Terrestrial laser scanner monitoring and characterization of the Revdalsfjellet rockslide (Northern Norway)

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The fjords in Troms County (Northern Norway) are characterized by deeply incised and steep glacier valleys and plateaus situated at an elevation around 500 and 800 m above sea level. On the eastern flank of Storfjorden several large slope instabilities developed, like the complex rockslides at Nordnes or Revdalsfjellet.

The Revdalsfjellet site is located on the edge of the plateau at an altitude of 670 m. The complex slide area faces towards the NW and is 330 m wide and 175 m deep. Its height and consequently its volume cannot be estimated since the basal failure surface is not visible in the field. The unstable area is delimited by a back-scar towards the SE and by a lateral fault to the NE. D-GPS measurements since 2005 and DInSAR measurements indicate annual displacements of less than 1 cm.

Two terrestrial laser scanning surveys were made in August 2007 and August 2008. The Revdalsfjellet rockslide was scanned from six viewpoints around the main escarpment. The TLS scans were cleaned from unwanted points (vegetation), co-registred and georeferenced using GPS points of the scan locations. The united TLS point clouds (approximately 20 million points) cover the entire accessible and visible area of the site. The average point spacing equals 40 to 45 mm at a mean distance of 100 m between the scanner and the object.

A high-resolution digital elevation model derived from the TLS point cloud was used for a detailed geomorphic analysis of the rockslide plateau, which is detached from the stable surrounding plateau by a 13 to 15 m high, 60° steep back-scar created by past slope movements. The NE-bounding fault and past displacements likely led to higher fracturing of the rock mass and preferential erosion along the fault. This explains the deeply incised, 33 m wide ravine separating the unstable area from the NE-bounding cliff.

The TLS point cloud enabled a structural characterization of the Revdalsfjellet rockslide using the Coltop3D software, which computes the spatial orientation (dip direction and dip angle) for each point with respect to its neighbourhood. The spatial orientation of the major rockslide features, i.e., the back-crack (dip direction/dip angle: 330°/60°), the NE-bounding fault (240°/85°), the foliation (009°/18° on the stable part; 077°/24° on the rockslide) and other discontinuity sets, was obtained. The orientation change of the foliation between the stable part and the displaced area is a further indication of ancient movements.

The comparison between the 2007 and 2008 TLS point clouds did not reveal significant displacements of the Revdalsfjellet rockslide. Given the rather small displacements measured by other techniques (D-GPS and DInSAR) and the precision of TLS comparisons (approximately 3 cm on single measurement points), this result is not surprising. However, filtering and/or interpolation techniques eventually yield better results. New measurements in the coming years should provide more information on the displacements of the Revdalsfjellet rockslide.