A Community-Driven Approach to Landslide Hazard Mapping, Risk Assessment, and Management in Nepal

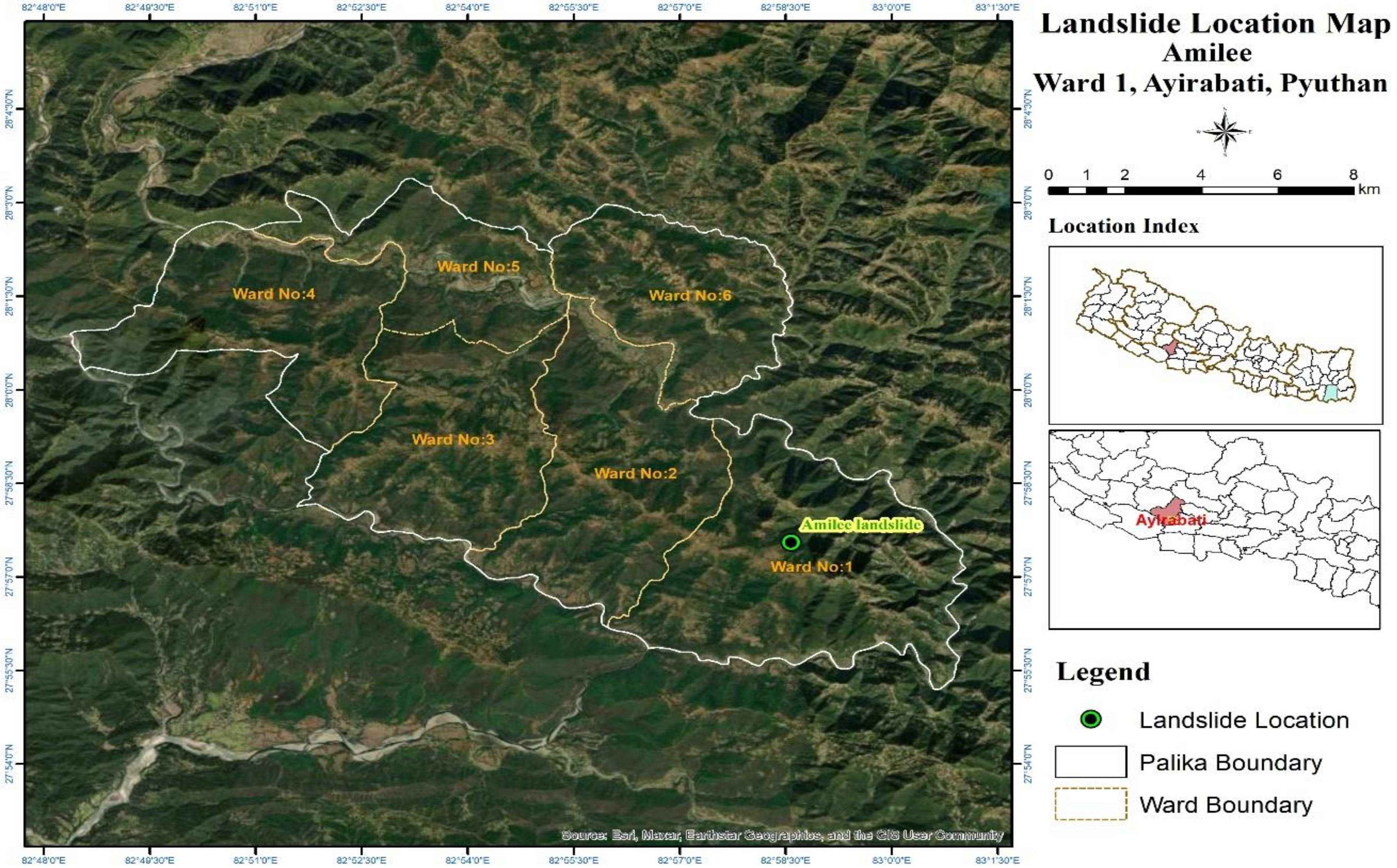
Achut Krishna Pandey (Nepal),
Subash Ghimire (Nepal),
Suresh Chaudhary (Nepal)

Background

- Landslides are among the top natural disasters in Nepal
- Nepal's rugged terrain, characterized by steep slopes and fragile geological formations, makes it highly susceptible to landslides, particularly during the monsoon season
- The increasing frequency and severity of landslides pose a significant threat to the country's socio-economic stability, necessitating a comprehensive approach to landslide risk management.

