

**Debris flow hazard and risk assessment using morphometrics in Hunza watershed, northern Pakistan**

Yaseen Ullah<sup>1\*</sup>, Muhammad Shafique<sup>1</sup>, and Nisar Ali Shah<sup>1</sup>

<sup>1</sup>*National Center of Excellence in Geology, University of Peshawar*

*\*Email: yaseengeo11@gmail.com*

Debris flows are prevalent geohydrological disasters within the Karakoram terrain, primarily caused by heavy rainfall interacting with rugged topography and loose sediment. This research aims to provide a quantitative method to assess the risk of debris flow in a given area by examining the relationship between building vulnerability, fan exposure, and catchment hazards. The risk assessment procedure implemented in the study is organized into three essential steps. Hazard evaluation was carried out in third first stage using the normalized differential snow index (NDSI), precipitation, and causative factors, including slope angle, melton ratio, relief ratio, stream power index, topographic wetness index and drainage density. In the subsequent stage, five morphometric factors were used to estimate the exposure assessment: the fan area, the mean slope of the fan, the width and incision of the channel, and the distance between buildings and the channel. In the third phase, the vulnerability level was assessed at both regional and local scales, taking into account factors such as building type, foundation material, physical condition, and age. The results of the risk assessment conducted at the regional scale indicate that 0.91% of the area is extremely vulnerable to debris flow disaster. The results of local scale risk assessment of fans indicate that a high-risk zone comprising 530 buildings and a 2 km section of the Karakoram Highway (KKH). These findings highlight the importance of utilizing scientific risk assessment to inform preventive measures and mitigate debris flow hazards in the Hunza watershed.