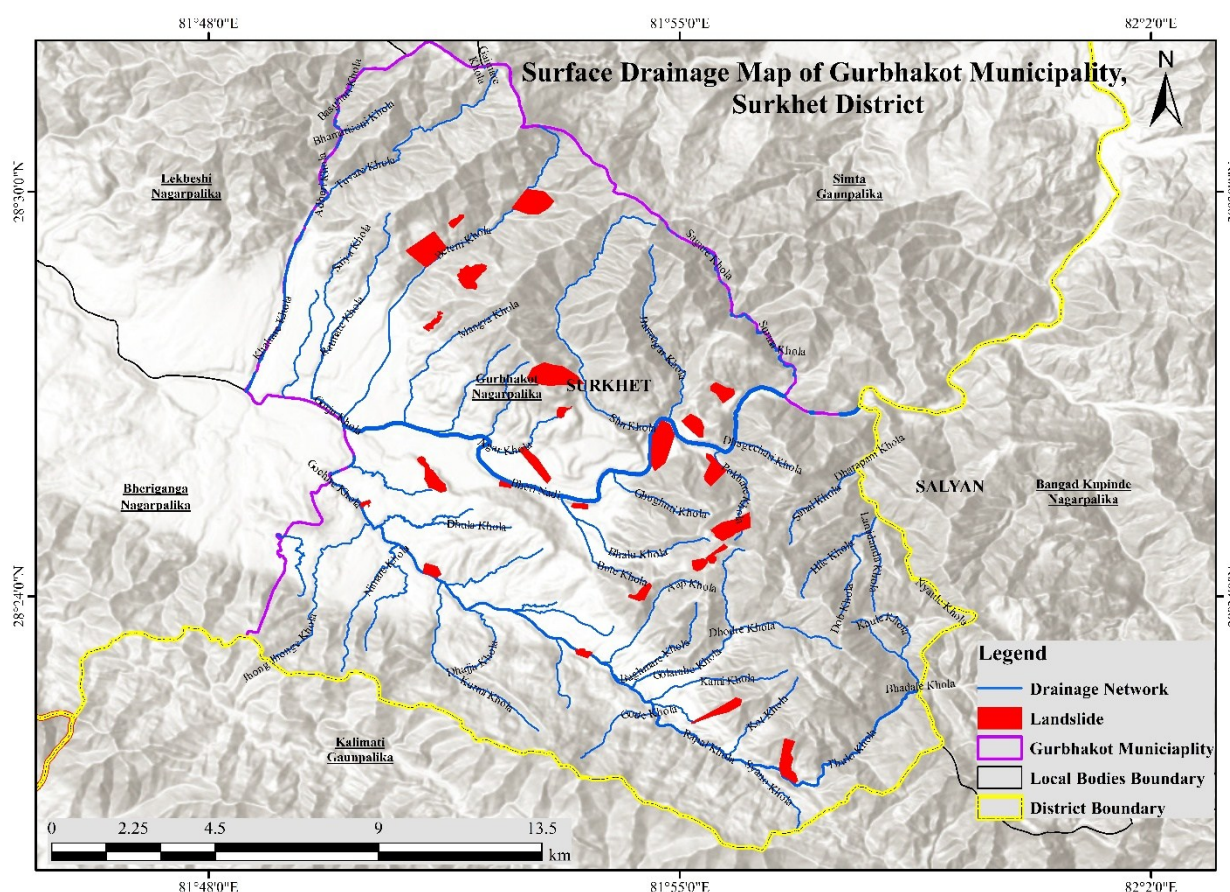


Figure 9 Geomorphological setting of Gurbhakot Municipality, Surkhet District

The Bheri and Babai River and its tributaries constitute the principal drainage network and have played a dominant role in shaping the present-day landscape. Continuous river incision has produced steep valley

walls and unstable slope conditions. The district contains numerous landslide complexes, debris flow channels, and erosion-prone hillsides.

The major geomorphic units include:

- Mountain ridges
- Structural hills
- Colluvial slopes
- River terraces
- Alluvial deposits
- Active floodplains
- Debris cones and fans

Large areas of the district exhibit evidence of previous mass movement activity. Landslide deposits are frequently observed along transportation corridors and settlements located on steep slopes. Active gullies and ephemeral streams contribute substantial sediment loads to the river systems during monsoon periods.

Geomorphic instability is further aggravated by slope modification, road excavation, and land-use changes. The district's topography and geomorphic characteristics make it highly vulnerable to landslide reactivation and debris flow generation.

2.2.3 Rukum West District

Rukum West possesses some of the most rugged mountain landscapes in western Nepal. The district is characterized by steep mountainous terrain, sharp ridgelines, deeply incised river valleys, and extensive slope failures.

The physiography reflects strong tectonic uplift combined with active erosion. Elevation ranges from approximately 700 m to over 6,000 m, creating highly variable terrain conditions. Major river systems including tributaries of the Bheri River have produced deeply entrenched valleys and high relief landscapes.

The district contains diverse geomorphic features such as:

- Structural ridges
- Escarpments
- River terraces
- Debris flow channels
- Landslide deposits
- Alluvial fans
- Colluvial foot slopes

Regional Setting

Large-scale landslides are common throughout the district. Numerous ancient and active landslide complexes can be observed along valley walls and transportation corridors. River incision continuously removes support from lower slope sections, contributing to slope instability.

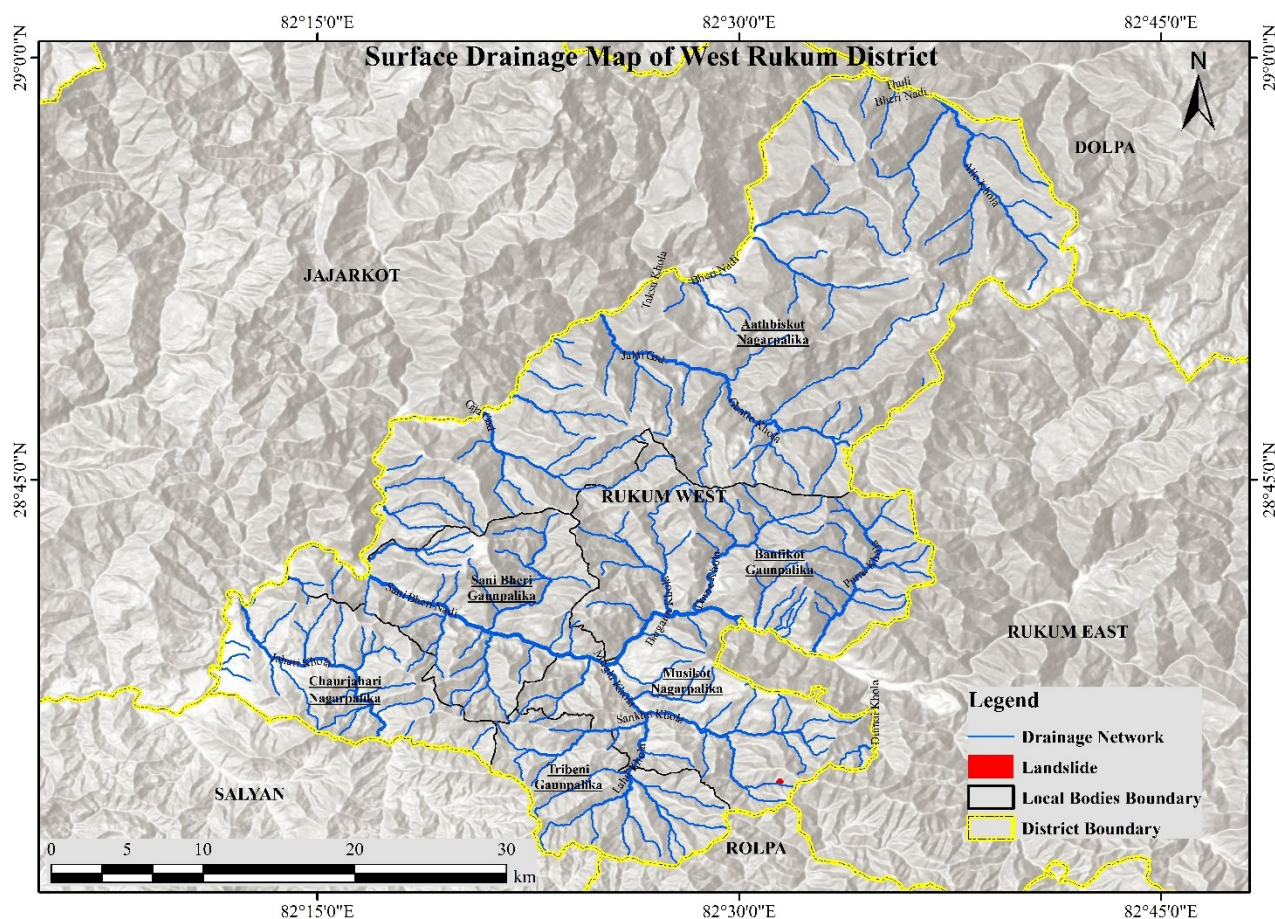


Figure 10 Geomorphological setting of Rukum West District.

Sediment transport processes are highly active, particularly during the monsoon season when intense rainfall generates debris flows and flash floods. The interaction between fluvial erosion and hillslope processes creates a dynamic geomorphic environment with significant hazard potential.

2.2.4 Parbat District

Parbat District is situated within the middle mountain region of Nepal and exhibits highly dissected terrain characterized by steep slopes, deep valleys, and active river systems. The geomorphology is strongly influenced by the Kali Gandaki and Modi River and its tributaries, which have produced one of the world's deepest river gorges.

The district consists of several distinct geomorphic units including:

- High mountain slopes
- River terraces
- Alluvial plains

Regional Setting

- Structural ridges
- Colluvial slopes
- Active floodplains

The Kali Gandaki River serves as the primary geomorphic agent within the district. Continuous river incision has created steep valley walls and extensive slope instability. Numerous tributary streams contribute to active sediment transport and localized erosion.

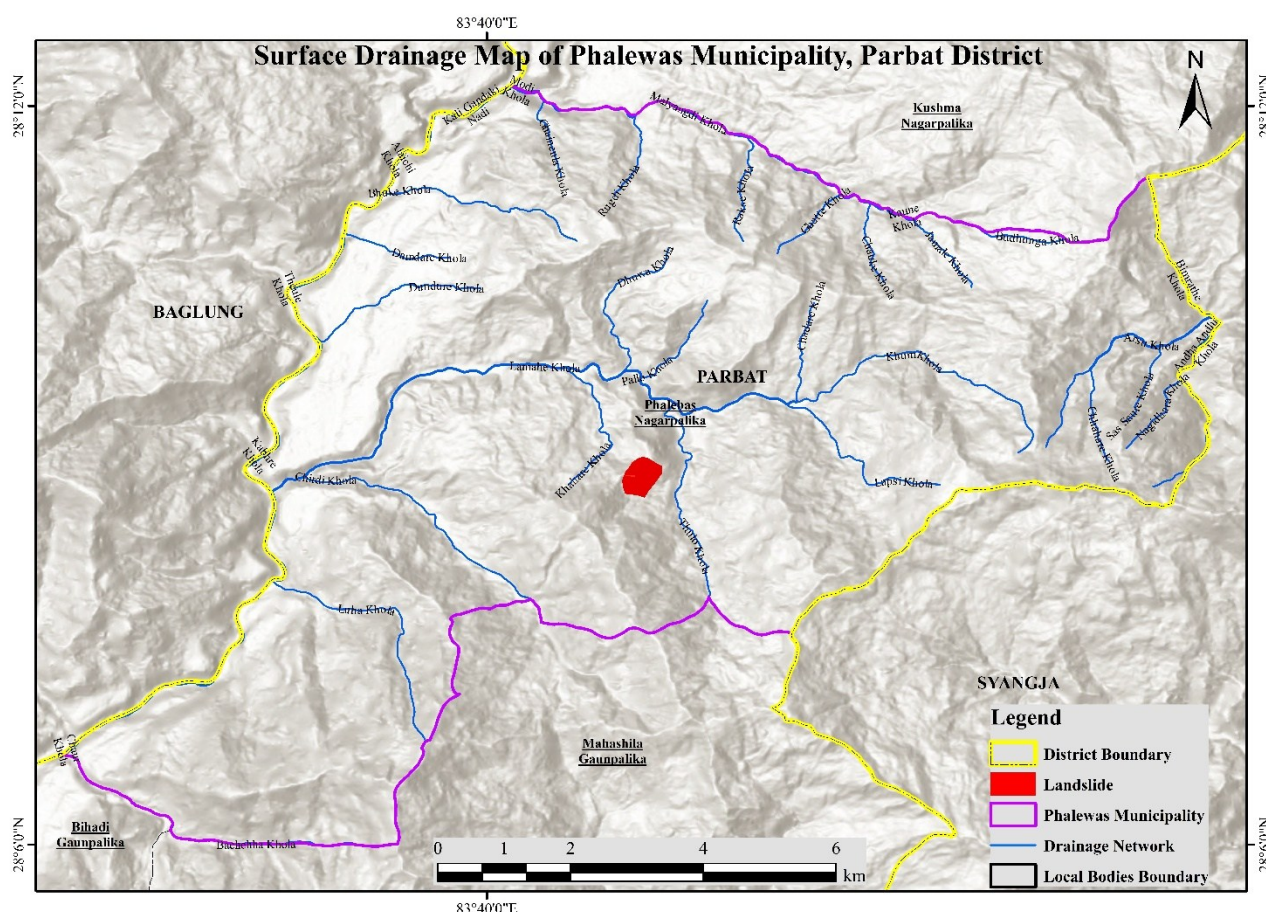


Figure 11 Geomorphological setting of Phalewas Municipality, Parbat District.

Large accumulations of colluvial materials occur on middle and lower slopes. These deposits are highly susceptible to failure during intense rainfall events. River terraces of varying elevations indicate multiple phases of river incision and landscape evolution.

Mass wasting processes including landslides, debris flows, and rockfalls are common. These processes contribute significantly to sediment production and geomorphic modification within the district.

2.2.5 Dhading District

Dhading District occupies a strategically important section of the central Nepal Himalaya and exhibits complex geomorphological characteristics resulting from active tectonics and intense fluvial erosion. Elevation ranges from approximately 300 m in river valleys to over 7,000 m in northern mountain areas.

Regional Setting

The district is traversed by major river systems including the Trishuli River, Budhi Gandaki River, and numerous tributaries. These rivers have carved deeply incised valleys and generated steep unstable slopes.

The dominant geomorphic units include:

- High mountain ridges
- Structural hills
- River terraces
- Alluvial fans
- Colluvial slopes
- Landslide deposits
- Active floodplains

The district contains numerous active and dormant landslide complexes. The 2015 Gorkha Earthquake significantly altered slope conditions, triggering widespread slope failures and increasing geomorphic instability across many areas.

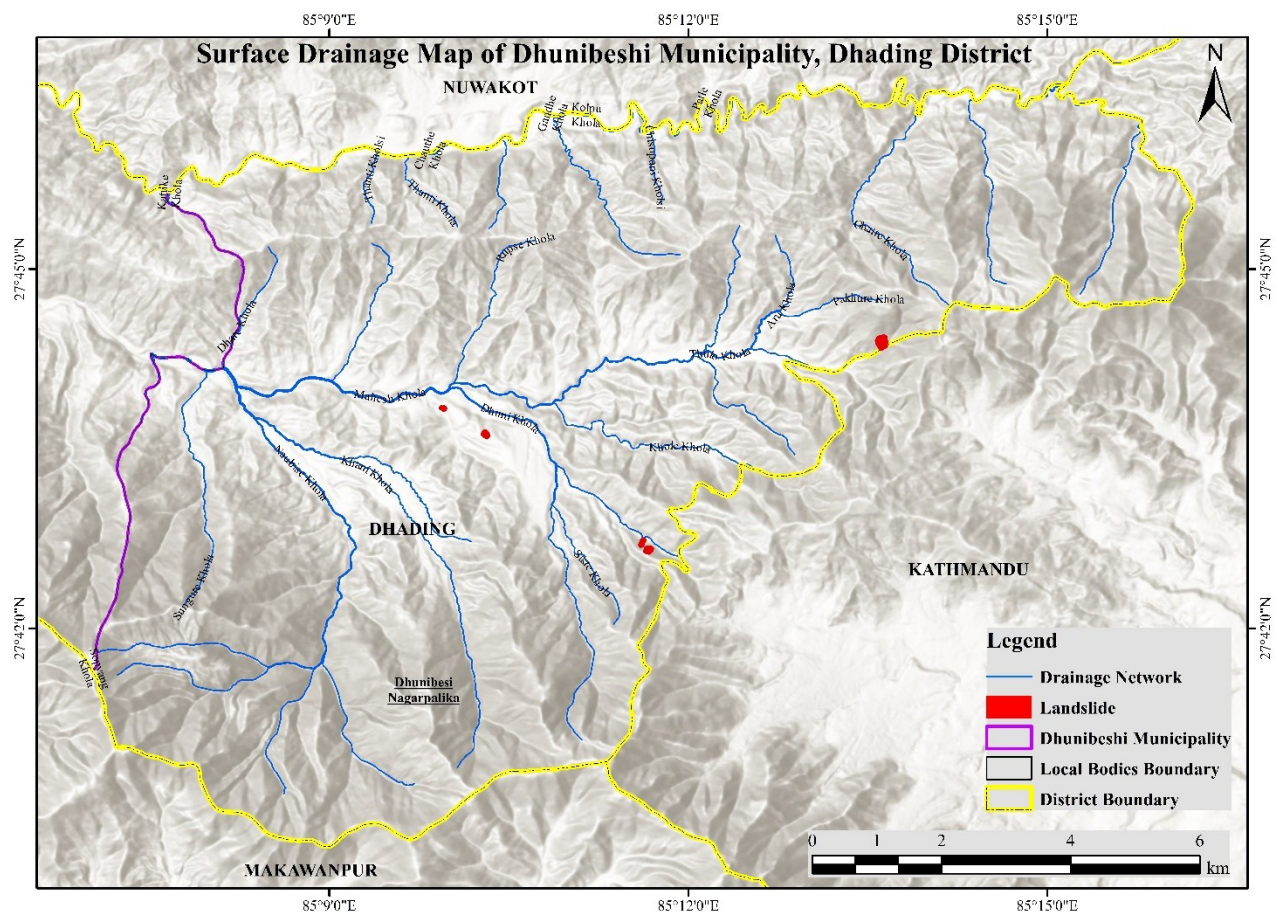


Figure 12 Geomorphological setting of Dhunibeshi Municipality, Dhading District.

Fluvial erosion remains one of the dominant landscape-forming processes. Riverbank undercutting frequently destabilizes adjacent slopes and contributes to landslide initiation. Extensive colluvial deposits derived from weathered bedrock are commonly observed on lower slope sections.

Regional Setting

The geomorphic setting of Dhading reflects a highly active landscape undergoing continuous adjustment in response to tectonic uplift, erosion, and climatic influences.

2.2.6 Dhankuta District

Dhankuta District lies within the eastern middle hills and exhibits highly dissected terrain characterized by steep hillslopes, narrow valleys, and dense drainage networks. The geomorphology is dominated by fluvial and slope processes acting upon weathered metamorphic bedrock.

The district contains numerous ridge-and-valley systems aligned with geological structures. River incision has produced deeply entrenched valleys and steep topographic gradients. Active erosion processes continuously modify hillslope geometry and contribute to sediment generation.

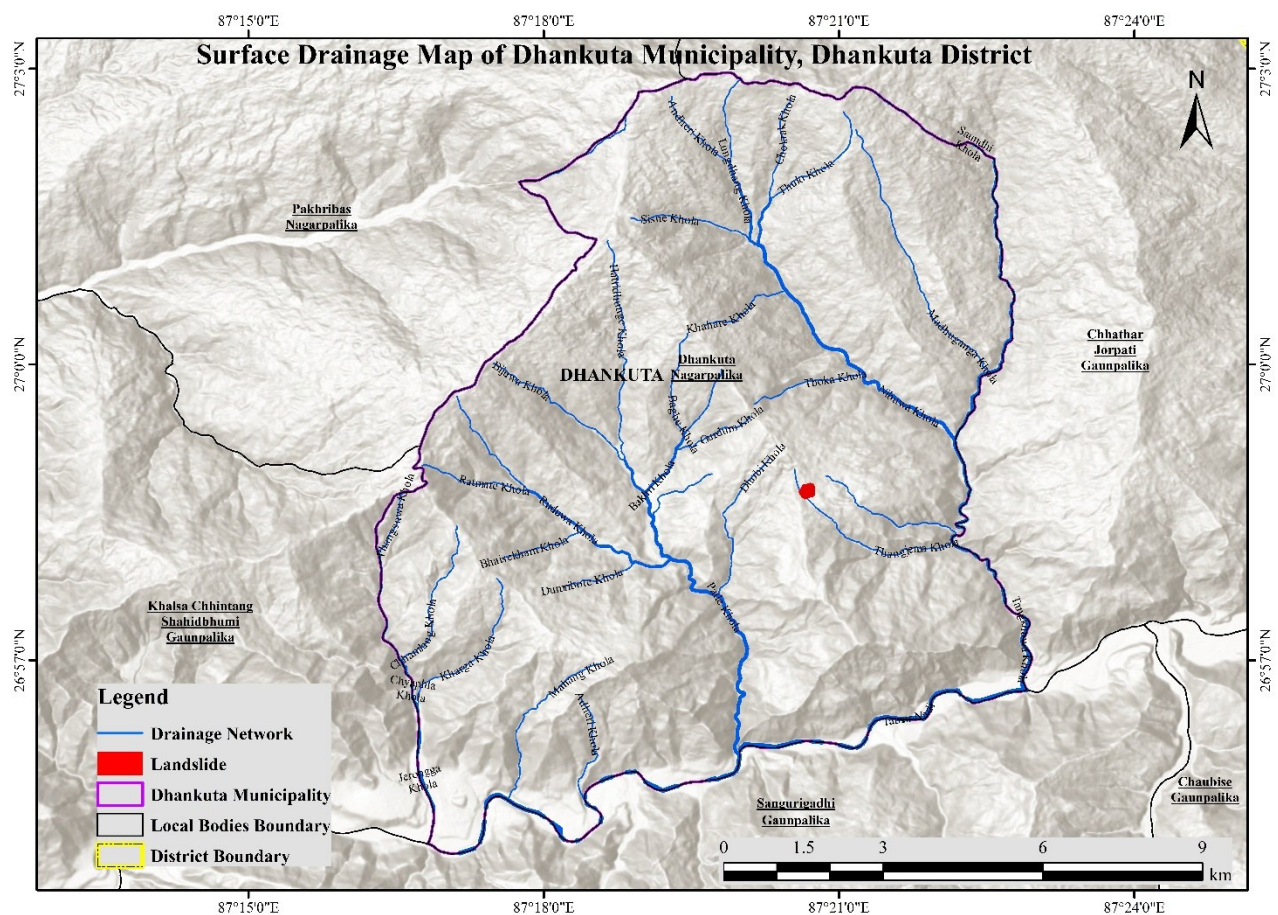


Figure 13 Geomorphological setting of Dhankuta Municipality, Dhankuta District.

Major geomorphic features include:

- Dissected hill slopes
- Structural ridges
- River terraces
- Alluvial fans
- Debris accumulation zones

- Gully systems

High drainage density promotes rapid runoff concentration during monsoon storms. As a result, shallow landslides, debris flows, and gully erosion are common. Extensive cultivation on steep slopes has further increased erosion susceptibility in many areas.

The geomorphic evolution of the district continues to be driven by the interaction of rainfall, weathering, river incision, and human activities.

2.2.7 Ilam District

Ilam District is characterized by highly dissected hill terrain, steep slopes, dense drainage networks, and extensive weathering. Elevation ranges from approximately 140 m in river valleys to over 3,600 m in high mountain areas.

The district's geomorphology is strongly influenced by high annual rainfall, which promotes intense erosion and slope instability. Numerous perennial streams and rivers dissect the landscape, producing steep valley sides and narrow ridge systems.

The major geomorphic units include:

- Mountain ridges
- Steep hill slopes
- River terraces
- Alluvial deposits
- Debris fans
- Colluvial slopes
- Active erosion zones

Tea plantation landscapes dominate many hill slopes and represent a significant anthropogenic modification of the natural terrain. While terracing reduces surface runoff in some areas, poorly managed slopes may remain vulnerable to landslides and erosion.

Landslides, debris flows, and gully erosion are common geomorphic processes, particularly during periods of intense monsoon rainfall. Riverbank erosion is also significant along major drainage corridors. The combination of fragile geology, steep terrain, and high precipitation has resulted in a highly dynamic geomorphic environment throughout the district.

2.2.8 Geomorphic Significance for Geohazard Assessment

The geomorphological characteristics of all study districts indicate active landscape evolution controlled by tectonic uplift, fluvial incision, weathering, and mass wasting processes. Common geomorphic indicators observed across the districts include steep slopes, deep river valleys, active erosion zones, landslide scars, debris accumulation areas, river terraces, and unstable colluvial deposits.

Regional Setting

These geomorphic conditions significantly increase susceptibility to landslides, debris flows, flash floods, riverbank erosion, and other geohazards. Therefore, detailed geomorphological assessment forms a critical component of rapid geohazard assessment and provides essential information for hazard mapping, risk evaluation, mitigation planning, and relocation decision-making.

2.3 Climate and Rainfall

The study districts of Kalikot, Surkhet, Rukum West, Parbat, Dhading, Dhankuta, and Ilam are situated within diverse physiographic regions of Nepal and exhibit significant variations in climatic conditions due to differences in elevation, topography, slope orientation, and regional atmospheric circulation. The climate of these districts ranges from subtropical conditions in lower river valleys to temperate and alpine conditions in higher mountain areas.

The climatic regime of the study area is primarily governed by the South Asian Monsoon system, which contributes approximately 75-85 percent of the annual rainfall between June and September. During the monsoon season, moisture-laden air masses originating from the Bay of Bengal move northward and are forced to rise along the Himalayan slopes, resulting in intense orographic precipitation. This rainfall constitutes the principal triggering mechanism for landslides, debris flows, flash floods, riverbank erosion, and slope failures throughout the study districts.

Rainfall distribution is highly variable both spatially and temporally. Eastern districts such as Ilam and Dhankuta generally receive significantly higher annual precipitation than western districts such as Kalikot and Surkhet. However, localized extreme rainfall events frequently occur across all districts and often trigger severe geohazards.

The climatic characteristics of the study districts therefore play a fundamental role in controlling weathering processes, groundwater recharge, surface runoff generation, erosion rates, sediment transport, and slope stability.

2.3.1 Kalikot District

Kalikot District experiences a predominantly subtropical to temperate mountain climate, with climatic conditions varying considerably with elevation. Lower river valleys experience relatively warm temperatures, whereas higher elevations remain cool throughout much of the year.

The district generally receives annual rainfall ranging between approximately 1,000 mm and 1,500 mm. Most precipitation occurs during the monsoon season between June and September. Winter precipitation occasionally occurs due to western disturbances, particularly in higher elevation areas.

Rainfall intensity often exceeds the infiltration capacity of weathered slopes, generating rapid surface runoff and increasing pore water pressure within colluvial and residual soil deposits. These conditions

Regional Setting

frequently trigger shallow landslides and debris flows. The combination of steep terrain and concentrated rainfall events often results in localized flash flooding along tributaries of the Karnali River.

Extended monsoon periods contribute to progressive saturation of hillslope materials, reducing shear strength and increasing the likelihood of slope failures. Many historical landslide events in Kalikot have been associated with prolonged rainfall episodes rather than short-duration storms.

The climatic conditions therefore represent a major controlling factor for geomorphic instability and disaster occurrence within the district.

2.3.2 Surkhet District

Surkhet District experiences a subtropical to temperate monsoon climate influenced by elevation and local topographic conditions. Temperature and precipitation vary considerably between the low-lying river valleys and higher mountain regions.

The district receives annual rainfall generally ranging from approximately 1,200 mm to 1,800 mm, with the majority concentrated during the summer monsoon season. Monsoon rainfall is often characterized by high intensity and prolonged duration, creating favorable conditions for landslide initiation.

The Bheri and Babai River watershed and associated tributary catchments respond rapidly to intense precipitation events. During monsoon storms, surface runoff increases significantly, resulting in accelerated erosion, slope instability, and sediment transport. Many slopes within the district consist of weathered sedimentary rocks and phyllites, schists, and colluvial materials that become highly susceptible to failure following saturation.

Extreme rainfall events have repeatedly caused widespread landslides, road blockages, debris flows, and damage to settlements and infrastructure. Climate variability and changing rainfall patterns have increased concerns regarding the frequency and magnitude of hydro-meteorological disasters in the district.

The close relationship between rainfall intensity and landslide occurrence highlights the importance of rainfall monitoring and early warning systems for disaster risk reduction.

2.3.3 Rukum West District

Rukum West experiences diverse climatic conditions due to its wide elevation range and complex topography. Lower elevations exhibit subtropical climatic characteristics, while higher elevations experience temperate and alpine climatic conditions.

Annual rainfall generally ranges between approximately 1,200 mm and 2,000 mm. Most precipitation occurs during the monsoon season, although winter precipitation is occasionally observed in higher mountain regions.

Regional Setting

The district frequently experiences intense monsoon storms that generate large volumes of runoff within steep mountain watersheds. Such conditions promote rapid erosion, debris flow initiation, and slope failures. Prolonged rainfall periods often result in saturation of weathered slope materials, reducing slope stability and increasing the probability of landslide occurrence.

Several major disaster events within the district have been associated with exceptionally heavy monsoon rainfall that triggered multiple landslides and flash floods. River systems carrying high sediment loads further contribute to riverbank erosion and channel instability.

The climatic regime therefore plays a crucial role in shaping both geomorphic processes and geohazard susceptibility throughout the district.

2.3.4 Parbat District

Parbat District experiences a subtropical to temperate monsoon climate characterized by warm summers, mild winters, and substantial seasonal rainfall. Climatic conditions are strongly influenced by elevation and the presence of the Kali Gandaki Valley and Modi Valley.

Annual rainfall typically ranges between approximately 2,000 mm and 3,000 mm. Orographic effects associated with surrounding mountain ranges significantly enhance precipitation in many parts of the district.

The monsoon season contributes the majority of annual rainfall and is frequently associated with landslides, debris flows, and riverbank erosion. High-intensity rainfall events often produce rapid increases in river discharge and slope saturation.

The steep slopes and deeply incised valleys characteristic of Parbat District facilitate rapid runoff concentration. As a result, even short-duration rainfall events may generate localized flooding and debris flow activity.

The district's extensive colluvial deposits, weathered rock masses, and steep terrain are particularly sensitive to changes in rainfall intensity and duration. Consequently, climate and rainfall represent critical factors influencing geohazard occurrence and landscape evolution within the district.

3.3.5 Dhading District

Dhading District exhibits considerable climatic diversity due to its large elevation range extending from low river valleys to high mountain environments. The climate varies from subtropical conditions in southern areas to alpine conditions in northern high-altitude regions.

Annual rainfall generally ranges from approximately 1,500 mm to 2,500 mm depending on elevation and topographic position. The district receives substantial monsoon precipitation due to its location within the central Himalayan region.

Regional Setting

The Trishuli and Budhi Gandaki River basins experience significant hydrological responses during intense rainfall events. Heavy monsoon precipitation frequently causes slope failures, debris flows, riverbank erosion, and flooding.

The district was severely affected by rainfall-induced landslides following the 2015 Gorkha Earthquake. Earthquake-induced slope weakening combined with subsequent monsoon rainfall significantly increased landslide susceptibility across many areas.

Intense rainfall contributes to elevated groundwater levels, increased pore water pressure, and reduction of soil shear strength. These processes represent major triggers for slope instability within the district.

The combination of steep terrain, fragile geology, seismic disturbance, and heavy monsoon rainfall makes Dhading one of Nepal's most landslide-prone districts.

2.3.6 Dhankuta District

Dhankuta District experiences a humid subtropical to temperate climate with substantial monsoon influence. The district receives relatively high rainfall compared to many western regions of Nepal due to its location in eastern Nepal.

Annual rainfall generally ranges from approximately 2,000 mm to 2,800 mm. Monsoon precipitation accounts for the majority of annual rainfall, while occasional winter precipitation occurs at higher elevations.

The district's steep terrain and dense drainage network facilitate rapid runoff generation during rainfall events. Intense precipitation often triggers shallow landslides, debris flows, gully erosion, and localized flooding.

Agricultural terraces and road corridors are particularly vulnerable to rainfall-induced slope failures. Weathered soil profiles become saturated during prolonged rainfall periods, increasing the likelihood of mass movement processes.

The district's climatic conditions support dense vegetation cover; however, localized land-use changes and infrastructure development may increase susceptibility to rainfall-induced hazards.

2.3.7 Ilam District

Ilam District is among the wettest regions of Nepal and experiences a humid subtropical to temperate climate. The district receives significant monsoon rainfall due to its eastern location and favorable topographic orientation relative to moisture-bearing monsoon winds.

Annual rainfall commonly ranges between approximately 2,500 mm and 3,500 mm, with some localized areas receiving even higher precipitation. The monsoon season extends from June to September and is characterized by frequent heavy rainfall events.

Regional Setting

The exceptionally high rainfall contributes to intensive weathering, erosion, and slope instability throughout the district. Landslides and debris flows are common during the monsoon season and frequently affect settlements, agricultural lands, and transportation infrastructure.

Dense drainage networks rapidly convey runoff toward major river systems, while steep slopes facilitate rapid downslope movement of water and sediment. Tea plantation landscapes and cultivated slopes are particularly sensitive to excessive rainfall and associated erosion processes.

The combination of fragile geology, steep terrain, and high rainfall intensity makes Ilam one of the most geohazard-prone districts in eastern Nepal.

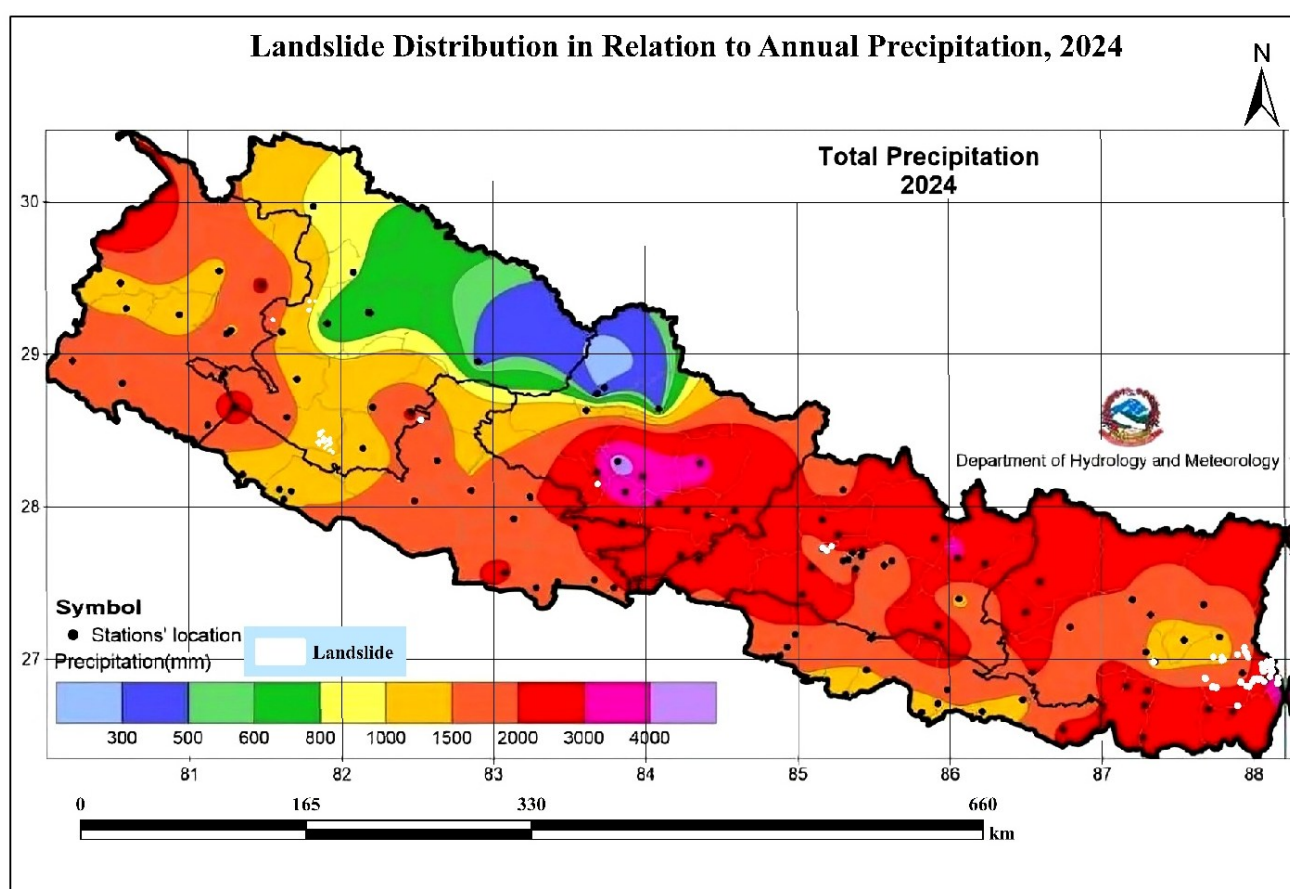


Figure 14 Spatial distribution of landslides in relation to annual precipitation (2024) across Nepal (Department of Hydrology and Meteorology data)

Table 7 Locations of meteorological stations used for climatic data

S.N.	Station Name	District	Province
1	Chaurjhari Tar	Rukum	Karnali
2	Dhankuta	Dhankuta	Koshi
3	Dhunibesi	Dhading	Bagamati
4	Ilam Tea Estate	Ilam	Koshi
5	Kanyam Tea Estate	Ilam	Koshi
6	Kushma	Parbat	Gandaki

7	Manma	Kalikot	Karnali
8	Musikot(Rukumkot)	Rukum	Karnali
9	Nagma	Kalikot	Karnali
10	Pakhribas	Dhankuta	Koshi
11	Pusma Camp	Surkhet	Karnali
12	Surkhet Airport	Surkhet	Karnali

2.3.8 Climatic Implications for Geohazards

The climatic characteristics of all study districts indicate that monsoon rainfall is the primary triggering factor for landslides, debris flows, flash floods, and riverbank erosion. Prolonged rainfall increases groundwater recharge and slope saturation, while short-duration high-intensity storms generate rapid runoff and erosion.

The relationship between climate and geohazards can be summarized as follows:

- Intense rainfall increases surface runoff and erosion.
- Prolonged rainfall elevates groundwater levels and pore water pressure.
- Slope saturation reduces soil and rock mass stability.
- River discharge increases during monsoon periods, enhancing bank erosion.
- Sediment transport and debris flow activity intensify during extreme precipitation events.
- Climate variability may increase the frequency and magnitude of hydro-meteorological hazards.

Considering the strong influence of rainfall on hazard occurrence, continuous rainfall monitoring, watershed management, drainage improvement, and community-based early warning systems are essential components of disaster risk reduction within the study districts.

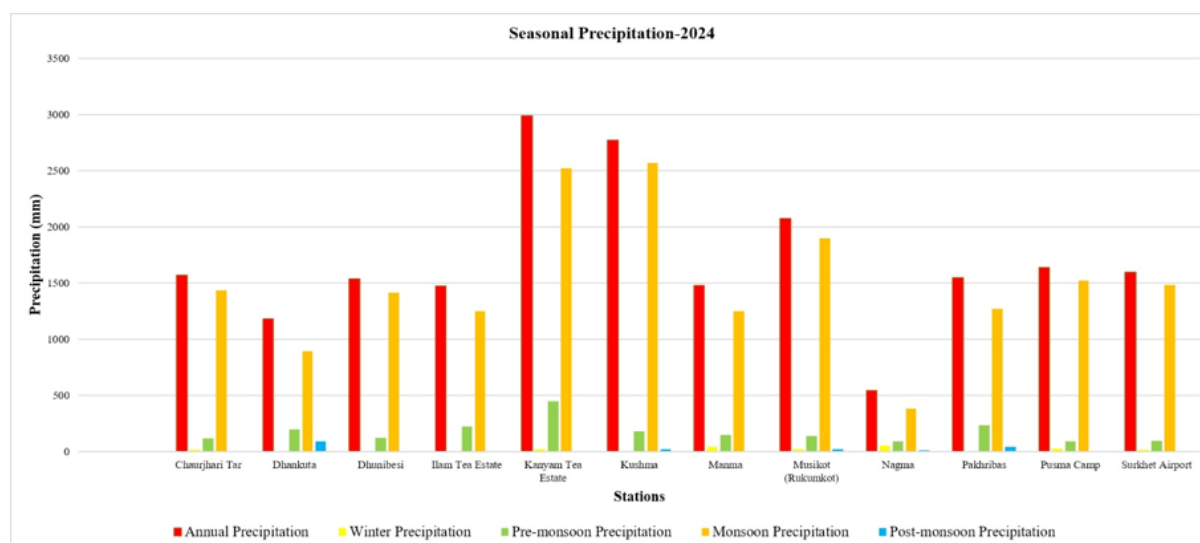


Figure 15 Seasonal precipitation in 2024 across meteorological stations in the study area

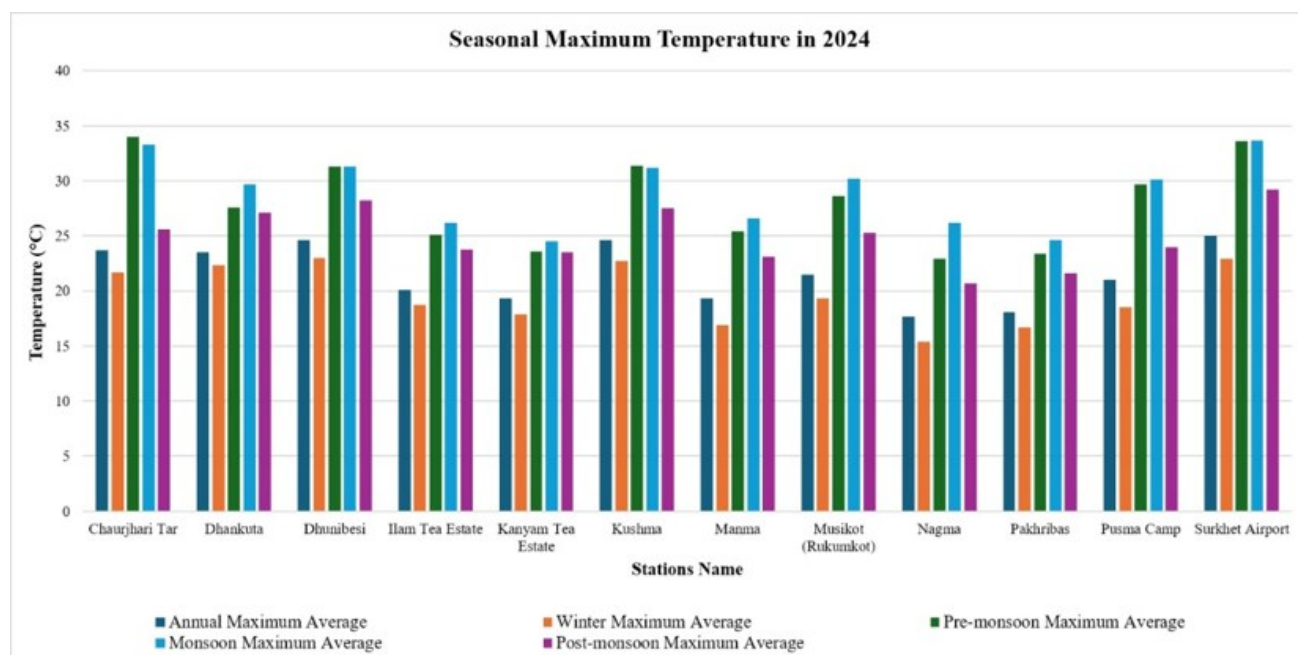


Figure 16 Seasonal maximum temperature in 2024 across meteorological stations in the study area.

