

**Multidisciplinary characterization of landslides using UAV photogrammetry and geophysical methods: A case study of an active landslide with early warning applications**

Tanveer Ahmed<sup>1,2,3\*</sup>, Nisar Ali Shah<sup>1</sup>, Muhammad Shafique<sup>1</sup>, Khaista Rehman<sup>1</sup>,  
Syed Tayyab Ali Shah<sup>3</sup>, Zahra Hassan<sup>3</sup>, Sajid Ali<sup>3</sup>

<sup>1</sup> National Centre of Excellence in Geology, University of Peshawar, Peshawar, Pakistan

<sup>2</sup> GIS and Space Applications in Geosciences (GSAG), National Centre of GIS and Space Applications (NCGSA), Institute of Space Technology, Islamabad, Pakistan

<sup>3</sup> National Disaster Management Authority, Islamabad, Pakistan

\*Email: tanveerndma@gmail.com

Northern Pakistan is vulnerable to frequent and severe landslide hazards, substantially threatening lives, infrastructure, and the environment due to its distinctive tectonic activity and climatic conditions. Effective landslide hazard management necessitates a comprehensive understanding of both surface and subsurface characteristics of potential landslide zones. This study adopts an integrated methodological framework, combining Unmanned Aerial Vehicle (UAV)-based photogrammetry, with geophysical techniques such as Electrical Resistivity Tomography (ERT) and the Microtremor Survey Method (MSM). This multidisciplinary approach facilitated a detailed characterization of the recently initiated Dolai landslide in the Muzaffarabad district, which obstructed the main Kohala-Muzaffarabad highway and threatened the blockage of the Jhelum River downstream. UAV-based photogrammetry offers high-resolution spatial and temporal datasets, enabling precise surface characterization. In parallel, ERT and MSM provide critical insights into subsurface conditions, including soil stratification, pore water pressure, and shear stress. The integration of these methods significantly enhances the accuracy of landslide hazard assessments and the efficacy of early warning systems. The findings from this investigation are pivotal for local authorities and stakeholders, informing the implementation of targeted mitigation measures, refining risk assessment strategies, and ultimately safeguarding vulnerable communities and critical infrastructure from the persistent threat of landslides in this geologically dynamic region.

**Keywords:** Landslide characterization; subsurface; UAV-based Photogrammetry; ERT; MSM