Chapter 6

Session 5 - Hydrology and Sediment Fluxes in Permafrost Regions

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Five years of monitoring the front slope of the highly active Hinteres Langtalkar rock glacier using terrestrial laser scanning: A case study in the Central Alps, Austria

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The Hinteres Langtalkar rock glacier in the Hohe Tauern National Park (Central Alps, Austria) has been monitored using terrestrial laser scanning during the last years beginning with 2000. The ongoing sliding process and the steepness of the rock glacier front slope prevent standard geodetic measurements as well as surface motion analysis by photogrammetric methods. Long-range laser scanners are able to acquire high-resolution 3D data of surface structures. We report on the sensor and software set-up, the logistics and the procedure for data evaluation for rock glacier monitoring, as well as the results of a long-term monitoring in terms of 3D motion and deformations. It is shown that the system (Laser Scanner LPM2k produced by Riegl Laser Measurement Systems, Austria, combined with software for scanning and data evaluation by JOANNEUM RESEARCH and DIBIT Messtechnik GmbH, Austria) is capable of updating the database for the surface change of the rock glacier within a single day's measurement campaign. Single time-of-flight measurements with distance accuracy of 5 cm are automatically combined to a measurement grid that enables the generation of a dense digital elevation model (DEM) of the rock glacier surface. Repeatable sensor orientation is performed using reflective targets fixed on stable surfaces somewhere in the spherical field of view of the sensor. The differences between DEMs of subsequent measurement epochs are used to describe the 3D surface deformations. In addition matching based on DEM structure allows identifying both global (velocity field distribution) and local (debris flow, other mass movements) effects of creeping permafrost. The results gathered through 5 years of monitoring are presented and analysed. The accuracy gained is within a range of 10cm in elevation. The elevation change varies from -5.0 m to +2.5 m. The obtained results enable the access to high-resolution surface deformation data in all three dimensions. The proposed terrestrial laser scanning method is able to extend, complement and verify state-of-the-art remote sensing strategies for rock glacier monitoring.