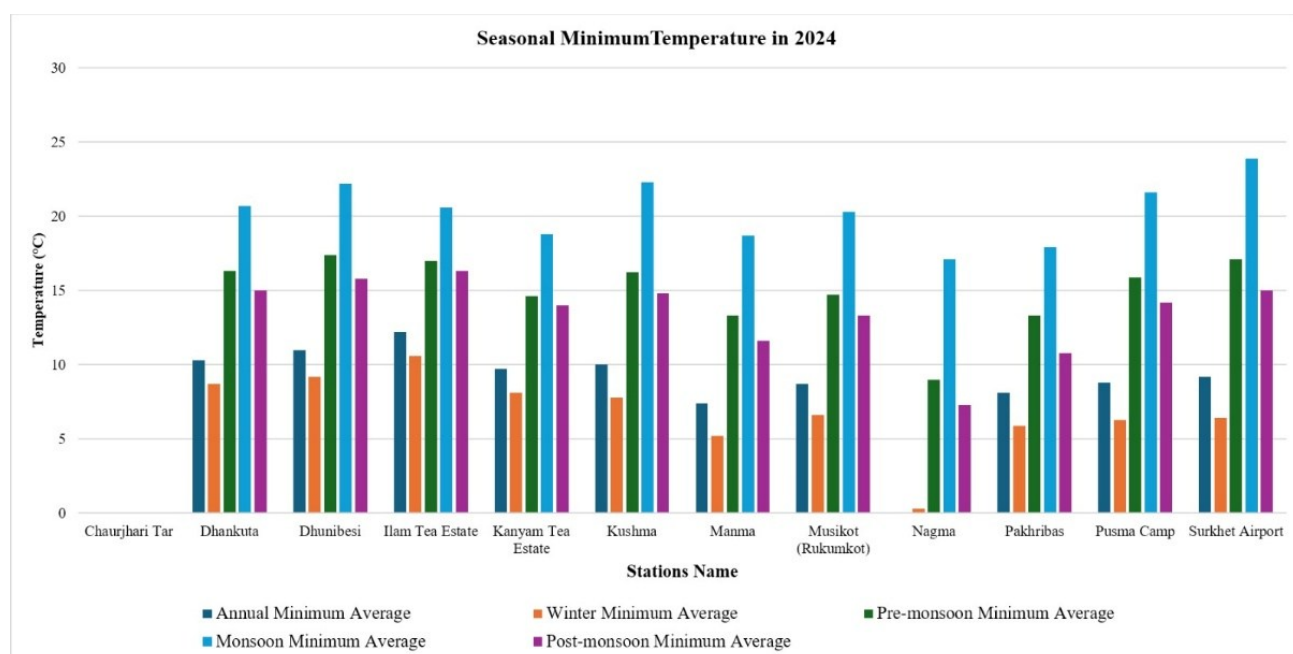


Figure 17 Seasonal minimum temperature in 2024 across meteorological stations in the study area.

2.4 Hydrology and Drainage

The study districts of Kalikot, Surkhet, Rukum West, Parbat, Dhading, Dhankuta, and Ilam are located within major river basins of Nepal and exhibit highly dynamic hydrological systems controlled by monsoon precipitation, rugged topography, geological conditions, drainage density, and watershed characteristics. The hydrology of these districts plays a critical role in shaping the landscape and directly influences the occurrence of landslides, debris flows, flash floods, riverbank erosion, and sediment-related hazards.

Regional Setting

The river systems within the study area are characterized by steep gradients, high-energy flows, rapid runoff response, and significant seasonal discharge variations. During the monsoon season, river discharge may increase several-fold compared to dry season conditions, resulting in enhanced erosion, sediment transport, bank failure, channel migration, and flooding.

The drainage systems generally exhibit dendritic to sub-dendritic patterns controlled by geological structures, topography, and tectonic activity. Numerous first-order and second-order streams originate from steep mountain slopes and rapidly converge into larger river systems. These drainage networks efficiently collect and transport runoff, making the watersheds highly responsive to intense rainfall events.

From a geohazard perspective, hydrological processes are among the most important controlling factors. Surface runoff, groundwater infiltration, riverbank erosion, channel incision, and sediment transport collectively contribute to slope instability and disaster occurrence across all study districts.

2.4.1 Kalikot District

Kalikot District lies predominantly within the Karnali River Basin, one of Nepal's largest and most significant river systems. The hydrological regime of the district is controlled by the Karnali River and numerous tributaries originating from the surrounding mountain catchments.

The Karnali River serves as the principal drainage artery, flowing through deeply incised valleys and receiving runoff from multiple sub-watersheds. Major tributaries include Tila River, Pachal Khola, Khadgakhola, and numerous seasonal streams that drain steep mountainous terrain.

The drainage network exhibits a high drainage density due to rugged topography and steep slope gradients. During the monsoon season, runoff generation is rapid because of limited infiltration capacity on steep slopes and shallow soil profiles. Consequently, stream discharge increases dramatically within short periods following intense rainfall.

Hydrologically, the district is characterized by:

- Steep watershed gradients
- High runoff coefficients
- Rapid concentration of surface flow
- Significant seasonal discharge fluctuations
- Active sediment transport processes

The Tila River watershed is particularly important as it drains a substantial portion of the district and contributes significant sediment loads to the Karnali River system. Riverbank erosion is common along major channels where lateral erosion continuously undermines adjacent slopes.

Regional Setting

Flash floods frequently occur in small tributary catchments during intense rainfall events. These floods transport large volumes of sediment, boulders, and woody debris downstream, often causing damage to settlements, agricultural land, bridges, and transportation infrastructure.

Groundwater resources are primarily associated with fractured bedrock aquifers and localized alluvial deposits along river valleys. Springs constitute important water sources for rural communities; however, their discharge often varies seasonally depending on rainfall and groundwater recharge conditions.

2.4.2 Surkhet District

Surkhet District lies within the Middle Karnali River Basin and serves as an important hydrological transition zone between the high mountains of Karnali Province and the Siwalik and Terai regions of western Nepal. The district possesses a diverse hydrological system consisting of perennial rivers, seasonal streams, springs, wetlands, and groundwater resources that support agriculture, domestic water supply, and ecological functions.

The principal drainage system of the district is dominated by the Bheri River, which traverses the district and ultimately joins the Karnali River. Major tributaries include the Itram River, Ghatgaun Khola, Madu Khola, Chingad Khola, and numerous seasonal streams originating from the surrounding hills and Siwalik ranges.

The Surkhet Valley represents a unique hydrological setting within the district. The valley functions as an intermontane basin surrounded by the Lesser Himalayan and Siwalik hills. Surface runoff from surrounding hills converges toward the valley floor, creating an extensive network of drainage channels and seasonal streams.

The district exhibits diverse drainage characteristics including:

- Dendritic drainage pattern in the hill regions.
- High drainage density in the Siwalik areas.
- Broad alluvial valleys in Surkhet Valley.
- Deeply incised river channels in mountainous terrain.
- Numerous ephemeral streams with flashy hydrological responses.

During the monsoon season, river discharge increases substantially due to intense rainfall and upstream watershed contributions. The Bheri River and its tributaries frequently experience high sediment loads and increased erosive power, resulting in riverbank erosion, channel migration, and localized flooding.

The Siwalik region of Surkhet is particularly susceptible to gully erosion and sediment production due to weak sedimentary formations and highly erodible soils. Numerous small watersheds generate flash floods during intense rainfall events, transporting large quantities of sediment and debris into major river systems.

Regional Setting

Groundwater resources are comparatively abundant within the Surkhet Valley. Unconsolidated alluvial deposits form productive aquifers that support domestic and agricultural water use. Numerous springs emerging from hill slopes also constitute important water sources for rural communities.

Hydrological processes significantly influence geohazard occurrence throughout the district. Riverbank erosion, toe cutting, seasonal flooding, debris-laden flows, groundwater seepage, and concentrated surface runoff contribute to landslide initiation and slope instability in many locations.

The interaction between monsoon rainfall, active river systems, and fragile geological conditions makes hydrological factors one of the primary drivers of disaster occurrence in Surkhet District.

2.4.3 Rukum West District

Rukum West lies primarily within the Bheri River watershed and contains numerous tributary catchments draining rugged mountain terrain. The district's hydrology is strongly influenced by topography, monsoon precipitation, and active geomorphic processes.

The principal river systems include:

- Bheri River tributaries
- Sisne Khola
- Various seasonal and perennial mountain streams

The drainage network exhibits high relief and steep channel gradients. Stream channels are deeply entrenched and possess considerable erosive power during high-flow conditions. Many watersheds respond rapidly to rainfall due to steep slopes and shallow soil cover.

Hydrological characteristics include:

- High seasonal flow variability
- Active sediment transport
- Frequent flash flood occurrence
- Rapid runoff generation
- Extensive watershed erosion

Numerous tributary channels function as debris flow pathways during intense rainfall events. These channels transport large quantities of sediment and coarse debris into major river systems. Sediment accumulation and channel aggradation are common in lower valley sections.

Groundwater occurrence is largely controlled by fractured bedrock systems and localized alluvial deposits. Springs are widely distributed and provide important domestic water supplies. However, excessive groundwater emergence along slope faces may weaken slope materials and contribute to landslide initiation.

Regional Setting

River channel migration and bank erosion are active processes within several river corridors, particularly during monsoon periods when discharge and sediment loads reach peak levels.

2.4.4 Parbat District

Parbat District lies within the Kali Gandaki River Basin and contains one of Nepal's most dynamic river systems. The Kali Gandaki River serves as the dominant hydrological and geomorphological feature of the district.

Major drainage systems include:

- Kali Gandaki River
- Modi Khola
- Pati Khola
- Various mountain tributaries

The Kali Gandaki River has carved a deep gorge through the Himalayan terrain and exhibits substantial erosive power. Continuous channel incision has produced steep valley walls and unstable slopes throughout much of the district.

The drainage system is characterized by:

- Deeply incised channels
- High-energy river flow
- Significant sediment transport
- Active riverbank erosion
- Complex tributary interactions

During monsoon periods, river discharge increases substantially due to rainfall and upstream runoff contributions. Flood peaks often result in channel widening, bank erosion, and localized flooding along low-lying river terraces.

The Modi Khola watershed contributes significant runoff and sediment to the Kali Gandaki system. Numerous landslides occurring within tributary catchments supply large volumes of sediment to river channels, influencing channel morphology and flood behavior.

Groundwater resources are primarily associated with river terrace deposits and fractured bedrock aquifers. Groundwater discharge through springs and seepage zones influences local slope stability and surface hydrological conditions.

2.4.5 Dhading District

Dhading District occupies a strategically important position within the Gandaki River Basin and contains several major river systems including the Trishuli River and Budhi Gandaki River.

The district's hydrology is dominated by:

- Trishuli River
- Budhi Gandaki River
- Ankhu Khola
- Thopal Khola
- Numerous mountain tributaries

The drainage network reflects strong structural and topographic controls. River systems flow through steep mountain valleys and exhibit high stream power during monsoon periods.

Hydrological characteristics include:

- High drainage density
- Significant seasonal discharge variation
- Active bank erosion
- Extensive sediment transport
- Flash flood susceptibility

The Budhi Gandaki watershed is particularly important due to its steep terrain and high rainfall. Numerous tributary streams contribute runoff and sediment from landslide-prone slopes. Sediment production increased significantly following the 2015 Gorkha Earthquake due to widespread slope destabilization.

Riverbank erosion and channel migration are common along major river corridors. Toe erosion resulting from high-flow conditions frequently destabilizes adjacent slopes and contributes to landslide occurrence. Groundwater recharge occurs through rainfall infiltration, fractured rock systems, and riverbank infiltration. Springs and seepage zones are widespread throughout the district and play important roles in local water supply and slope hydrology.

2.4.6 Dhankuta District

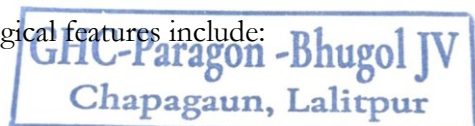
Dhankuta District lies within the Koshi River Basin and possesses a dense drainage network controlled by steep topography and high monsoon rainfall.

Major river systems include:

- Tamor River tributaries
- Arun River tributaries
- Numerous perennial streams

The district exhibits one of the highest drainage densities among the study areas. Closely spaced drainage channels rapidly collect runoff from steep hillslopes and convey water toward major river systems.

Hydrological features include:



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- Dense drainage network
- High runoff generation
- Frequent gully erosion
- Seasonal flash flooding
- Active sediment transport

During intense rainfall events, streams frequently experience rapid increases in discharge. High stream velocities promote erosion, channel incision, and sediment mobilization. Debris flows originating from landslide-prone catchments often utilize existing drainage channels as transport pathways.

Groundwater occurs mainly within weathered rock zones and fractured bedrock aquifers. Numerous springs emerge along slope breaks and structural discontinuities, providing essential water resources for local communities.

Hydrological processes strongly influence slope stability, particularly where prolonged rainfall elevates groundwater levels and promotes seepage-induced failures.

2.4.7 Ilam District

Ilam District is located within the eastern Koshi Basin and receives some of the highest rainfall in Nepal. Consequently, the district possesses an exceptionally dense and active drainage network. Major river systems of Ilam District include Mai Khola, Puwa Khola, Deumai Khola and numerous tributary streams. The drainage network is characterized by:

- High drainage density
- Perennial stream flow
- Rapid runoff response
- Intense erosion activity
- High sediment transport rates

The district's abundant rainfall results in continuous hydrological activity throughout much of the year. Streams remain perennial and contribute significant runoff to larger river systems. During monsoon periods, discharge levels increase dramatically and frequently trigger flash floods and bank erosion.

The steep terrain promotes rapid concentration of runoff and efficient sediment transport. Landslides occurring on hillslopes often deliver large quantities of debris directly into stream channels, resulting in temporary channel blockages and subsequent outburst flooding.

Groundwater recharge is substantial due to high rainfall. Numerous springs and seepage zones are distributed throughout the district, supporting domestic water supplies and agricultural activities. However, excessive groundwater accumulation may contribute to slope instability and landslide initiation.

The interaction between intense rainfall, steep slopes, and dense drainage networks makes hydrological processes a dominant factor influencing geohazard occurrence in Ilam.

2.4.8 Hydrological Implications for Geohazards

Hydrological conditions across all study districts demonstrate a strong relationship between water-related processes and geohazard occurrence. The major hydrological factors contributing to hazards include:

- Intense monsoon runoff generation.
- Rapid watershed response to extreme rainfall.
- Riverbank erosion and channel migration.
- Elevated groundwater levels and pore water pressures.
- Concentrated flow along drainage channels.
- Sediment transport and deposition.
- Debris flow initiation within tributary catchments.
- Flash flooding in steep mountain watersheds.

These processes frequently trigger landslides, debris flows, floods, and erosion-related hazards. Therefore, watershed management, drainage improvement, river training measures, slope drainage systems, groundwater monitoring, and flood early warning systems should form integral components of disaster risk reduction strategies within the study districts.

2.5 Land Use and Settlement Pattern

The study districts of Kalikot, Surkhet, Rukum West, Parbat, Dhading, Dhankuta, and Ilam exhibit diverse land use and settlement patterns shaped by topography, climate, hydrology, accessibility, agricultural practices, and socio-economic development. The majority of the population resides in rural settlements distributed across hillsides, river terraces, ridge tops, and valley bottoms. Agriculture remains the dominant land use in most districts, followed by forests, shrublands, grasslands, settlements, and riverine areas.

The rugged mountainous terrain of the Nepal Himalaya imposes significant constraints on land utilization. Consequently, settlements and agricultural lands are frequently established on marginal slopes, colluvial deposits, river terraces, and alluvial fans that are often exposed to landslides, debris flows, flash floods, and riverbank erosion. Expansion of rural road networks, population growth, and changing land-use practices have further increased exposure to geohazards in many areas.

Understanding land use and settlement patterns is essential for geohazard assessment because they directly influence exposure, vulnerability, risk distribution, and disaster impacts. Areas with dense settlements, critical infrastructure, and intensive agricultural activities located within hazard-prone zones require special attention during risk assessment and mitigation planning.

2.5.1 Kalikot District

Kalikot District is predominantly rural in character, with scattered settlements distributed across steep mountain slopes, ridge tops, and river valleys. The district has relatively low population density compared to many districts in central and eastern Nepal. Settlements are generally dispersed and closely linked to agricultural activities and local water sources.

Agriculture constitutes the primary land use within the district. Terraced farming is widely practiced on hill slopes, while valley bottoms and river terraces are utilized for seasonal crop cultivation. Major crops include maize, millet, wheat, barley, and pulses. Livestock rearing also forms an important component of rural livelihoods.

The dominant land-use categories include:

- Forest land
- Agricultural terraces
- Shrubland
- Grassland
- Settlements
- River corridors

Forests occupy a significant proportion of the district and provide timber, fuelwood, fodder, and ecosystem services. Community forests play an important role in watershed protection and slope stabilization.

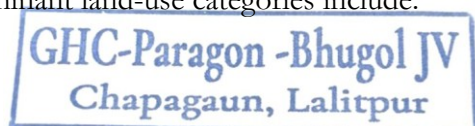
Settlement development is generally concentrated near transportation corridors, local markets, and administrative centers. However, many villages remain located on steep slopes and landslide-prone terrain. Expansion of rural roads has increased accessibility but has also contributed to localized slope instability and settlement exposure to geohazards.

River valleys along the Karnali and Tila Rivers contain important agricultural lands and settlements; however, these areas are vulnerable to flooding and riverbank erosion.

2.5.2 Surkhet District

Surkhet District exhibits one of the most diverse land-use patterns within Karnali Province due to its unique geographical setting, relatively favorable topography, and role as the provincial administrative and economic center. Compared to many mountain districts of western Nepal, Surkhet possesses extensive valley floors, productive agricultural land, rapidly expanding urban areas, and significant transportation infrastructure.

The dominant land-use categories include:



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- Forest land
- Agricultural land
- Urban and rural settlements
- Shrubland
- Grassland
- Riverine and floodplain areas

Agriculture remains a major land-use activity throughout the district. The fertile alluvial soils of Surkhet Valley support intensive cultivation of rice, wheat, maize, vegetables, and commercial crops. Irrigated agriculture is concentrated within valley floors and lowland areas, while rain-fed cultivation occurs on surrounding hill slopes.

Forests occupy a substantial proportion of the district, particularly in the Siwalik and Mahabharat hills. Community forests play an important role in watershed protection, biodiversity conservation, slope stabilization, and local livelihoods.

Settlement patterns vary considerably across the district. The Surkhet Valley contains relatively dense settlements and urban centers, including Birendranagar, which serves as the provincial capital of Karnali Province. Urban expansion around Birendranagar has accelerated significantly in recent decades due to migration, economic growth, and infrastructure development.

Rural settlements are distributed along hill slopes, ridge tops, river terraces, and transportation corridors. Traditional villages are generally located on relatively stable terrain with access to agricultural land and water resources. However, some settlements have expanded into areas susceptible to flooding, riverbank erosion, and landslides.

Road development has significantly influenced land-use change across the district. New transportation corridors have improved accessibility but have also increased slope modification, deforestation, and settlement expansion into hazard-prone terrain.

The Bheri River corridor and Surkhet Valley contain important economic infrastructure, educational institutions, health facilities, government offices, and commercial centers. Consequently, exposure of population and infrastructure to geohazards is relatively higher than in many other districts of Karnali Province.

From a disaster risk perspective, critical land-use concerns include:

- Urban expansion onto flood-prone areas.
- Settlement growth along unstable road corridors.
- Encroachment into riverbank zones.
- Slope modification associated with infrastructure development.

- Deforestation and watershed degradation in localized areas.

The evolving land-use pattern of Surkhet highlights the importance of integrating hazard-sensitive land-use planning into future development activities.

2.5.3 Rukum West District

Rukum West exhibits a mixed pattern of land use characterized by forests, agricultural terraces, pasturelands, and dispersed rural settlements. The district's rugged terrain limits the availability of flat land, resulting in extensive cultivation on terraced hill slopes.

The principal land-use categories include:

- Forest land
- Agricultural terraces
- Rangeland
- Shrubland
- Settlements
- River valleys

Agriculture remains the dominant economic activity. Maize, wheat, millet, barley, and potatoes are widely cultivated. Livestock grazing is particularly important in higher elevation areas where extensive pasturelands are available.

Settlement patterns are strongly influenced by topography and water availability. Villages are commonly located on stable ridge tops and moderately inclined slopes that offer favorable living conditions and access to agricultural land. However, many settlements remain exposed to landslides, debris flows, and earthquake-induced hazards.

The district's forest resources provide critical ecological functions including slope stabilization, groundwater recharge, and erosion control. Nonetheless, localized deforestation and road construction activities have increased geomorphic instability in some watersheds.

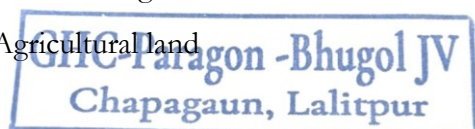
River valleys support agricultural production and transportation corridors but are frequently affected by erosion and flood-related hazards.

2.5.4 Parbat District

Parbat District exhibits relatively intensive land use compared to many western hill districts due to favorable climatic conditions, fertile soils, and better transportation connectivity. Settlement development is concentrated along road corridors, river terraces, market centers, and accessible hill slopes.

Major land-use categories include:

- Agricultural land



Mitlenad

- Forests
- Settlements
- Shrubland
- River terraces
- Commercial areas

Terraced agriculture dominates the landscape, particularly on moderate slopes. Major crops include rice, maize, wheat, millet, vegetables, and fruits. Commercial horticulture and livestock production are increasingly important components of the local economy.

The Kali Gandaki and Modi Khola valleys contain productive agricultural lands and relatively dense settlement concentrations. Urbanization and infrastructure development have expanded significantly in recent decades, resulting in increased land-use pressure and slope modification.

Many settlements are located on old river terraces and colluvial slopes. Although these locations provide suitable conditions for habitation, they may also be vulnerable to landslides, riverbank erosion, and debris flow impacts.

Forest areas remain important for biodiversity conservation, watershed management, and slope stabilization.

2.5.5 Dhading District

Dhading District possesses diverse land-use characteristics due to its large geographical extent and significant elevation range. The district contains a mixture of agricultural land, forests, settlements, commercial centers, and infrastructure corridors.

The major land-use classes include:

- Forest land
- Agricultural terraces
- Settlements
- Grazing land
- River corridors
- Infrastructure corridors

Agriculture remains the dominant livelihood sector, with rice, maize, wheat, vegetables, and fruits being widely cultivated. The fertile valleys of the Trishuli and Budhi Gandaki Rivers support intensive agricultural production.

Regional Setting

Settlement patterns vary considerably across the district. Dense settlements occur along transportation corridors and market centers, while remote mountain areas contain dispersed rural villages. Urbanization has increased in recent years due to improved connectivity with Kathmandu Valley.

The district contains several strategic transportation routes, hydropower projects, and critical infrastructure facilities. Consequently, exposure of infrastructure assets to geohazards is relatively high.

The 2015 Gorkha Earthquake significantly affected settlement patterns in some areas, leading to reconstruction activities and changes in land utilization. Numerous settlements remain vulnerable to landslides, slope failures, and riverbank erosion.

Forests occupy a substantial portion of the district and contribute significantly to watershed protection and environmental stability.

2.5.6 Dhankuta District

Dhankuta District is characterized by a combination of agricultural terraces, forests, settlements, and commercial farming areas. The district has a relatively high population density compared to many western hill districts and supports a diverse agricultural economy.

The dominant land-use categories include:

- Agricultural land
- Forests
- Settlements
- Commercial plantations
- Grasslands
- River corridors

Terraced farming is widespread due to steep topography. Major crops include rice, maize, millet, vegetables, citrus fruits, and cash crops. Commercial agriculture has expanded significantly in recent years due to improved market access.

Settlements are commonly located on ridge tops and moderately sloping terrain. Many villages have developed along transportation corridors and market centers. Urban expansion around Dhankuta Bazaar has contributed to increasing land-use intensity.

Forest areas play a crucial role in maintaining watershed stability and reducing erosion. However, localized land-use changes and infrastructure development have increased pressure on environmentally sensitive slopes.

Numerous settlements remain vulnerable to landslides and erosion due to their proximity to steep slopes and drainage channels.

2.5.7 Ilam District

Ilam District possesses one of the most distinctive land-use patterns in Nepal, characterized by extensive tea plantations, intensive agriculture, forests, and densely distributed rural settlements. The district's favorable climate and fertile soils support diverse agricultural production.

Major land-use categories include:

- Tea plantations
- Agricultural terraces
- Forests
- Settlements
- Commercial farming areas
- Riverine land

Tea cultivation represents the most prominent land use and contributes significantly to the district's economy. In addition, cardamom, ginger, vegetables, maize, and rice are widely cultivated throughout the district.

Settlement patterns are relatively dense compared to many western hill districts. Villages are distributed along ridge tops, hill slopes, and transportation corridors. Improved road access has accelerated settlement expansion and land-use transformation in recent decades.

The district's steep terrain and high rainfall create challenges for sustainable land management. Improper slope modification, road construction, and drainage deficiencies can increase susceptibility to landslides and erosion.

Forest resources remain important for biodiversity conservation, water regulation, and slope stabilization. Community forestry programs have played a positive role in maintaining environmental conditions and reducing land degradation.

2.5.8 Implications for Geohazard Assessment

Land use and settlement patterns directly influence the exposure and vulnerability of communities to geohazards. Across all study districts, settlements, agricultural lands, transportation infrastructure, schools, health facilities, and public utilities are frequently located in areas susceptible to landslides, debris flows, riverbank erosion, and flooding.

Several common characteristics observed across the districts include:

- Extensive cultivation on steep terraced slopes.
- Settlement expansion along road corridors.
- Occupation of river terraces and valley bottoms.

Regional Setting

- Infrastructure development within hazard-prone terrain.
- Dependence on slope-based agriculture and natural resources.
- Increasing land-use pressure due to population growth and connectivity improvements.

These factors contribute to increased disaster risk and highlight the need for integrated land-use planning, hazard-sensitive settlement development, watershed management, slope stabilization measures, and community-based disaster risk reduction programs.

A detailed assessment of land use and settlement distribution will therefore form a critical component of the geohazard risk assessment, exposure mapping, vulnerability analysis, and mitigation planning process for the study districts.

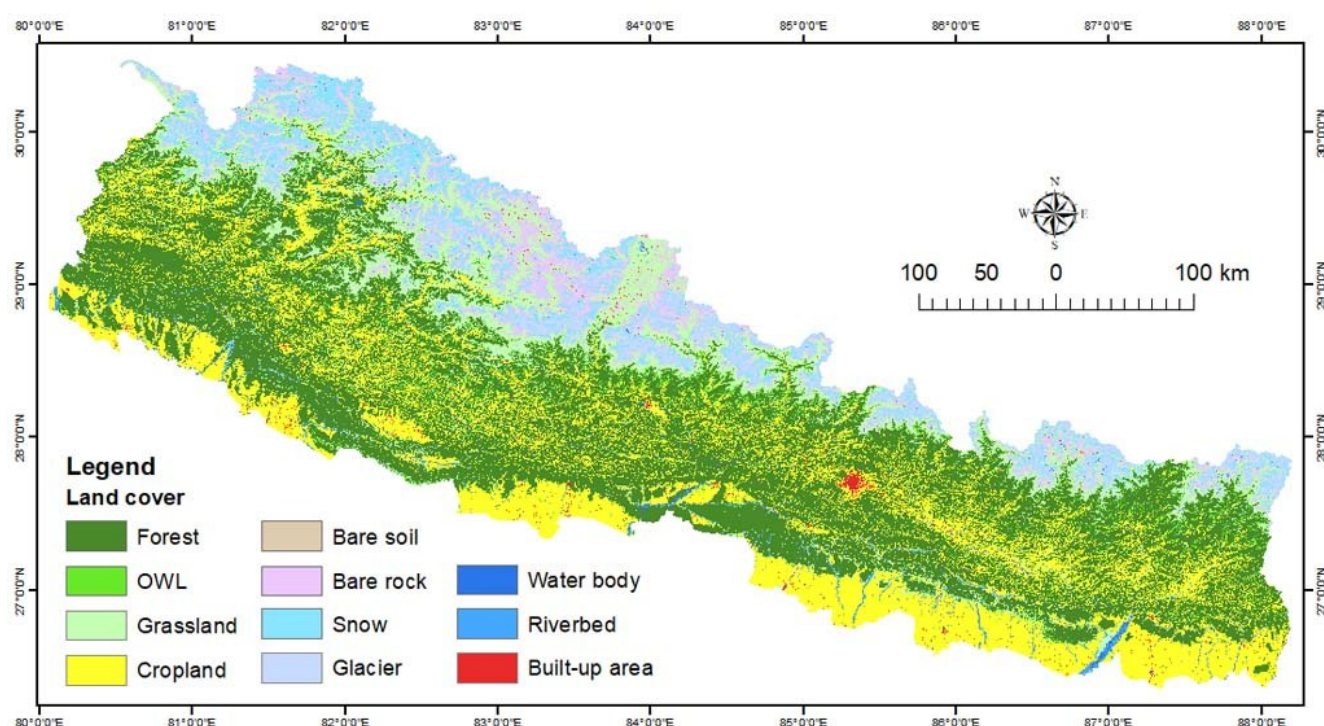


Figure 18 Land cover of Nepal (FRTC, 2022)

2.6 Disaster History of the Area

The study districts of Kalikot, Jajarkot, Rukum West, Parbat, Dhading, Dhankuta, and Ilam have experienced a long history of natural disasters due to their location within the tectonically active Himalayan region and their exposure to intense monsoon rainfall. The combination of fragile geology, steep topography, active river systems, and rapidly expanding human settlements has resulted in frequent occurrences of landslides, debris flows, flash floods, riverbank erosion, earthquakes, and drought-related impacts.

Among these hazards, rainfall-induced landslides and floods represent the most frequent and destructive events affecting lives, property, infrastructure, and livelihoods. Major earthquakes, particularly the 2015

Regional Setting

Gorkha Earthquake and the 2023 Jajarkot Earthquake, have further demonstrated the vulnerability of mountainous districts to multi-hazard disasters. Historical disaster events provide important insights into hazard patterns, triggering mechanisms, vulnerable locations, and future risk trends.

2.6.1 Kalikot District

Kalikot District has historically experienced recurrent landslides, debris flows, flash floods, and riverbank erosion events. The rugged terrain, fragile geological formations, and intense monsoon rainfall create highly favorable conditions for slope instability throughout the district.

Monsoon-induced landslides are among the most common disasters affecting Kalikot. Numerous settlements and agricultural terraces located on steep slopes have been damaged by landslides triggered by prolonged rainfall. Road corridors constructed along unstable hillsides frequently experience slope failures, resulting in transportation disruptions and isolation of communities.

The Karnali River and its tributaries periodically generate flash floods and bank erosion, particularly during periods of intense rainfall. Flood events often damage agricultural land, irrigation systems, footbridges, and local infrastructure. Debris flows originating from steep tributary catchments have repeatedly affected settlements situated along stream corridors.

In recent decades, increasing road construction activities have altered slope conditions and contributed to localized increases in landslide occurrence. Many disaster events within the district are associated with a combination of natural and human-induced factors.

The district remains highly vulnerable to future rainfall-induced disasters due to continued settlement expansion into hazard-prone areas and increasing climatic variability.

3.6.2 Surkhet District

Surkhet District has experienced a long history of natural disasters including floods, landslides, debris flows, riverbank erosion, droughts, forest fires, and earthquakes. Owing to its location within the Bheri-Karnali river system and the presence of fragile Siwalik formations, the district remains highly susceptible to both hydro-meteorological and geological hazards.

Flooding represents one of the most significant hazards affecting the district. The Bheri River and its tributaries have repeatedly caused flood-related damage to agricultural land, settlements, roads, irrigation systems, and public infrastructure. Monsoon-induced flooding frequently affects low-lying areas within the Surkhet Valley and along major river corridors.

Landslides and debris flows are common in the surrounding hill regions, particularly within the Siwalik and Mahabharat ranges. Intense monsoon rainfall regularly triggers slope failures, resulting in road blockages, damage to settlements, and disruption of transportation networks. Rural roads constructed on steep slopes are especially vulnerable to rainfall-induced failures.

Regional Setting

The district experienced significant impacts during the extreme flood events of August 2014, when widespread flooding and landslides affected many parts of western Nepal. Numerous households, agricultural lands, and infrastructure facilities within Surkhet were damaged by floodwaters and sediment deposition.

Riverbank erosion remains a persistent problem along the Bheri River and other major streams. Lateral channel migration and bank cutting have resulted in the loss of agricultural land and have threatened settlements located near river corridors.

Although Surkhet was not located within the epicentral region of the 2015 Gorkha Earthquake, seismic shaking was felt throughout the district and highlighted the vulnerability of buildings and infrastructure to future seismic events. Several active fault systems in western Nepal continue to pose long-term earthquake risks.

The district is also increasingly affected by climate-related hazards including extreme rainfall events, prolonged dry periods, forest fires, and localized drought conditions. These hazards have implications for water resources, agriculture, and ecosystem stability.

Historical disaster records indicate that the most common and damaging hazards in Surkhet include:

- Monsoon-induced flooding.
- Riverbank erosion.
- Landslides and debris flows.
- Flash floods in tributary watersheds.
- Forest fires during dry seasons.
- Drought and water scarcity in localized areas.
- Earthquake-related risks.

Recent urban growth within Birendranagar and expansion of infrastructure networks have increased exposure of population and assets to disaster risks. Consequently, future disaster management efforts should prioritize flood risk reduction, slope stabilization, watershed conservation, river training measures, land-use regulation, and community-based early warning systems.

The disaster history of Surkhet demonstrates the importance of adopting an integrated multi-hazard risk management approach that considers the interactions between hydrological, geological, climatic, and human-induced processes.

2.6.3 Rukum West District

Rukum West has a long history of landslides, debris flows, floods, and earthquake-related impacts. The district's steep mountainous terrain and highly dissected watersheds create conditions favorable for frequent slope failures during the monsoon season.

Regional Setting

Rainfall-induced landslides occur annually and represent the most widespread disaster type. Many settlements, roads, and agricultural areas have experienced repeated damage from slope failures. Debris flows generated within steep tributary catchments frequently impact transportation corridors and local infrastructure.

The district was also affected by the 2023 western Nepal earthquake sequence, which generated structural damage and increased concern regarding future landslide activity. Earthquake-induced destabilization of slopes remains a significant issue in several localities.

Riverbank erosion along tributary rivers and streams causes loss of agricultural land and threatens settlements located near river channels. During extreme rainfall events, flash floods transport large volumes of sediment and debris, resulting in channel blockage, bank erosion, and infrastructure damage.

Historical disaster records indicate that hydro-meteorological hazards remain the dominant source of disaster losses within the district.

2.6.4 Parbat District

Parbat District has experienced frequent landslides, riverbank erosion, flash floods, and slope failures associated with monsoon rainfall. The steep terrain and deeply incised river valleys contribute to widespread geomorphic instability.

The Kali Gandaki River and Modi Khola systems have historically caused flood-related impacts, particularly during periods of intense monsoon discharge. Riverbank erosion has damaged agricultural land, roads, and infrastructure along river corridors.

Landslides are common throughout the district, especially in areas underlain by weathered phyllites and schists. Slope failures frequently occur along roads where excavation activities have disturbed natural slope conditions. Monsoon storms often trigger multiple landslide events simultaneously across different watersheds.

Although the district was less severely affected than neighboring areas during the 2015 Gorkha Earthquake, seismic shaking contributed to localized slope failures and increased awareness of earthquake-related hazards.

Historical disaster events demonstrate the close relationship between rainfall intensity, slope instability, and infrastructure vulnerability within the district.

2.6.5 Dhading District

Dhading District is among the most disaster-prone districts in Nepal and has experienced a wide range of hazards including earthquakes, landslides, debris flows, floods, and riverbank erosion.

Regional Setting

The district was severely impacted by the 2015 Gorkha Earthquake, which caused extensive casualties, destruction of settlements, damage to public infrastructure, and widespread slope instability. Thousands of landslides were triggered throughout the district during and after the earthquake.

Subsequent monsoon seasons generated additional slope failures due to earthquake-induced weakening of hillsides. Numerous roads, schools, health facilities, and settlements were repeatedly affected by landslides and debris flows.

The Budhi Gandaki and Trishuli river systems have also produced significant flood and erosion impacts. Flash floods and riverbank erosion frequently damage agricultural land and infrastructure located along river corridors.

Several major landslide events in the district have resulted in fatalities, road closures, and displacement of households. The district remains highly susceptible to both seismic and hydro-meteorological disasters, making it one of Nepal's most significant multi-hazard risk areas.

2.6.6 Dhankuta District

Dhankuta District has experienced recurring landslides, debris flows, flash floods, and erosion-related disasters for many decades. The district's steep terrain and high monsoon rainfall contribute to frequent slope failures and drainage-related hazards.

Landslides represent the most common disaster type affecting local communities. Agricultural terraces, rural roads, and settlements located on steep slopes frequently experience damage during intense rainfall events. Shallow landslides and debris flows are particularly common in highly weathered soil and rock formations.

Riverbank erosion and localized flooding periodically affect low-lying settlements and agricultural land. Numerous small watersheds respond rapidly to rainfall, generating flash floods and sediment-laden flows.

Road expansion and land-use changes have increased susceptibility to slope instability in some areas. Historical disaster records indicate that many landslides occur in areas where natural drainage systems have been altered or slope cutting has been undertaken without adequate stabilization measures.

The district's disaster history highlights the importance of integrated watershed management and slope protection measures.

2.6.7 Ilam District

Ilam District is one of the most landslide-prone districts in eastern Nepal due to its exceptionally high rainfall, steep terrain, and fragile geological conditions. Historical records indicate frequent occurrences of landslides, debris flows, erosion, and localized flooding.

Regional Setting

Monsoon-induced landslides occur almost every year and often affect settlements, tea plantations, transportation infrastructure, and agricultural land. Several major landslide events have resulted in fatalities, displacement of households, and disruption of economic activities.

The Mai Khola, Puwa Khola, and associated tributary systems periodically generate flash floods and riverbank erosion. These events frequently damage bridges, roads, irrigation infrastructure, and cultivated land.

The district has also experienced increasing disaster impacts associated with changing rainfall patterns and extreme weather events. Intense short-duration rainfall events have become increasingly important triggers of slope failures and flash flooding.

Tea-growing regions located on steep hillsides are particularly vulnerable to erosion and landslide activity. Historical disaster trends indicate that hydro-meteorological hazards remain the dominant risk factor affecting communities throughout the district.

2.6.8 Summary of Major Disaster Trends

Review of historical disaster events across the study districts reveals several common patterns:

- Landslides are the most frequent and widespread hazard affecting all districts.
- Monsoon rainfall is the principal triggering factor for slope failures, debris flows, and flash floods.
- Riverbank erosion is a recurring problem along major river systems and tributary channels.
- Road construction and slope modification have increased landslide susceptibility in many locations.
- Earthquakes significantly increase the likelihood of subsequent rainfall-induced landslides.
- Settlements, agricultural land, transportation infrastructure, and public facilities are increasingly exposed to geohazards.
- Climate variability and extreme rainfall events are contributing to increasing disaster risk.

The historical disaster record demonstrates that the study districts are characterized by complex multi-hazard environments where geological, hydrological, climatic, and human factors interact to generate significant disaster impacts. Understanding these historical trends is essential for effective hazard assessment, risk mapping, mitigation planning, and relocation decision-making within the framework of the proposed rapid geohazard assessment.

CHAPTER 3: HAZARD ASSESSMENT APPROACH

3.1 Hazard Classification System

A standardized hazard classification system was adopted to ensure consistency in the identification, characterization, comparison, and prioritization of geohazards across all assessed locations. The classification framework was designed to capture the diversity of geological and hydro-meteorological hazards commonly encountered within the mountainous terrain of Nepal and to facilitate objective risk evaluation.

The classification process involved the identification of hazard type, hazard mechanism, activity status, spatial extent, potential magnitude, and likely impact on exposed elements. Hazards were categorized based on field observations, geomorphological evidence, historical disaster records, drone surveys, topographic analysis, and stakeholder consultations.

The principal hazard categories considered during the assessment included:

- Landslides
- Rockfalls
- Debris Flows
- Flooding
- Riverbank Erosion
- Gully Erosion
- Slope Instability
- Ground Subsidence

Hazard Assessment Approach

- Complex Multi-Hazard Processes

Landslides were further classified according to the movement mechanism and material involved, including rotational slides, translational slides, debris slides, earth slides, rock slides, and complex failures. Rockfall hazards were characterized based on source area conditions, block size, slope geometry, and potential travel distance.

Each identified hazard was assigned an activity classification comprising:

Active Hazard: Hazards exhibiting current movement, fresh scarps, recent deposits, active erosion, open tension cracks, or ongoing deformation.

Dormant Hazard: Hazards showing evidence of past activity but currently stable under prevailing environmental conditions.

Reactivated Hazard: Previously stabilized hazards exhibiting renewed movement or signs of instability due to triggering factors such as rainfall, earthquakes, or anthropogenic disturbances.

Potential Hazard: Areas where geological, geomorphological, hydrological, or environmental conditions indicate a high likelihood of future hazard development despite the absence of observable current movement.

Hazard severity was subsequently categorized into Very High, High, Moderate, Low, and Very Low classes based on the combination of probability of occurrence and expected consequences. This classification provided the foundation for hazard ranking and risk evaluation throughout the study.

The adopted classification system enabled systematic comparison among sites and supported transparent decision-making regarding relocation priorities and risk reduction interventions.

3.2 Site Investigation Methodology

Detailed site investigations were undertaken to verify hazard conditions, identify triggering mechanisms, evaluate slope stability, and assess the level of risk posed to settlements and infrastructure. The investigations combined desk-based analyses, field reconnaissance, geotechnical observations, UAV mapping, and community consultations.

Prior to field deployment, available secondary information including geological maps, topographic maps, DEM data, satellite imagery, disaster inventories, previous studies, and local government records were reviewed. Preliminary hazard boundaries and investigation targets were identified during this phase.