Study Area

Amilee landslide located in Ayirabati Rural Municipality, Pyuthan District, Lumbini Province.



Objectives

- To develop a detailed landslide hazard map for the Amilee area that incorporates both scientific data and local knowledge.
- To assess the risk posed by potential future landslides to the local community, infrastructure, and environment.
- To propose mitigation strategies that are informed by both technical analyses and community input, ensuring they are practical and sustainable.
- To engage the local community in the process of landslide risk assessment and management, fostering a sense of ownership and resilience

Methodology

Data Collection

1. Primary Data:

- ✓ Global Positioning System (GPS): To locate landslide features and collect coordinate data for mapping.
- ✓ Brunton Compass: To measure the orientation of geological structures.
- ✓ Field Observations: Detailed observations of the landslide area, including soil and rock types, vegetation cover, and signs of slope instability,

2. Secondary Data :

- ✓ Geological Maps: Lithological characteristics of the study area. (Government of Nepal, Department of Mines and Geology)
- ✓ Landslide Inventories: Historical landslides in the region were reviewed to identify patterns and high-risk areas.

Methodology

Data Processing and Analysis

1. Geographic Information Systems (GIS):

- ✓ Identify high-risk zones.
- ✓ Create hazard zonation maps.

2. Google Earth Analysis :

- ✓ Land use and vegetation cover changes.
- ✓ Landslide progression over time.
- ✓ Identified areas where human activities increased landslide risk.

3. Kinematic Analysis with DIPS Software:

- ✓ DIPS (Discontinuity Analysis and Rock Slope Stability) software for kinematic analysis.
- ✓ Assessed Slope Failure Types risks of planar sliding, wedge sliding, and toppling.
- ✓ Helped estimate failure likelihood and guided mitigation measures.

Community Engagement

Local knowledge and concerns included in hazard assessment.

- **Participatory Rural Appraisal (PRA):**
  - ✓ **Focus Group Discussions (FGDs):** Gathered diverse community views on landslide risks.
  - ✓ **Workshops & Training:** Educated community on landslide risks and preparedness.
  - ✓ **Stakeholder Meetings:** Ensured alignment of mitigation with local plans.

- **Local Knowledge Integration:** Used community insights on historical landslides, soil, vegetation, and traditional slope stabilization to validate scientific data and improve hazard maps.

