

Assessment of landslide hazard, vulnerability, and risk in the data-poor region of Eastern Hindu Kush ranges

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Landslides are common geological hazards in mountainous terrain and have significant impacts on urbanization and the environment. The Upper Chitral valley of northern Pakistan is characterized by high-relief topography and active tectonics, with favorable conditions for landslides and debris flow. The aim of current research work is to assess the landslide hazard, vulnerability, and risk assessment in the Hindu Kush ranges using limited data. A comprehensive landslide inventory was developed through on-screen digitization and field observations and subsequently correlated with causative factors to develop a landslide susceptibility index (LSI). A landslide susceptibility map was integrated with triggering factors (Rainfall and PGA) to the landslide hazard index (LHI). The vulnerability assessment was conducted using a semi-quantitative multi-criterion evaluation (MCE) approach. The testing procedure of risk is based on the index system and consists of three stages. In step 1, the physical, environmental, and social vulnerability indexes were determined using direct and pairwise comparison matrices. In step 2, the most vulnerable zones were analyzed by integrating all vulnerability indexes. In step 3, landslide vulnerability and hazard index were integrated to develop a landslide risk index map. The risk map showed that a significant portion of the area (37.25%) had very low risk, while the low, moderate, high, and very high-risk zones comprised 62.22%, 0.37%, 0.11%, and 0.05% of the area, respectively. The developed landslide risk map can provide valuable assistance in effective landslide mitigation and land use planning.

Keywords: Hindu Kush; Landslides; Susceptibility; Vulnerability; Risk