



Landslide monitoring using multi-temporal terrestrial laser scanning (TLS) and electrical resistivity tomography (ERT) in the high Arctic, Ny-Ålesund

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The acceleration of climate-induced changes in high arctic environments is evident and lead to a wide range of processes (e.g. glacier retreat, landslide activity). Recent studies (Bernard et al. 2014) provide evidence that, the stability of the talus covered slopes is reducing and thus landslides are occurring more frequently on the slopes surrounding the Austre Lovénbreen glacier.

The Austre Lovénbreen glacier basin is a relatively small arctic glacier basin located at 79°N, Ny-Ålesund (Svalbard) and geologically is part of the Kongsvegen Group, which is composed of the Nielsenfjellet, Steenfjellet and the Bogegga Formation. This study focusses on the quantitative and spatiotemporal identification of shallow translational soil slides (i.e. debris slides, Hungr et al. 2014) originating from the talus-covered slopes of the periglacial valley system.

The assessment of the soil slides on the slopes of the Austre Lovénbreen basin was performed i) by geological field surveys (09/2017, 09/2018), ii) by terrestrial laser scanning (TLS) campaigns measuring more than 300 single laser scans (08/2012, 08/2013, 08/2014, 08/2015, 08/2016, 09/2017, 09/2018), and iii) by electrical resistivity tomography (ERT) in order to perform subsurface investigations (09/2018).

The results provide insights into the slide geometry, thickness, volume, as well as time of formation and deformation behaviour. Data show that since 2012 several soil slides in the range between 500 m³ und 5000 m³ have failed on the steeply inclined (35-42°) talus slopes. In many cases the failure surface was formed at the contact between the talus material and a subsurface ice layer, which is covered by the talus deposits. Interestingly, the ice layers extent up to 100 m above the present-day Austre Lovénbreen glacier surface in the basin. The ice layer was also detectable by previous ground penetrating radar (GPR) studies, and if exposed by slides, also visible by TLS measurements (reflectivity), webcam images and field surveys. The subsurface ice, acting as a failure surface, limits the slide thickness to values between 1 and 5 m.

Concerning trigger mechanisms, rainfall data in combination with the webcam images suggests that the formation of the shallow soil slides is related to intense rainfall events and furthermore to the mass loss of the valley glacier reducing the retaining effect at the foot.

The results contribute to better understanding of recent changes in high arctic landscape systems and may give further indications on future landslide activity in the high arctic.

Bernard, Eric & Friedt, Jean & Saintenoy, Albane & Tolle, Florian & Griselin, Madeleine & Marlin, Christelle (2014): Where does a glacier end? GPR measurements to identify the limits between valley slopes and actual glacier body. Application to the Austre Lovénbreen, Spitsbergen. *Int J Appl Earth Obs Geoinf.* 27:100 – 108.
Hungr, Oldrich & Leroueil, Serge & Picarelli, Luciano. (2014): The Varnes classification of landslide types, an update. *Landslides* 2014, 11:167-94.