Field investigations were conducted using multidisciplinary teams consisting of engineering geologists, geotechnical engineers, GIS specialists, survey personnel, and social mobilizers. At each site, systematic observations were undertaken to document:

- Geological conditions



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Hazard Assessment Approach

- Lithology and weathering characteristics
- Structural discontinuities
- Slope geometry
- Drainage conditions
- Groundwater manifestations
- Erosion features
- Existing protective measures
- Hazard indicators
- Infrastructure conditions

Particular attention was given to identifying geomorphic indicators of instability such as scarps, tension cracks, displaced vegetation, tilted trees, bulging slopes, rockfall deposits, seepage zones, erosion gullies, and channel migration.

Measurements of slope angle, slope height, scarp dimensions, crack width, and drainage characteristics were collected using handheld GPS units, laser range finders, clinometers, and field survey equipment. Site photographs and georeferenced observations were systematically recorded.

Community consultations were conducted with affected households, local authorities, and key informants to document historical hazard occurrences, seasonal patterns, previous damages, and local perceptions of risk. Historical disaster information was subsequently cross-verified with field evidence.

The integrated site investigation approach provided comprehensive information regarding hazard characteristics, site conditions, and exposure levels, thereby supporting robust hazard and risk assessment.

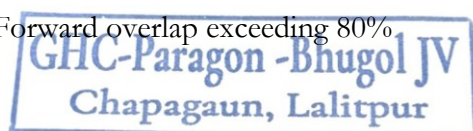
3.3 UAV/Drone Survey Methodology

Unmanned Aerial Vehicle (UAV) surveys were conducted to obtain high-resolution spatial data for hazard characterization, terrain analysis, and mapping of affected areas. UAV technology provided detailed topographic and geomorphological information that could not be obtained through conventional field methods alone.

Prior to survey implementation, flight planning was undertaken based on site accessibility, terrain conditions, airspace restrictions, weather conditions, and assessment objectives. Ground Control Points (GCPs) were established in some places to improve positional accuracy and facilitate georeferencing of aerial imagery.

The UAV surveys were designed to achieve sufficient image overlap for photogrammetric processing. Typical survey parameters included:

- Forward overlap exceeding 80%



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Hazard Assessment Approach

- Side overlap exceeding 70%
- Appropriate flight altitude for target resolution
- Multiple flight lines for complete site coverage

The acquired imagery was processed using photogrammetric software to generate:

- Orthomosaic images
- Three-dimensional terrain models
- Hazard boundary maps

Drone-derived datasets were used to identify landslide scarps, erosion features, drainage pathways, debris accumulation zones, rockfall source areas, channel migration patterns, and settlement exposure.

The high-resolution terrain models significantly improved the accuracy of hazard mapping and enabled detailed assessment of inaccessible or hazardous areas. UAV data also served as a valuable baseline for future monitoring and post-disaster comparison. The integration of UAV-based observations with field investigations enhanced overall assessment reliability and facilitated evidence-based hazard classification.

3.4 Elements-at-Risk Assessment

The Elements-at-Risk Assessment was conducted to identify and quantify populations, infrastructure, services, and economic assets potentially affected by identified hazards.

The assessment considered both direct and indirect exposure within the potential hazard influence area. Spatial overlay analysis using GIS was employed to determine the relationship between hazard boundaries and exposed elements.

Elements assessed included:

- Residential buildings
- Population
- Schools
- Health facilities
- Government buildings
- Roads and bridges
- Water supply systems
- Irrigation infrastructure
- Agricultural land
- Commercial establishments
- Forest
- Religious and cultural heritage sites

Hazard Assessment Approach

Population exposure was evaluated using household surveys, municipal records, and field verification. Infrastructure exposure was assessed through direct site inspection and GIS mapping.

The assessment generated a comprehensive inventory of exposed assets and provided critical input for subsequent risk evaluation.

3.5 Risk Evaluation Criteria

Risk evaluation was undertaken by integrating hazard characteristics with exposure and vulnerability information. The objective was to estimate the potential consequences associated with identified hazards and support informed decision-making.

Risk was evaluated using the general relationship:

$$\text{Risk} = \text{Hazard} \times \text{Exposure} \times \text{Vulnerability}$$

$$\text{Risk} = \text{Hazard} \times \text{Exposure} \times \text{Vulnerability}$$

Hazard ratings derived from the hazard ranking process were combined with exposure indicators and vulnerability characteristics. Vulnerability assessment considered factors such as:

- Structural condition of buildings
- Population sensitivity
- Access to emergency services
- Socio-economic conditions
- Existing mitigation measures
- Preparedness capacity

Risk levels were categorized as:

Table 8 Risk level categorization

Risk Score	Risk Level
Very High	Immediate Action Required
High	Priority Mitigation Required
Moderate	Risk Reduction Measures Required
Low	Monitoring Recommended
Very Low	Routine Observation

The risk evaluation process enabled identification of settlements and infrastructure requiring urgent intervention, detailed investigation, or long-term monitoring.

3.6 Treatability Assessment

Hazard Assessment Approach

Treatability assessment was conducted to determine whether identified hazards could be effectively managed through engineering, bioengineering, drainage improvement, land-use management, or other mitigation measures, or whether relocation represented the most appropriate risk reduction option.

The assessment considered:

- Hazard magnitude and extent
- Failure mechanism
- Site accessibility
- Geological conditions
- Engineering feasibility
- Environmental implications
- Social acceptability
- Economic viability
- Long-term sustainability

Potential treatment measures evaluated included:

- Surface drainage management
- Subsurface drainage systems
- Retaining structures
- Slope regrading
- Rockfall protection measures
- River training works
- Bioengineering interventions
- Watershed conservation measures

Each site was classified into one of three treatability categories:

Treatable: Hazards that can be reduced to acceptable levels through technically feasible and economically viable mitigation measures.

Partially Treatable: Hazards where mitigation can reduce risk but residual risk remains significant.

Non-Treatable: Hazards where engineering interventions are technically impractical, economically prohibitive, environmentally unsuitable, or incapable of reducing risk to acceptable levels.

Sites classified as non-treatable were considered candidates for relocation and resettlement planning. The treatability assessment therefore provided the critical linkage between hazard assessment and practical risk management recommendations.

The framework ensured that recommendations were technically sound, economically realistic, socially acceptable, and aligned with long-term disaster risk reduction objectives.

CHAPTER 4: SITE-WISE RAPID ASSESSMENT

4.1 Ilam District

4.1.1 Suryodaya-1, SD-1 LS 1 (Paireni)

4.1.1.1 *Location and Accessibility*

The landslide site SD-1 LS 1 (Paireni) is located in Ward No. 1 of Suryodaya Municipality, Ilam District. The site lies on a south-facing slope and can be accessed through a local road connected to the municipal road network from Fikkal to Manebhyanjang. The nearest settlement is approximately 100 m from the landslide. The area is characterized by moderate terrain and agricultural terraces.

4.1.1.2 *Hazard Type*

The identified hazard is an active translational landslide with evidence of continuous slope movement. Secondary processes such as soil creep, gully erosion, and surface runoff erosion are also observed on the road cut slope.

4.1.1.3 *Geological and Geomorphological Conditions*

The area is underlain by highly weathered colluvial soil mixed with fragmented rock debris. The slope consists of silty clay and sandy silt with occasional gravel and boulder-sized materials. The bedrock is not exposed on the slope.

Geomorphologically, the site is located on a moderate hillside with slope gradients ranging from 25° to 40°. The terrain exhibits concave slope morphology with visible scarps, tension cracks, and displaced vegetation, indicating active mass movement.

4.1.1.4 Cause and Triggering Factors

The main causes and triggering factors responsible for the landslide include:

- Intense and prolonged rainfall leading to soil saturation.
- Steep slope geometry, road cut slope, and gravitational instability.
- Unmanaged surface runoff and poor drainage conditions.
- Agricultural terracing and slope modification.

4.1.1.5 Current Site Condition

The landslide is active, with fresh tension cracks near the crown, recent soil displacement, and minor failures observed. Surface water is flowing through cracks and erosion channels, increasing instability. The affected area is about 100 m by 90 m, indicating significant slope instability and potential risk to nearby land and infrastructure, while vegetation is sparse in the active zone with partial cover of grasses, shrubs, and trees.

4.1.1.6 Elements at Risk

The landslide poses a risk to two households located upslope and adjacent to the affected area, as well as nearby agricultural land, terrace farming areas, and a rural road section passing close to the toe of the landslide. Further expansion of the landslide could cause additional damage to surrounding settlements and infrastructure.

4.1.1.7 Hazard Severity and Risk Level

Based on field observations, slope condition, movement indicators, and exposure of vulnerable elements:

Hazard Severity: High

Risk Level: Moderate

The combination of active slope movement, continuous rainfall infiltration, rural roads, and proximity of settlements indicates a high probability of future damage if no mitigation measures are implemented.

4.1.1.8 Recommended Mitigation Measures

The following mitigation measures are recommended:

- Construction of surface and subsurface drainage systems.
- Retaining structures (gabion walls and breast walls) at the roadside.
- Toe protection works against stream erosion.

Site-Wise Rapid Assessment

4.1.1.9 Relocation Requirement (if necessary)

At present, relocation is not required as the nearby households are outside the active landslide zone. However, mitigation measures and continuous monitoring are recommended, especially during the monsoon season, to ensure safety.

4.1.1.10 Site Photographs



Photograph 1 Landslide Site, Paireni Tol

4.1.2 Suryodaya-1, SD-1 LS 2 (Shree Khola Chhghare, Shree Khola Tol)

4.1.2.1 Location and Accessibility

Located at Shree Khola Chhaghare (Shree Khola Tol), Ward No. 1 of Suryodaya Municipality, accessible via the Sano Banghi–Mane Bhanjyang road.

4.1.2.2 Hazard Type

Reactivated debris flow and localized landslide within an old landslide mass.

4.1.2.3 Geological and Geomorphological Conditions

The area consists of old colluvial landslide deposits with organic soil over sandy to silty clay derived from weathered gneiss and schist on a gentle to steep convex-concave slope.

Site-Wise Rapid Assessment

4.1.2.4 *Cause and Triggering Factors*

Heavy rainfall, irrigation seepage, and reactivation of an old landslide mass are the main contributing factors.

4.1.2.5 *Current Site Condition*

The landslide is active with localized cracks and ongoing slope movement affecting cultivated land and nearby structures.

4.1.2.6 *Elements at Risk*

One house, agricultural land, and the Sano Banghi–Mane Bhanjyang road are exposed to potential damage.

4.1.2.7 *Hazard Severity and Risk Level*

The hazard severity is moderate to high, with an overall community risk level classified as high.

4.1.2.8 *Recommended Mitigation Measures*

Implement surface and subsurface drainage management, construct retaining/support walls, and conduct regular monitoring during the monsoon season.

4.1.2.9 *Relocation Requirement (if necessary)*

Relocation of the affected household is recommended due to the reactivation of the old landslide.

4.1.2.10 *Site Photographs*

Photograph 2 Landslide Site, Shreekhola Chaghare

4.1.3 *Suryodaya-1, SD-1 LS 3 (Bilaunepakha Durga Bhawani Tol)*4.1.3.1 *Location and Accessibility*

Located at Bilaunepakha (Durga Bhawani Tol), Ward No. 1 of Suryodaya Municipality, accessible via the Fikkal–Jogmai road corridor.

4.1.3.2 Hazard Type

Localized translational and rotational landslide with associated channel-side debris flow activity.

4.1.3.3 Geological and Geomorphological Condition

The area consists of colluvial deposits and residual soil over weathered and fractured gneissic bedrock on moderately steep to steep slopes adjacent to the Jogmai River.

4.1.3.4 Cause and Triggering Factors

The landslide is primarily caused by river toe erosion, weak colluvial materials, road slope cutting, poor drainage, and intense monsoon rainfall.

4.1.3.5 Current Site Condition

The slope remains active with shallow debris movement, fresh exposed soil, loose colluvial deposits, and localized runoff channels descending toward the river.

4.1.3.6 Elements at Risk

The Fikkal–Jogmai road, nearby cultivated land, and local transportation access are exposed to potential damage.

4.1.3.7 Hazard Severity and Risk Level

The hazard severity is low; however, the overall community risk level is currently classified as low due to the limited number of exposed households.

4.1.3.8 Recommended Mitigation Measures

Construct drainage diversion channels, gabion toe protection, retaining structures, and implement proper surface water management.

4.1.3.9 Relocation Requirement (if necessary)

Relocation is not currently required, as no houses are under direct threat, but continuous monitoring is recommended.

4.1.3.10 Site Photographs



Photograph 3 Landslide Site, Bilaune Pakba

4.1.1 Suryodaya-1, SD-1 LS 4 (Ghising Gaun (Makarjung))

4.1.1.1 Location and Accessibility

Located at Ghising Gaun (Makarjung), Ward No. 1 of Suryodaya Municipality, Ilam District, on a steep terraced hillside accessible by a blacktop rural road and foot trails.

4.1.1.2 Hazard Type

Active translational landslide with progressive creep movement and localized slope deformation.

4.1.1.3 Geological and Geomorphological Condition

The area consists of thin residual soil, colluvial debris, and weathered rock mass on steep concave slopes within an old colluvial deposition zone affected by road cuts and poor drainage.

4.1.1.4 Cause and Triggering Factors

The instability is mainly caused by weak slope materials, road toe cutting, concentrated surface runoff, prolonged slope saturation, and intense monsoon rainfall.

4.1.1.5 Current Site Condition

The site exhibits active slope deformation, widening flanks, surface erosion, localized scarps, and downslope movement near clustered residential houses.

4.1.1.6 Elements at Risk

Eight households, terrace farmland, residential structures, rural roads, and foot trails are potentially exposed to continued slope movement.

Site-Wise Rapid Assessment

4.1.1.7 Hazard Severity and Risk Level

The hazard severity and community risk level are high, with a high probability of further movement during intense rainfall periods.

4.1.1.8 Recommended Mitigation Measures

Drainage improvement, surface runoff diversion, gabion and retaining structures, toe support measures, bioengineering, and regular crack monitoring are strongly recommended.

4.1.1.9 Relocation Requirement (if necessary)

Immediate relocation of two households is required, as they are located directly below the active crown area. Households situated within the active deformation zone should be closely monitored and considered for relocation if ground movement accelerates

4.1.1.10 Site Photographs



Photograph 4 Landslide Site, Ghising Gaun (Makarjung)

4.1.2 Suryodaya-1, SD-1 LS 5 (Teenghare (Purbeli Tol))

4.1.2.1 Location and Accessibility

Located at Teenghare (Purbeli Tol), Ward No. 1 of Suryodaya Municipality, Ilam District, situated along the Gorkhe–Manebhanjyang road corridor within a rural agricultural settlement.

4.1.2.2 Hazard Type

Active and reactivated translational landslide with associated shallow debris flow, soil creep, and localized erosion.

4.1.2.3 Geological and Geomorphological Condition

The site consists of thick residual and colluvial soils on moderately steep terraced slopes with natural spring seepage and concave topography that concentrates monsoon runoff.

4.1.2.4 Cause and Triggering Factors

The instability is primarily controlled by weak colluvial materials, geological conditions, intense rainfall, irrigation seepage, seasonal saturation, and concentrated surface runoff.

4.1.2.5 Current Site Condition

The landslide is characterized by a shallow scarp, downslope displacement, minor gullies, surface erosion, and shallow debris movement, with previously observed cracks that have been filled by local residents.

4.1.2.6 Elements at Risk

Two households, foot trails, approximately 4 ropani of cultivated land, and a population of about 12 people are directly exposed to potential future landslide expansion.

4.1.2.7 Hazard Severity and Risk Level

The probability of occurrence is high during intense and prolonged rainfall, and the community risk level is considered high due to the potential impact on houses, agricultural land, and livelihoods.

4.1.2.8 Recommended Mitigation Measures

Detailed investigation of drainage conditions, proper surface and subsurface drainage management, runoff diversion, and continuous monitoring during the monsoon season are strongly recommended.

4.1.2.9 Relocation Requirement (if necessary)

Immediate relocation of one household is required. The other two households, located within the active influence zone, should be closely monitored and considered for relocation if the landslide expands or reactivates.

4.1.2.10 *Site Photographs*

Photograph 5 Landslide Site, Teenghare (Purbeli Tol)

4.1.3 **Suryodaya-1, SD-1 LS 6 (Chhaghare Jirel, Sagharmatha Tol)**4.1.3.1 *Location and Accessibility*

Located at Chhaghare, Jirel area of Suryodaya Municipality, Ilam District, along the rural road connecting Manebhanjyang and surrounding settlements.

4.1.3.2 *Hazard Type*

Active translational landslide and debris slide developed within a forested natural slope, showing both shallow and deep-seated failure characteristics.

4.1.3.3 *Geological and Geomorphological Condition*

The site consists of thin residual soil over thick gravel- and boulder-dominated colluvial deposits with highly weathered slope materials. Natural springs, seepage zones, and dense vegetation are present throughout the landslide body.

4.1.3.4 *Cause and Triggering Factors*

The instability is primarily caused by road-cut excavation, weak colluvial materials, slope saturation, concentrated runoff, and intense monsoon rainfall.

4.1.3.5 *Current Site Condition*

The landslide exhibits exposed scarps on the midslope, tension cracks near the crown and road alignment, active soil erosion, and continued movement along the slide body. Dense vegetation conceals parts of the landslide, while seepage and runoff continue to weaken the slope.

4.1.3.6 *Elements at Risk*

The main element at risk is the road connecting Manebhanjyang and nearby settlements. Continued movement may result in road-edge failure, blockage of transportation routes, and disruption of local connectivity and economic activities.

4.1.3.7 *Hazard Severity and Risk Level*

The probability of further movement is high during the monsoon season. Although no houses are directly threatened, the hazard level is moderate due to the importance of the road network and the potential impact on access and transportation.

4.1.3.8 *Recommended Mitigation Measures*

Detailed geotechnical investigation, comprehensive drainage management, stabilization of road-cut slopes, rehabilitation of damaged gabion structures, and control of surface runoff are recommended before further road improvements are undertaken.

4.1.3.9 *Relocation Requirement (if necessary)*

Relocation is not required as there are no households within the active hazard zone; however, regular monitoring of cracks, seepage zones, and road conditions is strongly recommended.

4.1.3.10 *Site Photographs*





Photograph 6 Landslide Site, Chhaghare Jirel (Sagarmatha Tol)

4.1.4 Suryodaya-1, SD-1 LS 7 (Khadka Gau, Indreni Tol)

4.1.4.1 Location and Accessibility

Located at Indreni Tole, Khadka Gaun (Satghare), Ward No. 1 of Suryodaya Municipality, Ilam District, within a rural agricultural settlement situated on steep hillslopes above Thapa Kholsa.

4.1.4.2 Hazard Type

The site is affected by a reactivated and active composite landslide consisting of translational sliding, debris flow, and slow creep movement.

4.1.4.3 Geological and Geomorphological Condition

The area is characterized by spur-and-ridge topography with steep convex-concave slopes, terraced agricultural land, road-cut slopes, and a dendritic drainage network. The slope descends toward Thapa Kholsa and exhibits several localized unstable zones.

4.1.4.4 Cause and Triggering Factors

The landslide mass comprises residual soil, colluvial deposits, and fractured to highly weathered gneiss bedrock. Loose slope materials, erosional gullies, and instability associated with road-cut excavation are evident throughout the affected area.

4.1.4.5 Current Site Condition

The instability was significantly reactivated during the intense rainfall event of Ashwin 18–19, 2082, resulting in concentrated runoff, terrace erosion, debris movement, and localized slope failures. Bare soil exposures, erosion scars, and disturbed ground conditions are visible along rural roads and cultivated terraces.

4.1.4.6 *Elements at Risk*

Three households, approximately 5 ropani of agricultural land, local rural roads, and a population of about 14 people are exposed to potential impacts. Cracking has already been observed in at least one house, indicating ongoing ground movement.

4.1.4.7 *Hazard Severity and Risk Level*

The probability of further landslide occurrence is high during periods of intense or prolonged rainfall, and the overall community risk level is considered high due to the potential impacts on houses, agricultural land, and access roads.

4.1.4.8 *Recommended Mitigation Measures*

Immediate drainage improvement is strongly recommended to reduce infiltration and concentrated runoff. Additional measures should include detailed geotechnical investigation, stabilization of vulnerable slope sections, maintenance of existing rock and gabion structures, runoff diversion, and continuous monitoring of cracks and ground movement.

4.1.4.9 *Relocation Requirement (if necessary)*

One household requires immediate relocation due to its proximity to the active crown area. The site remains treatable; however, a detailed engineering investigation and appropriate slope stabilization measures are necessary before long-term mitigation can be implemented..

4.1.4.10 *Site Photographs*





Photograph 7 Landslide Site, Khadka Gaun (Indreni Tol)

4.1.5 Suryodaya-1, SD-1 LS 8 (Manebhanjyang)

4.1.5.1 Location and Accessibility

The landslide site is located at Manebhanjyang (Sunakhari Tole), Suryodaya Municipality–01, Ilam District. The site is accessible through a rural earthen road connecting Manebhanjyang with nearby settlements. The road follows the natural slope contour and passes through the unstable slope section, making it vulnerable during monsoon periods..

4.1.5.2 Hazard Type

The site represents an active shallow-seated translational debris failure (CAT-II) involving residual soil, colluvial deposits, and weathered rock materials. The failure is mainly associated with seasonal monsoon-related slope instability.

4.1.5.3 Geological and Geomorphological Condition

The area is situated in moderately steep mountainous terrain with localized convex slope geometry. The slope comprises loose colluvial and residual soils with boulder-mixed debris over weathered rock. Active erosion, debris accumulation, drainage concentration, and multiple springs within the landslide body indicate high infiltration potential and reduced slope stability during rainfall events..

4.1.5.4 Cause and Triggering Factors

The main causes of instability are weak and loose colluvial materials, rural road cutting, inadequate drainage management, and natural slope modification. The major triggering factors are intense monsoon rainfall, infiltration-induced saturation, concentrated runoff, and seasonal erosion, which promote debris movement and widening of the unstable zone..

4.1.5.5 *Current Site Condition*

The landslide is currently active with observed road cut instability, loose debris accumulation, minor hill erosion, and active erosional gullies. Tension cracks are present near the head portion, with moderate widening along the left flank and minor widening along the right flank. Existing gabion protection is present but partially affected by debris deposition. No direct structural damage has been reported.

4.1.5.6 *Elements at Risk*

The major element at risk is the rural road connecting Manebhanjyang to surrounding areas. The landslide also affects nearby cultivable land and may disrupt agricultural activities and transportation of agricultural products. No houses are currently located within the immediate risk zone.

4.1.5.7 *Hazard Severity and Risk Level*

The hazard condition is assessed as moderate, with higher susceptibility during intense rainfall and monsoon periods. The community risk level is low due to absence of houses within the immediate hazard area; however, the risk to road connectivity and local infrastructure is considered moderate.

4.1.5.8 *Recommended Mitigation Measures*

The site is considered treatable through combined civil and bioengineering approaches. Recommended measures include improvement of surface drainage, construction of retaining and toe support structures, strengthening of existing gabion protection, stabilization of road cuts, debris management, and plantation of suitable vegetation for erosion control.

4.1.5.9 *Relocation Requirement (if necessary)*

No relocation is required at present as there are no houses immediately threatened by the landslide. Regular monitoring is recommended, particularly during the monsoon season, to identify any expansion of the unstable zone toward settlement areas.

4.1.5.10 *Site Photographs*





Photograph 8 Landslide Site, Manebhanjyang (Sunakhari Tol)

4.1.6 Suryodaya-2, SD-2 LS 1 (Siddhikhola Chhetra)

4.1.6.1 Location and Accessibility

Located in the Siddhikhola area of Ward No. 2, Suryodaya Municipality, Ilam District, and accessible through local rural roads and agricultural trails.

4.1.6.2 Hazard Type

Active translational landslide and debris flow associated with stream-bank erosion along Siddhikhola.

4.1.6.3 Geological and Geomorphological Condition

The site comprises residual soil, colluvium, and alluvium on moderately steep to steep dissected slopes adjacent to an active stream channel.

4.1.6.4 Cause and Triggering Factors

The hazard is mainly caused by stream toe erosion, weak colluvial-alluvial materials, poor drainage, concentrated runoff, and intense rainfall.

4.1.6.5 Current Site Condition

Active debris flow and bank erosion are occurring along Siddhikhola, with debris accumulation, channel erosion, and minor widening of the left flank.

4.1.6.6 Elements at Risk

Two households, agricultural land, and the local rural access road are potentially exposed to future slope movement and erosion.

4.1.6.7 Hazard Severity and Risk Level

The probability of occurrence is high during intense rainfall, but the current community risk level is low due to the limited number of exposed households.

Site-Wise Rapid Assessment

4.1.6.8 Recommended Mitigation Measures

Construction of gabion toe protection, drainage improvement, bioengineering measures, and stream-bank stabilization are recommended.

4.1.6.9 Relocation Requirement (if necessary)

Relocation is not currently required; however, continued monitoring is recommended if erosion progresses toward the settlement.

4.1.6.10 Site Photographs



Photograph 9 Landslide Site, Siddhikboula Area

4.1.7 Suryodaya-2, SD-2 LS 2 (Manedanda Tol)

4.1.7.1 Location and Accessibility

Located at Manedanda Tole, Ward No. 2 of Suryodaya Municipality, Ilam District, Koshi Province. The settlement is situated on a moderately steep to steep terraced hillslope and is primarily dependent on agriculture.

4.1.7.2 Hazard Type

The site is affected by reactivated and active shallow translational landslides and debris slides.

4.1.7.3 *Geological and Geomorphological Condition*

The area consists of residual and colluvial soils developed on steep terraced slopes with localized drainage concentration, gullies, perennial streams, and possible old colluvial deposits. Multiple slope breaks created by road construction have further weakened slope stability.

4.1.7.4 *Cause and Triggering Factors*

The instability is mainly triggered by intense rainfall, slope saturation, concentrated surface runoff, weak lithology, cultivation practices, poor drainage conditions, and road-cut excavation.

4.1.7.5 *Current Site Condition*

Two active landslides are present on concave slopes located on either side of a convex hillslope spur. The failures are dominated by fine-grained debris movement flowing toward Siddha Khola, accompanied by active erosion, localized cracking, hanging debris, and progressive expansion of the failure zones.

4.1.7.6 *Elements at Risk*

Roads, houses, foot trails, and approximately 2 ropani of cultivated land are exposed to the hazard. One house has already been completely destroyed, and six households are currently at immediate risk.

4.1.7.7 *Hazard Severity and Risk Level*

The probability of further landslide occurrence is high, particularly during the monsoon season, and the community risk level is assessed as high due to the presence of vulnerable households and infrastructure within the active landslide zone.

4.1.7.8 *Recommended Mitigation Measures*

Proper drainage management, surface runoff diversion, crack monitoring, bioengineering measures, and public awareness programs are urgently recommended to reduce ongoing slope instability.

4.1.7.9 *Relocation Requirement (if necessary)*

Relocation of one household located within the active landslide zone is required, while the remaining households in the same zone should be closely monitored and reassessed if slope movement shows any signs of increase.

4.1.7.10 Site Photographs



Photograph 10 Landslide Site, Manedanda Tol

4.1.8 Suryodaya-2, SD-2 LS 3 (Arthetar Tol)

4.1.8.1 Location and Accessibility

Located at Arthetar Tole, Ward No. 2 of Suryodaya Municipality, Ilam District, Koshi Province. The settlement is situated on an agricultural hillslope and is accessible through local roads and foot trails.

4.1.8.2 Hazard Type

The site is affected by a localized shallow translational landslide with minor debris movement.

4.1.8.3 Geological and Geomorphological Condition

The area consists of residual soil over weathered colluvial deposits, with weak silty clay-dominated surficial materials. The topography is characterized by a moderately sloping cultivated hillside with localized drainage concentration.

4.1.8.4 *Cause and Triggering Factors*

The instability is primarily caused by rainfall, poor drainage management, weak near-surface soil materials, and localized concentration of surface runoff.

4.1.8.5 *Current Site Condition*

The landslide is characterized by a fresh scarp, shallow soil displacement, slight widening at the head scarp, and localized failure along a cut slope section. The affected area remains relatively small and localized.

4.1.8.6 *Elements at Risk*

Roads, cultivated terraces, nearby houses, and agricultural land are exposed to potential impacts. One household is considered to be at immediate risk.

4.1.8.7 *Hazard Severity and Risk Level*

The probability of further landslide occurrence is moderate, particularly during the monsoon season, while the overall community risk level is assessed as low to moderate.

4.1.8.8 *Recommended Mitigation Measures*

Improvement of surface drainage, runoff diversion, localized slope protection, bioengineering measures, and periodic monitoring of the failure area are recommended.

4.1.8.9 *Relocation Requirement (if necessary)*

Relocation is not currently required.

4.1.8.10 *Site Photographs*





Photograph 11 Landslide Site, Arthetar Tol

4.1.9 Suryodaya-2, SD-2 LS 4 (Deurali Tol)

4.1.9.1 Location and Accessibility

Located at Deurali Tol, Ward No. 2 of Suryodaya Municipality, Ilam District, and accessible through the local rural road network.

4.1.9.2 Hazard Type

Active translational landslide and debris slide associated with road-cut instability and localized erosion.

4.1.9.3 Geological and Geomorphological Condition

The area comprises colluvial soil and weathered gneiss bedrock on moderately steep concave slopes with gullies, kholsis, and multiple erosion scarps.

4.1.9.4 Cause and Triggering Factors

The instability is mainly caused by geological weakness, road cutting, toe erosion, poor drainage, slope saturation, and intense monsoon rainfall.

4.1.9.5 Current Site Condition

The site remains active with fresh exposed scarps, localized debris deposition, gully erosion, and widening of the right flank during rainfall events.

4.1.9.6 Elements at Risk

Rural roads, three households, agricultural land, forest areas, and local infrastructure are potentially exposed to future slope movement.

4.1.9.7 Hazard Severity and Risk Level

The hazard severity and community risk level are moderate, with the likelihood of reactivation increasing during intense monsoon rainfall.

Site-Wise Rapid Assessment

4.1.9.8 *Recommended Mitigation Measures*

Construction of retaining and support walls, proper roadside drainage canals, runoff management, and stabilization of loose slope materials are recommended.

4.1.9.9 *Relocation Requirement (if necessary)*

Relocation is not immediately required; however, households located close to the active landslide boundary should be regularly monitored.

4.1.9.10 *Site Photographs*

Photograph 12 Landslide Site, Deurali Tol

4.1.10 *Suryodaya-2, SD-2 LS 5 (Mayukhola Area)*4.1.10.1 *Location and Accessibility*

Located in the Mayukhola Area of Ward No. 2, Suryodaya Municipality, Ilam District, within steep mountainous terrain traversed by rural roads and agricultural terraces.

4.1.10.2 *Hazard Type*

Reactivated translational landslide with associated debris flow and stream-bank erosion.

4.1.10.3 Geological and Geomorphological Condition

The site consists of colluvial soil deposits and weathered bedrock on steep terraced slopes, with active toe erosion by Mayu Khola and localized gullies.

4.1.10.4 Cause and Triggering Factors

The instability is mainly caused by intense rainfall, slope saturation, road-cut excavation, weak colluvial materials, and poor surface drainage.

4.1.10.5 Current Site Condition

The landslide exhibits shallow slope failures, debris deposition, toe cutting, road instability, and damage to agricultural terraces.

4.1.10.6 Elements at Risk

Two households, rural roads, and terrace farmland are potentially exposed to future landslide activity.

4.1.10.7 Hazard Severity and Risk Level

The probability of occurrence and community risk level are high, particularly during intense monsoon rainfall.

4.1.10.8 Recommended Mitigation Measures

Drainage improvement, crack monitoring, toe stabilization, bioengineering measures, and roadside slope protection are recommended.

4.1.10.9 Relocation Requirement (if necessary)

Immediate relocation of one household is required, as it lies within the landslide flow path. The other households located near the active zone should be closely monitored, particularly during the monsoon.

4.1.10.10 Site Photographs



Photograph 13 Landslide Site, Mayukhola Area

4.1.11 Suryodaya-2, SD-2 LS 6 (Makhamali Tol)

4.1.11.1 Location and Accessibility

Located at Makhamali Tol, Ward No. 2 of Suryodaya Municipality, Ilam District, within a terraced agricultural settlement situated on a mid-slope hilly terrain above Mayu Khola.

4.1.11.2 Hazard Type

Reactivated translational landslide with shallow to moderately deep debris slide characteristics.

4.1.11.3 Geological and Geomorphological Condition

The site consists of colluvial soil deposits, weathered bedrock, and localized seepage zones, with thick colluvial accumulation in the lower slope section.

4.1.11.4 Cause and Triggering Factors

The instability is primarily caused by intense rainfall, slope saturation, irrigation seepage, road-cut excavation, weak colluvial materials, and concentrated surface runoff.

4.1.11.5 Current Site Condition

The landslide extends from the road section downslope toward Mayu Khola, showing active scarps, terrace deformation, vegetation disturbance, and progressive movement along natural drainage paths.

4.1.11.6 Elements at Risk

Four households, approximately 18 people, agricultural terraces, rural roads, and foot trails are directly exposed to the hazard.

4.1.11.7 Hazard Severity and Risk Level

The probability of future landslide occurrence is high, and the overall community risk level is considered high due to the presence of households within the active influence zone.

Site-Wise Rapid Assessment

4.1.11.8 *Recommended Mitigation Measures*

Immediate drainage diversion, surface runoff management, toe protection measures, bioengineering, and engineered stabilization structures are strongly recommended.

4.1.11.9 *Relocation Requirement (if necessary)*

Relocation is not immediately required; however, the four households within the active landslide influence area should be closely monitored and considered for relocation if movement continues or accelerates.

4.1.11.10 *Site Photographs*

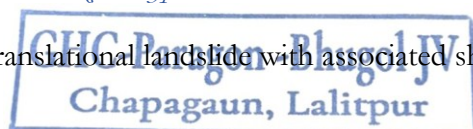
Photograph 14 Landslide Site, Makhamali Tol

4.1.12 *Suryodaya-3, SD-3 LS 1 (Mehelbote)*4.1.12.1 *Location and Accessibility*

Located at Mehelbote, Ward No. 3 of Suryodaya Municipality, Ilam District, within a cultivated terraced hillside characterized by concentrated drainage and seasonal spring activity.

4.1.12.2 *Hazard Type*

Active translational landslide with associated shallow debris movement.



4.1.12.3 *Geological and Geomorphological Condition*

The site consists of thin residual soil over thick colluvial deposits, with saturated sandy to silty clay soils and weak slope materials susceptible to rainfall-induced failure.

4.1.12.4 *Cause and Triggering Factors*

The instability is primarily caused by concentrated surface drainage, slope saturation, weak colluvial materials, poor agricultural drainage practices, and intense monsoon rainfall.

4.1.12.5 *Current Site Condition*

The landslide extends downslope toward the road corridor and is characterized by active widening, shallow debris movement, erosion gullies, and progressive deformation of cultivated terraces.

4.1.12.6 *Elements at Risk*

Three households, approximately 5 ropani of agricultural land, rural roads, and foot trails are exposed to potential impacts from continued slope movement.

4.1.12.7 *Hazard Severity and Risk Level*

The probability of further landslide activity is high during intense and prolonged rainfall, and the overall community risk level is considered high.

4.1.12.8 *Recommended Mitigation Measures*

Immediate surface drainage management, improvement of terrace drainage, scientific irrigation practices, bioengineering measures, and regular monitoring during the monsoon season are strongly recommended.

4.1.12.9 *Relocation Requirement (if necessary)*

One household requires immediate relocation, as the house is located directly within the landslide flow path and below the active crown area, where reactivation could result in the house being swept away. The site is treatable through appropriate drainage and slope stabilization measures; however, the other three households within the affected zone should be closely monitored, particularly during future monsoon seasons.

4.1.12.10 Site Photographs



Photograph 15 Landslide Site, Mehelbote

4.1.13 Suryodaya-4, SD-4 LS 1 (Sankate (Unuytar Tol))

4.1.13.1 Location and Accessibility

Located at Sankate (Unuytar Tol), Ward No. 4 of Suryodaya Municipality, Ilam District, Koshi Province.

4.1.13.2 Hazard Type

The site is affected by an active to reactivated deep-seated translational landslide associated with long-term creep movement.

4.1.13.3 Geological and Geomorphological Condition

The area is situated on a moderately steep to steep slope exhibiting old landslide morphology and active drainage channels. Geological conditions comprise thin residual soil over thick colluvial deposits resting on weathered and fractured bedrock.

4.1.13.4 Cause and Triggering Factors

The instability is mainly controlled by monsoon rainfall, drainage concentration, poor surface drainage, weak slope materials, old landslide reactivation, and road-cut excavation.

4.1.13.5 Current Site Condition

The landslide is characterized by prominent crown cracks, downslope movement, localized slope failures, road cracking, and gradual retrogressive expansion. The landslide body extends beyond the road corridor and continues to affect the surrounding slope.

4.1.13.6 Elements at Risk

Approximately 20 people, residential structures, roads, and agricultural land are exposed to the hazard.

4.1.13.7 Hazard Severity and Risk Level

The probability of further landslide occurrence is high, and the community risk level is assessed as high due to the active nature of the landslide and its direct impact on settlement and transportation infrastructure.

4.1.13.8 Recommended Mitigation Measures

Immediate surface drainage management is recommended, together with bioengineering measures, civil engineering stabilization works, toe protection, and continuous monitoring of slope movement.

4.1.13.9 Relocation Requirement (if necessary)

Relocation of one household located within the active landslide zone is required, while the remaining households in the same zone should be closely monitored and reassessed if slope movement shows any signs of increase.

4.1.13.10 Site Photographs



Photograph 16 Landslide Site, Sankate (Unnytar Tol)

4.1.14 Suryodaya-4, SD-4 LS 2 (Salleri)

4.1.14.1 Location and Accessibility

Located at Salleri, Ward No. 4 of Suryodaya Municipality, Ilam District, Koshi Province. The site is accessible through a rural road and lies within a tea cultivation area.

4.1.14.2 Hazard Type

Active shallow translational soil slide.

4.1.14.3 Geological and Geomorphological Condition

The site is situated on a moderately steep hillslope with tea plantation terraces, where a convex upper slope transitions into a concave lower slope. Localized drainage concentration and residual soil over colluvial deposits contribute to slope instability.

4.1.14.4 Cause and Triggering Factors

The landslide is primarily caused by road-cut excavation, concentrated surface runoff, weak sandy-colluvial soil materials, and intense monsoon rainfall.

4.1.14.5 Current Site Condition

A fresh crown scarp is visible above and below the rural road. The landslide extends downslope through tea cultivation areas with ongoing surface erosion and minor retrogressive movement. Limited flank activity is observed.

4.1.14.6 Elements at Risk

The rural road and tea plantation land are the main exposed elements. No residential structures are currently at risk.

Site-Wise Rapid Assessment

4.1.14.7 Hazard Severity and Risk Level

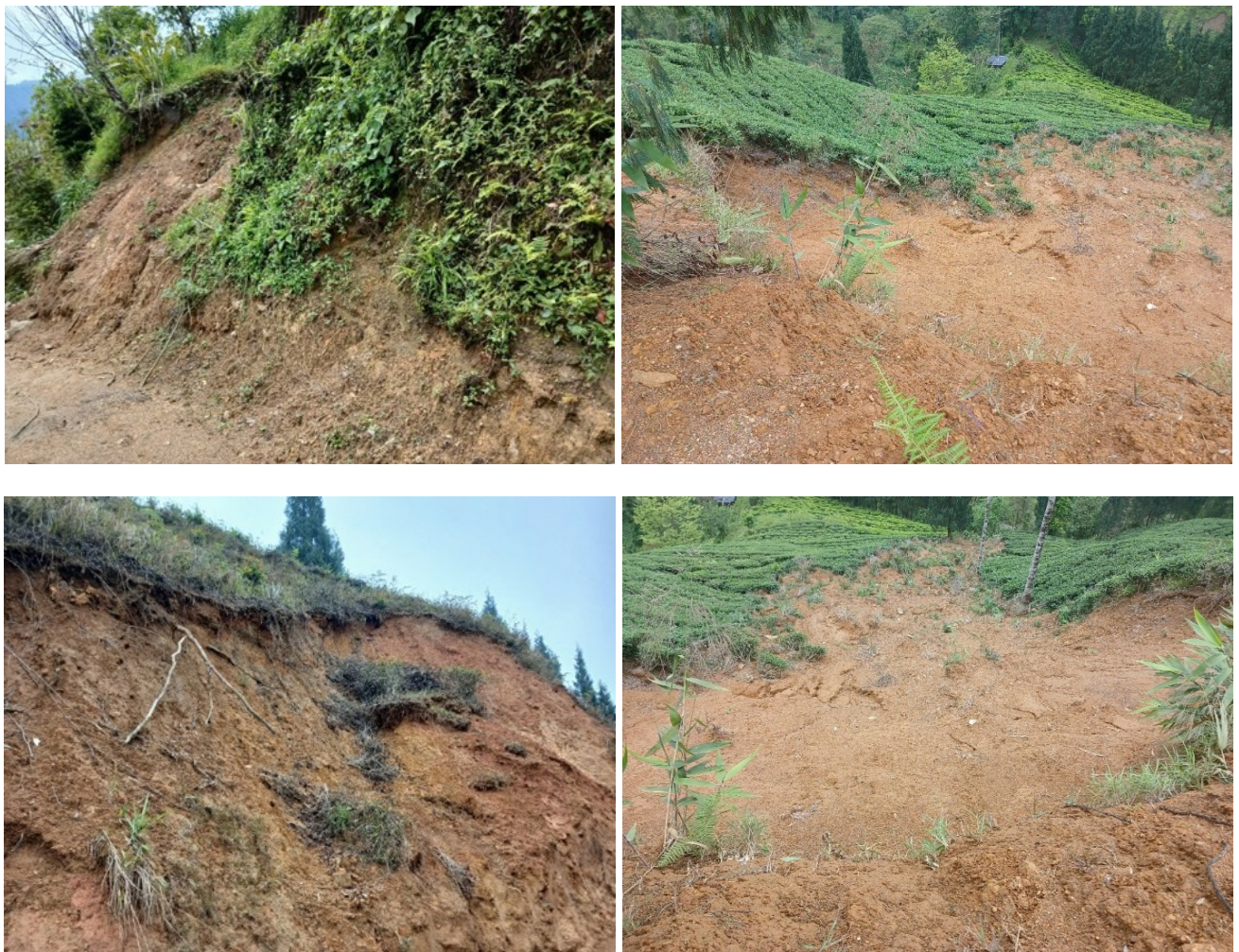
The probability of further landslide occurrence is moderate, while the overall community risk level is low due to the absence of nearby settlements and population exposure.

4.1.14.8 Recommended Mitigation Measures

Road drainage correction, proper surface water management, runoff diversion, and bioengineering measures are recommended to prevent further erosion and slope degradation.

4.1.14.9 Relocation Requirement (if necessary)

Relocation is not required.

4.1.14.10 Site Photographs

Photograph 17 Landslide Site, Salleri

4.1.15 Suryodaya-4, SD-4 LS 3 (Shreebung)

4.1.15.1 Location and Accessibility

Located at Shreebung, Ward No. 4 of Suryodaya Municipality, Ilam District, Koshi Province. The settlement is accessible through rural tracks and foot trails and supports an agriculture-based rural economy.

4.1.15.2 Hazard Type

Active to reactivated shallow translational landslides and debris slides.

