World Academy of Science, Engineering and Technology
International Journal of Geotechnical and Geological Engineering
Vol:18, No:05, 2024

Gradient Length Anomaly Analysis for Landslide Vulnerability Analysis of Upper Alaknanda River Basin, Uttarakhand Himalayas, India

Authors : Hasmithaa Neha, Atul Kumar Patidar, Girish Ch Kothyari

Abstract : The northward convergence of the Indian plate has a dominating influence over the structural and geomorphic development of the Himalayan region. The highly deformed and complex stratigraphy in the area arises from a confluence of exogenic and endogenetic geological processes. This region frequently experiences natural hazards such as debris flows, flash floods, avalanches, landslides, and earthquakes due to its harsh and steep topography and fragile rock formations. Therefore, remote sensing technique-based examination and real-time monitoring of tectonically sensitive regions may provide crucial early warnings and invaluable data for effective hazard mitigation strategies. In order to identify unusual changes in the river gradients, the current study demonstrates a spatial quantitative geomorphic analysis of the upper Alaknanda River basin, Uttarakhand Himalaya, India, using gradient length anomaly analysis (GLAA). This basin is highly vulnerable to ground creeping and landslides due to the presence of active faults/thrusts, toe-cutting of slopes for road widening, development of heavy engineering projects on the highly sheared bedrock, and periodic earthquakes. The intersecting joint sets developed in the bedrocks have formed wedges that have facilitated the recurrence of several landslides. The main objective of current research is to identify abnormal gradient lengths, indicating potential landslide-prone zones. High-resolution digital elevation data and geospatial techniques are used to perform this analysis. The results of GLAA are corroborated with the historical landslide events and ultimately used for the generation of landslide susceptibility maps of the current study area. The preliminary results indicate that approximately 3.97% of the basin is stable, while about 8.54% is classified as moderately stable and suitable for human habitation. However, roughly 19.89% fall within the zone of moderate vulnerability, 38.06% are classified as vulnerable, and 29% fall within the highly vulnerable zones, posing risks for geohazards, including landslides, glacial avalanches, and earthquakes. This research provides valuable insights into the spatial distribution of landslide-prone areas. It offers a basis for implementing proactive measures for landslide risk reduction, including land-use planning, early warning systems, and infrastructure development techniques.

Keywords : landslide vulnerability, geohazard, GLA, upper Alaknanda Basin, Uttarakhand Himalaya
Conference Title : ICGEG 2024 : International Conference on Geology and Engineering Geology
Conference Location : London, United Kingdom
Conference Dates : May 23-24, 2024