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Seasonal Response and Characterization of a Scree Slope and Active Debris Flow Catchment Using Multiple Geophysical Techniques: The case of the Meretschibach Catchment, Switzerland

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Various types of mass movements cause extensive natural hazards in populated mountain regions. They need to be quantified, and possibly predicted, for implementing effective mitigation and protection measures. The Meretschibach catchment in the Valais area, Switzerland, is a source region for such events. Various forms of instabilities occur on the steep slopes. They manifest themselves in form of smaller rock falls and rock slides on the open scree slopes. Moreover, large sediment volumes of channelized stream deposits can evolve into debris flows, with a substantial run-out along the Meretschibach.

Geophysical methods, such as electrical resistivity tomography (ERT) and ground-penetrating-radar (GPR) have been proven to be powerful tools for characterizing mass movements and slope instabilities. They complement other remote sensing techniques and in-situ geotechnical experiments. Ground-based and helicopter-borne GPR measurements were carried out at the Meretschibach test site, to determine the depth to the bedrock. The results indicate that the bedrock is generally shallow, ranging from a few centimetres to about 5 metres vertically below the surface. A particularly interesting aspect of the GPR investigations was the observation that bedrock depth could be resolved by both, ground-based and helicopter-borne GPR data. Ground-based GPR surveying proved to be extremely challenging on the steep slopes, and some areas were even inaccessible due to safety concerns. It is therefore encouraging for future projects that helicopter-borne GPR acquisition offers a promising alternative.

The spatial distribution of the soil moisture content and the temporal variations were determined with repeated ERT measurements. The resulting tomograms allowed a conductive soil layer and more resistive bedrock to be distinguished clearly. The ERT results were in good agreement with in-situ geotechnical measurements in a nearby test pit, and the depth of the soil-bedrock interface was broadly consistent with the GPR results. A comparison of tomograms obtained during the relatively dry month of June 2014, with those acquired after heavy rainfall in July 2014, showed significant changes of the shallow subsurface resistivities. These changes could be attributed in a quantitative fashion to variations of the soil water Saturation.