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Multi-temporal analysis of optical remote sensing for time-series displacement of gravitational mass movements, Sattelkar, Obersulzbach Valley, Austria

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Remote sensing for natural hazard assessment and applications offers data on even vast areas, often difficult and dangerous to access. Today, satellite data providers such as PlanetLabs Inc. and the European Copernicus program provide a sub-weekly acquisition frequency of high resolution multispectral imagery. The availability of this high temporal data density suggests that the detection of short-term changes is possible; however, limitations of this data regarding qualitative, spatiotemporal reliability for the early warning of gravitational mass movements have not been analysed and extensively tested.

This study analyses the effective detection and monitoring potential of PlanetScope Ortho Tiles (3.125 m, daily revisit rate) and Sentinel-2 (10 m, 5-day revisit) satellite imagery between 2018 and 2020. These results are compared to high accuracy UAS orthoimages (0.16 m, 5 acquisitions from 2018-2020). The analysis is conducted based on digital image correlation (DIC) using COSI-Corr (Caltech), a well-established software and the newly developed IRIS (NHAZCA). The mass wasting processes in a steep, glacially-eroded, high alpine cirque, Sattelkar (2'130-2'730 m asl), Austria, are investigated. It is surrounded by a headwall of granitic gneiss with a cirque infill characterised by massive volumes of glacial and periglacial debris including rockfall deposits. Since 2003 the dynamics of these processes have been increased, and between 2012-2015 rates up to 30 m/a were observed.

Similar results are returned by the two software tools regarding hot-spot detection and signal-to-noise ratio; nonetheless IRIS results in an overall better detection, including a more delimitable ground motion area, with its iterative reference and secondary image combination. This analysis is supported by field investigations as well as clearly demarcated DIC-results from UAS imagery. Here, COSI-Corr shows limitations in the form of decorrelation and ambiguous velocity vectors due to high ground motion and surface changes for very high resolution of this input data. In contrast, IRIS performs better returning more coherent displacement rates. The results of both DIC tools for satellite images are affected by spatial resolution, data quality and imprecise image co-registration.

Knowledge of data potential and applicability is of high importance for a reliable and precise detection of gravitational mass movements. UAS data provides trustworthy, relative ground motion rates for moderate velocities and thus the possibility to draw conclusions regarding landslide processes. In contrast satellite data returns results which cannot always be clearly delimited due to spatial resolution, precision, and accuracy. Nevertheless, iterative calculations by IRIS improve the validity of the results.