

Geospatial Intelligence: Application Of Remote Sensing And GIS In Mapping Landslide Susceptibility Zones

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ABSTRACT

Remote sensing and Geographic Information Systems (GIS) have emerged as powerful tools in the assessment and mapping of landslide susceptibility zones, offering rapid, cost-effective, and reliable spatial analysis. This paper explores the integration of satellite imagery, terrain modeling, and GIS-based multi-criteria analysis to identify vulnerable regions prone to landslides. By combining environmental factors such as slope, lithology, land use, and precipitation patterns, remote sensing and GIS enable the creation of high-accuracy susceptibility maps. Case studies from Himalayan and Western Ghats regions highlight the potential of these technologies in disaster risk reduction, urban planning, and sustainable infrastructure development. The findings underscore the need for continuous data updates, advanced image processing techniques, and community-based validation to enhance prediction accuracy and practical applicability in geotechnical engineering contexts.

Keywords: *Remote Sensing, GIS, Landslide Susceptibility, Terrain Analysis, Geotechnical Engineering, Disaster Risk Reduction*

INTRODUCTION

Landslides are among the most destructive natural hazards in mountainous and hilly terrains, causing significant loss of life, property, and infrastructure. The complexity of landslide occurrence is influenced by a combination of geological, hydrological, and anthropogenic factors. Traditional field-based mapping is time-consuming and often limited in scope. Remote sensing and GIS technologies have revolutionized landslide susceptibility mapping by enabling large-scale, high-resolution spatial analysis that integrates multiple environmental parameters.

REMOTE SENSING FUNDAMENTALS FOR LANDSLIDE MAPPING

Remote sensing involves the acquisition of information about the Earth's surface without direct contact, typically through satellite or aerial platforms. In landslide studies, optical imagery (e.g., Landsat, Sentinel-2), radar data (e.g., Sentinel-1 SAR), and LiDAR have been extensively utilized. These datasets provide critical information on topography, vegetation cover, moisture content, and land use, all of which are essential indicators of slope stability.

GIS-BASED MULTI-CRITERIA ANALYSIS

GIS enables the integration of spatial datasets and the application of multi-criteria decision analysis (MCDA) techniques to assess landslide susceptibility. Common factors include slope gradient, aspect, curvature, lithology, soil type, land cover, and precipitation. Weighted overlay methods assign relative importance to each factor based on expert judgment or statistical analysis, resulting in susceptibility zonation maps.

CASE STUDY: HIMALAYAN REGION

The Himalayan belt is highly prone to landslides due to steep slopes, fragile geology, and intense monsoonal rainfall. A study integrating Sentinel-2 optical imagery, SRTM DEM-derived slope and aspect data, and geological maps in a GIS environment successfully identified high-susceptibility zones along key transportation corridors. This

mapping facilitated targeted slope stabilization measures and informed infrastructure planning.

CHALLENGES AND FUTURE DIRECTIONS

Despite the proven effectiveness of remote sensing and GIS in landslide mapping, challenges remain. These include cloud cover in optical imagery, data resolution limitations, and the need for continuous updates to reflect changing land use patterns. Future advancements may include AI-based image classification, UAV-based surveys for ultra-high-resolution mapping, and participatory GIS approaches involving local communities.

CONCLUSION

The integration of remote sensing and GIS in landslide susceptibility mapping offers a robust framework for hazard assessment and risk management. By combining diverse datasets and advanced spatial analysis techniques, these tools provide valuable insights for geotechnical engineers, urban planners, and disaster management authorities. Continuous technological innovations and collaborative approaches will further enhance the accuracy and applicability of susceptibility maps in mitigating landslide risks.

Factor	Data Source	Description
Slope Gradient	SRTM DEM	Derived from elevation data to assess steepness
Land Cover	Sentinel-2 Imagery	Classification to identify vegetation and built-up areas
Lithology	Geological Survey Maps	Information on rock types and structures

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