4.1.15.3 Geological and Geomorphological Condition

The site is situated on a moderately steep terraced hillslope with a convex upper slope transitioning into a concave lower slope. Gullies and seasonal drainage channels are present. Geological conditions comprise thin residual soil over loose colluvial deposits developed on cultivated terraces.

4.1.15.4 Cause and Triggering Factors

The instability is primarily caused by weak colluvial soil, poor surface drainage, concentrated runoff, and intense monsoon rainfall.

4.1.15.5 Current Site Condition

Two localized shallow slope failures are present on the eastern side of the settlement. Active surface erosion, minor retrogression, and the potential for widening during future monsoon events are observed.

4.1.15.6 Elements at Risk

Five households, terrace fields, rural tracks, and foot trails are exposed to potential impacts, with approximately 28 people considered at risk.

4.1.15.7 Hazard Severity and Risk Level

The probability of further landslide occurrence is moderate, and the community risk level is assessed as moderate.

4.1.15.8 Recommended Mitigation Measures

Surface drainage improvement, runoff management, bioengineering measures, localized civil engineering stabilization works, monitoring, and community awareness and preparedness programs are recommended.

4.1.15.9 Relocation Requirement (if necessary)

Relocation is not currently required, but the affected households should be monitored during intense rainfall periods.

4.1.15.10 Site Photographs



Photograph 18 Landsite Site, Shreebung

4.1.16 Suryodaya-4, SD-4 LS 4 (Thalukhola (Bhalukhola Area))

4.1.16.1 Location and Accessibility

Located at Bhalukhola/Thalukhola Khand, Ward No. 4 of Suryodaya Municipality, Ilam District, Koshi Province. The area consists of a small rural settlement with agricultural activities and is connected by rural roads, foot trails, and a bridge crossing Bhaluhola.

4.1.16.2 Hazard Type

The site is affected by localized translational landslides and debris-flow-related slope failures associated with drainage concentration and channel erosion.

4.1.16.3 Geological and Geomorphological Condition

The terrain is characterized by moderately steep to steep dissected hillslopes with convergent drainage patterns, active gullies, and erosion-prone slopes. The geological setting consists of residual and colluvial soils, slope-wash deposits, and alluvial/gully materials over weathered bedrock.

4.1.16.4 Cause and Triggering Factors

The instability is primarily caused by intense rainfall, concentrated surface runoff, drainage-channel erosion, slope saturation, weak colluvial materials, and toe erosion along Bhalukhola.

4.1.16.5 Current Site Condition

The area exhibits multiple localized slope failures, active erosional gullies, debris accumulation, drainage concentration, and roadside instability. Although some sections appear relatively stabilized, there remains a possibility of reactivation during periods of intense rainfall.

4.1.16.6 Elements at Risk

Rural roads, foot trails, bridge infrastructure, and nearby agricultural land are exposed to potential impacts. No households are currently under immediate threat, and no direct population exposure has been identified.

4.1.16.7 Hazard Severity and Risk Level

The probability of hazard occurrence remains high due to recurring monsoon-induced erosion and debris movement; however, the overall community risk level is low because of the limited exposure of settlements.

4.1.16.8 Recommended Mitigation Measures

Drainage management, gully stabilization, surface runoff diversion, bioengineering measures, and localized civil engineering interventions are recommended to reduce future erosion and slope instability.

4.1.16.9 Relocation Requirement (if necessary)

Relocation is not required.

4.1.16.10 Site Photographs



Photograph 19 Landslide Site, Bhalukbola/Thalukbola Khand

4.1.17 Suryodaya-5, SD-5 LS 1 (Sungtung)

4.1.17.1 Location and Accessibility

Located at Sungtung, Ward No. 5 of Suryodaya Municipality, Ilam District, Koshi Province. The site is accessible through a rural road and is situated within an agricultural landscape.

4.1.17.2 Hazard Type

Active shallow translational landslide complex with associated debris-flow activity.

4.1.17.3 Geological and Geomorphological Condition

The area is characterized by steep dissected hillslopes, multiple convergent drainage channels, active erosion gullies, and evidence of old landslide scars. Geological conditions consist of thin residual soil and colluvial deposits over highly weathered and fractured gneiss and schist bedrock.

4.1.17.4 Cause and Triggering Factors

The instability is mainly caused by road-cut excavation, concentrated surface runoff, weak weathered slope materials, and intense monsoon rainfall.

4.1.17.5 Current Site Condition

The landslide consists of a complex shallow landslide mass with multiple debris-flow channels, crown cracks, active erosion, and localized widening. Minor to moderate retrogression and flank expansion are ongoing, with the potential for further reactivation during intense rainfall events.

4.1.17.6 Elements at Risk

The rural road is the primary exposed element. No houses or population are currently at immediate risk.

Site-Wise Rapid Assessment

4.1.17.7 Hazard Severity and Risk Level

Although the probability of localized reactivation exists during monsoon periods, the current community risk level is low due to the absence of residential exposure.

4.1.17.8 Recommended Mitigation Measures

Road drainage improvement, surface runoff management, retaining structures where necessary, bioengineering measures, and regular monitoring of crown cracks and drainage channels are recommended.

4.1.17.9 Relocation Requirement (if necessary)

Relocation is not required.

4.1.17.10 Site Photographs



Photograph 20 Landslide Site, Suntung

4.1.18 Suryodaya-5, SD-5 LS 2 (Ambitar)*4.1.18.1 Location and Accessibility*

Located at Suntung, Ward No. 5, Suryodaya Municipality, Ilam District, Koshi Province. The site is accessible through a rural road and lies within an agricultural landscape. No households are located within the immediate influence area.

4.1.18.2 Hazard Type

Active shallow translational landslide complex with associated debris-flow activity.

4.1.18.3 Geological and Geomorphological Condition

The site is situated on a steep dissected hillslope characterized by multiple convergent drainage channels, active erosion gullies, and old landslide scars. Geological materials comprise thin residual soil and colluvial deposits over highly weathered and fractured gneiss and schist bedrock.

4.1.18.4 Cause and Triggering Factors

The instability is primarily associated with road-cut excavation, concentrated surface runoff, weak weathered slope materials, and intense monsoon rainfall.

4.1.18.5 Current Site Condition

The landslide consists of a complex shallow landslide mass with multiple debris-flow channels, crown cracks, active erosion, minor to moderate retrogression, and localized widening. Seasonal reactivation is likely during periods of intense rainfall.

4.1.18.6 Elements at Risk

The rural road and agricultural land are the primary elements exposed to potential impacts.

4.1.18.7 Hazard Severity and Risk Level

Although the landslide remains active and reactivable, no households are currently exposed. The probability of hazard occurrence is low to moderate, while the community risk level is assessed as low to negligible.

4.1.18.8 Recommended Mitigation Measures

Road drainage improvement, surface runoff management, localized retaining structures where required, bioengineering measures, and periodic monitoring of crown cracks and debris-flow channels are recommended.

4.1.18.9 Relocation Requirement (if necessary)

No relocation is required as no households are located within the affected area.

4.1.18.10 Site Photographs



Photograph 21 Landslide Site, Ambitar

4.1.19 Suryodaya-5, SD-5 LS 3 (Mechi Bagar)

4.1.19.1 Location and Accessibility

Located at Mechi Bagar, Ward No. 5, Suryodaya Municipality, Ilam District, Koshi Province. The site is accessible through local rural roads and foot trails and is situated within an agricultural settlement area.

4.1.19.2 Hazard Type

Active translational landslide with debris-slide characteristics.

4.1.19.3 Geological and Geomorphological Condition

The site is located on a steep hillslope with a concave drainage catchment, dissected terrain, active gully development, and a stream at the slope toe. Geological conditions comprise residual soil over colluvial deposits containing boulder-rich sandy to silty clay materials.

4.1.19.4 Cause and Triggering Factors

The instability is primarily caused by intense rainfall, concentrated surface runoff, slope saturation, and weak colluvial slope materials. Monsoon rainfall acts as the principal triggering factor.

Site-Wise Rapid Assessment

4.1.19.5 *Current Site Condition*

The landslide is characterized by an elongated debris-slide mass with an exposed crown scarp located upslope of the settlement and a well-defined debris track extending downslope. Active retrogression, localized erosion, and potential debris movement toward the stream channel are ongoing concerns.

4.1.19.6 *Elements at Risk*

Residential houses, agricultural terraces, foot trails, drainage pathways, and local rural roads are exposed to potential impacts. Approximately 40 people are at risk, and 8 houses are considered to be under immediate threat from continued landslide activity.

4.1.19.7 *Hazard Severity and Risk Level*

The probability of further landslide occurrence is high, and the community risk level is assessed as high due to the active nature of the landslide and its proximity to residential areas and agricultural land.

4.1.19.8 *Recommended Mitigation Measures*

Immediate surface drainage management, regular monitoring, community preparedness programs, bioengineering measures, check dams, toe protection works, and appropriate retaining structures are recommended to reduce future slope movement and erosion.

4.1.19.9 *Relocation Requirement (if necessary)*

Immediate relocation of one household is required. The other households located near the active landslide boundary should be closely monitored, and relocation should be considered if landslide activity intensifies or the crown continues to retrogress toward the settlement.

4.1.19.10 *Site Photographs*



Photograph 22 Landslide Site, Ambe Tol

4.1.20 Suryodaya-7, SD-7 LS 1 (Ambe Tol)

4.1.20.1 *Location and Accessibility*

Located at Ambe Tol, Ward No. 7, Suryodaya Municipality, Ilam District, Koshi Province. The settlement is accessible through rural roads and foot trails and consists of 32 households with approximately 160 residents. The local economy is primarily based on agriculture and terrace farming.

4.1.20.2 *Hazard Type*

A reactivated complex landslide comprising rotational sliding, translational sliding, and localized debris-flow processes.

4.1.20.3 *Geological and Geomorphological Condition*

The site is situated on a moderately steep to steep hillslope characterized by converging runoff channels, a concave central depression, and localized gully erosion. Geological conditions consist of thin residual soil over thick colluvial deposits associated with an old landslide mass. Settlement and agricultural terraces have been developed on these colluvial materials, increasing vulnerability to slope instability.

4.1.20.4 *Cause and Triggering Factors*

The instability is primarily associated with weak colluvial soils, poor drainage conditions, slope saturation, slow creep movement, and prolonged monsoon rainfall. Seasonal rainfall acts as the principal triggering factor for reactivation.

4.1.20.5 *Current Site Condition*

The landslide exhibits exposed bare soil surfaces, active erosion rills, downslope debris transport, a central flow channel, and concealed tension cracks. Ongoing erosional widening and slight retrogression are evident, indicating continued instability and progressive slope degradation.

Site-Wise Rapid Assessment

4.1.20.6 Elements at Risk

Residential houses, agricultural terraces, foot trails, and the rural road are exposed to potential impacts. Two households are considered to be under immediate threat, although one household has already been relocated from the most hazardous area.

4.1.20.7 Hazard Severity and Risk Level

The probability of further landslide activity is high during monsoon periods. The community risk level is assessed as high due to the active nature of the landslide, continued erosion, and the presence of residential structures within the influence zone.

4.1.20.8 Recommended Mitigation Measures

Relocation is recommended for 1 household, while the other high-risk household has already been relocated from the active landslide zone.

4.1.20.9 Relocation Requirement (if necessary)

Relocation is recommended for one household, as the landslide is active and undergoing retrogression, and structural cracks are visible in the house.

4.1.20.10 Site Photographs



Photograph 23 Landslide Site, Ambe Tol

4.1.21 Suryodaya-9, SD-9 LS 1 (Dhode)

4.1.21.1 Location and Accessibility

Dhode Settlement, Suryodaya-09, Ilam District; located below Fikkal–Nayabazar road with hillside access through rural road network.

4.1.21.2 Hazard Type

Shallow translational debris slide with minor debris flow characteristics in the downslope portion.

4.1.21.3 Geological and Geomorphological Condition

Colluvial soil over bedrock on a $\sim 30^\circ$ dissected hillslope with convex upper slope and stream influence on both flanks.

4.1.21.4 Cause and Triggering Factors

Caused by road cutting and concentrated drainage; triggered mainly by intense rainfall and infiltration.

4.1.21.5 Current Site Condition

Active landslide with minor headward retrogression; erosion channel present and previous gabion wall collapsed.

4.1.21.6 Elements at Risk

Road, agricultural terraces (~ 32 ropani), and 1 previously affected house; minor population exposure (~ 4 persons).

4.1.21.7 Hazard Severity and Risk Level

Active but localized instability; overall risk moderate, with high probability of occurrence.

Site-Wise Rapid Assessment

4.1.21.8 Recommended Mitigation Measures

Slope stabilization with retaining structures, proper drainage management, toe protection, and bioengineering.

4.1.21.9 Relocation Requirement (if necessary)

No further relocation required as one house has already been relocated; additional relocation not necessary if mitigation is implemented.

4.1.21.10 Site Photographs



Photograph 24 Landslide Site, Dbode

4.1.22 Suryodaya-9, SD-9 LS 2 (Rai Gau)

4.1.22.1 Location and Accessibility

Suryodaya-09, Ilam District; Rai Gaun settlement located in mid-hill terrain with access via rural road network.

4.1.22.2 *Hazard Type*

Translational landslide with debris flow and earth flow characteristics involving colluvial and residual soil materials.

4.1.22.3 *Geological and Geomorphological Condition*

Colluvial and residual soils with thin organic cover on moderate to steep dissected slopes; poor drainage and spring activity present.

4.1.22.4 *Cause and Triggering Factors*

Triggered by rainfall and drainage concentration on weak slope materials with unmanaged surface runoff.

4.1.22.5 *Current Site Condition*

Reactivated active landslide with fresh scarp, visible cracks, and creep deformation (tree bending) along road section.

4.1.22.6 *Elements at Risk*

Rural road, foot trails, houses, and agricultural terraces (~50–60 ropani cultivable land) with ~5 people exposed.

4.1.22.7 *Hazard Severity and Risk Level*

Moderate to high risk at community level due to active movement and ongoing surface erosion; hazard probability is high.

4.1.22.8 *Recommended Mitigation Measures*

Drainage control, slope protection along road, bioengineering, and check dams for sediment and flow control.

4.1.22.9 *Relocation Requirement (if necessary)*

One household at immediate risk; no large-scale relocation needed, but local relocation may be required if movement intensifies.

Site-Wise Rapid Assessment

4.1.22.10 Site Photographs



Photograph 25 Landslide Site, Rai Gaun

4.1.23 Suryodaya-9, SD-9 LS 3 (Adarsha Tol)

4.1.23.1 Location and Accessibility

Suryodaya-09, Ilam District; Adarsha Tol settlement located on a mid-slope terrace system influenced by Padam Khola.

4.1.23.2 Hazard Type

Translational landslide with earth flow and active creep in colluvial soil with progressive deformation since 2072/2073.

4.1.23.3 Geological and Geomorphological Condition

Thick colluvial and residual soils with seepage zones; convex upper slope and concave lower slope with active river toe erosion.

Site-Wise Rapid Assessment

4.1.23.4 Cause and Triggering Factors

Triggered mainly by Padam Khola toe cutting, rainfall, and unmanaged drainage combined with road and slope cutting.

4.1.23.5 Current Site Condition

Active creep with ongoing reactivation, open tension cracks, terrace deformation, and moderate lateral widening of both flanks.

4.1.23.6 Elements at Risk

Six households, 35 people, agricultural terraces and village road; all houses within or near deformation zone.

4.1.23.7 Hazard Severity and Risk Level

High community risk with high probability of further movement due to continuous toe erosion and slope saturation.

4.1.23.8 Recommended Mitigation Measures

Toe protection restoration, drainage control, bioengineering, and detailed geotechnical investigation with continuous monitoring.

4.1.23.9 Relocation Requirement (if necessary)

All 6 houses at immediate risk; relocation may be required depending on movement rate and investigation outcomes.

4.1.23.10 Site Photographs



Photograph 26 Landsite Site, Adarsha Tol

4.1.24 Suryodaya-11, SD-11 LS 1 (Bhalu Khop)

4.1.24.1 Location and Accessibility

Located at Bhalu Khop, Ward No. 11 of Suryodaya Municipality, Ilam District, Koshi Province. The settlement supports an agriculture-based economy with some service-oriented business activities.

4.1.24.2 Hazard Type

The site is affected by a large reactivated deep-seated landslide characterized by translational sliding, debris flow, and long-term creep movement.

4.1.24.3 Geological and Geomorphological Condition

The area is situated on a moderately steep to steep mid-hill slope bounded by spurs on both sides and intersected by Birre Kholsi and numerous seasonal drainage channels. Geological conditions consist of thin residual soil and colluvial deposits over highly fractured and foliated gneiss bedrock, with foliation dipping toward the slope, creating unfavorable stability conditions.

4.1.24.4 Cause and Triggering Factors

The instability is mainly controlled by steep terrain, weak colluvial materials, slope saturation, concentrated surface drainage, road-cut excavation, and intense monsoon rainfall.

4.1.24.5 Current Site Condition

The landslide exhibits slow but persistent creep movement, evidenced by bent trees, deformed terraces, and deep tension cracks reaching 15–20 m in depth. Multiple debris slides, debris flows, erosional gullies, and localized failures are occurring within the larger creeping landslide mass. The landslide was first recognized around 2073 and has experienced periodic reactivation, including debris-flow activity associated with drainage blockage during 2082.

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4.1.24.6 *Elements at Risk*

Approximately 22 households, 108 residents, around 70 ropani of agricultural land, and an approximately 800 m section of the Mechi Highway are exposed to the hazard. Nineteen households are currently considered to be at immediate risk.

4.1.24.7 *Hazard Severity and Risk Level*

The probability of further landslide occurrence is high, and the community risk level is assessed as high to extremely high due to the large active landslide mass, extensive infrastructure exposure, and significant number of vulnerable households.

4.1.24.8 *Recommended Mitigation Measures*

Immediate drainage management is strongly recommended, together with scientific surface and subsurface drainage systems, retaining and slope-protection structures, bioengineering measures, erosion-control works, and detailed geotechnical investigation to guide long-term stabilization.

4.1.24.9 *Relocation Requirement (if necessary)*

Relocation should be considered for households located within the most active and high-risk sections of the landslide.

4.1.24.10 *Site Photographs*





Photograph 27 Landslide Site, Bhalu Khop

4.1.25 Suryodaya-12, SD-12 LS 1 (Rong Tol Kahare Khola Malim)

4.1.25.1 Location and Accessibility

The landslide site is located at Rongtol Khahare Khola Malim, Suryodaya Municipality–12, Ilam District. The area is accessible through local roads and trails connected to nearby settlements. The site is situated along a river valley where the slope is strongly influenced by the river channel and associated erosion processes.

4.1.25.2 Hazard Type

The site is affected by an active river-controlled translational debris slide/landslide. The landslide consists of residual soil and thick colluvial deposits with progressive slope deformation. Multiple scarps, tension cracks, and shallow debris failures indicate active movement.

4.1.25.3 Geological and Geomorphological Condition

The site is located on a moderately steep to steep mid-hill slope controlled by river valley processes. The slope comprises residual soil, thick colluvial deposits, and loose weathered materials over a soil–rock interface. The area is characterized by active river toe erosion, concave slope sections, concentrated surface runoff, and a highly dissected drainage network. Saturated zones are observed near drainage paths, increasing the susceptibility of slope failure.

4.1.25.4 Cause and Triggering Factors

The major causes of instability include continuous river bank erosion and toe cutting, weak and loose colluvial materials, natural steep slope conditions, drainage concentration, and slope saturation. The primary triggering factor is intense monsoon rainfall and flood events in Khahare Khola, which accelerate toe erosion, increase pore water pressure, and reactivate existing landslide features.

4.1.25.5 Current Site Condition

The landslide is currently active, showing large exposed scarps, tension cracks, debris accumulation, and ongoing river bank erosion. Active scarp development and headward retrogression are observed, with slight widening along both flanks. Localized debris slides and shallow translational failures are occurring, causing deformation of agricultural terraces and movement of debris toward the river channel.

4.1.25.6 Elements at Risk

The major elements at risk include agricultural terraces, local roads/trails, and irrigation canal infrastructure. Although there are no houses immediately affected, continued landslide expansion and river erosion may threaten local infrastructure, agricultural land, and community access routes.

4.1.25.7 Hazard Severity and Risk Level

The hazard condition is assessed as high during monsoon periods due to active river erosion, rainfall-induced saturation, and progressive slope movement. The overall community risk level is low to moderate because there are no settlements directly exposed; however, infrastructure and agricultural land remain vulnerable.

Hazard Category: CAT-II

Landslide Status: Active river-controlled translational debris slide

Risk Level: Low to Moderate (community), High (during extreme monsoon events)

4.1.25.8 Recommended Mitigation Measures

The site requires integrated slope and river management measures. Recommended interventions include river toe protection and river training works, construction of gabion walls/check dams, improvement of surface drainage, control of concentrated runoff, and bioengineering treatment of exposed slopes. Regular monitoring of tension cracks, scarps, and slope movement is recommended along with detailed geotechnical investigation for final stabilization design.

4.1.25.9 Relocation Requirement (if necessary)

Relocation is not required at present as there are no houses within the immediate hazard zone. However, periodic monitoring and preparedness measures are necessary due to the active nature of the landslide and possibility of future expansion toward nearby infrastructure and agricultural areas

4.1.25.10 *Site Photographs*

Photograph 28 Landslide Site, RongTol Khabare Khola Malim

4.1.26 Suryodaya-12, SD-12 LS 2 (Seti Devi Tol)

4.1.26.1 *Location and Accessibility*

The landslide site is located at Seti Devi Tole, Suryodaya Municipality–12, Ilam District. The site is accessible through a rural road network passing directly through the unstable slope area. The road alignment has influenced slope conditions by modifying the natural slope profile and intercepting subsurface water flow.

4.1.26.2 *Hazard Type*

The site is affected by an active/reactivated rotational–translational soil and debris landslide. The landslide represents a road-induced complex failure involving residual and colluvial materials. The presence of tension cracks, scarps, and active seepage indicates ongoing slope movement.

4.1.26.3 *Geological and Geomorphological Condition*

The area is situated on a moderately steep to steep hillslope with slope angles ranging from approximately 30°–45° and a concave slope morphology. The site consists of old landslide terrain with active scarp

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development, multiple tension cracks, and downslope debris accumulation. Geological conditions comprise residual and colluvial deposits with a clayey-silty soil matrix. The presence of springs and groundwater emergence zones increases infiltration and reduces slope stability.

4.1.26.4 *Cause and Triggering Factors*

The major causes of instability include weathered and weak slope materials, steep slope geometry, rural road cutting, inadequate drainage, concentrated runoff, and spring water seepage. The primary triggering factor is intense monsoon rainfall, which increases groundwater pressure, saturates slope materials, and accelerates landslide reactivation.

4.1.26.5 *Current Site Condition*

The landslide is currently active with progressive deformation. Observed features include tension cracks, multiple scarps, active springs, road surface cracking, and widening of the unstable zone. The head portion shows retrogressive movement, while slight widening is observed along the left flank and progressive widening along the right flank. One house has already experienced partial damage, and further movement may occur during extreme rainfall events.

4.1.26.6 *Elements at Risk*

The major elements at risk include 27 residential houses, rural road infrastructure, agricultural terraces, foot trails, and water supply pipelines. Approximately 5 houses are considered immediately vulnerable, with an estimated 16 people at risk. The landslide also threatens agricultural land and local transportation connectivity.

4.1.26.7 *Hazard Severity and Risk Level*

The landslide hazard condition is assessed as high, particularly during the monsoon season due to active slope movement, groundwater seepage, and rainfall-induced saturation. The overall community risk level is high to moderate due to exposure of residential structures and infrastructure.

4.1.26.8 *Recommended Mitigation Measures*

The site requires immediate implementation of integrated slope stabilization measures. Recommended interventions include surface water diversion, improvement of road drainage, installation of subsurface drainage to control groundwater, construction of retaining and toe support structures, and bioengineering stabilization. Regular monitoring of cracks, scarps, and slope movement is necessary. Detailed geotechnical investigation is recommended before final design of stabilization works.

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4.1.26.9 Relocation Requirement (if necessary)

Partial relocation is recommended for highly exposed households due to the active nature of the landslide. At least one household requires priority relocation based on the current hazard condition. Further monitoring and detailed assessment are required to determine additional relocation needs.

4.1.26.10 Site Photographs



Photograph 29 Landslide Site, Seti Devi Tol

4.1.27 Suryodaya-12, SD-12 LS 3 (Deurali Tol)

4.1.27.1 Location and Accessibility

Suryodaya-02, Ilam District; Deurali Tol settlement located on a moderately steep slope near ridge with kholsi and gully influence. Accessible via rural road network branching from the main Suryodaya–Ilam road corridor.

4.1.27.2 Hazard Type

Translational debris slide with minor rock involvement in colluvial soil over weathered gneiss bedrock.

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4.1.27.3 Geological and Geomorphological Condition

Thin residual soil over fractured foliated gneiss; concave slope geometry with active gully erosion and localized scarping.

4.1.27.4 Cause and Triggering Factors

Triggered by intense rainfall, slope cutting for road construction, riverbank/toe erosion, and concentrated surface runoff.

4.1.27.5 Current Site Condition

Active road-side slope failure with fresh scarps, exposed soil, and ongoing erosion and localized debris deposition.

4.1.27.6 Elements at Risk

Rural road, nearby houses, and agricultural land affected; ~3 houses and ~12 people at immediate risk.

4.1.27.7 Hazard Severity and Risk Level

Moderate community risk with seasonal reactivation during monsoon and intense rainfall events.

4.1.27.8 Recommended Mitigation Measures

Retaining structures, proper road drainage system, and slope stabilization with erosion control measures required.

4.1.27.9 Relocation Requirement (if necessary)

No immediate relocation required, but local protection or shifting of 3 exposed houses may be needed if erosion continues.

4.1.27.10 Site Photographs



Photograph 30 Landslide Site, Deurali Tol

4.1.28 Suryodaya-12, SD-12 LS 4 (Sundarbasti Tol)

4.1.28.1 Location and Accessibility

Located at Sundarbasti, Ward No. 12 of Suryodaya Municipality, Ilam District, and accessible through local rural roads, foot trails, and agricultural terraces.

4.1.28.2 Hazard Type

Active translational landslide characterized by shallow debris sliding and erosional gully development.

4.1.28.3 Geological and Geomorphological Condition

The area consists of residual and colluvial soils with an organic top layer on moderately steep to steep concave slopes, with Sundar Khola flowing along the toe.

4.1.28.4 Cause and Triggering Factors

The instability is mainly caused by weak soil materials, poor drainage management, concentrated surface runoff, stream erosion, and intense monsoon rainfall.

4.1.28.5 Current Site Condition

The site exhibits active gully erosion, visible crown cracks, debris movement toward drainage channels, and progressive localized slope instability.

4.1.28.6 Elements at Risk

Approximately 35 households, cultivable terrace land, rural roads, foot trails, and irrigation channels are potentially exposed to future damage.

4.1.28.7 Hazard Severity and Risk Level

The hazard severity and community risk level are moderate, with increased susceptibility during intense monsoon rainfall.

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4.1.28.8 *Recommended Mitigation Measures*

Surface drainage improvement, terrace runoff management, stream-bank protection, and erosion control measures should be implemented before the monsoon season.

4.1.28.9 *Relocation Requirement (if necessary)*

Relocation is not currently required; however, the two households nearest to the active erosion zone should be closely monitored.

4.1.28.10 *Site Photographs*

Photograph 31 Landslide Site, Sundarbasti Tol

4.1.29 *Suryodaya-12, SD-12 LS 5 (Sundarkhola)*4.1.29.1 *Location and Accessibility*

Located at Sundar Khola in Ward No. 12 of Suryodaya Municipality, Ilam District, along the Sundar Khola river corridor and accessible through local rural roads and foot trails.

4.1.29.2 *Hazard Type*

Active translational landslide and debris flow associated with gully erosion and stream-bank instability.

4.1.29.3 Geological and Geomorphological Condition

The area consists of colluvial and residual soil deposits on moderately steep slopes within a deep river valley, with active stream erosion at the toe.

4.1.29.4 Cause and Triggering Factors

The instability is primarily caused by drainage mismanagement, toe cutting by Sundar Khola, weak soil materials, slope saturation, intense rainfall, and possible seismic influences.

4.1.29.5 Current Site Condition

The site exhibits active shallow slope failure, exposed soil near the crown, concentrated runoff channels, ongoing gully erosion, and sediment transport into the stream.

4.1.29.6 Elements at Risk

Agricultural land, foot trails, irrigation systems, and rural roads are potentially exposed, although no houses are currently under direct threat.

4.1.29.7 Hazard Severity and Risk Level

The probability of occurrence is high during intense rainfall events; however, the current community risk level remains low due to limited exposure of settlements.

4.1.29.8 Recommended Mitigation Measures

River training works, toe protection measures, retaining structures, and improved drainage management are recommended to reduce further erosion and instability.

4.1.29.9 Relocation Requirement (if necessary)

Relocation is not required at present, as no households are directly threatened by the current landslide activity.

4.1.29.10 Site Photographs



Photograph 32 Landslide Site, Sundar Khola

4.1.30 Suryodaya-12, SD-12 LS 6 (Triveni Tol)

4.1.30.1 Location and Accessibility

The hazard site is located at Triveni Tole, Suryodaya Municipality–12, Ilam District. The area is accessible through local rural roads and foot trails. The settlement is situated on a hillside with agricultural terraces and drainage channels influencing local slope conditions.

4.1.30.2 Hazard Type

The site is categorized as a debris flow/flash flood susceptible area with tension cracks (CAT-I). No distinct fresh landslide crown, main scarp, or active slide body was observed. However, old degraded landslide features, tension cracks, localized slope creep, and a seasonal debris-flow pathway indicate potential instability during intense rainfall events.

4.1.30.3 Geological and Geomorphological Condition

The area is located on a moderately steep to steep hillslope covered with dense vegetation and agricultural terraces. The slope morphology consists of a convex upper slope transitioning into a concave lower drainage zone. The ground condition is mainly composed of residual soil and colluvial deposits with moderate permeability. Past mass movement features, gully erosion, and seasonal drainage concentration are present, increasing susceptibility to rainfall-induced instability.

4.1.30.4 Cause and Triggering Factors

The major causes of hazard include intense monsoon rainfall, concentrated surface runoff, stream and gully erosion, and the presence of weak weathered soil materials. The main triggering factor is intense rainfall, which increases runoff, activates debris movement along the drainage channel, and may enlarge existing cracks and erosion features.

4.1.30.5 *Current Site Condition*

The site is currently stable to slightly active. No recent major landslide failure was observed; however, tension cracks are present within cultivated terraces and forested slopes. Localized slope creep, terrace deformation, seasonal debris movement, and channel erosion with sediment transport indicate ongoing low-level slope adjustment and potential debris-flow activity during extreme rainfall.

4.1.30.6 *Elements at Risk*

The main elements at risk include 11 households with approximately 62 people, rural road access, foot trails, and agricultural land. Around 10 ropani of land is vulnerable to erosion and debris deposition. Approximately 3 houses are considered exposed to potential debris-flow impacts during intense rainfall events.

4.1.30.7 *Hazard Severity and Risk Level*

The hazard severity is assessed as medium, mainly due to the possibility of rainfall-induced debris flow, flash flood activity, and gradual slope deformation. The community risk level is medium, with limited direct exposure but potential impacts on houses, roads, and agricultural land.

4.1.30.8 *Recommended Mitigation Measures*

The site is treatable through small-scale civil and bioengineering interventions. Recommended measures include improvement of surface drainage, construction of check dams and gabion structures along drainage channels, stabilization of erosion-prone slopes through vegetation-based bioengineering, and regular monitoring of tension cracks. Community awareness and monsoon preparedness measures should also be implemented.

4.1.30.9 *Relocation Requirement (if necessary)*

Relocation is not required at present as the site does not show evidence of active large-scale landslide movement. However, houses located near drainage pathways should be periodically monitored, especially during the monsoon season, and relocation considerations may be reviewed if debris-flow activity increases.

4.1.30.10 *Site Photographs**Photograph 33 Landslide Site, Triveni Tol*

4.1.31 Suryodaya-12, SD-12 LS 7 (Lumke Tol)

4.1.31.1 *Location and Accessibility*

The landslide site is located at Lumke Tole, Suryodaya Municipality–12, Ilam District. The site is accessible through local rural roads and foot trails. The settlement is located along a deeply incised stream valley where river processes significantly influence slope stability.

4.1.31.2 *Hazard Type*

The site is affected by an active river-controlled rotational–translational landslide involving colluvial deposits, residual soil, and weathered rock materials. The landslide consists of multiple reactivated slide blocks aligned along the drainage channel. Fresh scarps and tension cracks indicate ongoing progressive movement.

4.1.31.3 *Geological and Geomorphological Condition*

The area is characterized by moderately steep to steep hill slopes dissected by river and drainage channels. The slope consists of residual soil, thick colluvial deposits, and highly weathered rock fragments with silty clay and sandy clay materials. Agricultural terraces occupy the upper and middle slopes, while active river undercutting occurs at the slope toe. Concentrated monsoon runoff and groundwater seepage contribute to slope saturation and instability.

4.1.31.4 *Cause and Triggering Factors*

The major causes of landslide activity include continuous river toe erosion, weak colluvial deposits, steep slope geometry, groundwater seepage, and poor drainage conditions. The main triggering factors are intense and prolonged monsoon rainfall, river undercutting, increased pore water pressure, and concentrated surface runoff, which accelerate retrogressive slope failure.

4.1.31.5 *Current Site Condition*

The landslide is currently active with fresh scarps, tension cracks, and progressive slope deformation. The head portion shows active retrogression, while both flanks are widening, with moderate activity on the left flank and active widening on the right flank. Continuous river erosion at the toe is destabilizing the slope, resulting in agricultural land loss and sediment deposition into the river channel.

4.1.31.6 *Elements at Risk*

The major elements at risk include 1 household with approximately 6 people, agricultural land, rural access roads, foot trails, and irrigation facilities. Approximately 15 ropani of land is vulnerable to landslide expansion and debris movement. The single household located near the unstable zone is considered immediately exposed.

4.1.31.7 *Hazard Severity and Risk Level*

The landslide hazard condition is assessed as high to very high, particularly during intense rainfall events due to active river erosion and progressive slope movement. The community risk level is moderate to high due to direct exposure of settlement and local infrastructure.

4.1.31.8 *Recommended Mitigation Measures*

The site requires integrated river, drainage, and slope stabilization measures. Recommended interventions include river training works, gabion toe protection, surface and subsurface drainage improvement, construction of catch drains, slope stabilization using bioengineering techniques, and regular monitoring of cracks and slope movement. Detailed geotechnical investigation is recommended for final stabilization design.

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4.1.31.9 Relocation Requirement (if necessary)

Immediate relocation is not mandatory at present; however, the exposed household should be closely monitored due to active landslide movement and high monsoon susceptibility. If crack widening, scarp retrogression, or further slope displacement occurs, relocation of the affected household should be considered.

4.1.31.10 Site Photographs



Photograph 34 Landslide Site, Lumke Tol

4.1.32 Suryodaya-13, SD-13 LS1 (Doctor Gau Kolbote)

4.1.32.1 Location and Accessibility

The landslide site SD-1LS 1 (Doctor Gau Kolbote) is located in Ward No. 13 of Suryodaya Municipality, Ilam District. The site lies on a south-facing slope.

4.1.32.2 Hazard Type

The identified hazard is an active and reactivated translational landslide with evidence of continuous slope movement. The secondary process, such as toe erosion can also be observed.

4.1.32.3 *Geological and Geomorphological Condition*

The area lies on a moderate to steep mid-slope with convex upper and concave mid-slope terrain, underlain by colluvium soil over highly weathered, fractured gneiss bedrock, forming a deep, permeable, weakly cohesive soil mantle.

4.1.32.4 *Cause and Triggering Factors*

Road cutting at the slope toe and poor drainage are the root causes, while intense rainfall serves as the immediate trigger .

4.1.32.5 *Current Site Condition*

The 100 m long and 30 m wide active landslide exhibits headward cracking, retrogressive scarp retreat, minor flank extension, and toe erosion from road drainage, with a 6 m deep slip surface and 60 m runout

4.1.32.6 *Elements at Risk*

Five houses (three already relocated), fifteen people, the local road, and drainage infrastructure are at risk within a fragile agrovian economy.

4.1.32.7 *Hazard Severity and Risk Level*

The hazard probability is moderate to high, resulting in a moderate community risk level with very high priority for treatment; the site is treatable.

4.1.32.8 *Recommended Mitigation Measures*

Urgent drainage management, road protection, bioengineering, and slope stabilization are required. Only an inadequate drainage canal currently exists.

4.1.32.9 *Relocation Requirement (if necessary)*

The remaining two houses should be considered for relocation if drainage and stabilization measures are not implemented immediately, as three houses have already been relocated.

4.1.32.10 *Site Photographs*





Photograph 35 Landslide Site, Doctor Gaun Kolbote Tol

4.1.33 Suryodaya-14, SD-14 LS1 (Thulo Bardu Tol)

4.1.33.1 Location and Accessibility

The landslide site is located at Thulo Bardu Tole, Suryodaya Municipality–14, Ilam District. The area is accessible through the Bhalukhop–Katuse–Khudunabari rural road, which passes through the influence zone of the landslide. The settlement is located on a cultivated hill slope affected by long-term slope instability.

4.1.33.2 Hazard Type

The site is affected by an active deep-seated creep landslide with secondary debris slides. The landslide represents an old reactivated failure zone with slow downslope movement and localized debris failures. Multiple scarps, tension cracks, ground subsidence, and terrace deformation indicate ongoing activity.

4.1.33.3 Geological and Geomorphological Condition

The site is located on a moderately steep to steep cultivated hill slope with a large concave depression formed by previous landslide movement. The landslide body is bounded by seasonal streams on both flanks, which contribute to toe erosion. Geological conditions consist of residual and colluvial soil over weathered gneiss. The slope materials have low shear strength when saturated due to high groundwater infiltration through cracks, terraces, and drainage pathways. Secondary scarps, creep zones, and forested lower slopes are prominent geomorphological features.

4.1.33.4 Cause and Triggering Factors

The main causes of landslide instability include weak residual and colluvial materials, stream erosion at the landslide toe, groundwater infiltration, poor drainage management, and existing old landslide conditions. The major triggering factors are intense monsoon rainfall and prolonged saturation, which increase pore water pressure and accelerate creep movement and debris slide formation.

4.1.33.5 Current Site Condition

The landslide is currently active/reactivated with slow creep movement and localized debris slides. Observed features include fresh tension cracks, multiple scarps, ground settlement, terrace deformation, and progressive widening of the landslide body. The head portion is undergoing active retrogression, while both flanks show active movement. Existing gabion walls, bamboo plantation, and drainage structures provide partial protection; however, some drainage sections have been affected by subsidence.

4.1.33.6 Elements at Risk

The major elements at risk include approximately 50 households with around 210 people, residential structures, agricultural terraces, and the Bhalukhop–Katuse–Khudunabari rural road. Approximately 15 houses are directly threatened, while about 45 houses lie within the broader influence zone. Around 150 ropani of agricultural land is vulnerable to continued slope movement and deformation. One house has already been completely damaged and relocated.

4.1.33.7 Hazard Severity and Risk Level

The landslide hazard condition is assessed as high due to active creep movement, progressive retrogression, and potential expansion during monsoon periods. The community risk level is high due to exposure of settlements, agricultural land, and road infrastructure.

4.1.33.8 Recommended Mitigation Measures

The site requires comprehensive long-term stabilization measures. Recommended interventions include improvement of surface and subsurface drainage systems, additional toe protection works, strengthening and extension of existing gabion structures, control of stream erosion, and bioengineering stabilization of vulnerable slopes. A landslide monitoring system including crack mapping, movement tracking, and regular inspection should be established. Detailed geotechnical investigation is recommended for final stabilization design.

4.1.33.9 Relocation Requirement (if necessary)

Since one house has already been damaged and relocated, other highly exposed houses should be monitored closely. Additional relocation planning should be considered if crack widening, increased creep movement, or further retrogression is observed.

Site-Wise Rapid Assessment

4.1.33.10 Site Photographs



Photograph 36 Landslide Site, Thulo Bardu Tol

4.1.34 Suryodaya-14, SD-14 LS2 (Simle)

4.1.34.1 Location and Accessibility

Suryodaya-14, Ilam District; Simle settlement located on a mid-hill concave slope with rural road access.

4.1.34.2 Hazard Type

Shallow translational landslide with debris flow characteristics in road-cut slope materials triggered by rainfall saturation.

4.1.34.3 Geological and Geomorphological Condition

Colluvial deposits with boulder-rich sandy to silty clay matrix over moderately steep, highly weathered slope section.

4.1.34.4 Cause and Triggering Factors

Caused by road toe cutting, drainage mismanagement, and weak high-plasticity slope materials with rainfall saturation.

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4.1.34.5 Current Site Condition

Active localized failure following intense rainfall; minor flank widening and road-cut slope collapse observed.

4.1.34.6 Elements at Risk

Road infrastructure affected; 2 households (8 people) nearby but no direct structures within active slide zone.

4.1.34.7 Hazard Severity and Risk Level

Low community risk overall but high probability of reactivation during intense rainfall events.

4.1.34.8 Recommended Mitigation Measures

Drainage improvement and surface water control with strengthening of existing gabion structures.

4.1.34.9 Relocation Requirement (if necessary)

No relocation required as no houses are directly within the landslide zone; monitoring recommended during monsoon.

4.1.34.10 Site Photographs



Photograph 37 Landslide Site, Simle

4.1.35 Suryodaya-14, SD-14 LS (Sahakale)

4.1.35.1 Location and Accessibility

Simle is located in Ward No. 14 of Suryodaya Municipality, Ilam District, situated on a mid-hill slope of moderately steep terrain with concave hillslope and moderate to high relief, accessible via local roads.

4.1.35.2 Hazard Type

The site features an active shallow translational landslide with debris flow characteristics, initiated on 2082/06/19.

4.1.35.3 Geological and Geomorphological Condition

The area lies on a moderately steep concave mid-hill slope with moderate to high relief. The lithology is dominated by colluvial soft deposits, primarily boulder-dominated with fine materials including sandy to silty clay and mica-rich clay exhibiting genesis fractures and weathering.

4.1.35.4 Cause and Triggering Factors

Drainage mismanagement, geological control, road slope toe cutting, and low strength with high plasticity slope materials are the major causes. The triggering factors are intense rainfall and slope saturation following three days of prolonged rainfall, followed by slope collapse upon sun drying.

4.1.35.5 Current Site Condition

The localized landslide measures 60 to 80 meters in length and 25 to 40 meters in width, with a runout of 70 meters, crown slope of 45 degrees, and depth to slip surface ranging from 5 to 7 meters. The slide is currently active with minor widening observed on both flanks. Associated problems include slope instability, potential road blockage, and sediment transport downslope.

4.1.35.6 Elements at Risk

Two households with a total population of eight individuals, including four females, one person aged over 70 years, and one child under 10 years, are present. No houses are located directly within the landslide area. The primary infrastructure at risk is the local road. The community depends on an agriculture-based rural economy.

