

Evaluating the importance of the Geological strength index and susceptible zones in the mechanisms that trigger landslides in the Chukhayan-Kumrat Road area of Dir Upper, Pakistan.

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This study conducts a complete analysis of landslide vulnerability along the 83.5-kilometer Chukyatan-Kumrat Upper Dir road in North Pakistan. Despite its vital importance in transportation and tourism, the region is plagued by recurring landslides caused by hydro-meteorological hazards, creating serious stability risks. This study uses a multidisciplinary approach to merge the Landslide Susceptibility Index (LSI) analysis with the Geological Strength Index (GSI) obtained from joint investigation of bed rock in order to better understand the intricate connections that underlie landslide occurrences. The research region consists of a variety of rock formations covered in residual soils, such as ignimbrites, volcanic ash, granodiorites, andesites, meta-rhyolites, spotted slates, and metavolcanics. Using the Landslide Susceptibility Index (LSI) map created using the frequency ratio technique, locations near road cuttings, fault lines, and mineralogically changed and sheared lithology are indicated as highly vulnerable to future sliding occurrences. The Geological Strength Index (GSI) and Rock Mass Rating (RMR) assessments divide jointed bed rocks into generally stable (zones 1 and 2; GSI 67-58, RMR classes II and III) and sheared and changed (zones 3 and 4; GSI 38-16, RMR class IV) segments, highlighting their respective susceptibilities. These zones have a slicken-sided jointed structure that is mildly to heavily worn, which allows snow and precipitation to seep in. In addition to the impacts of precipitation and freeze-thaw cycles on the pores and joints of bedrock, the alteration process of minerals such as alkali feldspar, biotite, chlorite, and hornblende further weakens the rocks and acts as a major trigger for future landslides. Overall, this research offers useful insights for landslide susceptibility mapping in comparable geological contexts and helps the Chukyatan-Kumrat area build efficient mitigation and preparedness methods.