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Analysis of movement rates and their association with precipitation and snow melt patterns: an example from the Corvara landslide, Italy

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Landslides constitute serious geohazards in many hilly and mountainous regions and pose an important landscape-forming process in South Tyrol, Italy. It is well recognized that water influx, originating from precipitation or snow melt, represents a crucial preparatory and triggering factor of slope instability. Therefore, various attempts have been made to examine rainfall and snow melt patterns to identify critical thresholds for landslide occurrence (regional scale) or landslide behavior (local scale).

This study focused on a single large (1.69 km2) and complex earth slide – earth flow located in the Italian Dolomites (Corvara, South Tyrol), which shows surface displacement rates of a few cm/a in the accumulation zone up to several m/a in the most active parts of the track and source zones. The main aim of this research was to gain deeper insights into the spatio-temporal movement patterns of the Corvara landslide. The investigation focused on (i) the analysis of time-series data (2013 – 2018) derived from differential global navigation satellite system (DGNSS) measurements at 16 GPS stations and on (ii) the assessment of statistical relationships between measured velocity rates and selected cumulative time windows (n=19; from 3 days to 3 years) of antecedent precipitation and snow melt.

The results indicate strong variations of the movement rates in space and time with a slight decrease in measured landslide velocities over the years. Neighboring GPS stations tended to move simultaneously (i.e. higher correlations of movement rates (up to 0.9) among nearby stations) while no seasonality in landslide behavior was detected. In most cases, only weak to moderate correlations ($\sim$ 0.05 – 0.44) between velocity rates and cumulative antecedent precipitation were identified. No geomorphically meaningful associations were found by correlating measured movement rates with snow melt patterns.

In summary, the present research revealed that the movement of the Corvara landslide is complex in space and time and does not follow a clear seasonal pattern. The analysis provided valuable evidence that the spatio-temporal behavior of the Corvara landslide cannot be explained (or even predicted) by scrutinizing time series of surface data (GPS, rainfall and snow cover). Deeper insights into the past and current process dynamics might require intensive surveys of the spatially heterogeneous and highly variable subsurface conditions.