4.1.35.7 Hazard Severity and Risk Level

The probability of hazard occurrence is high during intense rainfall, yet the current risk level at the community is low. The site is treatable.

4.1.35.8 Recommended Mitigation Measures

Immediate mitigation measures are required before major monsoon periods. Recommended interventions include surface and subsurface drainage improvement, stream bank protection, construction of gabion toe walls and check dams, control of runoff concentration, and bioengineering stabilization of exposed slopes. Regular landslide monitoring, community awareness, and household safety planning should be implemented. Detailed geotechnical investigation is recommended for final stabilization design.

4.1.35.9 Relocation Requirement (if necessary)

Partial relocation of approximately two households may be required due to the active nature of the landslide and the direct exposure of these households. The remaining affected households should be closely monitored, and relocation should be considered if the landslide expands, debris-flow activity increases, or the risk of stream blockage escalates.

4.1.35.10 Site Photographs



Photograph 38 Landslide Site, Sabakale Tol

4.1.36 Mai-2, MI-2 LS1 (Purbe Kharpani)

4.1.36.1 Location and Accessibility

Located in Purbe Kharpani, Mai Municipality-02, Ilam District, the site is accessible through rural access roads and foot trails connecting scattered settlements and agricultural land. Access is generally available year-round, though movement may become difficult during monsoon due to slope instability and road damage.

4.1.36.2 Hazard Type

Large deep-seated slope deformation (creep) affecting a broad hillslope area, with multiple localized debris slides and concealed tension cracks within the moving mass.

4.1.36.3 Geological and Geomorphological Condition

Siwalik sandstone terrain overlain by residual and colluvial soils on moderately steep to steep slopes with dissected drainage channels and localized gully erosion.

4.1.36.4 Cause and Triggering Factors

Reactivation of an old landslide due to rainfall, geological weakness, slope saturation, concentrated drainage, and localized toe erosion.

4.1.36.5 Current Site Condition

Active creep deformation with seasonal movement, house cracking, and multiple small-scale failures occurring within the larger landslide boundary.

4.1.36.6 Elements at Risk

Twenty-eight households (152 people), residential buildings, water reservoir tank, rural roads, foot trails, agricultural terraces, and approximately 10 ropani of land are exposed.

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4.1.36.7 Hazard Severity and Risk Level

High hazard and high community risk due to the large unstable mass, ongoing deformation, and high probability of monsoon reactivation.

4.1.36.8 Recommended Mitigation Measures

Comprehensive drainage management, rehabilitation of damaged check dams and chutes, detailed geotechnical investigation, continuous monitoring, and community-based early warning measures are recommended.

4.1.36.9 Relocation Requirement (if necessary)

Immediate relocation is not required. However, all 28 households lie within the affected deformation zone. Relocation of the most vulnerable households should be considered based on the findings of a detailed hazard assessment and hazard zoning.

4.1.36.10 Site Photographs

Photograph 39 Landslide Site, Purbe Kharpani

4.1.37 Mai-9, MI-9 LS1 (Raga Pani)*4.1.37.1 Location and Accessibility*

Located in Rangapani, Mai Municipality-09, Ilam District, the site is accessible by rural roads and foot trails connecting scattered settlements and agricultural land. Access may be disrupted during monsoon due to ongoing slope movement and road damage.

4.1.37.2 Hazard Type

Large compound landslide comprising translational slides, creep, debris flow, and earthflow processes affecting a broad hillslope area.

4.1.37.3 Geological and Geomorphological Condition

Thick colluvial and residual soils over fractured and weathered schist bedrock on steep dissected slopes with active drainage gullies and river toe erosion.

4.1.37.4 Cause and Triggering Factors

Triggered by rainfall-induced saturation and controlled by geological weakness, slope curvature, and toe cutting by the Mai River.

4.1.37.5 Current Site Condition

Reactivated slow-moving landslide with widespread creep, undulating ground, shallow failures, and localized deep-seated deformation.

4.1.37.6 Elements at Risk

Approximately 68 houses, a school, roads, foot trails, electric poles, transmission lines, and about 100 ropani of land are exposed; 29 houses are at immediate risk.

4.1.37.7 Hazard Severity and Risk Level

High hazard and high community risk due to the large active landslide system, repeated reactivation, and potential impact on critical infrastructure.

4.1.37.8 Recommended Mitigation Measures

Comprehensive drainage management, bioengineering, civil engineering protection structures, continuous monitoring, and detailed geotechnical investigation are recommended.

4.1.37.9 Relocation Requirement (if necessary)

Immediate relocation is required for approximately eight of the most vulnerable households located near the crown area. For the remaining households, particularly the 29 identified as being at immediate risk, relocation should be considered based on detailed hazard zoning and assessment..

4.1.37.10 *Site Photographs**Photograph 40 Landslide Site, Rangapani*

4.1.38 Phakphokthum -1, PK-1 LS1 (Panchami Bazar)

4.1.38.1 *Location and Accessibility*

Located in Gumbesi Panchami Bazar, Phakphokthum Rural Municipality-01, Ilam District, the settlement is accessible by rural roads connecting local market areas and surrounding villages. Access may be partially disrupted during monsoon due to landslide activity and road damage.

4.1.38.2 *Hazard Type*

Large compound landslide comprising translational slides, debris flow, earth flow, and long-term creep affecting a broad hillslope area.

4.1.38.3 *Geological and Geomorphological Condition*

Residual and colluvial soils over weathered and fractured bedrock on steep to moderately steep dissected terrain with drainage convergence zones.

4.1.38.4 *Cause and Triggering Factors*

Triggered by intense rainfall, poor drainage, weak high-plasticity soils, road construction, and long-term geological controls.

Site-Wise Rapid Assessment

4.1.38.5 Current Site Condition

Reactivated slow-moving landslide with ground cracking, creep deformation, multiple shallow failures, and localized deep-seated movement.

4.1.38.6 Elements at Risk

About 120 households (680 people), rural roads, agricultural terraces, houses, foot trails, drainage systems, and existing gabion structures are exposed; approximately 40 houses and 210 people are at direct risk.

4.1.38.7 Hazard Severity and Risk Level

Moderate to high community risk with high probability of further movement during intense monsoon rainfall.

4.1.38.8 Recommended Mitigation Measures

Comprehensive drainage management, retaining and gabion structures, bioengineering measures, hazard monitoring, and community preparedness programs are urgently required.

4.1.38.9 Relocation Requirement (if necessary)

Approximately 40 houses are at immediate risk; relocation of the most vulnerable households should be considered following detailed geotechnical investigation and hazard zonation.

4.1.38.10 Site Photographs



Photograph 41 Landslide Slide, Panchami Bazar

4.1.39 Phakphokthum -6, PK-6 LS1 (Simasara)

4.1.39.1 Location and Accessibility

Located in Simasara, Phakphokthum Rural Municipality-06, Ilam District, the settlement is accessible through rural roads and foot trails connecting agricultural land and scattered households. Access may become difficult during monsoon due to slope movement and road damage.

4.1.39.2 Hazard Type

Large translational and creeping landslide extending approximately 1000–1300 m in length and 300–500 m in width, affecting a broad hillslope area.

4.1.39.3 Geological and Geomorphological Condition

Colluvial and residual soils over fractured and weathered gneiss bedrock with weak silty clay-rich materials and poor drainage conditions.

4.1.39.4 Cause and Triggering Factors

Triggered by intense rainfall, weak slope materials, road construction, drainage mismanagement, geological control, and localized toe erosion.

4.1.39.5 Current Site Condition

Active creeping landslide with multiple shallow translational failures, surface cracking, drainage gully development, localized deep-seated movement, and progressive widening.

4.1.39.6 Elements at Risk

Twenty-three households (120 people), about 200 ropani of agricultural land, rural roads, foot tracks, terraces, and residential structures are exposed; all 23 houses lie within the affected zone.

Site-Wise Rapid Assessment

4.1.39.7 Hazard Severity and Risk Level

Moderate community risk with high probability of further movement and reactivation during intense monsoon rainfall.

4.1.39.8 Recommended Mitigation Measures

Drainage control, slope monitoring, bioengineering, retaining structures, and road-slope stabilization measures are urgently required.

4.1.39.9 Relocation Requirement (if necessary)

Relocation is required due to the large active landslide extent and long-term instability. Relocation of affected households is already ongoing, with approximately 16 households identified for relocation. Continued monitoring is recommended to ensure safety during the relocation period and future monsoon seasons.

4.1.39.10 Site Photographs



Photograph 42 Landslide Site, Simsara

4.1.40 Sandakpur-1, SP-1 LS1 (Aahale)

4.1.40.1 Location and Accessibility

Sandakpur-01, Ilam District; Aahale settlement is located on a moderately steep to steep, highly dissected hillslope with rural road and foot-trail access.

4.1.40.2 Hazard Type

Complex landslide comprising translational slide, earthflow, debris flow, and long-term creep affecting a colluvium-covered slope.

4.1.40.3 *Geological and Geomorphological Condition*

Colluvial soil mantle over weak, weathered, and fractured gneiss bedrock with poor drainage and moisture-sensitive materials.

4.1.40.4 *Cause and Triggering Factors*

Triggered by intense rainfall, drainage mismanagement, road cutting, rural road construction, and saturation of thick colluvial deposits.

4.1.40.5 *Current Site Condition*

Active creeping landslide with multiple shallow to moderately deep translational failures, road instability, surface deformation, and sediment movement.

4.1.40.6 *Elements at Risk*

Rural roads, foot trails, agricultural land, and residential structures are exposed; 5 houses are currently at immediate risk.

4.1.40.7 *Hazard Severity and Risk Level*

Moderate to high community risk with high probability of reactivation and expansion during prolonged monsoon rainfall.

4.1.40.8 *Recommended Mitigation Measures*

Surface drainage improvement, bioengineering, toe stabilization, retaining structures, movement monitoring, and community preparedness are urgently required.

4.1.40.9 *Relocation Requirement (if necessary)*

Five households require relocation as a priority due to the active nature of the landslide. The remaining area, including the road alignment passing through the affected zone, requires mitigation measures through integrated drainage and slope stabilization works.

4.1.40.10 Site Photographs



Photograph 43 Landslide Site, Abale

4.1.41 Sandakpur-2, SP-2 LS1 (Todke)

4.1.41.1 Location and Accessibility

Sandakpur-02, Ilam District; Todke settlement is situated on a moderately steep hillslope affected by stream erosion and active toe cutting, with access through rural roads and foot trails.

4.1.41.2 Hazard Type

Complex earthflow and translational landslide characterized by long-term creep, multiple shallow to moderately deep failures, and differential ground settlement.

4.1.41.3 Geological and Geomorphological Condition

Thick colluvial soil deposits over highly weathered and fractured bedrock, with poor drainage and reduced slope stability.

4.1.41.4 Cause and Triggering Factors

Triggered by intense rainfall, riverbank/toe erosion, road construction, weak slope materials, and prolonged saturation of the slope mass.

4.1.41.5 Current Site Condition

Active slow-moving landslide with irregular crown geometry, localized translational failures, central drainage gully erosion, and ongoing toe retreat.

4.1.41.6 Elements at Risk

Agricultural land, foot trails, rural roads, and settlement areas are exposed; 9 houses are currently at immediate risk.

4.1.41.7 Hazard Severity and Risk Level

Moderate community risk with high probability of reactivation during prolonged monsoon rainfall and upstream flood events.

4.1.41.8 Recommended Mitigation Measures

The site requires integrated slope and drainage management measures. Recommended interventions include improvement of surface drainage, river toe protection, construction of retaining structures where feasible, bioengineering stabilization, and protection of vulnerable road sections. The type and extent of mitigation measures should be finalized through detailed geotechnical investigation and slope stability assessment.

4.1.41.9 Relocation Requirement (if necessary)

Partial relocation of five houses have already been carried out, with damaged houses moved from the downslope unstable area to safer locations near the road. Further relocation should be considered if landslide movement increases or additional deformation affects remaining houses and infrastructure..

4.1.41.10 Site Photographs



Photograph 44 Landslide Site, Todke

4.1.42 Sandakpur-2, SP-2 LS2 (Kamere)

4.1.42.1 Location and Accessibility

Sandakpur-02, Ilam District; Kamere settlement is located on a moderate to steep cultivated hillslope with access through rural roads and footpaths.

4.1.42.2 Hazard Type

Complex landslide comprising translational slide, earthflow, debris flow, and long-term creep affecting colluvial slope materials.

4.1.42.3 Geological and Geomorphological Condition

Residual and colluvial deposits with silty clay-rich weak soils over probable weathered and fractured bedrock at depth.

4.1.42.4 Cause and Triggering Factors

Triggered by intense rainfall, terrace cultivation, rural road construction, toe cutting, poor drainage, and weak high-plasticity slope materials.

4.1.42.5 Current Site Condition

Active and reactivated creeping landslide with multiple shallow translational failures, slope saturation, drainage-related erosion, and progressive downslope deformation.

4.1.42.6 Elements at Risk

Seven households (30 people), rural roads, footpaths, agricultural terraces, and residential structures are exposed; all 7 houses are at immediate risk.

Site-Wise Rapid Assessment

4.1.42.7 Hazard Severity and Risk Level

High community risk with high probability of further movement and failure during intense monsoon rainfall.

4.1.42.8 Recommended Mitigation Measures

Recommended measures include surface and subsurface drainage management, toe protection works, bioengineering, slope stabilization, regular monitoring, and community preparedness programs.

4.1.42.9 Relocation Requirement (if necessary)

All 7 houses lie within the hazard influence zone and are at immediate risk. Relocation of the most vulnerable households should be considered if slope movement continues or detailed investigation confirms deep-seated instability.

4.1.42.10 Site Photographs

Photograph 45 Landslide Site, Kamere

4.1.43 Sandakpur-3, SP-3 LS1 (Gairigau)*4.1.43.1 Location and Accessibility*

Sandakpur-03, Ilam District; Gairigau settlement is located on a moderate to steep concave hillslope and is accessible through local rural roads connecting the Sulubung–Jamuna corridor. Access may be affected by landslide activity and river erosion.

4.1.43.2 Hazard Type

Active translational rock/debris slide with localized creep and shallow failures developed in residual and colluvial soils over weathered gneiss bedrock.

4.1.43.3 Geological and Geomorphological Condition

Thin residual soil and colluvial deposits over fractured and weathered gneiss occur on an undulating midslope terrain affected by active toe erosion from the Mai River.

4.1.43.4 Cause and Triggering Factors

The landslide is primarily controlled by geological weakness, riverbank toe cutting, poor drainage conditions, road-slope disturbance, and weak slope materials, with intense rainfall acting as the main triggering factor.

4.1.43.5 Current Site Condition

The site exhibits multiple scarps, tension cracks, terrace deformation, active flank movement, and progressive widening associated with ongoing toe erosion and retrogressive slope failure.

4.1.43.6 Elements at Risk

Five households (25 people), approximately 100 ropani of agricultural land, rural roads, and a concrete bridge are exposed to the hazard.

4.1.43.7 Hazard Severity and Risk Level

Hazard severity and community risk are moderate, with a moderate probability of further movement and reactivation during intense monsoon rainfall.

4.1.43.8 Recommended Mitigation Measures

Recommended measures include drainage improvement, riverbank and toe protection works, bioengineering, slope stabilization structures, and regular monitoring of cracks and river erosion.

4.1.43.9 Relocation Requirement (if necessary)

All 5 houses are within the affected zone and at immediate risk. Localized relocation or protection of the exposed households should be considered if toe erosion and slope deformation continue to progress.

4.1.43.10 *Site Photographs**Photograph 46 Landslide Site, Gairigaun*

4.1.44 Sandakpur-4, SP-4 LS1 (Gumba)

4.1.44.1 *Location and Accessibility*

Located at Gumba, Ward No. 4, Sandakpur Rural Municipality, Ilam District, Koshi Province, the settlement is situated on a mid- to steep-slope agricultural terrain and is accessible through local rural roads and foot trails.

4.1.44.2 *Hazard Type*

The site is affected by a reactivated and active complex landslide comprising translational sliding, earthflow, and slow creep movement.

4.1.44.3 *Geological and Geomorphological Condition*

The area consists of residual and colluvial soils over bedrock, dominated by silty clay-rich materials with accumulated old landslide debris in the lower slope section.

4.1.44.4 Cause and Triggering Factors

The instability is mainly caused by weak colluvial deposits, prolonged rainfall, slope saturation, concentrated surface runoff, toe erosion, and reactivation of an old landslide mass.

4.1.44.5 Current Site Condition

The landslide currently exhibits multiple shallow- to deep-seated translational failures, tension cracks, undulating ground surfaces, terrace deformation, active erosion, and downslope displacement of materials.

4.1.44.6 Elements at Risk

Six households, approximately 22–27 people, cultivated terraces, foot trails, local roads, and the Panchakanya Mai Hydropower penstock alignment are exposed to continued slope movement.

4.1.44.7 Hazard Severity and Risk Level

The probability of further landslide activity is moderate, and the overall community risk level is assessed as moderate due to the presence of residential structures and critical infrastructure within the affected area.

4.1.44.8 Recommended Mitigation Measures

Recommended measures include detailed geotechnical investigation, continued drainage control, regular monitoring, bioengineering measures, retaining structures, and maintenance and upgrading of existing drainage and protection works.

4.1.44.9 Relocation Requirement (if necessary)

Relocation is not currently required; however, the six exposed households should be closely monitored, and localized relocation may be considered if slope movement accelerates or new signs of instability develop.

4.1.44.10 Site Photographs





Photograph 47 Landslide Site, Gumba

4.1.45 Mangsebung-3, MB-3 LS1 (Bhanjyang)

4.1.45.1 Location and Accessibility

Located at Bhanjyang, Ward No. 3, Mangsebung Rural Municipality, Ilam District, Koshi Province, the settlement is situated on a saddle ridge between two opposing hillslopes affected by long-term slope deformation and is accessible through rural roads and foot trails.

4.1.45.2 Hazard Type

The site is affected by a large active complex landslide comprising translational sliding, earthflow, and slow creep movement with both shallow and deep-seated failure components.

4.1.45.3 Geological and Geomorphological Condition

The area consists of colluvial and residual soils over fractured mudstone and sandstone bedrock, with thick weathered overburden and evidence of deep-seated instability on both flanks of the saddle ridge.

4.1.45.4 Cause and Triggering Factors

The instability is primarily controlled by geological weakness associated with the Main Boundary Thrust (MBT) zone, prolonged slope saturation, weak colluvial materials, road-cut excavation, poor drainage conditions, and intense monsoon rainfall.

4.1.45.5 Current Site Condition

The landslide currently exhibits progressive creep movement, retrogressive head scarp development, widening flanks, tension cracks, undulating ground surfaces, differential settlement, and localized shallow failures.

Site-Wise Rapid Assessment

4.1.45.6 *Elements at Risk*

Nine households, approximately 80 people, rural roads, foot trails, agricultural terraces, and residential structures are directly exposed to the hazard, with four households already experiencing impacts from ongoing slope movement.

4.1.45.7 *Hazard Severity and Risk Level*

The probability of further landslide activity is high, and the overall community risk level is high due to the extensive nature of the landslide and the exposure of households and infrastructure.

4.1.45.8 *Recommended Mitigation Measures*

Recommended measures include a detailed geotechnical investigation, comprehensive surface and subsurface drainage management, road stabilization, retaining structures, bioengineering measures, and continuous monitoring of ground cracks and slope movement.

4.1.45.9 *Relocation Requirement (if necessary)*

The landslide is partially treatable due to its large scale and deep-seated nature. Immediate relocation of approximately six households located near the crown edge is recommended. Relocation of other households should be assessed based on vulnerability, particularly if ground deformation continues to accelerate despite the implementation of mitigation measures.

4.1.45.10 *Site Photographs*





Photograph 48 Landslide Site, Bhanjyang

4.1.46 Mangsebung-3, MB-3 LS2 (Lamitar)

4.1.46.1 Location and Accessibility

Located at Lamitar, Ward No. 3, Mangsebung Rural Municipality, Ilam District, Koshi Province, the settlement is situated within a large agricultural area on a highly dissected mid-hillslope terrain and is accessible through local rural roads and foot trails.

4.1.46.2 Hazard Type

The site is affected by an active complex landslide comprising translational sliding, debris flow, earthflow, and long-term creep movement.

4.1.46.3 Geological and Geomorphological Condition

The area consists of colluvial and residual soils developed over Lower Siwalik deposits, with weak slope materials, highly weathered ground conditions, and multiple drainage gullies contributing to instability.

4.1.46.4 Cause and Triggering Factors

The instability is controlled by geological conditions, weak colluvial materials, concentrated surface runoff, poor road drainage, toe cutting associated with road construction, and intense monsoon rainfall.

4.1.46.5 Current Site Condition

The landslide currently contains multiple shallow to deep-seated failures within a creeping slope mass, characterized by active erosion, discontinuous slope failures, gully development, and progressive retrogressive widening.

Site-Wise Rapid Assessment

4.1.46.6 *Elements at Risk*

Approximately 65 households, 380 people, 10 ropani of agricultural land, water supply pipelines, roads, and foot trails are exposed to potential impacts, with around 9 households identified as being at immediate risk.

4.1.46.7 *Hazard Severity and Risk Level*

The probability of landslide occurrence is moderate under normal conditions and high during intense or prolonged rainfall. The overall community risk level is assessed as low to moderate.

4.1.46.8 *Recommended Mitigation Measures*

Recommended measures include immediate improvement of road drainage systems, runoff diversion, slope stabilization, gabion retaining structures, bioengineering measures, and regular monitoring to reduce further slope deterioration.

4.1.46.9 *Relocation Requirement (if necessary)*

Large-scale relocation is not currently required; however, the 9 households within the most vulnerable zone should be closely monitored, and relocation may be considered if slope movement intensifies or new instability develops.

4.1.46.10 *Site Photographs*





Photograph 49 Landslide Site, Lamitar

4.1.47 Mangsebung-6, MB-6 LS1 (Chisopani)

4.1.47.1 Location and Accessibility

Located at Panchami Dachar Chisopani, Ward No. 6, Mangsebung Rural Municipality, Ilam District, Koshi Province, the settlement is connected by rural roads and foot trails and supports an agriculture-based economy with local business activities.

4.1.47.2 Hazard Type

The site is affected by an active and reactivated translational landslide with associated earthflow movement.

4.1.47.3 Geological and Geomorphological Condition

The area is situated on a steep, highly dissected hillslope underlain by thick residual and colluvial soils over highly weathered and fractured gneiss bedrock. Numerous drainage channels and concentrated runoff paths contribute to slope instability.

4.1.47.4 Cause and Triggering Factors

The landslide is primarily triggered by intense rainfall, slope saturation, concentrated surface runoff, road-cut excavation, and weak weathered geological materials.

4.1.47.5 Current Site Condition

The landslide exhibits multiple shallow failures within a large creeping slope mass, characterized by broad crown cracks, active erosion, downslope displacement of materials, and progressive slope deformation.

4.1.47.6 Elements at Risk

Approximately 45 households, 222 residents, rural roads, foot trails, agricultural terraces, and nearly 100 ropani of agricultural land are exposed to the hazard.

Site-Wise Rapid Assessment

4.1.47.7 Hazard Severity and Risk Level

The probability of landslide occurrence is high, and the overall community risk level is assessed as moderate to high due to the large exposed population and widespread slope instability.

4.1.47.8 Recommended Mitigation Measures

A detailed geotechnical investigation is urgently required, followed by comprehensive drainage management, surface drains, retaining and gabion walls, check dams, slope stabilization measures, and continuous monitoring of slope movement and ground cracks.

4.1.47.9 Relocation Requirement (if necessary)

Approximately three households from the lower slope have already relocated to the upper slope area near the highway. Relocation of the remaining affected households should therefore be completed. For other houses and settlements, immediate relocation is not currently required; however, these households should be closely monitored, and localized relocation may be considered if slope movement accelerates or the hazard zone expands..

4.1.47.10 Site Photographs



4.1.48 Mangsebung-5, MB-5 LS1 (Setikhare)*4.1.48.1 Location and Accessibility*

Located at Setikhare, Ward No. 6, Mangsebung Rural Municipality, Ilam District, Koshi Province, the settlement is accessible through local rural roads and foot trails and is primarily dependent on agriculture.

4.1.48.2 Hazard Type

The site is affected by an active complex landslide system comprising translational sliding, debris slide, and debris flow processes.

4.1.48.3 Geological and Geomorphological Condition

The area is characterized by steep, highly dissected hillslopes with convergent topography, active drainage concentration, and debris-flow channels. The slope materials consist of highly weathered residual and colluvial soils over fractured and weathered mudstone and sandstone bedrock.

4.1.48.4 Cause and Triggering Factors

The instability is mainly controlled by weak geological materials, slope saturation, concentrated runoff, active drainage channels, and intense monsoon rainfall.

4.1.48.5 Current Site Condition

The landslide remains active with ongoing upslope retrogression, widening of the landslide boundaries, active erosion channels, and recurrent debris movement within an old landslide complex.

4.1.48.6 Elements at Risk

Approximately 45 households, 222 residents, rural roads, foot trails, agricultural terraces, and nearly 100 ropani of agricultural land are exposed to the hazard.

4.1.48.7 Hazard Severity and Risk Level

The hazard severity is high, with a high probability of debris-flow activity during intense rainfall and an overall high community risk level due to the active nature of the landslide and the large exposed population.

4.1.48.8 Recommended Mitigation Measures

Recommended measures include comprehensive drainage management, bioengineering works, retaining and slope stabilization structures, maintenance of existing gabion walls and vegetation cover, and continuous monitoring of erosion channels and landslide activity.

Site-Wise Rapid Assessment

4.1.48.9 Relocation Requirement (if necessary)

Relocation is not currently required; however, households located within the most active landslide zone should be closely monitored, and localized relocation may be considered if continued retrogression or debris-flow activity increases the level of risk.

4.1.48.10 Site Photographs

Photograph 51 Landslide Site, Setikbare

4.1.49 Deumai-1, DM-1 LS1 (Maidane)*4.1.49.1 Location and Accessibility*

Located at Maidane, Ward No. 1, Deumai Municipality, Ilam District, Koshi Province, the settlement is situated on a steep terraced hillslope with rural road access and is surrounded by agricultural land and dense vegetation.

4.1.49.2 Hazard Type

The site is affected by a rotational and translational landslide characterized by shallow debris slide movement and localized slope deformation.

4.1.49.3 Geological and Geomorphological Condition

The area consists of thick colluvial and residual soils over highly weathered gneiss bedrock, developed on a convex–concave hillslope morphology with terraced agricultural land.

4.1.49.4 Cause and Triggering Factors

The instability is primarily caused by drainage mismanagement, geological controls, rural road construction, road-slope cutting, weak slope materials, and concentrated surface runoff, with intense rainfall acting as the main triggering factor.

4.1.49.5 Current Site Condition

The landslide exhibits localized scarps, terrace deformation, shallow failures, flank widening, and minor slope movement. No fresh landslide body is currently visible, indicating partial stabilization of the affected slope.

4.1.49.6 Elements at Risk

Twenty households (120 people), approximately 30 ropani of agricultural land, local roads, road drainage systems, and residential structures are exposed to potential landslide impacts.

4.1.49.7 Hazard Severity and Risk Level

The probability of hazard occurrence is moderate under normal conditions but becomes high during intense or prolonged rainfall. The overall community risk level is assessed as medium.

4.1.49.8 Recommended Mitigation Measures

Recommended measures include improvement of surface and subsurface drainage, stabilization of road-cut slopes, bioengineering measures, localized retaining structures, erosion control works, and regular monitoring of slope movement and drainage conditions.

4.1.49.9 Relocation Requirement (if necessary)

All 20 houses lie within the hazard influence zone and should be closely monitored; relocation may be considered for the most vulnerable households if instability increases or new signs of movement develop.

4.1.49.10 Site Photographs



Photograph 52 Landslide Site, Maidane

4.2 Dhankuta District

4.2.1 Dhankuta-5, DK-5 LS 1 (Tudikhel, Mathillo Kopche)

4.2.1.1 Location and Accessibility

The hazard site is located at Tallo Tundikhel, Dhankuta Municipality-05, Dhankuta District. The area is situated within an urbanized ridge shoulder and is accessible through existing urban road networks. The site includes public and residential infrastructure such as Tundikhel ground, school facilities, retaining structures, and nearby houses

4.2.1.2 Hazard Type

The site is affected by a deep-seated slope deformation (creep-type landslide) (CAT-II). No fresh landslide scarp or recent failure surface was observed; however, the area shows signs of slow ground movement including tension cracks, ground subsidence, differential settlement, surface undulation, and structural deformation. The instability is interpreted as a slow-moving creep zone developed within artificial fill and weathered residual soil.

4.2.1.3 Geological and Geomorphological Condition

The site is located on a moderately steep hill slope modified by urban development and construction activities. The area consists of residual soil and artificial fill materials with weak foundation characteristics. The geomorphology is characterized by filled ground, surface depressions, concentrated drainage toward lower gullies, and modified slope conditions due to playground and infrastructure development. The soil has high sensitivity to water infiltration, resulting in reduced bearing capacity and increased deformation during monsoon periods.

4.2.1.4 *Cause and Triggering Factors*

The major causes of instability include weak residual and fill soils, poor drainage management, groundwater seepage, concentrated surface runoff, slope modification, excavation activities, and additional loading from urban structures. The main triggering factor is intense rainfall, which increases soil saturation and accelerates settlement and creep movement.

4.2.1.5 *Current Site Condition*

The site is currently active, exhibiting slow ground deformation rather than sudden failure. Observed features include tension cracks, pavement cracking, tilting of buildings, gabion wall displacement, retaining wall deformation, parapet cracking, and differential settlement. Existing gabion walls, retaining structures, and surface runoff diversion measures are present but require improvement and monitoring.

4.2.1.6 *Elements at Risk*

The major elements at risk include approximately 8–10 households (around 45 people), a school, sports hall, Tundikhel ground, residential and commercial structures, retaining walls, and road infrastructure. Approximately 3 houses and one school facility are considered immediately vulnerable due to ongoing ground deformation and structural impacts.

4.2.1.7 *Hazard Severity and Risk Level*

The hazard condition is assessed as high due to progressive ground deformation, structural impacts, and sensitivity to rainfall-induced saturation. The overall community risk level is assessed as moderate, but detailed investigation is required immediately to evaluate long-term stability.

4.2.1.8 *Recommended Mitigation Measures*

The site requires detailed geotechnical investigation followed by engineering stabilization measures. Recommended interventions include rehabilitation and improvement of surface and subsurface drainage systems, installation of horizontal drains, toe stabilization, strengthening of retaining structures, ground improvement where necessary, and restriction of additional filling or loading. Continuous crack and deformation monitoring should be implemented.

4.2.1.9 *Relocation Requirement (if necessary)*

Immediate relocation is not required at present; however, affected structures should be monitored closely. If deformation progresses or structural safety deteriorates, relocation or partial evacuation of highly affected buildings may be required based on geotechnical assessment.

4.2.1.10 Site Photographs



Photograph 53 Landslide Site, Tudikbel (Mathillo Kopche) Parbat District

4.3 Dhading District

4.3.1 Dhunibesi Municipality-9, DM-9 LS-1 (Jugedi)

4.3.1.1 Location and Accessibility

The landslide site is located at Jugedi, Dhunibesi Municipality–09, Dhading District. The site is accessible through the local road network. The landslide is located adjacent to the road section where concentrated runoff from the road drains into a natural gully, causing erosion and slope instability.

4.3.1.2 Hazard Type

The site is affected by an active creep-type landslide along a gully. The failure is associated with gully erosion-induced slope movement and subsidence. The landslide has an estimated extent of approximately 100 m length, 50 m width, and 20 m runout. The slip surface is developed along the gully zone, where continuous erosion and saturation have reduced slope stability.

4.3.1.3 Geological and Geomorphological Condition

The area is situated along a natural drainage gully with a subsiding slope condition. The slope consists mainly of colluvial deposits that are highly susceptible to erosion and weakening during rainfall. The geomorphological setting is characterized by concentrated drainage flow, gully incision, rill erosion, and localized slope deformation. Road drainage has modified the natural runoff pattern and increased erosion within the gully.

4.3.1.4 Cause and Triggering Factors

The major cause of landslide development is poor drainage management, where surface runoff from the road is concentrated into the adjacent gully. This has resulted in gully cutting, erosion, and progressive

Site-Wise Rapid Assessment

slope weakening. The main triggering factor is monsoon rainfall, which increases runoff discharge and accelerates erosion and slope movement.

4.3.1.5 *Current Site Condition*

The landslide is currently active and expanding. The site shows gully-based slope movement, road-edge cracking, and deformation of existing protection structures. A community building and cottage have been damaged and are considered unsuitable for continued occupation. The existing gabion wall has also been affected. The landslide is progressing from the gully zone and may continue to enlarge if drainage issues are not addressed.

4.3.1.6 *Elements at Risk*

The major elements at risk include approximately 60 households with around 309 people, a community building, cottage structures, rural road infrastructure, and agricultural land. One house located near the crown area is considered at immediate risk. Approximately 10 ropani of land is vulnerable to continued erosion and slope movement.

4.3.1.7 *Hazard Severity and Risk Level*

The hazard condition is assessed as moderate, with potential for further expansion due to active gully erosion and concentrated runoff. The community risk level is considered low to medium, as only limited residential structures are directly exposed; however, infrastructure damage and future expansion remain concerns.

4.3.1.8 *Recommended Mitigation Measures*

The site is treatable through appropriate drainage and slope stabilization measures. Recommended interventions include proper surface and subsurface drainage management, diversion of road runoff away from the gully, construction and strengthening of gabion and retaining structures along the gully sides, and stabilization of the road embankment. Regular monitoring of cracks and gully expansion is recommended.

4.3.1.9 *Relocation Requirement (if necessary)*

No relocation is needed at present condition. The house located near the crown should be monitored closely, and relocation should be considered if the landslide expands toward the settlement area.

4.3.1.10 *Site Photographs**Photograph 54 Landslide Site, Jugedi*

4.3.2 Dhunibesi Municipality-9, DM-9 LS-2 (Khatri Pouwa)

4.3.2.1 *Location and Accessibility*

The Khatri Pauwa landslide site is located at Dhunibesi Municipality–09, Dhading District. The site is accessible through the local road network, which passes near the affected slope. The settlement consists of three households with a total population of 14. The area is mainly dependent on agriculture and is situated on a steep hill slope influenced by old landslide activity.

4.3.2.2 *Hazard Type*

The site is affected by an active creep-type soil slide developed within colluvial deposits. The landslide represents the reactivation of an old landslide system, with downslope movement of loose soil materials. The crown slope is steep (approximately 60°), indicating high susceptibility to further movement during rainfall events.

4.3.2.3 *Geological and Geomorphological Condition*

The area is characterized by a steep natural slope with colluvial soil deposits. The slope geometry is unfavorable, and loose colluvial materials are prone to saturation and strength reduction during monsoon rainfall. The landslide area exhibits a disturbed slope profile with evidence of previous mass movement. The surrounding terrain is highly dissected, and surface runoff concentration contributes to erosion and instability.

4.3.2.4 *Cause and Triggering Factors*

The primary cause of instability is the reactivation of an old landslide body consisting of weak colluvial materials. Intense monsoon rainfall acts as the main triggering factor by increasing soil saturation and reducing shear strength. Poor drainage conditions and concentrated surface runoff further contribute to the progressive movement of slope materials.

4.3.2.5 *Current Site Condition*

The landslide is currently active, with soil movement occurring toward the lower slope section. The crown area shows potential for further retrogression, and the sliding surface has affected the stability of the upper slope. Existing gabion protection is present; however, additional slope stabilization and drainage improvement are required to control future movement.

4.3.2.6 *Elements at Risk*

The major elements at risk include one residential house located near the crown area of the landslide, agricultural land of approximately 13 ropani, and local access infrastructure. Currently, one house is considered highly vulnerable, with about four people directly exposed to the hazard.

4.3.2.7 *Hazard Severity and Risk Level*

The landslide is categorized as active creep landslide. The probability of occurrence is high, particularly during intense monsoon rainfall. The community risk level is assessed as high due to the direct threat to residential structures and agricultural land. Without mitigation, further expansion of the landslide may increase the affected area.

4.3.2.8 *Recommended Mitigation Measures*

Immediate mitigation measures include improvement of surface and subsurface drainage, diversion of concentrated runoff away from the unstable slope, bioengineering stabilization using deep-rooted vegetation, and improvement or extension of existing retaining/gabion structures. Detailed slope stability analysis and geotechnical investigation are recommended before implementing major stabilization works.

Site-Wise Rapid Assessment

4.3.2.9 Relocation Requirement (if necessary)

At present, complete relocation is not immediately required; however, the house located near the crown area should be regularly monitored. If slope movement accelerates or crack development increases, partial relocation of the vulnerable household should be considered.

4.3.2.10 Site Photographs



Photograph 55 Landslide Site, Khatri Pounva

4.3.3 Dhunibesi Municipality-9, DM-9 LS-3 (Nagarpalika Office)

4.3.3.1 Location and Accessibility

The site is located at Dhunibesi Municipality-09, Dhading District, Bagmati Province, within the municipality office area. The site is accessible through the local road network and is located near Andheri Khola. The area contains important public infrastructure including the veterinary/isolation building and municipal facilities. The site elevation is approximately within the mid-hill terrain and is influenced by river valley processes.

4.3.3.2 Hazard Type

The area is affected by an active rotational landslide with debris flow characteristics developed within colluvial deposits. The steep crown area and active toe erosion indicate ongoing slope instability.

4.3.3.3 Geological and Geomorphological Condition

The landslide area is located on a river-controlled slope along Andheri Khola. The slope consists of loose colluvial materials overlying residual soil and alluvial deposits, with no exposed competent bedrock observed within the affected zone. The lower slope is steep due to river incision, and continuous toe erosion by the river has reduced slope stability. The area is highly susceptible to rainfall-induced saturation and erosion.

4.3.3.4 Cause and Triggering Factors

The main cause of instability is river toe cutting by Andheri Khola, which has progressively weakened the slope support. The presence of loose colluvial materials and building load has further contributed to instability. Heavy rainfall acts as the primary triggering factor by increasing infiltration, saturation, and pore-water pressure within the slope materials.

4.3.3.5 Current Site Condition

The landslide is currently active, with visible cracks and deformation affecting the veterinary/isolation building and nearby road section. The slide has developed along the slope below the municipal infrastructure, causing partial damage to structures. No major stabilization measures have been implemented so far, although protection works are planned.

4.3.3.6 Elements at Risk

The major elements at risk include the municipal veterinary/isolation building, municipality-related structures, and local road infrastructure. Approximately one major building is directly exposed to the landslide hazard. Around eight people associated with the facility are considered directly vulnerable. Damage to the facility may affect essential public services.

4.3.3.7 Hazard Severity and Risk Level

The site is categorized as Active Rotational Landslide with Debris Flow Potential. The probability of occurrence is high, particularly during intense rainfall events and continued river erosion. The risk level is assessed as moderate to high, mainly due to the presence of critical government infrastructure within the landslide influence zone.

4.3.3.8 Recommended Mitigation Measures

Immediate mitigation measures include river toe protection through gabion walls or revetment structures, improvement of surface and subsurface drainage, and stabilization of the slope using bioengineering

Site-Wise Rapid Assessment

measures. Protection structures should be designed considering river flow conditions and slope stability requirements. Additional monitoring of cracks and slope movement is recommended.

4.3.3.9 Relocation Requirement (if necessary)

Complete relocation of the community is not required as the hazard is mainly affecting public infrastructure. However, the veterinary/isolation building should be assessed for safety, and temporary relocation or shifting of the facility should be considered if slope movement accelerates.

4.3.3.10 Site Photographs



Photograph 56 Landslide Site, Nagarpalika Office

4.3.4 Dhunibesi Municipality-2, DM-2 LS-1 Thulo Khola

4.3.4.1 Location and Accessibility

Thulo Khola landslide is located at Dhunibesi Municipality-02, Dhading District, Bagmati Province. The site is accessible by local road networks, with roads located above and below the affected slope.

4.3.4.2 Hazard Type

The site is affected by an active/reactivated debris slide with earth slump characteristics developed within colluvial soil. The landslide has an estimated dimension of 60 m length and 36 m width with a shallow slip surface (0–3 m).

4.3.4.3 Geological and Geomorphological Condition

The area consists of colluvial soil deposits on a steep hill slope with cultivated terraces and road-cut slopes. Weak soil materials, slope modification, and concentrated drainage have contributed to slope instability.

Site-Wise Rapid Assessment

4.3.4.4 Cause and Triggering Factors

The major causes are weak colluvial soil, steep slope condition, toe erosion, and road-cut disturbance. Intense monsoon rainfall and prolonged soil saturation acted as the main triggering factors for reactivation.

4.3.4.5 Current Site Condition

The landslide is currently active/reactivated, with fresh scarps, exposed soil, and localized slope deformation observed. Existing retaining structures provide partial protection, but drainage-related instability remains.

4.3.4.6 Elements at Risk

Three households (approximately 19 people) are located within the landslide influence area. Local roads, agricultural terraces, and nearby infrastructure are also vulnerable to future slope movement.

4.3.4.7 Hazard Severity and Risk Level

The landslide is classified as medium to high risk due to active movement and possible expansion during heavy rainfall. Immediate attention is required to protect houses and infrastructure.

4.3.4.8 Recommended Mitigation Measures

Immediate implementation of surface and subsurface drainage management is recommended to reduce water infiltration into the slope. Additional retaining structures, toe protection works, and bioengineering measures should be applied in unstable sections. Regular monitoring of cracks, slope movement, and drainage conditions should be carried out before and during monsoon period.

4.3.4.9 Relocation Requirement (if necessary)

One highly exposed household near the active landslide zone should be relocated as movement continues. Other households may be protected through stabilization measures and monitoring.

4.3.4.10 Site Photographs





Photograph 57 Landslide Site, Thulo Khola

4.4 Parbat District

4.4.1 Falebas-8, FB-8 LS 1 (Khalte)

4.4.1.1 Location and Accessibility

Khalte of Falebas Municipality, Ward No. 8, Parbat.

4.4.1.2 Hazard Type

The identified hazard is an active complex landslide (debris flow and creeping).

4.4.1.3 Geological and Geomorphological Condition

Highly crushed phyllite dipping towards slope may lead to plane faller and gentle to moderate slope was observed. Local fault passed.

4.4.1.4 Cause and Triggering Factors

Weak and weathered phyllite along with intense rainfall.

4.4.1.5 Current Site Condition

Foottrails along with drinking water supply at toe of the landslide damage by observing landslide reoccur and reactivated.

4.4.1.6 Elements at Risk

Drinking water supply, settlement near the landslide and earthen road are in the elements at risk.

4.4.1.7 Hazard Severity and Risk Level

Based on the field observation slope condition is weather along the highly jointed and fractured due the external and internal force.

Hazard severity is high.

Risk level is high.

4.4.1.8 *Recommended Mitigation Measures*

Surface drainage management, haphazard road cut should be well managed. Further details study to find out the slip surface.

4.4.1.9 *Relocation Requirement (if necessary)*

7 household should be relocated before this monsoon.

