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Process dynamics, real time monitoring and early warning at an imminent cliff fall (Hochvogel, Allgäu Alps)

Johannes Leinauer, Benjamin Jacobs, and Michael Krautblatter

Technical University Munich, Chair of Landslide Research, Department of Civil Geo and Environmental Engineering, München, Germany (johannes.leinauer@tum.de)

Costs for (re)installation and maintenance of protective structures are increasing while alpine hazards progressively threaten alpine communities, infrastructure and economics. With climatic changes, anticipation and clever early warning of rock slope failures based on the process dynamics become more and more important. The imminent rock slope failure at the Hochvogel summit (2592 m a.s.l., Allgäu Alps) offers a rare possibility to study a cliff fall at a high alpine carbonate peak during its preparation and until failure. In this real case scenario, we can develop and test an operative and effective early warning system.

The main cleft is two to six metres wide at the summit and at least 60 metres deep at the sides. Several lateral cracks are opening at faster pace and separate different instable blocks. 3D-UAV point clouds reveal a potentially failing mass of 260,000 m³ in six subunits. However, the pre-deformation is yet not pronounced enough to decide on the expected volume. Analysis of historical ortho- and aerial images yields an elongation of the main crack length from 10 to 35 m from 1960 until now. Discontinuous tape extensometer measurements show 35 cm opening of the main cleft between 2014 and 2020 with movement rates up to 1 cm/month. Since July 2018, automatic vibrating wire gauges deliver high-resolution data to an online server. In October 2019, we transferred the system into LoRa with data transmission every 10 min. Automatic warnings via SMS and email are triggered when crossing specific thresholds.

Here we demonstrate long-term process dynamics and 2-years of high-resolution data of a preparing alpine rock slope failure. Corresponding geodetic, photogrammetric, seismic and gravimetric measurements complete the comprehensive measurement design at the Hochvogel. This will help to decipher anticipative signals of initiating alpine rock slope failures and improve future event predictions.

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