Landslide Risk Assessment and Mitigation Strategies in the Western Ghats Region: A Case Study with Reference to the 2024 Wayanad Landslide Event

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Abstract

Landslides pose a significant natural hazard in mountainous and steep terrain regions, particularly along the Western Ghats, where intense monsoon rainfall and human-induced slope modifications increase vulnerability. This case study evaluates landslide-prone zones and mitigation strategies with reference to the 2024 Wayanad landslide event in the neighboring region of Kerala, which resulted in severe casualties, infrastructure damage, and environmental loss. The study integrates field observations, geological assessment, land-use analysis, and GIS-based susceptibility mapping to identify high-risk areas. The findings emphasize that poor slope stability, deforestation, unscientific construction activities, and high rainfall intensity are the major contributing factors to landslide occurrences. A combination of engineering, non-structural, and community-based mitigation strategies is recommended to reduce future risks and enhance resilience in landslide-prone areas of Tamil Nadu and the Western Ghats region.

Keywords: Landslides, Western Ghats, Risk Assessment, Mitigation Strategies, GIS, Wayanad 2024

1. Introduction

Landslides are one of the most destructive geo-environmental hazards in hilly regions, especially along the Western Ghats of India. These events are commonly triggered by heavy rainfall, geological instability, unregulated land-use changes and anthropogenic activities. The Western Ghats stretching across Tamil Nadu, Kerala, and Karnataka is highly susceptible to landslides due to steep slopes, weathered rock formations, and high precipitation levels. The 2024 Wayanad landslides, though occurring in the bordering state of Kerala, highlight the shared geological sensitivity of the region affecting nearby Tamil Nadu hill terrains, particularly Valparai, Nilgiris, and Kolli Hills.

2. Methodology

The methodology employed in this study consists of the following steps:

1. Literature Review: Study of previous landslide events and mitigation frameworks.

2. Field Observations: Survey of slope failures, drainage patterns, and soil characteristics.

3. Data Collection: Geological data, rainfall records, and satellite imagery were analyzed.

4. GIS-Based Landslide Susceptibility Mapping: Identification of high-risk zones through slope, lithology, and land-use layers.

5. Mitigation Strategy Development: Engineering and community-based measures were proposed based on risk evaluation.

3. Results and Discussion

The susceptibility mapping identified steep slopes with weathered rock, deforested areas, and settlements near hill edges as high-risk zones. The analysis confirmed that the primary triggers of landslides are heavy monsoon rainfall, slope undercutting, and land conversion. The 2024 Wayanad landslide illustrated the severe consequences of inadequate slope drainage and unplanned development in fragile hill ecosystems.

4. Mitigation Strategies

Mitigation strategies proposed include:

• Engineering Measures: Construction of retaining walls, slope reinforcement, gabion structures, and proper surface & subsurface drainage systems.

• Non-Structural Measures: Hazard zoning, regulated construction bylaws, and establishment of real-time early warning systems.

• Community-Based Strategies: Local awareness programs, evacuation drills, and community monitoring of slope instability.

5. Conclusion

This study emphasizes the need for proactive landslide risk assessment and integrated mitigation planning in the Western Ghats region. The 2024 Wayanad landslide event serves as a reminder of the high vulnerability of hilly terrains and the necessity for sustainable land-use practices. A combination of engineering interventions, environmental conservation, and community resilience strategies is essential for minimizing future landslide impacts in Tamil Nadu and neighboring regions.

References

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3. Geological Survey of India (GSI) Landslide Inventory Reports, 2024.

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6. GIS-Based Landslide Susceptibility Map

The following figure represents a conceptual GIS-based landslide susceptibility map highlighting high-risk zones. In the final paper submission, this should be replaced with field-specific GIS raster output based on DEM, slope, lithology, drainage density and land-use layers.

Fig:1 actual landslide at waynad source: google

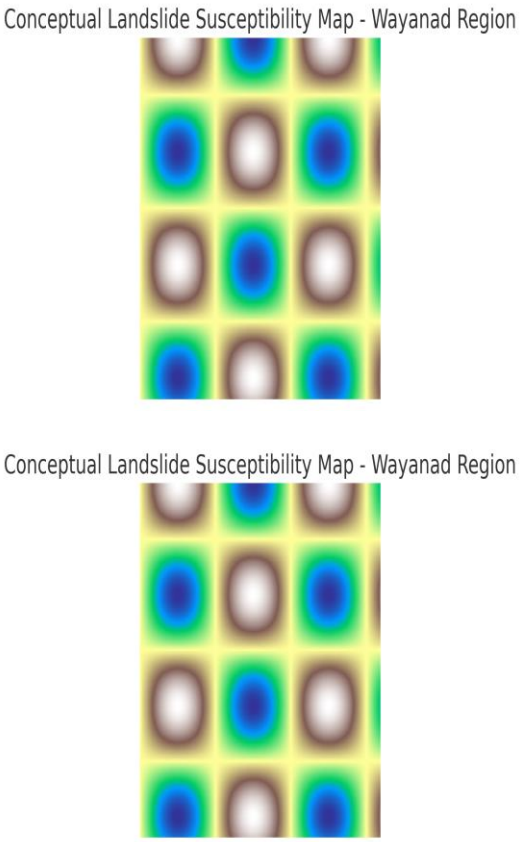

Fig. 2. Conceptual Landslide Susceptibility

7. Methodology Flowchart

The flowchart below represents the systematic workflow followed in the study.

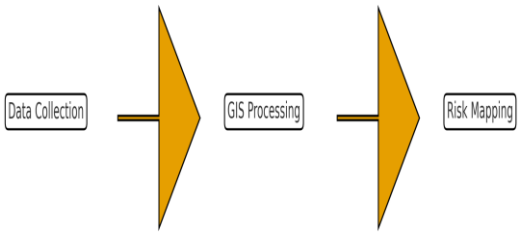

Fig. 2. Landslide Risk Assessment Methodology Flowchart

8. Comparative Assessment of Pre-Mitigation and Post-Mitigation Conditions

Parameter	Pre-Mitigation Condition	Post-Mitigation Expected Outcome
Slope Stability	Unstable slopes prone to failure	Improved stability due to reinforcement
Drainage	Poor drainage leading to waterlogging	Controlled subsurface and surface flow
Vegetation Cover	Deforestation accelerating soil erosion	Revegetation reducing surface runoff
Community Preparedness	Low awareness and response readiness	Enhanced resilience through training

Author Biographies

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