4.4.1.10 *Site Photographs*



Photograph 58 Landslide Site, Kbalte

4.4.2 Falebas-8, FB-8 LS 2 (Okhreni)

4.4.2.1 *Location and Accessibility*

Okhreni lies in the mid-hill area of Parbat District and is surrounded by agricultural land and scattered settlements. The area can be accessed via the Kusma–Falebas road corridor, followed by local village roads leading to the site. Transportation facilities are available throughout most of the year, although travel may be affected during the monsoon season.

4.4.2.2 *Hazard Type*

The identified hazard is an active complex landslide (debris flow and creeping).

4.4.2.3 *Geological and Geomorphological Condition*

Debris flow and creep slope gentle colluvial soil covered with residual soil 30°

4.4.2.4 *Cause and Triggering Factors*

Intense rainfall and toe cutting

4.4.2.5 *Current Site Condition*

Active.

4.4.2.6 *Elements at Risk*

Road and settlement nearby landslide.

4.4.2.7 *Hazard Severity and Risk Level*

Based on the field observation slope condition is weather along the highly jointed and fractured due the external and internal force.

Hazard severity is high

Risk level is high

4.4.2.8 *Recommended Mitigation Measures*

For the debris slide at the site, mitigation should include upslope drainage control to reduce infiltration into the failure zone and stabilize moisture conditions. Toe protection using gabion or retaining structures is required to resist further movement and support the lower slope. Bioengineering with deep-rooted native vegetation should be applied to improve long-term slope stability. Small debris check structures may be added along the flow path where necessary. Final design must be based on detailed site-specific geotechnical investigation.

4.4.2.9 *Relocation Requirement (if necessary)*

At present, relocation is not required, as timely implementation of appropriate mitigation measures is expected to effectively control the landslide and stabilize the slope.

4.4.2.10 *Site Photographs*





Photograph 59 Landslide Site, Okhrani Kalamuda

4.5 Rukum West District

4.5.1 Musikot-10, MK-10 LS 1 (Chaura)

4.5.1.1 Location and Accessibility

Chaura is a settlement located in Ward No. 10 of Musikot Municipality, in western Nepal. It lies in a hilly region characterized by steep slopes, terraced land, and scattered rural habitation typical of mid-hill topography. The area is accessible through local rural roads and is mainly surrounded by agricultural land and forested hills, with a largely rural livelihood base

4.5.1.2 Hazard Type

The identified hazard is active complex landslide with evidence of slope movement.

4.5.1.3 Geological and Geomorphological Condition

The area underlined by the bed rock of marble bed rock with contour dip. General to steep slope observed in the area

4.5.1.4 Cause and Triggering Factors

Weathering and jointed rock of marble along with intense rainfall

Site-Wise Rapid Assessment

4.5.1.5 Current Site Condition

The landslide is active with many cracks observed in the crown part. Radial and tensional crack was observed in both flanks of the landslide.

4.5.1.6 Elements at Risk

Six households are in the risk zone.

4.5.1.7 Hazard Severity and Risk Level

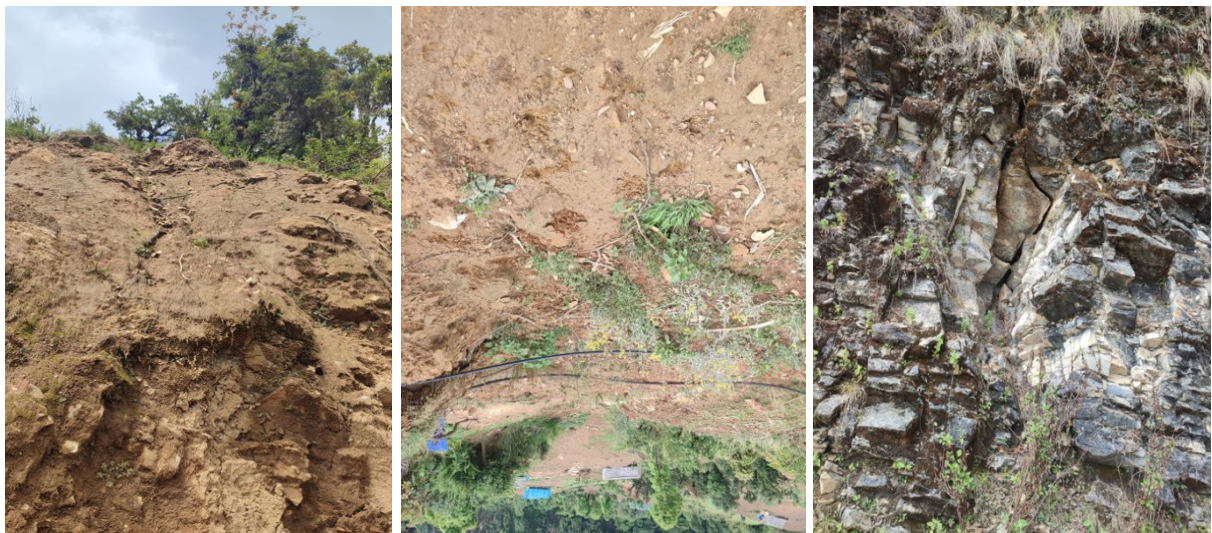
Based on the field observation slope condition is weather along the highly jointed and fractured due the external and internal force. Hazard severity is high. Risk level is high.

4.5.1.8 Recommended Mitigation Measures

Further detailed study required.

4.5.1.9 Relocation Requirement (if necessary)

Five households require immediate relocation due to direct exposure to the landslide hazard. An additional seven households remain at high risk and should be prioritized for monitoring and preparedness measures while mitigation works are implemented.

4.5.1.10 Site Photographs



Photograph 60 Landslide Site, Chaura

4.5.2 Athbiskot-13, AB-13 LS 1 (Kalo paio)

4.5.2.1 Location and Accessibility

Ward No. 13 of Athbiskot Municipality is situated in the mid-hill region of western Nepal. The area exhibits rugged physiography with a mix of steep slopes and terraced landforms typical of Himalayan foothill terrain. The settlement pattern is scattered, and accessibility is mainly through rural road networks. The local economy is predominantly based on subsistence agriculture, livestock rearing, and utilization of nearby forest resources.

4.5.2.2 Hazard Type

The identified hazard is active landslides with evidence of rock fall. Slope movement.

4.5.2.3 Geological and Geomorphological Condition

Interbedded dolomite and slate were observed with highly jointed dolomite. Very steep slope at the crown and rock cliff was observed in scar part.

4.5.2.4 Cause and Triggering Factors

Fragile type of geology highly jointed rock randomly orientated along with earthquake and intensional fall is the major triggering factor

4.5.2.5 Current Site Condition

Due to fragile geology highly jointed rock mass the area is highly active to rockfall reactivation of landslide may highly occur

4.5.2.6 *Elements at Risk*

Household engineering structures and along with urban road, cultivation land.

4.5.2.7 *Hazard Severity and Risk Level*

Based on the field observation slope condition is weather along the highly jointed and fractured due the external and internal force. Hazard severity is high. Risk level is high.

4.5.2.8 *Recommended Mitigation Measures*

Debris flow can be controlled through cascading engineering structures designed to reduce flow velocity and trap sediment along the channel. However, detailed site-specific study is required to further assess the treatability status and to finalize the design and effectiveness of the proposed mitigation measures

4.5.2.9 *Relocation Requirement (if necessary)*

At present conditions, relocation of the entire settlement comprising approximately 94 households is required due to the high level of landslide risk and overall slope instability.

4.5.2.10 *Site Photographs*



Photograph 61 Landslide Site, Kalo Pabiro

4.6 Surkhet District

4.6.1 Gurbhakot-2, GK-2 LS 1 (Gharti Base)

4.6.1.1 Location and Accessibility

The hazard site is located at Gharti Base, Gurbhakot-2, Surkhet, and is accessible through the local rural road network. GPS coordinates 28.3700 N, 81.92222 E.

4.6.1.2 Hazard Type

Debris-type gully erosion and sediment deposition hazard associated with monsoon runoff.

4.6.1.3 Geological and Geomorphological Condition

The area consists of moderate to steep agricultural slopes with loose colluvial and residual soils, while slightly weathered and fractured quartzite is exposed in the upper gully section.

4.6.1.4 Cause and Triggering Factors

Large catchment runoff and intense monsoon rainfall are the main causes and triggering factors of gully erosion and downstream sediment deposition.

4.6.1.5 Current Site Condition

The gully remains active during monsoon periods, causing runoff, sediment deposition, flooding, and localized erosion near downstream settlement areas.

4.6.1.6 Elements at Risk

Approximately 7 houses, agricultural land, and downstream settlement areas are vulnerable to monsoon runoff and sediment deposition.

4.6.1.7 Hazard Severity and Risk Level

The hazard severity is moderate with a Low to Medium community risk level during intense monsoon rainfall.

4.6.1.8 Recommended Mitigation Measures

Proper surface drainage management and construction of retaining/protection walls along the right flank are recommended to control erosion and divert gully flow.

4.6.1.9 Relocation Requirement (if necessary)

Relocation is currently not necessary; however, continuous monitoring and mitigation measures are required.

4.6.1.10 Site Photographs



Photograph 62 Landslide Site, GhartiBase

4.6.2 Gurbhakot-2, GK-2 LS 2 (Khahare)

4.6.2.1 Location and Accessibility

The hazard site is located at Khahare, Gurbhakot-2, Surkhet, and is accessible through the local Khahare–Gharti Base rural road. GPS coordinates 28.3559 N, 81.9450 E.

4.6.2.2 Hazard Type

Debris-type gully erosion and monsoon runoff hazard.

4.6.2.3 Geological and Geomorphological Condition

The area consists of moderate to steep agricultural slopes with loose colluvial and residual soils, while moderately weathered and fractured quartzite is exposed in the upper gully section.

4.6.2.4 Cause and Triggering Factors

Large catchment runoff, moderate to steep slope condition, and intense monsoon rainfall are the major causes and triggering factors of the gully erosion.

Site-Wise Rapid Assessment

4.6.2.5 *Current Site Condition*

The gully remains active during monsoon periods, causing sediment deposition, flooding, localized erosion, and runoff overflow into nearby settlement areas and agricultural land.

4.6.2.6 *Elements at Risk*

Approximately 3 households, agricultural land, and the local Khahare–Gharti Base road are vulnerable to monsoon runoff and gully erosion hazards.

4.6.2.7 *Hazard Severity and Risk Level*

The hazard severity is moderate with Medium community risk level during intense monsoon rainfall.

4.6.2.8 *Recommended Mitigation Measures*

Proper surface and subsurface drainage management, retaining walls along the gully flanks, and maintenance of culverts and protection structures are recommended.

4.6.2.9 *Relocation Requirement (if necessary)*

Relocation is currently not necessary; however, continued monitoring and drainage improvement are required.

4.6.2.10 *Site Photographs*



Photograph 63 Landslide Site, Khabare

4.6.3 Gurbhakot-3, GK-3 LS 1 (Atka)

4.6.3.1 Location and Accessibility

The hazard site is located at Atka, Gurbhakot-3, Surkhet, and is accessible through the local rural road network connected to the settlement and (Saraswati Nera Adharbhut Vidhyala) school area. GPS coordinates 28.4013 N, 81.9708 E.

4.6.3.2 Hazard Type

Large-scale translational and rotational landslide with slope subsidence, rockfall, and debris hazard.

4.6.3.3 Geological and Geomorphological Condition

The area consists of moderately steep to steep slopes with highly weathered and fractured quartzite mixed with colluvial debris and residual soil. Subsidence, multiple ground cracks, loose debris accumulation, and rockfall-prone conditions are observed across the upper slope.

4.6.3.4 Cause and Triggering Factors

Improper road cut excavation, weak and fractured quartzite, inadequate drainage, and heavy backfill pressure behind retaining structures are the major causes, while intense rainfall and infiltration through cracks are the main triggering factors.

4.6.3.5 Current Site Condition

A portion of the slope near the road has already failed, while the upper slope is undergoing progressive subsidence with widening cracks and retaining wall deformation near Saraswati Near Aadharbhut Vidhyala.

Site-Wise Rapid Assessment

4.6.3.6 *Elements at Risk*

Approximately 15 houses, Saraswati Near Aadharbhut Vidhyala, local road sections, and about 20–22 ropani of land are vulnerable to further slope failure and rockfall hazards.

4.6.3.7 *Hazard Severity and Risk Level*

The hazard severity is high with a medium community risk level due to active slope instability, settlement exposure, and risk to school infrastructures.

4.6.3.8 *Recommended Mitigation Measures*

Retaining wall strengthening and modification, construction of rockfall/debris protection structures, proper drainage management, slope stabilization works, crack monitoring, and bioengineering measures are recommended.

4.6.3.9 *Relocation Requirement (if necessary)*

Restricted use of highly vulnerable areas near the school and unstable slope sections may be necessary if slope movement continues.

4.6.3.10 *Site Photographs*

4.6.4 Gurbhakot-3, GK-3 LS 2 (Hileghari Seta)

4.6.4.1 Location and Accessibility

The hazard site is located at Hileghari-Seta, Gurbhakot-3, Surkhet, and is accessible through the local rural road passing through the settlement area. GPS coordinates 28.4074 N, 81.9441 E

4.6.4.2 Hazard Type

Debris-type shallow landslide associated with road cut slope instability and rainfall infiltration.

4.6.4.3 Geological and Geomorphological Condition

The area consists of moderate to steep slopes with weathered and fractured quartzite mixed with coarse soil materials. A slight depression at the upper slope allows water accumulation, while settlements are located both above and below the road section.

4.6.4.4 Cause and Triggering Factors

Road slope cutting disturbed the natural slope stability and drainage pattern, while intense monsoon rainfall and infiltration of runoff into the depressed area triggered slope movement and seepage.

4.6.4.5 Current Site Condition

The slope remains active with ongoing downslope movement, seepage in houses, surface cracks, and localized instability affecting the road and nearby settlements.

4.6.4.6 Elements at Risk

Approximately 5 houses, rural road sections, agricultural land, and settlements both above and below the road are vulnerable to further landslide movement.

4.6.4.7 Hazard Severity and Risk Level

The hazard severity is moderate with Low to Medium community risk level, particularly during intense monsoon rainfall.

4.6.4.8 Recommended Mitigation Measures

Proper surface and subsurface drainage management, retaining structures, slope stabilization works, runoff diversion, vegetation cover, and erosion control measures are recommended.

4.6.4.9 Relocation Requirement (if necessary)

Relocation of 5 houses is currently necessary; however, continuous monitoring and immediate drainage improvement are required to reduce future risk.

4.6.4.10 Site Photographs



Photograph 65 Landslide Site, Hilleghari Seta

4.6.5 Gurbhakot-3, GK-3 LS3 (Lekhkurule)

4.6.5.1 Location and Accessibility

The hazard site is located at Lekh Kurule, Gurbhakot-3, Surkhet, and is accessible through the local rural road passing near the affected slope. Latitude: 28°24'11.96"N, Longitude: 81°58'02.03" E

4.6.5.2 Hazard Type

Shallow landslide with rockfall and debris hazard associated with road cut slope instability.

4.6.5.3 Geological and Geomorphological Condition

The area consists of moderate to steep slopes with loose colluvial and residual soil materials, along with slightly weathered and fractured quartzite prone to rockfall and slope failure.

4.6.5.4 Cause and Triggering Factors

Road cutting weakened the natural slope stability, while intense monsoon rainfall triggered shallow landslide movement and minor rockfall from the exposed slope.

Site-Wise Rapid Assessment

4.6.5.5 Current Site Condition

The slope remains unstable with shallow landslide movement, loose debris, minor rockfall activity, and cracks observed in nearby houses during rainfall periods.

4.6.5.6 Elements at Risk

Approximately 5 houses, nearby road sections, and a school are vulnerable to further landslide movement, debris deposition, and rockfall hazards.

4.6.5.7 Hazard Severity and Risk Level

The hazard severity is moderate with Medium community risk level, particularly during intense monsoon rainfall.

4.6.5.8 Recommended Mitigation Measures

Proper drainage management, retaining/protection structures, rockfall netting, slope regrading, vegetation planting, and regular monitoring are recommended to stabilize the slope.

4.6.5.9 Relocation Requirement (if necessary)

Relocation is currently not necessary; however, temporary protection and close monitoring are required during monsoon periods.

4.6.5.10 Site Photographs



Photograph 66 Landslide Site, Lekbkurule

4.6.6 Gurbhakot-3, GK-3 LS4 (Aal Kurule near Lekh Kurule)

4.6.6.1 Location and Accessibility

The hazard site is located at Aal Kurule (Lekh Kurule), Gurbhakot-3, Surkhet, and is accessible through the local rural road passing along the affected slope section. GPS coordinates 28°26'42.51" N, 81°56'05.72" E.

4.6.6.2 Hazard Type

Large scaled landslide (Complex landslide) involving debris movement, rotational failure, and slope instability associated with road cut excavation.

4.6.6.3 Geological and Geomorphological Condition

The area consists of steep and highly dissected hill slopes composed of weathered and fractured quartzite overlain by colluvial soil and debris deposits. Loose debris accumulation and steep terrain have significantly reduced slope stability.

4.6.6.4 Cause and Triggering Factors

Road slope cutting (toe cutting), weak geological conditions, steep terrain, and poor drainage are the major causes, while intense monsoon rainfall and infiltration are the main triggering factors.

4.6.6.5 Current Site Condition

The landslide remains active with multiple tension cracks, steep scarps, continuous debris movement, and erosion affecting the road section and nearby settlement areas.

4.6.6.6 Elements at Risk

Approximately 10 houses, local road sections, agricultural land, and nearby settlement areas are directly vulnerable to further landslide movement and debris flow.

Site-Wise Rapid Assessment

4.6.6.7 Hazard Severity and Risk Level

The hazard severity is high due to active large-scale slope instability and ongoing debris movement; the community risk level is considered Medium to High.

4.6.6.8 Recommended Mitigation Measures

Construction of retaining and toe protection structures, proper surface and subsurface drainage management, slope stabilization, bioengineering measures, and controlled road drainage practices are recommended.

4.6.6.9 Relocation Requirement (if necessary)

Relocation may be necessary if landslide activity further increases during monsoon periods.

4.6.6.10 Site Photographs

Photograph 67 Landslide Site, Alkurule

4.6.7 Gurbhakot-4, GK-4 LS1 (Jhalepahar)

4.6.7.1 Location and Accessibility

The hazard site is located at Jhale Pahar, Gurbhakot-4, Surkhet, and is accessible through the local rural road passing above the settlement area. GPS coordinates 28.4115 N, 81.9273 E

4.6.7.2 Hazard Type

Rain-induced flood and rill erosion hazard associated with concentrated surface runoff.

4.6.7.3 Geological and Geomorphological Condition

The area consists of moderate to steep agricultural slopes with loose colluvial and residual soil materials, while slightly weathered and fractured quartzite is exposed in the upper slope area.

4.6.7.4 Cause and Triggering Factors

Improper drainage management and concentration of road runoff are the major causes, while intense monsoon rainfall acts as the primary triggering factor.

4.6.7.5 Current Site Condition

Monsoon runoff from the road enters the settlement area, causing rill erosion, sediment deposition, localized flooding, and damage to nearby land and houses.

4.6.7.6 Elements at Risk

Approximately 3 houses, agricultural land, downstream settlement areas, and local rural road sections are vulnerable to flooding and erosion hazards.

4.6.7.7 Hazard Severity and Risk Level

The hazard severity is moderate with Low to Medium community risk level, especially during intense monsoon rainfall.

4.6.7.8 Recommended Mitigation Measures

Proper surface and subsurface drainage management, retaining/protection walls, runoff diversion structures, and erosion control measures are recommended.

4.6.7.9 Relocation Requirement (if necessary)

Relocation is currently not necessary; however, improved drainage management and regular monitoring are required.

4.6.7.10 *Site Photographs**Photograph 68 Landslide Site, Jharle Pahar*

4.6.8 Gurbhakot-4, GK-4 LS 2 (Naule Pani)

4.6.8.1 *Location and Accessibility*

The hazard site is located at Naule Pani, Gurbhakot-4, Surkhet, and is accessible through the local rural road crossing the affected gully area.

4.6.8.2 *Hazard Type*

Debris-type gully erosion and monsoon runoff hazard.

4.6.8.3 *Geological and Geomorphological Condition*

The area consists of moderate to steep agricultural slopes with loose colluvial and residual soil materials. The gully passes through the rural road section, and erosion-prone conditions are observed along the drainage path.

4.6.8.4 *Cause and Triggering Factors*

Large catchment runoff and intense monsoon rainfall are the major causes and triggering factors of gully erosion and flooding within the settlement area.

4.6.8.5 *Current Site Condition*

The gully remains active during monsoon periods, causing sediment deposition, localized flooding, erosion, and runoff overflow into nearby houses and agricultural land.

4.6.8.6 *Elements at Risk*

Houses, rural road sections, agricultural land, and downstream settlement areas are vulnerable to gully erosion, flooding, and sediment deposition hazards.

4.6.8.7 *Hazard Severity and Risk Level*

The hazard severity is moderate with Low to Medium community risk level, especially during intense monsoon rainfall periods.

4.6.8.8 *Recommended Mitigation Measures*

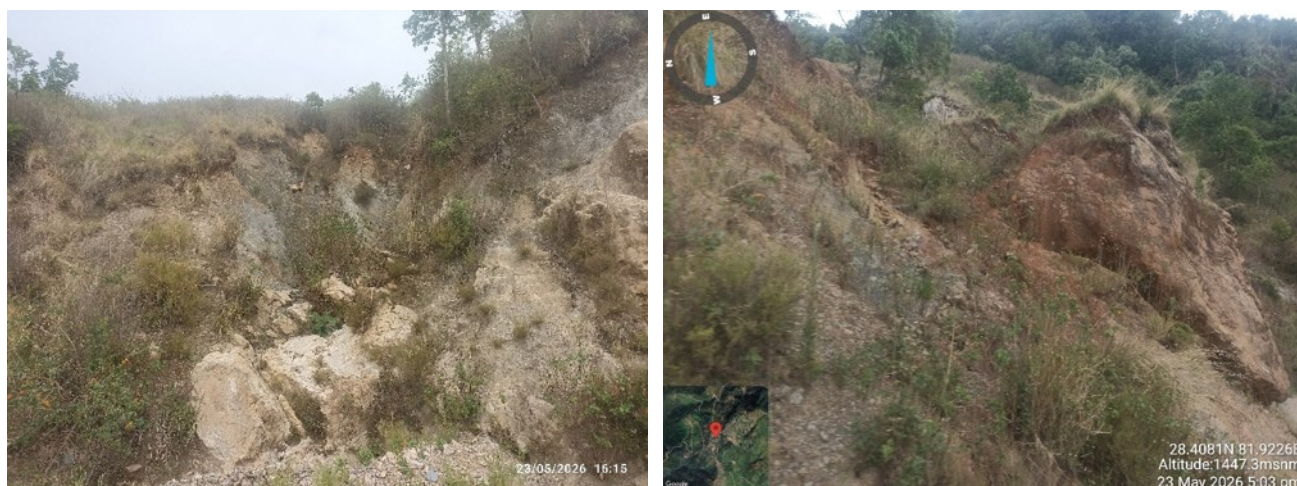
Proper surface and subsurface drainage management, retaining walls along both flanks, runoff diversion, and erosion control measures are recommended to reduce future risk.

4.6.8.9 *Relocation Requirement (if necessary)*

Relocation is currently not necessary; however, continuous monitoring and drainage improvement are required.

4.6.8.10 *Site Photographs*





Photograph 69 Landslide Site, Naule Pani

4.6.9 Gurbhakot-4, GK-4 LS 3 (Aptakura)

4.6.9.1 Location and Accessibility

The hazard site is located at Aap Takura, Gurbhakot-4, Surkhet, and is accessible through the local rural road and bridge approach area. GPS coordinates 28.3860 N, 81.8912 E

4.6.9.2 Hazard Type

Debris-type shallow landslide associated with slope cutting and bridge construction activities.

4.6.9.3 Geological and Geomorphological Condition

The area consists of moderate to steep slopes with loose colluvial and residual soil materials. Terrace farming is practiced near the crown area, and a culvert is present along the upper part of the landslide.

4.6.9.4 Cause and Triggering Factors

Haphazard slope cutting during bridge construction and weak soil conditions are the major causes, while intense monsoon rainfall acts as the primary triggering factor.

4.6.9.5 Current Site Condition

The slope remains unstable with ongoing soil and debris movement, particularly around the abandoned bridge construction area and cut slope sections.

4.6.9.6 Elements at Risk

Approximately 11 houses, agricultural land, bridge approach sections, culvert structures, and nearby access routes are vulnerable to further slope failure and erosion.

4.6.9.7 Hazard Severity and Risk Level

The hazard severity is moderate with Low to Medium community risk level, especially during intense monsoon rainfall periods.

Site-Wise Rapid Assessment

4.6.9.8 *Recommended Mitigation Measures*

Proper retaining structures, slope regrading, drainage management, vegetation cover, controlled excavation, and regular monitoring are recommended to stabilize the slope.

4.6.9.9 *Relocation Requirement (if necessary)*

Relocation is currently not necessary; however, slope stabilization and drainage improvement are required before continuation of bridge construction activities.

4.6.9.10 *Site Photographs*

Photograph 70 Landslide Site, Aaptakura

4.6.10 Gurbhakot-7, GK-7 LS 1 (Naule Khola)

4.6.10.1 *Location and Accessibility*

The hazard site is located at Nauli Khola, Gurbhakot-7, Surkhet, and is accessible through the local rural road passing near the affected slope area. GPS coordinates 28°25'24.96" N, 81°50'24" E

4.6.10.2 *Hazard Type*

Shallow debris-type landslide associated with saturated soil and road cut slope instability.

4.6.10.3 Geological and Geomorphological Condition

The area consists of moderate slopes with loose residual soil materials. Terrace farming is widely practiced, and the slope has been stabilized with multi-level gabion retaining structures.

4.6.10.4 Cause and Triggering Factors

Road cutting and fully saturated soil conditions were the major causes, while intense rainfall during Ashoj 2080 acted as the primary triggering factor.

4.6.10.5 Current Site Condition

The slope is currently stabilized with stepped gabion retaining walls, and there is very low possibility of immediate reactivation under present conditions.

4.6.10.6 Elements at Risk

Agricultural land and rural road sections were previously affected by the shallow landslide and debris movement.

4.6.10.7 Hazard Severity and Risk Level

The hazard severity is currently low with low community risk due to successful stabilization and slope protection measures.

4.6.10.8 Recommended Mitigation Measures

Regular maintenance of gabion walls, proper drainage management, slope monitoring, and vegetation cover maintenance are recommended for long-term stability.

4.6.10.9 Relocation Requirement (if necessary)

Relocation is not necessary as the site has been effectively stabilized.

4.6.10.10 Site Photographs





Photograph 71 Landslide Site, Naule Khola

4.6.11 Gurbhakot-7, GK-7 LS 2 (Sano Thakleni)

4.6.11.1 Location and Accessibility

The hazard site is located at Sano Thakleni, Gurbhakot-7, Surkhet, and is accessible through the local rural road passing near the affected gully area. GPS coordinates 28°24'23.40" N, 81°51'16.61" E

4.6.11.2 Hazard Type

Debris-type gully erosion and monsoon runoff hazard.

4.6.11.3 Geological and Geomorphological Condition

The area consists of moderate to steep agricultural slopes with loose colluvial and residual soil materials. The gully passes through the rural road area and erosion-prone conditions are observed along the drainage path.

4.6.11.4 Cause and Triggering Factors

Large catchment runoff and intense monsoon rainfall are the major causes and triggering factors of gully erosion, flooding, and sediment deposition within the settlement area.

4.6.11.5 Current Site Condition

The gully remains active during monsoon periods, causing sediment deposition, localized flooding, erosion, and runoff overflow into nearby houses and agricultural land.

4.6.11.6 Elements at Risk

Approximately 10 houses, agricultural land, rural road sections, and downstream settlement areas are vulnerable to gully erosion and flooding hazards.

Site-Wise Rapid Assessment

4.6.11.7 Hazard Severity and Risk Level

The hazard severity is moderate with Low to Medium community risk level, particularly during intense monsoon rainfall.

4.6.11.8 Recommended Mitigation Measures

Proper surface and subsurface drainage management, retaining/protection walls along the gully flanks, runoff diversion structures, and erosion control measures are recommended.

4.6.11.9 Relocation Requirement (if necessary)

Relocation is currently not necessary; however, drainage improvement and regular monitoring are required to reduce future risk.

4.6.11.10 Site Photographs



Photograph 72 Landslide Site, Sano Thakleni

4.6.12 Gurbhakot-8, GK-8 LS 1 (Bhedawari PulBazar)

4.6.12.1 Location and Accessibility

The hazard site is located at Bhedawari PulBazar, Gurbhakot-8, Surkhet, near the Bheri River Bridge and accessible through the local road network. GPS coordinates 28.4277 N, 81.8738 E.

4.6.12.2 Hazard Type

Debris-type gully erosion associated with weak mudstone and concentrated surface runoff.

4.6.12.3 Geological and Geomorphological Condition

The area consists of moderate to steep slopes with weak mudstone and colluvial soil, while moderately steep sandstone slopes are present on adjacent sides. The mudstone is highly susceptible to weathering and erosion during rainfall events.

4.6.12.4 Cause and Triggering Factors

Weak mudstone terrain, concentrated road runoff, and inadequate drainage are the major causes, while intense monsoon rainfall acts as the primary triggering factor.

4.6.12.5 Current Site Condition

Active gully erosion is observed near the bridge area, where concentrated runoff continues to erode the weak mudstone slope and affect nearby land and settlement areas.

4.6.12.6 Elements at Risk

Approximately 3 houses, nearby settlement areas, agricultural land, roadside sections, and adjacent infrastructures are vulnerable to continued erosion and slope instability.

4.6.12.7 Hazard Severity and Risk Level

The hazard severity is moderate with Low to Medium community risk level, especially during intense monsoon rainfall periods.

4.6.12.8 Recommended Mitigation Measures

Proper surface and subsurface drainage management, improved retaining structures, runoff diversion, and nature-based slope stabilization measures are recommended to reduce erosion.

4.6.12.9 Relocation Requirement (if necessary)

Relocation is currently not necessary; however, regular monitoring and drainage improvement are required to prevent future instability.

4.6.12.10 Site Photographs



Photograph 73 Landslide Site, Bheda Wari Pulbazar

4.6.13 Gurbhakot-8, GK-8 LS 2 (Gangate Khola)

4.6.13.1 Location and Accessibility

The site is located at Gangate Khola, Gurbhakot Municipality–8, Surkhet District, Karnali Province, at an elevation of about 438.3 m. GPS coordinates 28.4324 N, 81.8544 E. The area is accessible through a rural road network near the floodplain settlement.

4.6.13.2 Hazard Type

Flood and riverbank erosion hazard associated with river encroachment and seasonal monsoon flooding.

4.6.13.3 Geological and Geomorphological Condition

The area lies within a low-lying floodplain influenced by a large catchment area. Residual cohesive soil is highly susceptible to saturation, erosion, and riverbank instability during monsoon periods.

4.6.13.4 Cause and Triggering Factors

Major causes include large catchment runoff, river encroachment, weak residual cohesive soil, and lack of river protection measures. Intense monsoon rainfall is the primary triggering factor.

4.6.13.5 Current Site Condition

Active flooding and riverbank erosion are observed during monsoon seasons, causing continuous loss of agricultural land and threatening nearby settlements and roads.

4.6.13.6 Elements at Risk

Approximately 9 houses, rural road sections, and 25–30 ropani of agricultural land are exposed to flood and erosion hazards.

4.6.13.7 Hazard Severity and Risk Level

The hazard severity is moderate to high during intense monsoon rainfall, with a low-to-medium community risk level affecting around 39 people.

4.6.13.8 Recommended Mitigation Measures

Construction of embankments, gabion walls, and river training works along with proper drainage management and bioengineering measures are recommended to control flooding and erosion.

4.6.13.9 Relocation Requirement (if necessary)

Immediate relocation is not currently required, but continuous monitoring and preparedness are necessary if river erosion progresses toward settlement areas.

4.6.13.10 Site Photographs





Photograph 74 Landslide Site, Gangate Khola

4.6.14 Gurbhakot-9, GK-9 LS 1 (Nadekot)

4.6.14.1 Location and Accessibility

The site is located at Nadekot, Gurbhakot Municipality-9, Surkhet District, Karnali Province, at an elevation of about 1027 m. GPS coordinates 28.4000 N, 81.9040 E. The area is accessible through a rural road network constructed along moderately steep hill slopes.

4.6.14.2 Hazard Type

Active creep and localized landslide along a road-cut slope descending toward Bhalu Khola.

4.6.14.3 Geological and Geomorphological Condition

The area consists of moderately steep terrain with residual and colluvial soil overlying weathered slope materials. Road cutting and slope undercutting have reduced slope stability, while seepage and water infiltration further weaken the ground.

4.6.14.4 Cause and Triggering Factors

Major causes include road-cut excavation, poor surface drainage, slope undercutting, and weak residual soil. Intense monsoon rainfall and prolonged water infiltration are the main triggering factors.

4.6.14.5 Current Site Condition

Active land creep, tilted trees, ground deformation, and cracks in houses are observed around the affected slope. Localized slope movement continues during monsoon periods.

4.6.14.6 Elements at Risk

Approximately 8 houses, nearby agricultural land, and sections of the rural road are directly threatened by ongoing slope movement.

Site-Wise Rapid Assessment

4.6.14.7 Hazard Severity and Risk Level

The hazard severity is moderate to high due to active creep and progressive deformation, with low-to-medium community risk affecting around 27 people.

4.6.14.8 Recommended Mitigation Measures

Diversion drains, retaining structures, toe protection, surface drainage improvement, and bioengineering measures such as deep-rooted vegetation plantation are recommended to stabilize the slope.

4.6.14.9 Relocation Requirement (if necessary)

Relocation of 2 highly vulnerable houses is urgently recommended due to ongoing slope movement and structural damage.

4.6.14.10 Site Photographs



Photograph 75 Landslide Site, Nadekkot

4.6.15 Gurbhakot-9, GK-9 LS 2 (Dapcha)

4.6.15.1 Location and Accessibility

The site is located at Khuti, Dapcha in Gurbhakot Municipality–9, Surkhet District, Karnali Province, at an elevation of about 1480 m. GPS coordinates 28.4198 N, 81.9306 E. The settlement is accessible through a rural road constructed along the upper slope.

4.6.15.2 Hazard Type

Active debris and gully erosion hazard associated with concentrated monsoon runoff and slope instability.

4.6.15.3 Geological and Geomorphological Condition

The area consists of moderate to steep slopes underlain by purple shale and quartzite bedrock with overlying pebble- to boulder-sized colluvial and residual soil. Large catchment runoff and weak slope materials have increased erosion and instability.

4.6.15.4 Cause and Triggering Factors

Major causes include steep slope conditions, large catchment area, concentrated runoff from the road section, and weak slope materials. Intense monsoon rainfall is the primary triggering factor.

4.6.15.5 Current Site Condition

Active gully erosion, channel deepening, sediment deposition, and slope instability are observed. Cracks have developed in several houses located near the gully and downstream area.

4.6.15.6 Elements at Risk

Approximately 5 houses, agricultural land (5–6 ropani), and nearby road sections are directly threatened by erosion and slope failure.

4.6.15.7 Hazard Severity and Risk Level

The hazard severity is moderate to high during monsoon periods, with medium-to-high community risk affecting around 24 people.

4.6.15.8 Recommended Mitigation Measures

Proper surface and subsurface drainage management, retaining structures, road drainage improvement, channel stabilization, and slope protection measures are recommended to control erosion and reduce future risk.

4.6.15.9 Relocation Requirement (if necessary)

Relocation of 5 highly vulnerable houses is recommended due to continuous erosion and increasing slope instability.

4.6.15.10 Site Photographs



Photograph 76 Landslide Site, Dapcha

4.6.16 Gurbhakot-9, GK-9 LS 3 (Simghat Botechaur)

4.6.16.1 Location and Accessibility

The site is located at Simghat Botechaur, Gurbhakot Municipality–9, Surkhet District, Karnali Province, at an elevation of about 470.4 m. GPS coordinates 28.4230 N, 81.8899 E. The settlement lies along the Bheri River and is accessible through local rural roads.

4.6.16.2 Hazard Type

Active riverbank landslide and slope instability caused by continuous toe cutting along the Bheri River.

4.6.16.3 Geological and Geomorphological Condition

The area is characterized by steep riverbank slopes with loose colluvial and residual soil over weathered and fractured materials. Continuous river erosion and rugged topography have increased slope instability and land subsidence.

4.6.16.4 Cause and Triggering Factors

Major causes include continuous toe cutting by the Bheri River, steep slope conditions, weak geological materials, and slope saturation. Intense monsoon rainfall is the main triggering factor.

4.6.16.5 Current Site Condition

Active slope movement, ground subsidence, and cracks are observed within the settlement area. Two houses have already been severely damaged due to progressive landslide activity.

4.6.16.6 Elements at Risk

Approximately 2 houses, agricultural land (10–15 ropani), and nearby settlement areas are directly exposed to landslide and erosion hazards.

4.6.16.7 Hazard Severity and Risk Level

The hazard severity is high due to continuous toe erosion and active slope deformation, with moderate community risk during intense monsoon periods.

4.6.16.8 Recommended Mitigation Measures

Toe protection works such as gabion walls, revetments, and river training structures are recommended along the Bheri River. Surface and subsurface drainage improvement, bioengineering measures, and continuous slope monitoring are also required.

4.6.16.9 Relocation Requirement (if necessary)

Relocation of 2 highly vulnerable houses is recommended due to ongoing slope deformation and risk of further failure.

4.6.16.10 Site Photographs





Photograph 77 Landslide Site, Simghat Botechaun

4.6.17 Gurbhakot-9, GK-9 LS 4 (Bhulke)

4.6.17.1 Location and Accessibility

Bhulke is located in Ward No. 9 of Gurbhakot along the floodplain of the Bheri River and is accessible through rural road networks.

GPS Location: Latitude 28°26'03.97"N, Longitude 81°54'34.48"E, Elevation: 439 m.

4.6.17.2 Hazard Type

The area is affected mainly by flood and riverbank erosion hazards associated with monsoon-induced river overflow and toe cutting.

4.6.17.3 Geological and Geomorphological Condition

The settlement lies on a low-lying sandy floodplain consisting of loose alluvial deposits that are highly erodible and vulnerable to inundation and channel migration.

4.6.17.4 Cause and Triggering Factors

The major causes are settlement within the active floodplain and riverbank erosion, while intense monsoon rainfall acts as the primary triggering factor.

4.6.17.5 Current Site Condition

Active flooding and minor toe erosion by the Bheri River continue to affect houses, agricultural land, and nearby settlement areas during monsoon periods.

4.6.17.6 Elements at Risk

Approximately 10 houses, agricultural land (50–60 ropani), local infrastructure, and around 71 people are vulnerable to flooding and erosion.

Site-Wise Rapid Assessment

4.6.17.7 Hazard Severity and Risk Level

The hazard level is moderate to high during intense monsoon rainfall due to active floodplain erosion, repeated inundation, and previous destruction of one residential house.

4.6.17.8 Recommended Mitigation Measures

Strengthening and extending embankments and gabion walls, improving drainage management, and implementing bioengineering measures are recommended to control flooding and riverbank erosion.

4.6.17.9 Relocation Requirement (if necessary)

Relocation may be required for highly vulnerable households located directly within the active floodplain or near eroding riverbanks if flooding intensity increases in the future.

4.6.17.10 Site Photographs



Photograph 78 Landslide Site, Bhulke

4.6.18 Gurbhakot-9, GK-9 LS 5 (Tharuhoriya)

4.6.18.1 Location and Accessibility

TharuKhoriya is located in Ward No. 9 of Gurbhakot and is accessible through rural roads and foot trails.

Site-Wise Rapid Assessment

GPS Location: Latitude 28°25'51.17"N, Longitude 81°55'12.38"E, Elevation: 290 m.

4.6.18.2 Hazard Type

The area is affected by an active debris landslide associated with gully erosion and downslope sediment movement.

4.6.18.3 Geological and Geomorphological Condition

The site consists of steep, highly dissected slopes composed mainly of cohesive residual soil that is highly prone to erosion and instability during saturation.

4.6.18.4 Cause and Triggering Factors

The major causes include steep slopes, loose residual soil, and erosion, while the 2015 earthquake and intense monsoon rainfall acted as primary triggering factors.

4.6.18.5 Current Site Condition

The landslide remains active with ongoing slope movement, erosion, and sediment transport through the gully, threatening nearby houses and agricultural land.

4.6.18.6 Elements at Risk

Approximately 4 houses, agricultural land (10–12 ropani), and settlement areas located near the gully and deposition zone are at immediate risk.

4.6.18.7 Hazard Severity and Risk Level

The hazard level is medium to high due to active slope instability, continuous erosion, and high probability of reactivation during monsoon rainfall.

4.6.18.8 Recommended Mitigation Measures

Construction of drainage channels, check dams, gabion structures, and bioengineering measures such as vetiver plantation are recommended to stabilize the slope and control erosion.

4.6.18.9 Relocation Requirement (if necessary)

Relocation of 4 highly vulnerable houses located along the unstable slope and gully edge is recommended to reduce future risk.

4.6.18.10 Site Photographs



Photograph 79 Landslide Site, Tharuboriya

4.6.19 Gurbhakot-10, GK-10 LS 1 (Bhedabari Mathillo Lamitale Tol)

4.6.19.1 Location and Accessibility

Lamitale Tole, Gurbhakot Ward No. 10, is located at GPS coordinates $28^{\circ}26'15.9''\text{N}$, $81^{\circ}53'02.9''\text{E}$ at an elevation of about 561 m, accessible through a rural road network.

4.6.19.2 Hazard Type

Active flood and debris-flow hazard affecting the settlement located below a steep gully during intense monsoon rainfall.

4.6.19.3 Geological and Geomorphological Condition

The area consists of unconsolidated colluvial and debris deposits on relatively flat terrain below a steep gully draining a large catchment area.

4.6.19.4 Cause and Triggering Factors

Steep slopes, concentrated runoff from the upper catchment, and intense monsoon rainfall are the main causes triggering debris-laden flooding.

4.6.19.5 Current Site Condition

Floodwater and sediment frequently enter houses and agricultural land, affecting around 15 houses and causing repeated inundation during heavy rainfall.

4.6.19.6 Elements at Risk

Approximately 63 people, 15 houses, rural access routes, and 50–60 ropani of agricultural land are vulnerable to flooding and debris deposition.

4.6.19.7 Hazard Severity and Risk Level

The hazard is active with medium community risk and high probability of occurrence during intense monsoon rainfall.

4.6.19.8 Recommended Mitigation Measures

Construct check dams, improve surface drainage channels, and provide flood-control structures to safely divert runoff and trap debris before reaching the settlement.

4.6.19.9 Relocation Requirement (if necessary)

Immediate relocation is not currently required, but temporary evacuation may be necessary during extreme monsoon events if flooding intensifies.

4.6.19.10 Site Photographs



Photograph 80 Landslide Site, Bhedabari Mathillo Lamitale Tole

4.6.20 Gurbhakot-10, GK-10 LS 2 (Hanimane Umrepani)

4.6.20.1 Location and Accessibility

Hanimane, Gurbhakot Ward No. 10, is located at GPS coordinates 28°26'44.79"N, 81°53'15.39"E at an elevation of about 820 m, accessible through rural roads and agricultural trails.

