Performance testing of optical flow time series analyses based on a fast, high-alpine landslide

Doris Hermle¹, Michele Gaeta², Michael Krautblatter¹, Paolo Mazzanti², and Markus Keuschnig³

¹Technical University of Munich, Civil and Geo, and Environmental Engineering, Associate Professorship of Landslides, Munich, Germany (doris.hermle@tum.de)
²NHAZCA S.r.l., Rome, Italy
³GEORESEARCH Forschungsgesellschaft mbH, Puch bei Hallein, Austria

Accurate remote analyses of high-alpine landslides are a key requirement for future alpine safety. In critical stages of alpine landslides, UAV (unmanned aerial vehicle) data can be employed, using image registration techniques to derive ground motion with high temporal and spatial resolution. Nevertheless, the classical area-based algorithms, dynamic surface alterations, and limited velocity range restrict detection, which results in noise from decorrelation, preventing their application to fast and complex landslides.

Here for the first time to our knowledge, we apply optical flow time series to analyse one of the fastest and most critical debris flow source zones in Austria. The benchmark site Sattelkar (2'130-2'730 m asl), a steep, high-alpine cirque in Austria, is highly sensitive to rainfall and melt-water events, which led to a 70,000 m³ debris slide event in July 2014. We use a UAV data set (0.16 m) collected over three years (five acquisitions, 2018-2020). Our novel approach is to employ optical flow, which, along with phase correlation, is incorporated into the software IRIS. To test the performance, we compared the two algorithms by applying them to image stacks to calculate time-series displacement curves and ground motion maps. These maps enable us to precisely identify compartments of the complex landslide body and reveal different displacement patterns, with displacement curves reflecting an increased acceleration. Traceable boulders in the UAS orthophotos independently validate the methodology applied. We demonstrate that UAV optical flow time series analysis generates a better signal extraction and a wider observable velocity range, highlighting how it can be applied to a fast, high-alpine landslide.