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Complex landslide dynamics: analyzing and evaluating high-resolution surface displacements using close range remote sensing techniques

Margherita J. Stumvoll (1), Elmar M. Schmaltz (2), and Thomas Glade (1)

(1) University of Vienna, Department of Geography and Regional Research, Vienna, Austria (margherita.stumvoll@univie.ac.at/ thomas.glade@univie.ac.at), (2) Federal Agency for Water Management, Institute for Land and Water Management Research, Petzenkirchen, Austria (elmar.schmaltz@baw.at)

Hillslope systems are very sensitive to land cover changes, especially regarding changes of the hydro-meteorological subsurface conditions. The systems adaptation to these changes can be observed in e.g. slow-moving landslides. The observation of surface changes of particularly slow landslides in a rather short time scale (e.g. seasonal or few years) is difficult and requires attention in the choice of the observation technique. Multiple studies investigated the efficiency of different remote sensing techniques in landslide observation, but only few focussed on the assessment of slow moving and complex landslide processes.

In this study, we aim to detect the surface changes of the complex Hofermühle-Landslide near Konrad-sheim in Lower Austria by comparing and combining three methods of remote sensing techniques: 1) Analysis of Terrestrial Laser Scanning (TLS) point clouds; 2) Structure from Motion (SfM) from aerial photographs recorded with Remotely Piloted Aircraft Systems (RPAS); and 3) Observations of spatially distributed Ground Control Points (GCP) on the landslide area with a Differential Global Positioning System (DGPS). The generated landslide surfaces of all methods ($\sim$ 10 TLS campaigns, 6 UAV campaigns, 10 DGPS campaigns) are then compared for the different time periods of recording within a total observation period of 4 years (2015 to 2018), in order to detect hotspots of surficial changes and to compute movement rates. Further, we analyse, which method provides the highest accuracy and whether a combination of methods provides a more reliable generation of the hillslope surface and how these different models determine any analysis of surface changes.

The first results indicate that the landslide movements can be distinguished to a retreat of landslide scarps but also subsidence in a larger extent of a major part of the hillslope that indicates rather subsurface activity. In order to interpret the findings in a more accurate way, surface retreat rates and detected subsidence have to be quantified based on the three observation methods applied in this study. Nevertheless, our first results suggest a coupled complex movement of the entire landslide system, which most likely arises from past land cover changes (deforestation) and/or the current grassland cover, leading to lower interception and thus higher infiltration rates with subsequent water percolation into potential shear surfaces. In this regard, remote sensing techniques are limited to ensure a detailed interpretation of the landslide development with its interrelation between surface and subsurface movement. Therefore, we postulate that further research should focus on the assessment with additional information about the hydrological behaviour of the hillslope, e.g. by permanent hydrological monitoring.