Geophysical Research Abstracts
Vol. 20, EGU2018-12698, 2018
EGU General Assembly 2018

Landslide monitoring using multi-temporal surface and sub-surface measurement techniques – embedding quantitative data into theoretical landscape development concepts

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Evaluating the interrelation of preparatory factors (predisposition and variable disposition) and thresholds (intrinsic and extrinsic) required to initiate landslide processes is one of the main goals in landslide research. To improve our perception of landscape development the embedment of recent processes into larger spatio-temporal scales, the consideration of feedback dynamics and parameter interdependencies is essential. This especially holds true considering the possible prediction of future landslide dynamics. Long-term landslide monitoring projects collecting high resolution quantitative data aim to expand the spatio-temporal scale of single events to acquire a more realistic process-based understanding.

Within this study different types of landslide processes (namely shallow and deep seated slides/ earth flows/ rock and block falls/ process combinations) are examined on a long-term basis via a combination of different surface and subsurface investigation techniques. The monitoring sites are utilized to evaluate advantages and disadvantages of these different techniques. Regarding sliding processes, direct (dynamic probing/ drilling/ mapping) and indirect methods (electrical resistivity tomography) are used to examine and observe internal structures. Slope dynamics are evaluated by means of sub-surface (e.g. inclinometer, tensiometer) and surface data (e.g. mapping campaigns, terrestrial laser scanning TLS, GPS). To correlate sliding dynamics with hydro-meteorological parameters, surface (weather station) and sub-surface (TDR's/ piezometer) values are recorded. Regarding rock and block falls, rates and volumes are evaluated with multi-temporal TLS data and DoDs (DEMs of difference).

The study sites are located in the southwestern part of Lower Austria in the geological unit of the (Rhenodanubian) Flysch Zone (noeslide.at). Due to its specific lithological characteristics (high clay content/ deeply weathered) the Flysch Zone exhibits the highest density of landslide events throughout Austria. This being the most influential preparatory factor, anthropogenic impact regarding both geomorphological as well as climatological factors – changing over time - have to be taken into account as variable disposition factors.

Here we present the first results of the monitoring outcomes. Data acquired so far on the structural composition of the different landslide types (slide/ flows/ falls), their dynamics and the correlation with hydrological cause variables (e.g. precipitation/ infiltration/ weathering) is analyzed with respect to the questions i) which kind of preparatory factors are most important regarding which process, ii) whether there are correlations with extrinsic thresholds such as precipitation and if yes, iii) how these correlations are defined and iv) whether – based on this - statements can be made about future dynamics.

In the future, main objective of this study will be to incorporate quantitative data and theoretical concepts of landscape development through embedding short term measurements and analysis results into a larger spatio-temporal scale.