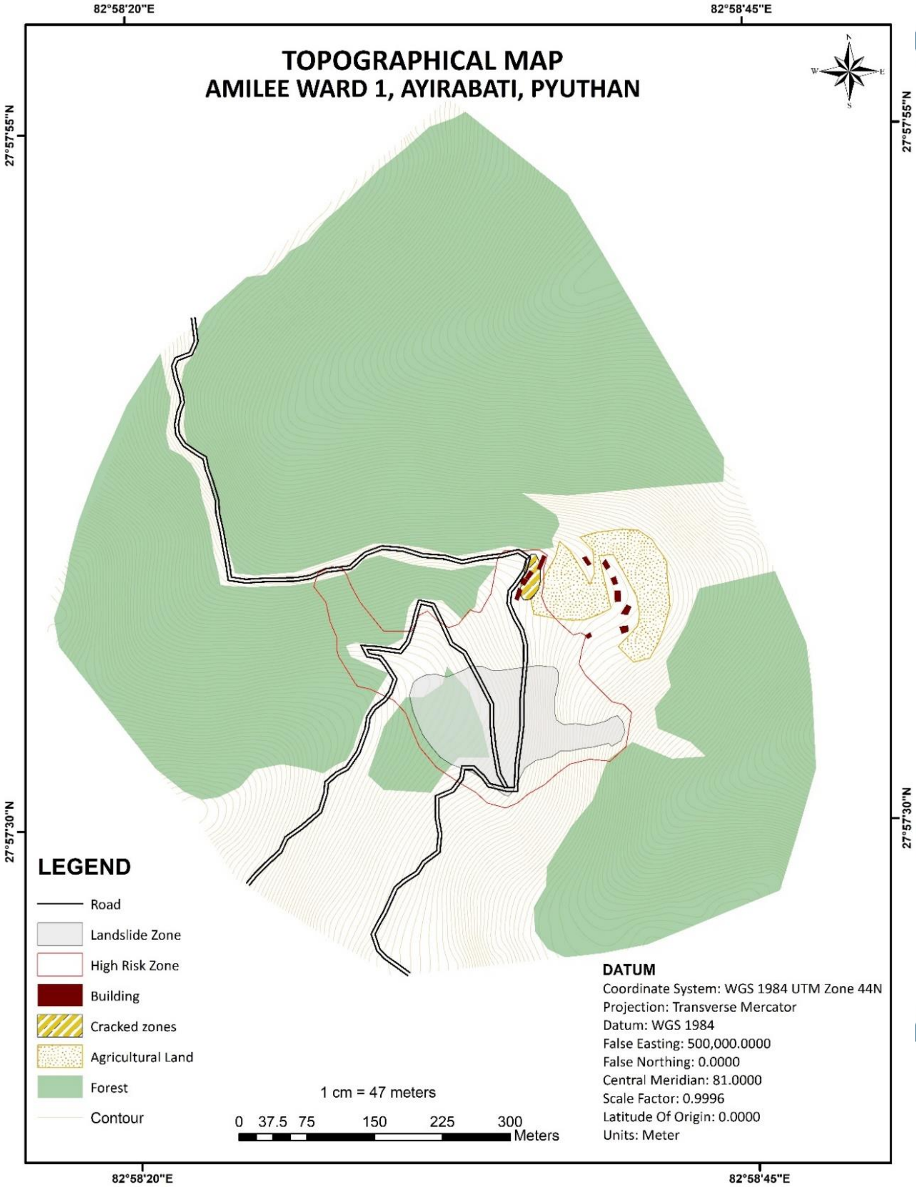
Hazard Scenario and Mapping

➢ Hazard Scenario

Type of movement	Rock type	Land cover	Triggering cause	Impact
Debris flow	Limestone, Shale	Sparse forest and agricultural land	Rainfall and haphazard road construction	Ward office and settlement

➢ Hazard Mapping:

The hazard mapping process identified several zones within the Amilee area with landslide risk. The hazard maps was created using a combination of field data, GIS analysis, and community input.



Slope Stability Analysis

- **Fieldwork Measurements:** Recorded orientation and number of discontinuities, slope type, slope angle, and sediment friction angles.
- **Stability Analysis:** Parameters analyzed to assess slope stability.
- **DIPS Software:** Used to input data and create diagrams estimating slope failure likelihood.

Landslide	Slope (°)	Planar sliding	Planar sliding (no limits)	Direct toppling	Flexural toppling	Wedge sliding
Amilee Landslide	42	0	0	0	33.33%	33.33%

Key findings:

- **Population at Risk:** 200 residents; 40% children and elderly, complicating evacuation.
- **Infrastructure at Risk:**
  - ✓Ward Office: Vulnerable to landslide damage.
  - ✓Roads: Main road at risk, could isolate community.
  - ✓Agricultural Land: 0.36 hectares affected, reducing crop yields.
- **Environmental Impact:**
  - ✓River Damming: Landslide sediment could block Jhimruk River.
  - ✓Forest Loss: Tree loss, risking further deforestation.
- **Economic Impact:**
  - ✓Agricultural & Property Losses: Reduced crop yields and risk to homes.

