World Academy of Science, Engineering and Technology
International Journal of Geotechnical and Geological Engineering
Vol:15, No:03, 2021

Slope Instability Study Using Kinematic Analysis and Lineament Density Mapping along a Part of National Highway 58, Uttarakhand, India

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Abstract : Slope instability is a major problem of the mountainous region, especially in parts of the Indian Himalayan Region (IHR). The on-going tectonic, rugged topography, steep slope, heavy precipitation, toe erosion, structural discontinuities, and deformation are the main triggering factors of landslides in this region. Besides the loss of life, property, and infrastructure caused by a landslide, it also results in various environmental problems, i.e., degradation of slopes, land use, river quality by increased sediments, and loss of well-established vegetation. The Indian state of Uttarakhand, being a part of the active Himalayas, also faces numerous cases of slope instability. Therefore, the vulnerable landslide zones need to be delineated to safeguard various losses. The study area is focused in Garhwal and Tehri -Garhwal district of Uttarakhand state along National Highway 58, which is a strategic road and also connects the four important sacred pilgrims (Char Dham) of India. The lithology of these areas mainly comprises of sandstone, quartzite of Chakrata formation, and phyllites of Chandpur formation. The greywacke and sandstone rock of Saknidhar formation dips northerly and is overlain by phyllite of Chandpur formation. The present research incorporates the lineament density mapping using remote sensing satellite data supplemented by a detailed field study via kinematic analysis. The DEM data of ALOS PALSAR (12.5 m resolution) is resampled to 10 m resolution and used for preparing various thematic maps such as slope, aspect, drainage, hill shade, lineament, and lineament density using ARCGIS 10.6 software. Furthermore, detailed field mapping, including structural mapping, geomorphological mapping, is integrated for kinematic analysis of the slope using Dips 6.0 software of Rockscience. The kinematic analysis of 40 locations was carried out, among which 15 show the planar type of failure, five-show wedge failure, and rest, 20 show no failures. The lineament density map is overlapped with the location of the unstable slope inferred from kinematic analysis to infer the association of the field information and remote sensing derived information, and significant compatibility was observed. With the help of the present study, location-specific mitigation measures could be suggested. The mitigation measures would be helping in minimizing the probability of slope instability, especially during the rainy season, and reducing the hampering of road traffic.

Keywords : Indian Himalayan Region, kinematic analysis, lineament density mapping, slope instability
Conference Title : ICSGGHA 2021 : International Conference on Structural Geology and Geological Hazard Assessment
Conference Location : Bangkok, Thailand
Conference Dates : March 08-09, 2021