4.6.20.2 Hazard Type

Active rain-induced flood and gully erosion hazard affecting settlements located below the drainage channel.

4.6.20.3 Geological and Geomorphological Condition

The area consists of loose colluvial and residual soil with highly weathered and fractured sandstone on moderate to steep slopes.

4.6.20.4 Cause and Triggering Factors

Improper drainage management, concentrated monsoon runoff, and intense rainfall are the main causes triggering gully erosion and flooding.

4.6.20.5 Current Site Condition

Sediment-laden runoff frequently enters the settlement during monsoon rainfall, causing flooding, erosion, and damage to houses and agricultural land.

4.6.20.6 Elements at Risk

Approximately 14 people, 3 houses, nearby rural roads, and 6–8 ropani of agricultural land are exposed to flooding and erosion hazards.

4.6.20.7 Hazard Severity and Risk Level

The hazard is active with medium community risk and high probability of occurrence during intense monsoon rainfall.

Site-Wise Rapid Assessment

4.6.20.8 *Recommended Mitigation Measures*

Construct proper surface drainage, retaining walls, and erosion-control structures to safely divert runoff and stabilize the gully sides.

4.6.20.9 *Relocation Requirement (if necessary)*

Relocation of at least 2 highly vulnerable houses is recommended due to continued flood and erosion risk near the gully area.

4.6.20.10 *Site Photographs*

Photograph 81 Landslide Site, Hanimane - Umerpani

4.6.21 Gurbhakot-11, GK-11 LS 1 (Barmagara)

4.6.21.1 *Location and Accessibility*

Barmagar, Gurbhakot Ward No. 11, is located at GPS coordinates 28°26'31.17"N, 81°55'11.23"E at an elevation of about 585.6 m, accessible through local rural roads and foot trails.

4.6.21.2 Hazard Type

Active debris-type gully erosion along the seasonal Koldhata Khola affecting nearby settlements and agricultural land.

4.6.21.3 Geological and Geomorphological Condition

The area consists of loose alluvium and colluvium deposits on moderately steep terrain with exposed gullies and unstable erosion-prone slopes.

4.6.21.4 Cause and Triggering Factors

Forest fire, loss of vegetation cover, intense monsoon rainfall, and concentrated runoff along the seasonal gully are the major triggering factors.

4.6.21.5 Current Site Condition

The gully remains active during monsoon periods, causing channel widening, erosion, sediment transport, and damage to nearby land, houses, and access paths.

4.6.21.6 Elements at Risk

Approximately 102 people, 22 houses, a nearby school, agricultural land, rural access routes, and livestock-based livelihoods are vulnerable to continued erosion.

4.6.21.7 Hazard Severity and Risk Level

The hazard shows high probability of occurrence during monsoon with a medium community risk level due to recurring seasonal erosion.

4.6.21.8 Recommended Mitigation Measures

Construct check dams and drainage channels, stabilize exposed gully sections, restore vegetation cover, and apply bioengineering and slope protection measures.

4.6.21.9 Relocation Requirement (if necessary)

Immediate relocation is not currently required, but continuous monitoring and protection of highly vulnerable houses near the gully are necessary during monsoon seasons.

4.6.21.10 Site Photographs



Photograph 82 Landslide Site, Barmagar

4.6.22 Gurbhakot-11, GK-11 LS 2 (Awalsurma)

4.6.22.1 Location and Accessibility

Awal Surma, Gurbhakot Ward No. 11, is located at GPS coordinates 28°27'02.20"N, 81°55'47.58"E at an elevation of about 596.14 m, accessible through local rural roads and foot trails.

4.6.22.2 Hazard Type

Active rain-induced flood and gully erosion hazard affecting settlements located near the downstream gully area.

4.6.22.3 Geological and Geomorphological Condition

The area consists of loose colluvial and residual soil on moderate to steep slopes with active gully erosion and localized retaining gabion walls.

4.6.22.4 Cause and Triggering Factors

Improper drainage management, concentrated monsoon runoff, and intense rainfall over a large catchment area are the main triggering factors.

4.6.22.5 Current Site Condition

Sediment-laden floodwater and boulders frequently enter the settlement during monsoon periods, causing flooding, erosion, and damage to houses and agricultural land.

4.6.22.6 Elements at Risk

Approximately 105 people, 25 houses, 1 school, rural roads, and agricultural land are vulnerable to flooding, sediment deposition, and erosion.

4.6.22.7 Hazard Severity and Risk Level

The hazard is active with medium community risk and high probability of occurrence during intense monsoon rainfall.

4.6.22.8 Recommended Mitigation Measures

Construct proper drainage systems, retaining walls, and erosion-control structures to safely divert runoff and stabilize the gully sections.

4.6.22.9 Relocation Requirement (if necessary)

Immediate relocation is not currently necessary, but continuous monitoring and temporary evacuation may be required during severe monsoon events.

4.6.22.10 Site Photographs



Photograph 83 Landslide Site, Awalsurma

4.6.23 Gurbhakot-11, GK-11 LS 3 (Simkhola)

4.6.23.1 Location and Accessibility

SimKhola–Thadokhola settlement, Ward No. 11, Gurbhakot, Surkhet, located at GPS: 28°27'43.74"N, 81°53'38.5"E at an elevation of about 852 m, accessible by rural road and foot trails.

4.6.23.2 Hazard Type

Active debris-related gully hazard associated with blockage, overtopping failure, debris flow, and localized outburst flooding during monsoon periods.

4.6.23.3 Geological and Geomorphological Condition

Moderate to steep slopes composed of residual and colluvial soils over fractured phyllite and quartzite bedrock, with active gully erosion and unstable debris accumulation zones.

4.6.23.4 Cause and Triggering Factors

Sediment buildup and channel blockage within the gully, triggered by intense monsoon rainfall, overtopping failure, and weak weathered slope materials.

4.6.23.5 Current Site Condition

The gully remains active with ongoing erosion, sediment transport, and risk of sudden debris outburst; nearby houses and agricultural land remain vulnerable during heavy rainfall.

4.6.23.6 Elements at Risk

About 5 houses, rural roads, animal sheds, agricultural land (20–22 ropani), and approximately 22 people are directly exposed to debris flow and flooding risk.

4.6.23.7 Hazard Severity and Risk Level

The hazard severity is moderate to high during intense monsoon events, with a low-to-medium community risk level due to potential outburst flooding and erosion.

4.6.23.8 Recommended Mitigation Measures

Construct check dams, strengthen retaining walls, improve drainage capacity, provide toe protection, and stabilize the gully using bioengineering and channel protection measures.

4.6.23.9 Relocation Requirement (if necessary)

Relocation of 5 highly vulnerable houses near the active gully channel is recommended to reduce future disaster risk.

4.6.23.10 Site Photographs



Photograph 84 Landslide Site, Sim Khola

4.6.24 Gurbhakot-11, GK-11 LS 4 (Khahare)*4.6.24.1 Location and Accessibility*

Khahare (Simkhola Gadapani) settlement, Ward No. 11, Gurbhakot, Surkhet, is located at GPS: 28°27'14.38"N, 81°53'26.34"E at an elevation of about 777.33 m, accessible through a rural road along steep terrain.

4.6.24.2 Hazard Type

Active debris-flow and gully outburst hazard associated with temporary debris dam formation and sudden breaching during intense rainfall.

4.6.24.3 Geological and Geomorphological Condition

The area consists of loose colluvial soil, weathered rock fragments, and large boulders on moderately steep slopes adjacent to an active seasonal gully channel.

4.6.24.4 Cause and Triggering Factors

Improper road-cut excavation, poor drainage management, debris accumulation within the gully, and intense monsoon rainfall are the major causes and triggering factors.

4.6.24.5 Current Site Condition

The slope and gully remain active with unstable debris and boulders, while ongoing erosion and deposition continue to threaten downstream settlements and agricultural land.

4.6.24.6 Elements at Risk

About 10 houses, rural roads, 30–40 ropani of agricultural land, and approximately 34 people are directly exposed to debris flow and gully outburst hazards.

4.6.24.7 Hazard Severity and Risk Level

The hazard severity is high during intense monsoon rainfall, with a high community risk level due to potential debris outburst and slope instability.

4.6.24.8 Recommended Mitigation Measures

Slope stabilization, proper surface and subsurface drainage, construction of check dams and debris barriers, bioengineering treatment, and regular monitoring are recommended.

4.6.24.9 Relocation Requirement (if necessary)

Relocation of 10 highly vulnerable houses downstream of the gully is strongly recommended to reduce future disaster risk.

4.6.24.10 Site Photographs



Photograph 85 Landslide Site, Khahare

4.6.25 Gurbhakot-12, GK-12 LS 1 (Sundaha)

4.6.25.1 Location and Accessibility

Sundaha settlement, Ward No. 12, Gurbhakot, Surkhet, is located at GPS: 28°28'7.68"N, 81°51'14.76"E at an elevation of about 306 m, accessible through a rural road network.

4.6.25.2 Hazard Type

Passive shallow debris landslide developed on a steep road-cut slope composed of loose residual soil.

4.6.25.3 Geological and Geomorphological Condition

The area consists of moderately steep road-cut slopes with loose residual soil and no exposed bedrock, making the slope vulnerable to rainfall-induced instability.

4.6.25.4 Cause and Triggering Factors

Road-cut excavation removed natural toe support, while intense rainfall increased soil saturation and triggered shallow slope failure.

4.6.25.5 Current Site Condition

The landslide is presently passive but remains vulnerable to reactivation during heavy monsoon rainfall despite existing retaining walls and vetiver plantation.

4.6.25.6 Elements at Risk

About 7 houses, rural roads, a man-made irrigation pond supporting nearly 200 ropani of agricultural land, and approximately 22 people are exposed to potential landslide impacts.

4.6.25.7 Hazard Severity and Risk Level

The hazard severity is low to moderate, with possible reactivation during intense monsoon rainfall and a low-to-medium community risk level.

4.6.25.8 Recommended Mitigation Measures

Maintain and strengthen retaining walls and bioengineering works, improve surface drainage, and regularly inspect the road-cut slope before monsoon seasons.

4.6.25.9 Relocation Requirement (if necessary)

Relocation is not immediately necessary; however, continuous monitoring and maintenance are essential to ensure long-term slope stability.

4.6.25.10 Site Photographs



Photograph 86 Landslide Site, Sundaba

4.6.26 Gurbhakot-12, GK-12 LS 2 (Wallo Beteni)

4.6.26.1 Location and Accessibility

Wollo Beteni settlement, Ward No. 12, Gurbhakot, Surkhet, is located at GPS: 28°29'50.35"N, 81°52'47.70"E at an elevation of about 1252 m, accessible through local rural trails (2-3 hours) walk near the Beteni River.

4.6.26.2 Hazard Type

Active river-induced landslide caused by continuous toe cutting along the Beteni River.

4.6.26.3 Geological and Geomorphological Condition

The area consists of loose colluvial soil deposits over fractured quartzite bedrock on moderate to steep slopes affected by active river erosion and subsidence.

4.6.26.4 Cause and Triggering Factors

Continuous toe erosion by the Beteni River and intense monsoon rainfall have reduced slope stability and triggered progressive slope movement.

4.6.26.5 Current Site Condition

The slope remains active with visible cracks, subsidence, and localized mass movement; however, nearby houses are abandoned and currently unoccupied.

4.6.26.6 Elements at Risk

Agricultural land (10–15 ropani), unstable slope terrain, and possible future river blockage due to landslide debris are the major elements at risk.

Site-Wise Rapid Assessment

4.6.26.7 Hazard Severity and Risk Level

The hazard severity is moderate during intense monsoon periods, with a low community risk level due to the absence of occupied houses.

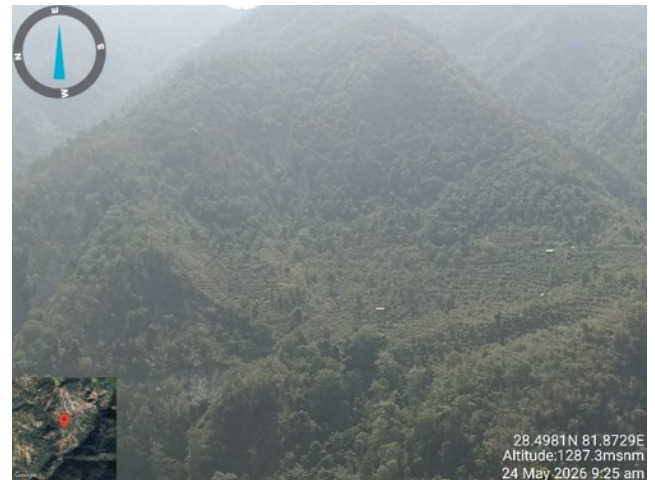
4.6.26.8 Recommended Mitigation Measures

Construct toe protection works such as gabion walls and revetments, improve surface and subsurface drainage, and implement bioengineering for slope stabilization.

4.6.26.9 Relocation Requirement (if necessary)

Relocation is not currently necessary because the affected houses are abandoned, but future settlement or construction in the unstable area should be restricted.

4.6.26.10 Site Photographs



Photograph 87 Landslide Site, Wallo Beteni

4.6.27 Gurbhakot-12, GK-12 LS 3 (Lamidada)*4.6.27.1 Location and Accessibility*

Lami Danda settlement lies in Gurbhakot Municipality–12, Surkhet District, Karnali Province at GPS coordinates 28.4813 N, 81.8640 E and elevation of about 1063.1 m. The area is accessible through a rural road passing along steep hill slopes.

4.6.27.2 Hazard Type

Inactive debris landslide developed on a road-cut slope composed of colluvial soil and fractured quartzite.

4.6.27.3 Geological and Geomorphological Condition

The area consists of moderate to steep slopes with weathered and fractured quartzite bedrock overlain by colluvial soil and rock fragments. Terrace farming and road cutting have modified the natural slope condition.

4.6.27.4 Cause and Triggering Factors

The landslide was mainly caused by road-cut excavation that removed toe support, while intense monsoon rainfall weakened the fractured slope materials and triggered failure.

4.6.27.5 Current Site Condition

The landslide is presently inactive; however, loose debris, weakened slope materials, and inadequate drainage indicate possible reactivation during heavy rainfall.

4.6.27.6 Elements at Risk

About 6 houses, nearby agricultural land (1–2 ropani), and the rural road remain vulnerable to future slope instability.

4.6.27.7 Hazard Severity and Risk Level

The hazard probability is moderate during intense monsoon periods, and the community risk level is assessed as low to medium.

4.6.27.8 Recommended Mitigation Measures

Improve surface and subsurface drainage, restore toe support using retaining structures, stabilize loose slope materials, and establish vegetation cover to reduce erosion and prevent reactivation.

4.6.27.9 Relocation Requirement (if necessary)

Relocation is not immediately required, but continuous monitoring and preventive stabilization measures are recommended for vulnerable houses near the slope.

4.6.27.10 *Site Photographs*

Photograph 88 Landslide Site, Lamidanda

4.6.28 Gurbhakot-14, GK-14 LS 1 (Hileni, Sanghure Gaun)

4.6.28.1 *Location and Accessibility*

Hileni (Sanghure Gaun) is located in Gurbhakot Municipality-14, Surkhet District, Karnali Province at GPS coordinates 28.4855 N, 81.8515 E and elevation of about 871.8 m. The settlement is accessible through local rural roads across terraced hillside terrain.

4.6.28.2 *Hazard Type*

Large-scale active creep-type landslide affecting cultivated slopes and residential areas.

4.6.28.3 *Geological and Geomorphological Condition*

The slope consists of weak colluvial and residual soils with seepage zones on a moderately steep hillside influenced by multiple river valleys and continuous toe erosion by the Beteni River.

4.6.28.4 Cause and Triggering Factors

Continuous toe cutting by the Beteni River, groundwater seepage, weak soil conditions, probable thrust-related geological weakness, and prolonged intense rainfall are the major causes and triggers.

4.6.28.5 Current Site Condition

Active slow creep movement is observed with land subsidence, bent trees, seepage, ground cracks, and structural damage to houses and agricultural terraces.

4.6.28.6 Elements at Risk

About 6 houses, local access paths, agricultural land exceeding 100 ropani, and nearby rural infrastructure are directly threatened.

4.6.28.7 Hazard Severity and Risk Level

The hazard probability and community risk level are very high due to ongoing progressive slope deformation and continuous house damage.

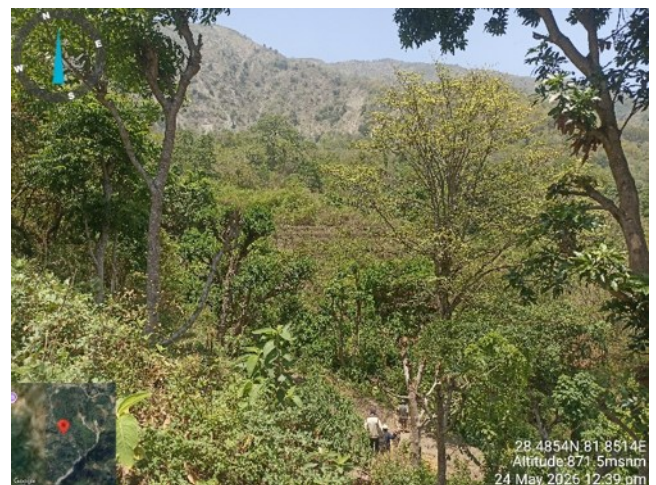
4.6.28.8 Recommended Mitigation Measures

Implement surface drainage management, toe protection along the Beteni River, bioengineering treatment, slope monitoring, and restrict further construction in unstable zones.

4.6.28.9 Relocation Requirement (if necessary)

Immediate relocation of 6 highly vulnerable houses is strongly recommended due to the large-scale and continuously active creep movement.

4.6.28.10 Site Photographs





Photograph 89 Landslide Site, Hileni Sanghure Gau

4.6.29 Gurbhakot-14, GK-14 LS 1 (Kapase)

4.6.29.1 Location and Accessibility

Kapase settlement lies in Gurbhakot Municipality-14, Surkhet District, Karnali Province at GPS coordinates 28.4932 N, 81.8621 E and elevation of about 1177.3 m. The area is connected by the Kapase–Chainpur rural road crossing steep terraced slopes.

4.6.29.2 Hazard Type

Active shallow translational debris landslide developed below a road-cut slope within residual and colluvial soil deposits.

4.6.29.3 Geological and Geomorphological Condition

The area consists of moderately steep to steep terraced slopes composed of weak residual and colluvial soils highly susceptible to erosion and failure during saturation.

4.6.29.4 Cause and Triggering Factors

Road-cut excavation, toe undercutting, poor drainage, and prolonged monsoon rainfall infiltration are the main causes and triggering factors of the landslide.

4.6.29.5 Current Site Condition

Fresh exposed soil and debris indicate ongoing active slope movement, with the landslide threatening nearby houses, agricultural land, and the rural road.

4.6.29.6 Elements at Risk

About 4 houses, 20–22 ropani of agricultural land, and the Kapase–Chainpur rural road are vulnerable to continued landslide expansion.

Site-Wise Rapid Assessment

4.6.29.7 Hazard Severity and Risk Level

The probability of hazard occurrence is high during intense monsoon periods, while the community risk level is assessed as low to medium.

4.6.29.8 Recommended Mitigation Measures

Construct diversion drains, retaining and toe-protection structures, improve slope drainage, and implement bioengineering measures such as deep-rooted vegetation plantation.

4.6.29.9 Relocation Requirement (if necessary)

Relocation is not immediately necessary; however, stabilization and drainage improvement works are urgently required before the monsoon season to reduce risk to vulnerable houses.

4.6.29.10 Site Photographs



Photograph 90 Landslide Site, Kapase

4.7 Kalikot District

4.7.1 Palata-6, PT-6 LS 1 (Kam Basti)

4.7.1.1 Location and Accessibility

The landslide site PT-6 LS 1 (Kam Basti) is located in Ward No. 6 of Palata Rural Municipality, Kalikot District. The Site lies in a remote hilly area characterized by steep slopes, scattered houses, and agricultural terraces. The area is accessible through the Kalikot–Thirpu–Palata rural road network. Kam Basti falls within the northern part of Kalikot District. The settlement is located in rugged hill terrain.

4.7.1.2 Hazard Type

The identified hazard is debris flow which is inactive.

4.7.1.3 Geological and Geomorphological Condition

The area is underlain by highly jointed quartzite bedrock with randomly oriented joints. The terrain ranges from gentle to steep slopes, largely controlled by the resistant but fractured quartzite. The slope fac

4.7.1.4 Cause and Triggering Factors

The main causes of the present debris flow is intense rainfall and the fractured quartzite which lead to landslide activation

4.7.1.5 Current Site Condition

Debris flow, seems to be active during monsoon

4.7.1.6 Elements at Risk

3 households are at medium risk also earthen roads are at a certain risk.

4.7.1.7 Hazard Severity and Risk Level

Based on the field observation slope condition is weather along the highly jointed and fractured due the external and internal force.

Hazard severity is high

Risk level is high

4.7.1.8 Recommended Mitigation Measures

Cascading engineering structures are recommended to control debris flow by reducing flow velocity and progressively trapping sediment along the channel. However, a detailed site-specific investigation is required to further assess the treatability status and to finalize the design and effectiveness of the proposed mitigation measures.

Site-Wise Rapid Assessment

4.7.1.9 Relocation Requirement (if necessary)

At present, relocation is not required; however, continuous monitoring is recommended and this status should be reviewed following implementation of mitigation measures and further site assessment. Not now

4.7.1.10 Site Photographs



Photograph 91 Landslide Site, Kam Basti

4.7.2 Palata-3, PT-6 LS 1 (Bhita)

4.7.2.1 Location and Accessibility

Bhita patala 3 Kalikot District lies in the mountainous region of Karnali Province and is characterized by steep topography, narrow river valleys, and scattered rural settlements. Within the district, Palata Rural Municipality is located in the northern part and is connected through the Kalikot–Palata rural road network.

Bhita Village, situated in Ward No. 3 of Palata Rural Municipality, is accessible through local rural roads extending from the main Palata road corridor, followed by short foot trails in some sections. The settlement area mainly consists of hillside terraces and dispersed residential clusters.

4.7.2.2 Hazard Type

The identified hazard is an active complex landslide with the evidence of slope failure and debris deposit.

4.7.2.3 Geological and Geomorphological Condition

Highly jointed bed rock of quartzite may lead to rock fall moderately to highly slope.

4.7.2.4 Cause and Triggering Factors

Intense rainfall and highly jointed rock mass.

4.7.2.5 *Current Site Condition*

Active.

4.7.2.6 *Elements at Risk*

Rural road connecting settlement near by the landslide.

4.7.2.7 *Hazard Severity and Risk Level*

Based on the field observation slope condition is weather along the highly jointed and fractured due the external and internal force.

Hazard severity is high

Risk level is high

4.7.2.8 *Recommended Mitigation Measures*

A series of gabion walls is recommended for slope stabilization and toe protection, along with improved surface water and drainage management to reduce infiltration and control runoff. Further detailed site-specific investigation is required to finalize the design and ensure effectiveness of the proposed measures.

4.7.2.9 *Relocation Requirement (if necessary)*

At present, relocation is not required; however, the situation should be kept under observation and reviewed following implementation of the proposed mitigation measures and further site assessment.

4.7.2.10 *Site Photographs**Photograph 92 Landslide Site, Bhita*

4.7.3 Palata-3, PT-6 LS 2 (Jogkhola, Dalitbasti)

4.7.3.1 *Location and Accessibility*

Jogkhola Dalit Basti is a small hillside settlement located in Ward No. 3 of Palata Rural Municipality, Kalikot District. The area falls within the rugged terrain of Karnali Province and is characterized by steep slopes and scattered habitation. The settlement is connected through the Kalikot–Palata rural road, while internal movement is facilitated by local village tracks and foot trails. Accessibility is moderate during the dry season and comparatively difficult during monsoon periods.

4.7.3.2 *Hazard Type*

The identified hazard is a complex landslide with evidence of slope movement gully erosion.

4.7.3.3 Geological and Geomorphological Condition

Highly jointed and weather bed rock of gneisses along with moderately slope about 50°

4.7.3.4 Cause and Triggering Factors

Intense rainfall , unmanaged drainage

4.7.3.5 Current Site Condition

Inactive but high possibility of reactivation

4.7.3.6 Elements at Risk

Urban road

4.7.3.7 Hazard Severity and Risk Level

Based on the field observation slope condition is weather along the highly jointed and fractured due the external and internal force.

Hazard severity is high

Risk level is high

4.7.3.8 Recommended Mitigation Measures

Drainage management, bioengineering measures, and check dams are recommended at suitable locations to control surface runoff, enhance slope stability, and reduce debris transport. Further site-specific investigation is required to determine appropriate design and placement of these measures.

4.7.3.9 Relocation Requirement (if necessary)

At present, relocation is not required. Continuous monitoring is recommended, along with implementation of the proposed mitigation measures to ensure long-term stability.

4.7.3.10 Site Photographs





Photograph 93 Landslide Site, Jogkbhola, Dalit Basti

4.7.4 Palata-8, PT-8 LS 1 (Thulo Mandu)

4.7.4.1 Location and Accessibility

Administratively, Thulo Mandu falls under Ward No. 8 of Palata Rural Municipality in Kalikot District. The settlement is located within the rugged hill terrain of Karnali Province and is characterized by scattered houses and agricultural terraces. The area can be accessed through the Kalikot–Palata rural road corridor, followed by local village roads connecting the settlement. Accessibility is generally seasonal, with transportation becoming comparatively difficult during periods of heavy rainfall.

4.7.4.2 Hazard Type

The identified hazard is a complex landslide with evidence of slope movement gully erosion.

4.7.4.3 Geological and Geomorphological Condition

Highly jointed bed rock of quartzite may lead to rock fall, kyanite grade of mineralization was observed in toe part.

4.7.4.4 Cause and Triggering Factors

Toe cutting, intense rainfall.

4.7.4.5 Current Site Condition

Active and reactive.

4.7.4.6 *Elements at Risk*

All settlements located near the landslide-affected road alignment, along with adjacent agricultural land, are at risk of damage from potential slope failure and debris movement.

4.7.4.7 *Hazard Severity and Risk Level*

Based on the field observation slope condition is weather along the highly jointed and fractured due the external and internal force.

Hazard severity is high

Risk level is high

4.7.4.8 *Recommended Mitigation Measures*

Given the large scale and magnitude of the landslide, permanent stabilization measures are not considered feasible. Therefore, risk reduction should focus on protective and adaptive measures, including controlled drainage management, slope monitoring, and restriction of exposure in high-risk zones. Further detailed study is required to assess long-term management options.

4.7.4.9 *Relocation Requirement (if necessary)*

Relocation of all settlements is required, comprising approximately 94 households, due to the high-risk condition and large-scale instability of the landslide area.

4.7.4.10 *Site Photographs*





Photograph 94 Landslide Site, Thulo Madu, Bade, Buase

4.7.5 Naraharinath-5, NH-5 LS 1 (Rupsha)

4.7.5.1 Location and Accessibility

Rupsha, Naraharinath Rural Municipality, ward no. 5, Kalikot district, Karnali Province

4.7.5.2 Hazard Type

The identified hazard is a complex landslide with evidence of slope movement gully erosion. Multiple scarps and tensional and radial crack was observed in different part of landslide

4.7.5.3 Geological and Geomorphological Condition

The area is characterized by steep to very steep, highly weathered hill slopes composed of loose colluvial and residual soil with exposed rock fragments. Evidence of recent slope failure, erosion, and debris accumulation indicates an unstable geomorphological setting, making the area susceptible to landslides and surface runoff-induced erosion, particularly during intense rainfall.

4.7.5.4 Cause and Triggering Factors

Intense rainfall, road cut (toe cutting)

4.7.5.5 Current Site Condition

Active

4.7.5.6 Elements at Risk

Settlement along with roads and cultivation land.

4.7.5.7 Hazard Severity and Risk Level

Based on the field observation slope condition is weather along the highly jointed and fractured due the external and internal force.

Hazard severity is high

Risk level is high

4.7.5.8 *Recommended Mitigation Measures*

Given the large scale and magnitude of the landslide, permanent stabilization measures are not considered feasible. Therefore, risk reduction should focus on protective and adaptive measures, including controlled drainage management, slope monitoring, and restriction of exposure in high-risk zones. Further detailed study is required to assess long-term management option.

4.7.5.9 *Relocation Requirement (if necessary)*

Partial relocation of approximately 20 households is required due to high exposure to landslide risk, while the remaining houses should be kept under continuous monitoring and reviewed periodically based on slope behavior and effectiveness of mitigation measures.

4.7.5.10 *Site Photographs*



Photograph 95 Landslide Site, Rupsa

CHAPTER 5: CONCLUSION AND RECOMMENDATION

5.1 Ilam District

The rapid assessment of landslide-affected settlements in Ilam District of Koshi Province was carried out across six local levels (three municipalities and three rural municipalities), namely Mai Municipality, Deumai Municipality, Suryodaya Municipality, Phakphokthum Rural Municipality, Sandakpur Rural Municipality, and Mangsebung Rural Municipality. Altogether, 52 landslide-affected settlements were assessed, comprising 2 in Mai Municipality, 2 in Phakphokthum Rural Municipality, 5 in Sandakpur Rural Municipality, 4 in Mangsebung Rural Municipality, 1 in Deumai Municipality, and 38 in Suryodaya Municipality. The assessment evaluated the impacts of landslides, existing hazard conditions, risk level, and recommendations based on detailed field inspections.

Among the assessed settlements, 6 were categorized as Very High priority, 17 as High priority, 20 as Medium priority, and 9 as Low priority. Based on the NDRRMA hazard categorization, 9 settlements fall under Category I (safe with routine monitoring), 27 settlements under Category II (requiring mitigation measures), 14 settlements under Category II with partial relocation, and 2 settlements under Category III (requiring complete relocation due to extremely high geo-hazard conditions). Considering the severity of hazards and the potential future impacts, 16 households from the Category III settlements and an additional 40 households from Category II settlements requiring partial relocation (totaling 56 households) have been identified for immediate relocation. These include settlements such as Rangapani, Ahale, Todke, Bhanjyang, Chisopani, Ghising Gaun (Makarjung), Teenghare (Purbeli Tol), Khadka Gaun (Indreni Tol), Manedanda Tol, Mayukhola Area, Mehelbote, Sanakate (Unuytar Tol), Mechi Bagar, Seti Devi Tol, Sahakale Tol, as well as the Category III settlements Simsara and Ambe Tol.

The settlements of Simsara (Phakphokthum Rural Municipality–6), Todke (Sandakpur Rural Municipality–2), and Chisopani (Mangsebung Rural Municipality–6) have already undergone relocation or are currently under relocation with the support of the provincial government. The remaining Category II settlements with High and Medium priority require detailed geotechnical investigation and appropriate structural and bioengineering interventions, while Category I settlements require only periodic monitoring and routine maintenance to ensure long-term stability.

5.1.1 Mai Municipality

The rapid assessment conducted in Mai Municipality identified two landslide-affected settlements, namely Purbe Kharpani (Ward No. 2) and Rangapani (Ward No. 9). Both landslides are old, deep-seated slope failures that have undergone periodic reactivation and continue to exhibit active deformation during the monsoon season. Their instability is primarily associated with weak geological formations, highly weathered residual and colluvial soils, prolonged rainfall-induced saturation, concentrated surface runoff, and localized toe erosion.

Based on the adopted NDRRMA landslide categorization framework, the assessed settlements have been classified as Category II and Category II with partial relocation according to their hazard level and urgency of intervention. Category II represents settlements where landslide hazards can be controlled or their impacts minimized through appropriate engineering and non-engineering mitigation measures. Category II with partial relocation indicates that although most of the settlement can be protected through mitigation measures, households located within the most hazardous portions require relocation.

The landslide at Purbe Kharpani has been categorized as Category II. The site is characterized by a large deep-seated slope deformation system with active creep, localized debris slides, concealed tension cracks, and seasonal movement affecting a broad hillslope. Although the landslide exhibits ongoing deformation and poses a significant risk to the community, immediate relocation has not been recommended. Instead, comprehensive surface and subsurface drainage improvement, rehabilitation of damaged protective structures, detailed geotechnical investigation, continuous monitoring, bioengineering measures, and community-based preparedness are recommended to reduce future landslide risk.

The Rangapani landslide has been classified as Category II with partial relocation owing to its active landslide condition and localized threat to residential areas and infrastructure. While a large portion of the settlement can be protected through appropriate stabilization measures, eight households located within the most hazardous section of the landslide have been identified for immediate relocation. In addition to relocation, detailed geotechnical investigation, drainage improvement, slope stabilization, bioengineering measures, and continuous monitoring are recommended to minimize further expansion of the landslide and reduce future risk.

Overall, the assessment indicates that Mai Municipality is significantly affected by rainfall-induced landslides developed within fragile geological settings. While both landslide-affected settlements are considered manageable through appropriate mitigation measures, partial relocation of eight highly exposed households at Rangapani is required to ensure community safety. The municipality should therefore prioritize the implementation of engineering and bioengineering interventions, continuous monitoring, and relocation of the identified households while integrating landslide risk reduction into local development planning to enhance long-term community resilience.

5.1.2 Phakphokthum Rural Municipality

The rapid assessment conducted in Phakphokthum Rural Municipality identified two landslide-affected settlements, namely Panchami Bazar (Ward No. 1) and Simsara (Ward No. 6). Both landslides are associated with weak residual and colluvial soils overlying weathered and fractured bedrock and have been repeatedly reactivated by intense monsoonal rainfall, poor drainage conditions, and anthropogenic disturbances such as road construction and slope modification.

Based on the adopted NDRRMA landslide categorization framework, the investigated settlements have been classified into Category II and Category III according to their hazard severity and urgency of intervention. Category II represents settlements where landslide hazards can be controlled or their impacts minimized through appropriate engineering and non-engineering mitigation measures. Category III represents unsafe settlements where the existing geo-hazard conditions are extremely difficult to control technically and economically, making relocation the most appropriate long-term risk reduction measure.

The Panchami Bazar landslide has been categorized as Category II. The landslide exhibits active creep deformation, ground cracking, multiple shallow failures, and localized deep-seated movement affecting residential areas, roads, agricultural terraces, and drainage structures. Although the landslide poses a significant hazard to the community, immediate relocation has not been recommended. Instead, comprehensive surface and subsurface drainage management, retaining and gabion structures, bioengineering measures, detailed geotechnical investigation, continuous monitoring, and community-based preparedness programs are recommended to reduce future landslide risk.

The Simsara landslide has been assigned to Category III owing to its active movement, progressive enlargement, and direct impact on residential areas and local infrastructure. The landslide poses a serious threat to lives and property, and 16 households have been identified for immediate relocation. According to the assessment, the relocation process is already ongoing with the support of the Provincial Government. In addition to relocation, continued slope monitoring, drainage improvement, bioengineering measures, and stabilization of critical road sections are recommended to minimize further expansion of the landslide.

Overall, the assessment indicates that while Panchami Bazar can be managed through appropriate mitigation and continuous monitoring, the Simsara landslide has reached a level of instability that necessitates relocation as the primary long-term risk reduction strategy. The municipality should therefore continue the ongoing relocation process while implementing complementary engineering and bioengineering measures to reduce residual landslide hazards and enhance community resilience.

5.1.3 Sandakpur Rural Municipality

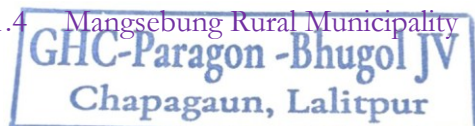
The rapid assessment conducted in Sandakpur Rural Municipality identified five landslide-affected settlements, namely Ahale (Ward No. 1), Todke (Ward No. 2), Kamere (Ward No. 2), Gairigaun (Ward No. 3), and Gumba (Ward No. 4). The landslides are developed within highly weathered residual and colluvial soils over fractured bedrock and are primarily influenced by prolonged monsoonal rainfall, poor drainage conditions, road construction, toe erosion, and the reactivation of old landslide masses. Most of the sites exhibit progressive creep deformation, shallow translational failures, tension cracking, terrace deformation, and localized deep-seated movement.

Based on the adopted NDRRMA landslide categorization framework, Kamere, Gairigaun, and Gumba have been classified as Category II, representing settlements where landslide hazards can be controlled or their impacts minimized through appropriate engineering and non-engineering mitigation measures. These settlements exhibit localized slope instability affecting residential areas, agricultural land, and local infrastructure. Detailed geotechnical investigation, drainage improvement, retaining and toe protection structures, bioengineering measures, and continuous monitoring are recommended to reduce future landslide risk.

The Ahale and Todke settlements have been classified as Category II with partial relocation, indicating that while most of the affected areas can be stabilized through suitable mitigation measures, households located within the most hazardous portions require relocation. Based on the assessment, four households at Ahale and five households at Todke have been identified for immediate relocation. The relocation process at Todke has already been completed with the support of the Provincial Government, while relocation at Ahale remains a priority. In addition to relocation, integrated drainage improvement, slope stabilization, toe protection, bioengineering works, and regular monitoring are recommended to minimize future landslide activity.

Overall, the assessment indicates that Sandakpur Rural Municipality is highly susceptible to rainfall-induced landslides due to its fragile geological setting and rugged terrain. Although no settlements fall under Category III, the identified Category II and Category II with partial relocation sites require timely implementation of engineering and bioengineering measures, together with relocation of the identified households, to effectively reduce landslide risk and enhance long-term community resilience.

5.1.4 Mangsebung Rural Municipality



Mangsebung

Conclusion

The rapid assessment conducted in Mangsebung Rural Municipality identified four landslide-affected settlements, namely Bhanjyang (Ward No. 3), Lamitar (Ward No. 3), Setikhare (Ward No. 5), and Chisopani (Ward No. 6). These landslides are developed within highly weathered colluvial and residual soils over fractured sandstone, mudstone, and gneiss bedrock and are primarily influenced by intense monsoonal rainfall, prolonged slope saturation, poor drainage conditions, road-cut excavation, and weak geological materials. Most sites exhibit progressive creep deformation, active erosion, tension cracks, retrogressive widening, and shallow- to deep-seated slope failures.

Based on the adopted NDRRMA landslide categorization framework, Lamitar and Setikhare have been classified as Category II, indicating that the landslide hazards can be managed through appropriate engineering and non-engineering mitigation measures. These settlements require detailed geotechnical investigation, continuous monitoring, drainage improvement, retaining and toe protection structures, bioengineering works, and maintenance of existing protective measures to reduce future landslide risk.

The Bhanjyang and Chisopani settlements have been classified as Category II with partial relocation, indicating that while most parts of the affected areas can be stabilized through suitable mitigation measures, households located within the most hazardous portions require relocation. Based on the assessment, six households at Bhanjyang and three households at Chisopani have been identified for immediate relocation. The relocation process at Chisopani has already been completed with the support of the Provincial Government, while relocation of the identified households at Bhanjyang remains a priority. In addition to relocation, comprehensive drainage management, slope stabilization, retaining structures, bioengineering measures, and continuous monitoring are recommended to minimize future landslide activity.

Overall, the assessment indicates that Mangsebung Rural Municipality is highly susceptible to rainfall-induced landslides due to its fragile geological setting and steep terrain. Although no settlements fall under Category I or Category III, the identified Category II and Category II with partial relocation settlements require timely implementation of engineering and bioengineering measures together with relocation of the identified households to effectively reduce landslide risk and enhance long-term community resilience.

5.1.5 Deumai Municipality

The rapid assessment conducted in Deumai Municipality identified one landslide-affected settlement, namely Maidane located in Ward No. 1. The landslide is developed within thick colluvial and residual soils over highly weathered bedrock on a steep terraced hillslope. The instability is primarily associated with weak slope materials, drainage mismanagement, rural road construction, road-cut excavation, concentrated surface runoff, and intense monsoonal rainfall.

Based on the adopted NDRRMA landslide categorization framework, the Maidane settlement has been classified as Category II, indicating that the landslide hazard can be controlled or its impacts minimized

through appropriate engineering and non-engineering mitigation measures. The landslide is characterized by rotational and translational movement accompanied by shallow debris slides, localized scarps, terrace deformation, flank widening, and minor slope movement. Although no major recent landslide activity is evident, the slope remains susceptible to reactivation during prolonged or intense rainfall events.

The affected settlement has been assigned Medium Priority for intervention. While residential areas, agricultural land, local roads, and drainage systems remain exposed to potential landslide impacts, no immediate household relocation has been recommended based on the current level of hazard. Instead, the site requires detailed geotechnical investigation, continuous monitoring, and implementation of appropriate mitigation measures to reduce future risk.

Recommended measures include improvement of surface and subsurface drainage systems, stabilization of road-cut slopes, bioengineering interventions, localized retaining and toe protection structures, erosion control works, and regular monitoring of slope movement and drainage conditions. Overall, the Maidane landslide can be effectively managed through timely implementation of these mitigation measures, thereby reducing future landslide risk and enhancing the resilience of the affected community.

5.1.6 Suryodaya Municipality

The rapid assessment conducted in Suryodaya Municipality identified a total of 38 landslide-affected settlements distributed across Wards 1, 2, 3, 4, 5, 7, 9, 11, 12, 13, and 14. The assessed landslides are predominantly associated with steep terrain, highly weathered residual and colluvial soils, fractured bedrock, concentrated surface runoff, and intense monsoonal precipitation. In several locations, anthropogenic activities such as road construction, modification of natural drainage patterns, and cultivation on marginal slopes have further aggravated slope instability. Most of the investigated landslides are old failures that have undergone periodic reactivation, exhibiting signs of progressive creep, gully erosion, tension cracks, localized subsidence, and seasonal movement.

Based on the adopted NDRRMA landslide categorization system, the assessed settlements were classified into Category I, Category II, Category II with partial relocation, and Category III according to their hazard level and urgency of intervention. Category I represents relatively safe conditions requiring only periodic monitoring and maintenance of existing drainage systems. Category II represents settlements where landslide hazards can be managed through detailed geotechnical investigation and implementation of appropriate structural and non-structural mitigation measures. Category II with partial relocation indicates that although most of the settlement can be protected through mitigation measures, households located within the most hazardous portions require relocation. Category III represents unsafe settlements where the existing geo-hazard conditions are extremely difficult to control technically and economically, making relocation the most appropriate long-term solution.

Conclusion

The settlements categorized as Category I include Bilaune Pakha (Durgabhawani Tol), Siddhikhola Area, Arthetar Tol, Salleri, Suntung, Ambitar, Deurali Tol (Ward 12), Sundar Khola, and Triveni Tol. These sites presently exhibit relatively low levels of instability, and periodic monitoring together with maintenance of natural drainage systems is considered sufficient to minimize future risk.

The majority of the investigated settlements fall under Category II, including Paireni Tol, Shreekhola Chaghare (Shreekhola Tol), Chhaghare Jirel (Sagarmatha Tol), Manebhanjyang (Sunakhari Tol), Deurali Tol (Ward 2), Makhamali Tol, Shreebung, Bhalukhola/Thalukhola Khand, Dhode, Rai Gaun, Adarsha Tol, Bhalu Khop, Rong Tol–Khahare Khola Malim, Sundarbasti Tol, Lumke Tol, Doctor Gaun–Kolbote Tol, Thulo Bardu Tol, and Simle. These settlements exhibit localized erosion, progressive creep, seasonal movement, and drainage-related instability, but the associated hazards can be substantially reduced through appropriate engineering and bioengineering measures, including surface and subsurface drainage improvement, retaining structures, toe protection, slope regrading, vegetative stabilization, and continuous monitoring.