Causes of landslide

- **Natural Causes:**
  - ✓ Geology: Weak, weathered rocks (limestone, shale, quartzite) prone to failure.
  - ✓ Rainfall: Heavy monsoonal rains saturate soil, raising pore water pressure and instability.

- **Anthropogenic Causes:**
  - Unplanned Road Construction: Excavation and vegetation removal destabilize slopes, with inadequate retaining walls and drainage.
  - Improper Waste Management: Waste accumulation on slopes adds load, increasing instability.

Discussion

- **Historical Knowledge:**
  - ✓Local insights on past landslides were used to validate hazard maps.
  - ✓Traditional practices, like terracing, were incorporated into mitigation strategies.

- **Integrating Scientific and Local Knowledge:**
  - ✓GIS technology combined with local input for creating accurate hazard maps.
  - ✓Community feedback helped validate data, ensuring maps reflected real risks and fostering trust.

- **Challenges:**
  - ✓Rugged terrain limited access to hazardous zones for data collection.
  - ✓Conflicting local accounts of past events required careful management and resolution.
  - ✓Unpredictable landslide dynamics and climate change impacts complicated long-term planning.

Mitigation Measures (Short Term)

- **Drainage Management:**
  Install roadside drainage to divert water and prevent slope saturation.
- **Slope Stabilization:**
  Construct retaining walls in high-risk areas using local materials.
  Use bioengineering techniques (terracing, deep-rooted vegetation) to stabilize soil and reduce erosion.
- **Gully Treatment:**
  Build check dams to slow water flow and stabilize gully floors.
  Plant vegetation with strong root systems to reinforce soil and prevent further erosion.

Mitigation Measures (Mid Term)

- **Early Warning Systems:**
  Install inclinometers and piezometers in high-risk areas to monitor slope movements and soil moisture.
  Develop community-based alert systems (sirens, SMS notifications) for timely evacuation warnings.

- **Capacity Building:**
  Conduct training programs on disaster preparedness, evacuation, and use of early warning systems.
  Organize regular community drills to practice evacuation procedures.

- **Stakeholder Engagement:**
  Establish formal partnerships with local government agencies to support mitigation measures with policy and funding.
  Engage NGOs for technical assistance and implementation of mitigation strategies.

Mitigation Measures (Long Term)

- **Reforestation:**
  Large-scale planting of deep-rooted, native vegetation in high-risk areas for slope stabilization.
  Engage the community in planting and maintaining trees to enhance effectiveness and foster local ownership.

- **Land Use Planning:**
  Implement zoning regulations to prevent development in high-risk areas identified by hazard maps.
  Promote sustainable practices like agroforestry and contour farming to reduce human impact on slope stability.

- **Infrastructure Retrofitting:**
  Retrofit roads and buildings in high-risk areas with structural supports, including reinforced foundations and improved drainage.
  Design new infrastructure with resilience, using flexible materials and elevated structures to withstand landslide impacts.

Conclusion

- **Community-Driven Approach:**

  The study highlights the effectiveness of combining community knowledge with scientific methods in landslide hazard mapping, risk assessment, and management in Nepal.

  This approach leads to more accurate hazard maps, better risk assessments, and successful mitigation strategies.

  Community involvement enhances the relevance, acceptance, and empowerment of residents in disaster risk reduction efforts.

- **Lessons Learned:**

  The Amilee landslide case can serve as a model for other landslide-prone areas in Nepal, contributing to a more resilient and disaster-prepared society.

Thank you!


NO POVERTY
CLEAN WATER AND SANITATION
ZERO HUNGER
QUALITY EDUCATION
GENDER EQUALITY
GOOD HEALTH AND WELL-BEING