

## **Landslide development characteristics and risk zoning along Dir road in Khyber Pakhtunkhwa, Pakistan**

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Landslides are among nature's most devastating disasters. They are defined as earth movement down a slope, rockslide, rockfall, or debris flow. Landslides are considerably more dangerous in the mountainous terrains. The Karakoram Highway, in northern Pakistan is the main highway and only land route between China and Pakistan, however, it is prone to landslides and rockfalls. Landslides and mountain or hill slope failures are highly correlated, and such landslides pose greater threats to valleys as the vulnerability of mountain slopes increases due to weathering, deforestation, and other human-induced activities. Due to the wide range of landslide phenomena, no single method exists to identify and map landslides, to establish landslide hazards, and to evaluate the associated risk. This study aims to develop the landslide inventory, hazard and risk zones. SRTM 30-meter DEM and geographical information system (GIS) technology were used to create and analyze a spatial database of 2 landslides. To determine the significance of event-controlling parameters in triggering the landslides, a multi-criterion evaluation was used. The parameters included lithology, slope gradient, slope aspect, elevation, land cover, rivers, and roads. The goal of landslide studies is to reduce the negative effects of landslide hazards through risk evaluation. The data was analyzed to show that land sliding is the most common type of hazard in the Dir, Kohistan area, and the results revealed five classes of landslide risk zones. The areas exposed to hazards are distributed at random, with only 13% of the research area falling within the high-risk zone. A large portion of the land is classified as no or low risk, with 27% classified as moderate risk. Furthermore, it was found that lithology has the greatest influence on land sliding, especially when the rock is highly fractured, as in lavas, tuffs, agglomerate, slate, quartz diorite, and as the soil cover is sandy clay, which has a high angle of internal friction and less cohesion, may also influence landslides. Similarly, the proximity of the landslides to faults, rivers, and roads played a role in initiating failures. Landslides also occurred at elevations ranging from 1300 to 2100 meters, primarily on southeast and south trending slopes. Landslides were more likely in areas with few or no forested slopes than in dense forests. One-third of the study area is highly or extremely vulnerable to future land sliding and requires immediate mitigation action. The rest of the study area is relatively stable and has a low or moderate susceptibility to land sliding.

**Keywords:** Landslides, hazard, GIS, risk, susceptibility