Submitted Abstract

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Abstract

Deep-seated gravitational slope deformations (DSGSDs) commonly encompass entire slopes from the crest areas to the valley floor and are often accompanied by a series of subsequent processes such as debris flows, landslides, and rockfalls. In most cases, a DSGSD is dissected into several slabs that may have different dimensions and deformation rates. Especially in glacially oversteepened valleys, spontaneous failure events occur in areas relatively close to the valley bottom.

On Christmas Eve in 2017, a rock avalanche with a volume of about 117,000 m^3 occurred in the Vals valley in Tyrol, burying the state road underneath and nearly reaching inhabited houses. The detachment area is located in the lower section of a DSGSD, the Windbichl DSGSD, that covers at least 4.3 km^2 and extends over a height difference of about 1000 meters. Since 2018, the province of Tyrol has been monitoring the detachment area of the Vals rock avalanche using various methods (periodic TLS tachymetric continuous measurements, extensometers), which resulted in about 10-15 mm/year horizontal deformation in the WSW direction and about 14 mm/year of horizontal deformation in the SSW direction with a vertical component of about -4 mm/year.

About 1.5 km east of the 2017 rock avalanche is the Horlicher Wand, a steep to overhanging rock face up to 450 meter high. The Horlicher Wand is also part of the Windbichl DSGSD. In an integrated approach, we analyzed the hazard potential of the entire Windbichl DSGSD with special focus on the Horlicher Wand.

The current state of deformation of the Windbichl DSGSD was assessed by analyzing 2D InSAR Sentinel-1 (2017-2019) in combination with detailed geomorphological mapping. For drone photogrammetry of the Horlicher Wand (2021), semi-automatic kinematic analysis of potential release areas on the rock face was validated with field data and runout simulations with RAMMS: rockfall.

InSAR data indicate vertical displacements of 0.8 cm/year and horizontal displacements of 1.5 cm/year. The 3D model of the rock face shows several unstable and overhanging parts susceptible to rockfall processes. Semi-automatic kinematic analysis identified wedge failure and flexural toppling/falling as main processes, which were also confirmed by field data. To investigate climate impacts, such as extreme precipitation on DSGSD movement patterns, longer InSAR observation time series and a basic engineering geology understanding of the underlying processes must first be investigated to filter possible climatic triggering and the geologic antecedent conditions.