The settlements classified as Category II with partial relocation comprise Ghising Gaun (Makarjung), Teenghare (Purbeli Tol), Khadka Gaun (Indreni Tol), Manedanda Tol, Mayukhola Area, Mehelbote, Sanakate (Unuytar Tol), Mechi Bagar, Seti Devi Tol, and Sahakale Tol. These settlements require both engineering mitigation and relocation of households situated within the most hazardous portions of the landslide zones. Based on the field assessment, 12 households have been identified for immediate relocation, including 2 households from Ghising Gaun (Makarjung), 1 household each from Teenghare (Purbeli Tol), Khadka Gaun (Indreni Tol), Manedanda Tol, Mayukhola Area, Mehelbote, Sanakate (Unuytar Tol), Mechi Bagar, and Seti Devi Tol, and 2 households from Sahakale Tol.

The only settlement categorized as Category III is Ambe Tol (Ward 7), where active landslide movement poses a direct threat to lives and property. Two households have been identified for immediate relocation from this settlement, as engineering interventions alone are unlikely to provide a sustainable long-term solution.

Overall, the assessment demonstrates that Suryodaya Municipality is highly susceptible to rainfall-induced landslides due to its fragile geological setting, rugged topography, and increasing anthropogenic disturbances. While Category I, Category II, and Category II with partial relocation settlements can largely be managed through systematic monitoring, engineering interventions, and localized relocation, Ambe Tol, the only Category III settlement, requires urgent relocation planning. The municipality should therefore prioritize implementation of slope stabilization measures, improvement of drainage systems, community-based landslide monitoring, relocation of identified households, and integration of landslide risk reduction into local land-use and development planning to enhance long-term community resilience.

5.2 Dhankuta

5.2.1 Dhankuta Municipality

The rapid assessment of the landslide-affected settlement at Tudikhel (Mathillo Kopche), Ward No. 5, Dhankuta Municipality, identified the site as having a medium landslide risk. The instability is associated with the fill materials placed along the western edge of the Tudikhel, where the development of tension cracks indicates ongoing slow slope creep. The presence of a natural spring beneath the filled area is likely contributing to elevated pore water pressure, thereby reducing slope stability. However, detailed geotechnical and hydrogeological investigations are required to confirm the failure mechanism and guide the design of appropriate mitigation measures.

The settlement is classified under NDRRMA Category II, indicating that the landslide hazard can be effectively managed through suitable engineering and non-engineering interventions. Although no immediate household relocation is required, the site has been assigned High Priority for intervention due to the potential for progressive slope movement. Slope stabilization, improved surface and subsurface drainage, and continuous monitoring are recommended to minimize future landslide risk and ensure the long-term safety and functionality of the area.

5.3 Dhading District

5.3.1 Dhunibesi Municipality

The rapid assessment conducted in Dhunibesi Municipality of Dhading District identified four landslide-affected settlements, namely Juggedi (Ward No. 9), Khatri Pouwa (Ward No. 9), Nagarpalika Office (Ward No. 9), and Thulo Khola (Ward No. 2). The assessed landslides are primarily associated with steep hill slopes, highly weathered residual and colluvial soils, fractured bedrock, concentrated surface runoff, road-cut excavation, and intense monsoonal rainfall. Most of the sites exhibit signs of progressive slope deformation, localized erosion, shallow failures, tension cracking, and seasonal reactivation.

Based on the adopted NDRRMA landslide categorization framework, Juggedi, Khatri Pouwa, and Nagarpalika Office have been classified as Category II, indicating that the landslide hazards can be controlled or their impacts minimized through appropriate engineering and non-engineering mitigation measures. Thulo Khola has been classified as Category II with partial relocation, where most of the affected area can be stabilized through suitable mitigation measures, while households located within the most hazardous portion require relocation.

All four settlements have been assigned High Priority for intervention. Based on the assessment, one household at Thulo Khola has been identified for immediate relocation due to direct exposure to landslide hazards. The remaining settlements require detailed geotechnical investigation, continuous monitoring,

drainage improvement, slope stabilization, retaining and toe protection structures, bioengineering measures, and proper management of surface runoff to reduce future landslide risk.

Overall, the assessment indicates that the landslide hazards in Dhunibesi Municipality are generally manageable through timely implementation of engineering and bioengineering interventions. Except for the localized relocation required at Thulo Khola, the remaining settlements can be effectively protected through appropriate mitigation measures, continuous monitoring, and integration of landslide risk reduction into local infrastructure development and land-use planning.

5.4 Parbat District

5.4.1 Phalebas Municipality

The rapid assessment conducted in Phalebas Municipality identified two landslide-affected settlements, namely Khalte and Okhrani Kalamuda, both located in Ward No. 8. The landslides are associated with highly weathered and fractured slope materials and have been repeatedly reactivated by intense monsoonal rainfall, toe erosion, weak geological conditions, and localized slope disturbances. The affected slopes exhibit creep movement, localized debris movement, progressive instability, and erosion, posing threats to nearby settlements, agricultural land, and local infrastructure.

Based on the adopted NDRRMA landslide categorization framework, Okhrani Kalamuda has been classified as Category II, indicating that the landslide hazard can be controlled or its impacts minimized through appropriate engineering and non-engineering mitigation measures. The settlement requires detailed geotechnical investigation, continuous monitoring, improvement of surface and subsurface drainage systems, slope stabilization, bioengineering measures, and protection of vulnerable slope sections to reduce future landslide risk.

The Khalte settlement has been classified as Category II with partial relocation, indicating that while most of the affected area can be stabilized through suitable mitigation measures, households located within the most hazardous portion require relocation. Based on the assessment, 12 households have been identified for immediate relocation due to their direct exposure to landslide hazards. In addition to relocation, surface drainage management, treatment of unstable road-cut slopes, toe protection, bioengineering measures, and detailed geotechnical investigations are recommended to control further slope movement and minimize future risk.

Overall, the assessment indicates that Phalebas Municipality is vulnerable to rainfall-induced landslides associated with weak geological formations and slope disturbances. Although no settlements fall under Category III, timely implementation of engineering and bioengineering measures together with the relocation of the identified households at Khalte will substantially reduce landslide risk and improve the long-term resilience of the affected communities.

5.5 Rukum West

The rapid assessment of landslide-affected settlements in Rukum West District of Karnali Province was carried out in Musikot Municipality and Aathbiskot Municipality. A total of two landslide-affected settlements, Chaura and Kalo Pahiro, were assessed to determine the landslide impacts, existing hazard conditions, risk level, and appropriate mitigation measures based on field investigations.

Among the assessed settlements, Chaura is categorized as Category II, indicating that the landslide hazard can be managed through suitable structural and non-structural mitigation measures, whereas Kalo Pahiro falls under Category III, representing an unsafe settlement where the existing geo-hazard conditions are extremely difficult to control. The settlements have been assigned High and Very High priority, respectively. Based on the assessment, 8 households at Kalo Pahiro have been identified for immediate relocation due to their direct exposure to severe landslide hazards. The Chaura settlement requires detailed geotechnical investigation, slope stabilization, drainage improvement, bioengineering measures, and regular monitoring to minimize future risk, while planned relocation remains the most appropriate long-term risk reduction strategy for Kalo Pahiro.

5.5.1 Musikot Municipality

The rapid assessment conducted in Musikot Municipality identified one landslide-affected settlement, namely Chaura in Ward No. 10. The landslide is developed on a steep hillslope underlain by highly weathered and jointed marble bedrock exhibiting unfavorable structural conditions that contribute to slope instability. Intense monsoonal rainfall, weathering of fractured bedrock, concentrated surface runoff, and adverse geological conditions have been identified as the principal factors controlling landslide occurrence and periodic reactivation.

Based on the adopted NDRRMA landslide categorization framework, the Chaura settlement has been classified as Category II, indicating that the landslide hazard can be controlled or its impacts minimized through appropriate engineering and non-engineering mitigation measures. The landslide exhibits active slope deformation characterized by localized crown cracks, tension cracks, minor ground displacement, and evidence of seasonal movement, indicating the need for continued monitoring and timely intervention.

The settlement has been assigned High Priority for risk reduction interventions. Although residential areas and local infrastructure remain exposed to landslide hazards, no immediate household relocation has been recommended based on the current assessment. Instead, detailed geotechnical investigation, improvement of surface and subsurface drainage systems, stabilization of unstable slope sections, bioengineering measures, localized retaining and toe protection structures, and continuous monitoring are recommended to reduce future landslide risk.

Overall, the assessment indicates that the Chaura landslide can be effectively managed through timely implementation of engineering and bioengineering measures together with continuous monitoring.

Integrating these interventions into local development planning will help minimize future landslide impacts and enhance the long-term resilience of the affected community.

5.5.2 Athbiskot Municipality

The rapid assessment conducted in Aathbiskot Municipality identified one landslide-affected settlement, namely Kalo Papiro in Ward No. 13. The landslide is developed within a fragile geological setting consisting of interbedded dolomite and slate, characterized by highly weathered, jointed, and fractured bedrock, steep slopes, and exposed rock cliffs. The instability is primarily controlled by weak geological conditions, unfavorable structural discontinuities, intense monsoonal rainfall, prolonged weathering, and continuous slope degradation.

Based on the adopted NDRRMA landslide categorization framework, the Kalo Papiro settlement has been classified as Category III, indicating that the existing geo-hazard conditions are extremely difficult to control technically and economically. The landslide exhibits active slope movement accompanied by frequent rockfall activity, progressive deformation, and unstable rock masses, posing a direct threat to residential areas and local infrastructure.

The settlement has been assigned Very High Priority for intervention. Based on the assessment, eight households have been identified for immediate relocation due to their direct exposure to the landslide hazard. Considering the magnitude of instability and the high likelihood of continued slope movement and rockfall during intense rainfall, relocation of the exposed households is considered the most appropriate long-term risk reduction measure.

In addition to relocation, detailed geotechnical investigations, continuous monitoring of slope conditions, improvement of surface and subsurface drainage, stabilization of unstable rock slopes where technically feasible, rockfall protection measures, and bioengineering interventions are recommended to minimize residual risk and prevent further deterioration. Overall, the Kalo Papiro landslide poses a significant threat to the local community and requires urgent implementation of relocation planning together with appropriate mitigation and monitoring measures to enhance long-term community resilience.

5.6 Kalikot

The rapid assessment of landslide-affected settlements in Kalikot District of Karnali Province was carried out in Palata Rural Municipality and Narharinath Rural Municipality. A total of five landslide-affected settlements were assessed, comprising four in Palata Rural Municipality (Thulo Madu–Bade–Buase, Kam Basti, Jogkhola–Dalit Basti, and Bhita) and one in Narharinath Rural Municipality (Rupsa). The assessment evaluated the landslide impacts, existing hazard conditions, risk level, and appropriate mitigation measures through detailed field investigations.

Among the assessed settlements, one settlement is categorized as Category III (Thulo Madu–Bade–Buase), three settlements fall under Category II (Kam Basti, Jogkhola–Dalit Basti, and Bhita), and one settlement (Rupsa) is classified as Category II with partial relocation under the NDRRMA classification. Four settlements have been assigned High Priority, while one settlement (Kam Basti) has been assigned Medium Priority. Based on the assessment, 94 households from Thulo Madu–Bade–Buase and 20 households from Rupsa, totaling 114 households, have been identified for immediate relocation due to their direct exposure to landslide hazards. The remaining Category II settlements require detailed geotechnical investigation, slope stabilization, drainage management, bioengineering measures, and continuous monitoring to reduce future landslide risk. Overall, the assessment indicates that while permanent relocation is essential for the most severely affected communities, the remaining settlements can be safeguarded through timely implementation of appropriate mitigation measures.

5.6.1 Palata Rural Municipality

The rapid assessment conducted in Palata Rural Municipality identified four landslide-affected settlements, namely Kam Basti (Ward No. 6), Bhita (Ward No. 3), Jogkhola–Dalit Basti (Ward No. 3), and Thulo Madu–Bade–Buase (Wards No. 8 and 9). These landslides are primarily associated with highly weathered and fractured quartzite and gneiss bedrock, intense monsoonal rainfall, unmanaged drainage conditions, localized toe erosion, and weak geological formations. Most sites exhibit evidence of debris flow, gully erosion, progressive slope movement, and localized rockfall hazards.

Based on the adopted NDRRMA landslide categorization framework, Kam Basti, Bhita, and Jogkhola–Dalit Basti have been classified as Category II, indicating that the landslide hazards can be controlled or their impacts minimized through appropriate engineering and non-engineering mitigation measures. These settlements require detailed geotechnical investigation, continuous monitoring, drainage improvement, retaining and toe protection structures, bioengineering interventions, and proper management of surface runoff to reduce future landslide risk. Among these settlements, Kam Basti has been assigned Medium Priority, whereas Bhita and Jogkhola–Dalit Basti have been assigned High Priority for intervention.

The Thulo Madu–Bade–Buase settlement has been classified as Category III, indicating that the existing geo-hazard conditions are extremely difficult to control technically and economically. The landslide is characterized by active and reactivated slope movement, progressive deformation, and widespread instability directly affecting settlements, agricultural land, roads, and other community infrastructure. Based on the assessment, 94 households have been identified for immediate relocation as the most appropriate long-term risk reduction measure due to the severe and persistent landslide hazard.

Overall, the assessment indicates that Palata Rural Municipality is highly vulnerable to rainfall-induced landslides developed within fragile geological settings. While the Category II settlements can be managed through timely implementation of engineering and bioengineering measures together with continuous

monitoring, the Category III settlement at Thulo Madu–Bade–Buase requires urgent relocation planning and implementation to safeguard lives and property and enhance the long-term resilience of the affected community.

5.6.2 Naraharinath Rural Municipality

The rapid assessment conducted in Naraharinath Rural Municipality identified one landslide-affected settlement, namely Rupsa in Ward No. 5. The landslide is characterized by complex slope deformation involving gully erosion, multiple scarps, and well-developed tension and radial cracks distributed across the landslide body. The instability is primarily associated with intense monsoonal rainfall, concentrated surface runoff, weak geological materials, and toe cutting caused by road construction activities, which have contributed to progressive slope weakening and periodic reactivation.

Based on the adopted NDRRMA landslide categorization framework, the Rupsa settlement has been classified as Category II with partial relocation, indicating that while the majority of the affected area can be protected through appropriate engineering and non-engineering mitigation measures, households located within the most hazardous portions require relocation. The landslide remains active and poses a significant threat to residential areas, agricultural land, and local road infrastructure, with a high probability of continued movement during future monsoon seasons.

The settlement has been assigned High Priority for intervention. Based on the assessment, 20 households have been identified for immediate relocation due to their direct exposure to landslide hazards. The remaining parts of the settlement require detailed geotechnical investigation, continuous monitoring, improvement of surface and subsurface drainage, slope stabilization, retaining and toe protection structures, bioengineering measures, and proper management of road drainage to reduce future landslide risk.

Overall, the assessment indicates that although the Rupsa landslide presents a significant hazard to the local community, the risk can be effectively reduced through a combination of partial relocation of the identified households and timely implementation of appropriate engineering and bioengineering mitigation measures. The Rural Municipality should therefore prioritize relocation planning for the affected households while integrating long-term landslide risk reduction into local development and land-use planning to enhance community resilience.

5.7 Surkhet

The rapid assessment of landslide-affected settlements in Gurbhakot Municipality, Surkhet District, covered 29 settlements across Wards 2, 3, 4, 7, 8, 9, 10, 11, 12, and 14 to evaluate existing geo-hazard conditions, risk levels, and appropriate mitigation measures. The assessment identified a combination of landslides, gully erosion, riverbank erosion, and flood-related hazards, primarily triggered by intense monsoon rainfall and aggravated by river toe erosion, weak colluvial and residual soils, road-cut excavation,

inadequate drainage, concentrated surface runoff, and floodplain encroachment. These hazards threaten settlements, agricultural land, rural roads, bridges, water supply systems, and other local infrastructure.

Based on the NDRRMA classification, 8 settlements fall under Category I, 15 under Category II, and 6 under Category III. In terms of intervention priority, 6 settlements have been assigned Very High Priority, 15 Medium Priority, and 8 Low Priority. A total of 31 households located in the six Category III settlements have been recommended for immediate relocation, as the existing geo-hazard conditions are considered extremely difficult to stabilize through engineering measures. The remaining Category II settlements require detailed geotechnical investigations followed by appropriate engineering and bioengineering interventions, including slope stabilization, drainage improvement, river training and toe protection works, and continuous monitoring. Category I settlements require periodic monitoring and routine maintenance to maintain slope stability.

Overall, the assessment indicates that while a limited number of highly vulnerable settlements require relocation, the majority of geo-hazard risks in Gurbhakot Municipality can be effectively reduced through timely implementation of appropriate structural and non-structural mitigation measures. Given the increasing probability of hazard occurrence during intense and prolonged monsoon rainfall, systematic monitoring, maintenance, and risk-informed land-use planning are essential to enhance the long-term resilience of the municipality..

5.7.1 Gurbhakot Municipality

The rapid assessment conducted in Gurbhakot Municipality identified 29 landslide-affected settlements distributed across Wards 2, 3, 4, 7, 8, 9, 10, 11, 12, and 14. The investigated sites include active and reactivated landslides, debris-flow channels, gully erosion areas, and flood-induced slope instability. Most hazards are associated with loose colluvial and residual soils over weathered quartzite, phyllite, sandstone, and alluvial deposits, while intense monsoonal rainfall, inadequate drainage, haphazard road construction, toe erosion, and vegetation degradation have significantly contributed to slope instability.

Based on the adopted NDRRMA landslide categorization framework, Jhale Pahar, Aaptakura, Naule Khola, Sano Thakleni, Simghat Botechaur, Lamidanda, Sundaha, and Wallobeteni have been classified as Category I, representing relatively stable conditions where routine maintenance, bio-engineering measures, and periodic monitoring are sufficient to maintain slope stability.

A majority of the assessed settlements fall under Category II, including GhartiBase, Khahare, Aalkurule, Atka, Lekhkurule, Naulepani, Gangatekhola, Bhedawari Pulbazar, Nadekot, Bhulke, Tharukhoriya, Hanimane, Lamitaleto, Awalsurma, and Barmagar. These settlements exhibit varying degrees of slope instability, localized erosion, creep movement, and seasonal reactivation; however, the associated hazards can be substantially reduced through detailed geo-technical investigation, improvement of surface and

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subsurface drainage systems, retaining and toe protection structures, bio-engineering measures, and continuous monitoring. Immediate relocation has not been recommended for these settlements.

The settlements classified as Category III comprise Hileghariseta, Dapcha, Khahare, Simkhola (Thadokhola), Hileni, and Kapase, where the existing geo-hazard conditions are extremely difficult to control technically and economically. These settlements exhibit active landslide movement, progressive deformation, debris-flow hazards, and severe threats to residential areas and local infrastructure. Based on the assessment, 31 households have been identified for immediate relocation, including 4 households at Hileghariseta, 7 households at Dapcha, 8 households at Khahare (Ward no. 11), 3 households at Simkhola (Thadokhola), 5 households at Hileni, and 4 households at Kapase.

Overall, the assessment indicates that Gurbhakot Municipality is highly susceptible to rainfall-induced landslides due to its fragile geological setting, steep terrain, and increasing anthropogenic disturbances. While Category I and Category II settlements can largely be managed through systematic monitoring and appropriate engineering and bioengineering interventions, the Category III settlements require urgent relocation planning and implementation. The municipality should therefore prioritize relocation of the identified households while simultaneously strengthening slope stabilization, drainage management, and long-term landslide risk reduction measures to enhance community resilience.

Table 9 List of Category I (Low-Risk) Landslide-Affected Settlements Identified During the Rapid Geo-hazard Assessment

S.N.	Province	District	Municipality / Rural Municipality	Ward No.	Settlement (Basti)	NDRRMA Category	Priority Level
1	Koshi	Ilam	Suryodaya Municipality	1	Bilaune Pakha (Durgabhawani Tol)	CAT-I	Medium
2	Koshi	Ilam	Suryodaya Municipality	2	Siddhikhola Area	CAT-I	Low
3	Koshi	Ilam	Suryodaya Municipality	2	Arthetar Tol	CAT-I	Low
4	Koshi	Ilam	Suryodaya Municipality	4	Salleri	CAT-I	Low
5	Koshi	Ilam	Suryodaya Municipality	5	Suntung	CAT-I	Low
6	Koshi	Ilam	Suryodaya Municipality	5	Ambitar	CAT-I	Low
7	Koshi	Ilam	Suryodaya Municipality	12	Deurali Tol	CAT-I	Medium
8	Koshi	Ilam	Suryodaya Municipality	12	Sundar Khola	CAT-I	Low
9	Koshi	Ilam	Suryodaya Municipality	12	Triveni Tol	CAT-I	Low
10	Karnali	Surkhet	Gurbhakot Municipality	4	Jhale Pahar	CAT-I	Low
11	Karnali	Surkhet	Gurbhakot Municipality	7	Naule Khola	CAT-I	Low
12	Karnali	Surkhet	Gurbhakot Municipality	7	Sano Thakleni	CAT-I	Low
13	Karnali	Surkhet	Gurbhakot Municipality	9	Simghat Botechaur	CAT-I	Low
14	Karnali	Surkhet	Gurbhakot Municipality	12	Lamidanda	CAT-I	Low
15	Karnali	Surkhet	Gurbhakot Municipality	12	Sundaha	CAT-I	Low
16	Karnali	Surkhet	Gurbhakot Municipality	12	Wallobeteni	CAT-I	Low

Note: Category I (CAT-I) represents settlements where the existing geo-hazard conditions are comparatively stable and no major structural interventions or relocation are currently required. These sites can be managed through routine monitoring, regular maintenance of surface drainage systems, localized erosion control, bioengineering measures, and small-scale stabilization works using locally available materials to prevent future deterioration and maintain long-term slope stability.

Table 10 List of Category II Landslide-Affected Settlements Identified During the Rapid Geo-hazard Assessment

S.N	Province	District	Municipality / Rural Municipality	Ward No.	Settlement (Basti)	NDRRMA Category	Priority Level
1	Koshi	Ilam	Mai Municipality	2	Purbe Kharpani	CAT-II	High
2	Koshi	Ilam	Phakphokthum Rural Municipality	1	Panchami Bazar	CAT-II	High
3	Koshi	Ilam	Sandakpur Rural Municipality	2	Kamere	CAT-II	Medium
4	Koshi	Ilam	Sandakpur Rural Municipality	3	Gairigaun	CAT-II	Medium
5	Koshi	Ilam	Sandakpur Rural Municipality	4	Gumba	CAT-II	Medium
6	Koshi	Ilam	Mangsebung Rural Municipality	3	Lamitar	CAT-II	Medium
7	Koshi	Ilam	Mangsebung Rural Municipality	5	Setikhare	CAT-II	High
8	Koshi	Ilam	Deumai Municipality	1	Maidane	CAT-II	Medium
9	Koshi	Ilam	Suryodaya Municipality	1	Paireni Tol	CAT-II	Low
10	Koshi	Ilam	Suryodaya Municipality	1	Shreekhola Chaghare (Shreekhola Tol)	CAT-II	High
11	Koshi	Ilam	Suryodaya Municipality	1	Chhaghare Jirel (Sagarmatha Tol)	CAT-II	Medium
12	Koshi	Ilam	Suryodaya Municipality	1	Manebhanjyang (Sunakhari Tol)	CAT-II	Low
13	Koshi	Ilam	Suryodaya Municipality	2	Deurali Tol	CAT-II	Medium
14	Koshi	Ilam	Suryodaya Municipality	2	Makhamali Tol	CAT-II	High
15	Koshi	Ilam	Suryodaya Municipality	4	Shreebung	CAT-II	High
16	Koshi	Ilam	Suryodaya Municipality	4	Bhalukhola/Thalukhola Khand	CAT-II	Medium
17	Koshi	Ilam	Suryodaya Municipality	9	Dhode	CAT-II	Medium

18	Koshi	Ilam	Suryodaya Municipality	9	Rai Gaun	CAT-II	Medium
19	Koshi	Ilam	Suryodaya Municipality	9	Adarsha Tol	CAT-II	High
20	Koshi	Ilam	Suryodaya Municipality	11	Bhalu Khop	CAT-II	Very High
21	Koshi	Ilam	Suryodaya Municipality	12	RongTol Khahare Khola Malim	CAT-II	Medium
22	Koshi	Ilam	Suryodaya Municipality	12	Sundarbasti Tol	CAT-II	Medium
23	Koshi	Ilam	Suryodaya Municipality	12	Lumke Tol	CAT-II	Medium
24	Koshi	Ilam	Suryodaya Municipality	13	Doctor Gaun Kolbote Tol	CAT-II	Medium
25	Koshi	Ilam	Suryodaya Municipality	14	Thulo Bardu Tol	CAT-II	High
26	Koshi	Ilam	Suryodaya Municipality	14	Simle	CAT-II	Medium
27	Koshi	Dhankuta	Dhankuta Municipality	5	Tudikhel (Mathillo Kopche)	CAT-II	High
28	Bagmati	Dhading	Dhunibesi Municipality	9	Jugedi	CAT-II	High
29	Bagmati	Dhading	Dhunibesi Municipality	9	Khatri Pouwa	CAT-II	High
30	Bagmati	Dhading	Dhunibesi Municipality	9	Nagarpalika Office	CAT-II	High
31	Gandaki	Parbat	Phalebas Municipality	8	Okhrani Kalamuda	CAT-II	High
32	Karnali	Rukum West	Musikot Municipality	10	Chaura	CAT-II	High
33	Karnali	Kalikot	Palata Rural Municipality	6	Kam Basti	CAT-II	Medium
34	Karnali	Kalikot	Palata Rural Municipality	3	Jogkhola, Dalit Basti	CAT-II	High
35	Karnali	Kalikot	Palata Rural Municipality	3	Bhita	CAT-II	High
36	Karnali	Surkhet	Gurbhakot Municipality	2	GhartiBase	CAT-II	Medium
37	Karnali	Surkhet	Gurbhakot Municipality	2	Khahare	CAT-II	Medium
38	Karnali	Surkhet	Gurbhakot Municipality	3	Aalkurule	CAT-II	Medium
39	Karnali	Surkhet	Gurbhakot Municipality	3	Atka	CAT-II	Medium
40	Karnali	Surkhet	Gurbhakot Municipality	3	Lekhkurule	CAT-II	Medium

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41	Karnali	Surkhet	Gurbhakot Municipality	4	Aaptakura	CAT-II	Medium
42	Karnali	Surkhet	Gurbhakot Municipality	4	Naulepani	CAT-II	Medium
43	Karnali	Surkhet	Gurbhakot Municipality	8	Gangatekhola	CAT-II	Medium
44	Karnali	Surkhet	Gurbhakot Municipality	8	Bhedawari Pulbazar	CAT-II	Medium
45	Karnali	Surkhet	Gurbhakot Municipality	9	Nadekot	CAT-II	Medium
46	Karnali	Surkhet	Gurbhakot Municipality	9	Bhulke	CAT-II	Medium
47	Karnali	Surkhet	Gurbhakot Municipality	9	Tharukhoriya	CAT-II	Medium
48	Karnali	Surkhet	Gurbhakot Municipality	10	Hanimane	CAT-II	Medium
49	Karnali	Surkhet	Gurbhakot Municipality	10	Lamitaletol	CAT-II	Medium
50	Karnali	Surkhet	Gurbhakot Municipality	11	Awalsurma	CAT-II	Medium
51	Karnali	Surkhet	Gurbhakot Municipality	11	Barmagar	CAT-II	Medium

Note: Category II (CAT-II) represents settlements affected by landslides or other geo-hazards where the risk can be reduced to an acceptable level through appropriate mitigation measures. These sites require detailed geological and geotechnical investigations followed by site-specific engineering, bioengineering, drainage improvement, and regular monitoring to ensure long-term slope stability and risk reduction.

Table 11 List of Category II (Partial Relocation) Settlements with Recommended Immediate Relocation of Vulnerable Households Identified During the Rapid Geo-hazard Assessment

S.N	Province	District	Municipality / Rural Municipality	Ward No.	Settlement (Basti)	NDRRMA Category	No of Households for Immediate Relocations	Priority Level
1	Koshi	Ilam	Mai Municipality	9	Rangapani	CAT-II with partial relocation	8	High

2	Koshi	Ilam	Sandakpur Rural Municipality	1	Ahale	CAT-II with partial relocation	4	Very High
3	Koshi	Ilam	Sandakpur Rural Municipality	2	Todke	CAT-II with partial relocation	5	Very High
4	Koshi	Ilam	Mangsebung Rural Municipality	3	Bhanjyang	CAT-II with partial relocation	6	High
5	Koshi	Ilam	Mangsebung Rural Municipality	6	Chisopani	CAT-II with partial relocation	3	High
6	Koshi	Ilam	Suryodaya Municipality	1	Ghising Gaun (Makarjung)	CAT-II with partial relocation	2	High
7	Koshi	Ilam	Suryodaya Municipality	1	Teenghare (Purbeli Tol)	CAT-II with partial relocation	1	High
8	Koshi	Ilam	Suryodaya Municipality	1	Khadka Gaun (Indreni Tol)	CAT-II with partial relocation	1	High
9	Koshi	Ilam	Suryodaya Municipality	2	Manedanda Tol	CAT-II with partial relocation	1	High
10	Koshi	Ilam	Suryodaya Municipality	2	Mayukhola Area	CAT-II with partial relocation	1	High
11	Koshi	Ilam	Suryodaya Municipality	3	Mehelbote	CAT-II with partial relocation	1	High
12	Koshi	Ilam	Suryodaya Municipality	4	Sanakate (Unuytar Tol)	CAT-II with partial relocation	1	High

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13	Koshi	Ilam	Suryodaya Municipality	5	Mechi Bagar	CAT-II with partial relocation	1	High
14	Koshi	Ilam	Suryodaya Municipality	12	Seti Devi Tol	CAT-II with partial relocation	1	Very High
15	Koshi	Ilam	Suryodaya Municipality	14	Sahakale Tol	CAT-II with partial relocation	2	High
16	Bagmati	Dhading	Dhunibesi Municipality	2	Thulo Khola	CAT-II with partial relocation	1	High
17	Gandaki	Parbat	Phalebas Municipality	8	Khalte	CAT-II with partial relocation	12	High
18	Karnali	Kalikot	Narharinath Rural Municipality	5	Rupsa	CAT-II with partial relocation	20	High

Note: Category II with Partial Relocation (CAT-II with Partial Relocation) represents settlements where most of the affected area can be stabilized through appropriate engineering and bioengineering measures; however, households located within the most hazardous portions of the landslide are recommended for immediate relocation. Detailed geological and geotechnical investigations, drainage improvement, slope stabilization, continuous monitoring, and relocation of the identified vulnerable households are required to effectively reduce the overall geo-hazard risk.

Table 12 List of Category III Settlements Requiring Immediate Relocation Identified During the Rapid Geo-hazard Assessment

S.N.	Province	District	Municipality / Rural Municipality	Ward No.	Settlement (Basti)	NDRRMA Category	No of Households for Immediate Relocations	Priority Level
1	Koshi	Ilam	Phakphokthum Rural Municipality	6	Simsara	CAT-III	16 (Relocation Process Ongoing)	Very High
2	Koshi	Ilam	Suryodaya Municipality	7	Ambe Tol	CAT-III	2	Very High

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3	Karnali	Rukum West	Aathbisakot Municipality	13	Kalo Pahi	CAT-III	8	Very High
4	Karnali	Kalikot	Palata Rural Municipality	8, 9	Thulo Madu, Bade, Buase	CAT-III	94	High
5	Karnali	Surkhet	Gurbhakot Municipality	3	Hileghariseta	CAT-III	5	Very High
6	Karnali	Surkhet	Gurbhakot Municipality	9	Dapcha (Khuti)	CAT-III	5	Very High
7	Karnali	Surkhet	Gurbhakot Municipality	11	Khahare (Simkhola, Gadapani)	CAT-III	10	Very High
8	Karnali	Surkhet	Gurbhakot Municipality	11	Simkhola (Thadokhola),	CAT-III	8	Very High
9	Karnali	Surkhet	Gurbhakot Municipality	14	Hileni	CAT-III	6	Very High
10	Karnali	Surkhet	Gurbhakot Municipality	14	Kapase	CAT-III	4	Very High

Note: Category III (CAT-III) represents settlements located in areas affected by severe and active geo-hazards where the existing instability is technically difficult and economically impractical to mitigate through engineering measures alone. These settlements require immediate relocation of the identified households as the primary risk reduction measure, together with detailed site investigations, continuous monitoring, and post-relocation management to minimize future loss of life and property.

CHAPTER 6: RECOMMENDATION

Based on the rapid geo-hazard assessment, the following recommendations are proposed to reduce the impacts of existing landslides and associated geo-hazard risks within the district:

6.1 Immediate Recommendations

1. Immediate Risk Reduction and Prioritization

The rapid geo-hazard assessment identified 95 landslide-affected settlements across Ilam, Dhankuta, Dhading, Parbat, Rukum West, Kalikot, and Surkhet Districts, comprising 16 Category I settlements, 69 Category II settlements (including 17 Category II settlements requiring partial relocation), and 10 Category III settlements. Among these, 11 settlements have been assigned Very High Priority, representing the highest level of risk and requiring immediate intervention before future monsoon seasons. Priority should be given to implementing emergency risk reduction measures at all Category III settlements and other Very High Priority locations through continuous monitoring, temporary protective works, emergency drainage improvement, community preparedness, and restriction of activities that may further destabilize affected slopes.

2. Relocation of Highly Vulnerable Households

Immediate relocation is recommended for 222 households from 28 settlements identified as either Category III or Category II with partial relocation, where households are directly exposed to active landslides and related geo-hazards. These include Rangapani (8 households), Simsara (16), Ahale (4),

Todke (5), Bhanjyang (6), Chisopani (3), Ghising Gaun (Makarjung) (2), Teenghare (Purbeli Tol) (1), Khadka Gaun (Indreni Tol) (1), Manedanda Tol (1), Mayukhola Area (1), Mehelbote (1), Sanakate (Unuytar Tol) (1), Mechi Bagar (1), Seti Devi Tol (1), Sahakale Tol (2), Thulo Khola (1), Khalte (12), Kalo Pahirol (8), Thulo Madu–Bade–Buase (94), Rupsa (20), Hileghariseta (5), Dapcha (Khuti) (5), Khahare (Simkhola, Gadapani) (10), Simkhola (Thadokhola) (8), Hileni (6), and Kapase (4). Planned relocation should be undertaken in coordination with local governments, ensuring the provision of suitable resettlement sites, essential infrastructure, public services, livelihood restoration, and long-term land tenure security for affected households.

3. Emergency Drainage Improvement and Temporary Slope Protection

Emergency drainage improvement and temporary slope stabilization measures should be implemented across all Category II, Category II with partial relocation, and Category III settlements to reduce the risk of landslide reactivation during future monsoon seasons. Priority should be given to Category III settlements including Simsara, Ambe Tol, Kalo Pahirol, Thulo Madu–Bade–Buase, Hileghariseta, Dapcha (Khuti), Khahare (Simkhola–Gadapani), Simkhola (Thadokhola), Hileni, and Kapase, followed by Category II with partial relocation settlements including Rangapani, Ahale, Todke, Bhanjyang, Chisopani, Ghising Gaun (Makarjung), Teenghare (Purbeli Tol), Khadka Gaun (Indreni Tol), Manedanda Tol, Mayukhola Area, Mehelbote, Sanakate (Unuytar Tol), Mechi Bagar, Seti Devi Tol, Sahakale Tol, Thulo Khola, and Rupsa. Similar drainage improvement works should also be undertaken at all Category II settlements, including Purbe Kharpani, Panchami Bazar, Kamere, Gairigaun, Gumba, Lamitar, Setikhare, Maidane, Paireni Tol, Shreekhola Chaghare, Chhaghare Jirel, Manebhanjyang, Deurali Tol, Makhamali Tol, Shreebung, Bhalukhola/Thalukhola Khand, Dhode, Rai Gaun, Adarsha Tol, Bhalu Khop, Rong Tol–Khahare Khola Malim, Sundarbasti Tol, Lumke Tol, Doctor Gaun–Kolbote Tol, Thulo Bardu Tol, Simle, Tudikhel (Mathillo Kopche), Jugedi, Khatri Pouwa, Nagarpalika Office, Okhrani Kalamuda, Chaura, Kam Basti, Jogkhola–Dalit Basti, Bhita, GhartiBase, Khahare, Aalkurule, Atka, Lekhkurule, Aaptakura, Naulepani, Gangatekhola, Bhedawari Pulbazar, Nadekot, Bhulke, Tharukhoriya, Hanimane, Lamitaletol, Awalsurma, and Barmagar, where engineering stabilization remains technically feasible.

The emergency works should include clearing blocked drains, culverts, roadside drains, and natural waterways; constructing temporary catch drains, diversion channels, cross-drainage structures, and runoff management systems to safely convey surface water away from unstable slopes; and minimizing infiltration into landslide bodies. Temporary slope protection measures such as sandbag barriers, gabion toe protection, dry stone masonry, bamboo check structures, localized retaining walls, and erosion-control works using locally available materials should be implemented to reduce ongoing slope deterioration. These measures should particularly focus on protecting vulnerable settlements, rural roads, bridges, drinking water supply systems, irrigation canals, schools, agricultural land, and other public infrastructure until permanent structural and bioengineering mitigation measures are completed.

6.2 Medium and Long-Term Management Plan

1. Management of Category I Settlements

The assessment identified 16 Category I settlements across the seven districts where the existing geo-hazard conditions are comparatively stable and no major structural interventions are presently required. Nevertheless, these settlements should be subjected to periodic monitoring and routine maintenance to prevent deterioration of slope conditions, particularly following intense monsoonal rainfall. Low-cost preventive measures, including bioengineering techniques using locally available vegetation, improvement and maintenance of surface drainage systems, construction of small catch drains and cross-drainage structures, localized retaining or breast walls, dry stone masonry, gabion protection, and erosion control works utilizing locally available materials, should be implemented where necessary to maintain slope stability and minimize the likelihood of future landslide initiation.

2. Detailed Investigations

A total of 69 Category II settlements require comprehensive geological, geotechnical, geomorphological, and hydrogeological investigations before the design and implementation of permanent mitigation measures. These settlements are distributed across all seven districts and include both Category II and Category II with partial relocation sites, where engineering stabilization remains technically feasible. Detailed investigations should include engineering geological mapping, subsurface exploration, geotechnical laboratory testing, groundwater assessment, rainfall–landslide relationship analysis, slope stability modeling, and hazard zonation to ensure that mitigation measures are technically sound, cost-effective, and sustainable.

3. Improvement of Surface and Subsurface Drainage Systems

Drainage deficiencies were identified as one of the principal triggering factors for landslide initiation and reactivation in the majority of the assessed settlements. Therefore, all Category II and Category III settlements (79 settlements in total) should be prioritized for comprehensive drainage improvement works to protect affected communities and critical infrastructure. Recommended interventions include construction and regular maintenance of lined surface drains, subsurface drainage systems, cross-drainage structures, catch drains, spring management systems, runoff diversion channels, roadside drainage improvements, and routine maintenance to minimize infiltration, reduce pore-water pressure, and safely convey stormwater away from unstable slopes.

4. Implementation of Structural, Bioengineering, and Land Management Measures

Long-term landslide risk reduction should be achieved through integrated structural and bioengineering interventions implemented according to site-specific geological and geomorphological conditions. Priority should be given to the 79 Category II and Category III settlements, particularly those classified as High

and Very High Priority, where residential areas, transportation networks, agricultural land, water supply systems, schools, and other public infrastructure remain exposed to continuing slope instability. Recommended engineering measures include retaining and breast walls, gabion toe protection, river training works, check dams, debris barriers, rockfall protection systems, slope regrading, erosion control, stabilization of road-cut slopes, and localized ground reinforcement. These measures should be complemented by bioengineering techniques such as grassing, shrub plantation, deep-rooted tree plantation, brush layering, live check dams, fascines, vegetative slope protection, and watershed conservation, together with strengthened land-use planning, community-based landslide monitoring, rainfall-based early warning systems, public awareness programs, and regular post-monsoon inspections to enhance the long-term resilience of vulnerable communities.

5. Promotion of Bioengineering and Watershed Restoration

Large-scale bioengineering and watershed rehabilitation programs should be implemented throughout the affected catchments to enhance long-term slope stability. Measures should include plantation of deep-rooted indigenous tree species, shrubs, grasses, bamboo, brush layering, live fascines, vegetative check dams, contour hedgerows, gully rehabilitation, and restoration of degraded forest areas. Catchment-scale soil and water conservation measures should also be promoted to reduce runoff, sediment transport, and erosion.

6. Implementation of Sustainable Relocation and Resettlement Programs

For Category III settlements and Category II settlements requiring partial relocation, planned resettlement should be implemented following detailed social, environmental, and engineering assessments. Suitable relocation sites should be selected after confirming their geological stability and accessibility to essential services. Relocation programs should include housing support, water supply, sanitation, electricity, road access, schools, healthcare facilities, livelihood restoration, and secure land tenure to ensure sustainable rehabilitation of affected communities.

7. Strengthen Monitoring, Early Warning, and Research

A long-term monitoring network should be established at critical landslide sites using periodic field inspections, rainfall gauges, crack monitoring, groundwater observations, remote sensing, drone surveys, and satellite-based deformation monitoring where feasible. Rainfall thresholds for landslide initiation should be developed to support community-based early warning systems. Continuous research should be encouraged to improve understanding of landslide mechanisms, climate change impacts, and the performance of mitigation measures under varying geological conditions.

8. Integration of Geo-hazard Risk into Land-use Planning and Infrastructure Development

Municipal and district land-use plans should incorporate the results of geo-hazard assessments and hazard zonation studies. New settlements, schools, hospitals, roads, irrigation canals, water supply systems, and other critical infrastructure should avoid active landslide zones, debris-flow channels, flood-prone areas, and unstable slopes. Mandatory engineering geological investigations should be required prior to major infrastructure development in mountainous terrain.

9. Improve Road Construction and Slope Management Practices

Road construction practices should strictly follow engineering geological recommendations to minimize slope disturbance. Appropriate slope angles, benching, retaining structures, bioengineering measures, spoil disposal sites, and drainage systems should be incorporated into all new road projects. Existing road corridors crossing unstable terrain should be systematically upgraded through slope stabilization, drainage improvement, and regular maintenance to reduce landslide occurrence.

10. Enhance Community Capacity and Institutional Coordination

Long-term geo-hazard risk reduction requires active participation of local communities and effective coordination among municipalities, provincial governments, federal agencies, and technical institutions. Regular awareness programs, community-based disaster risk management training, school education, simulation exercises, and technical capacity-building for local governments should be institutionalized. A centralized geo-hazard database should be maintained and periodically updated to support evidence-based planning, investment prioritization, and adaptive management of geo-hazards across the assessed districts.