Agglomerative hierarchical cluster method to analyze landslide displacements and assess risk scenarios

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In the Rotolon catchment (eastern Italian Alps) a large Deep-seated Gravitational Slope Deformation (DGSD) induces secondary phenomena that are threatening the local population. In 2010 a mass of 340.000 m^3 detached from the frontal part of the DGSD and then flow into the draining channel in the form of a debris flow, damaging a bridge and almost over-flooding, endangering the houses located 3 km downstream. For this reason, an Automated Total Station (ATS) has been installed in 2012 to monitor surface displacements so as to identify the most active regions of the slope in order to estimate the volume of material that could be mobilized in the next paroxysmal event and to assess the related risk. 42 benchmarks (5 stable control points and 37 on the active slope) have been monitored for two periods: the first one of 22 months between 2012 and 2014 and the second one for 12 months between 2015 and 2016. Analyzing the time series of displacements with the agglomerative hierarchical cluster method calculated with a simple single linkage algorithm, groups of similarly moving benchmarks have been clustered. For these groups the trend of acceleration and deceleration of displacements follows similar patterns. Even though the methodology does not take into account the position of the benchmarks, matching patterns are found in contiguous benchmarks within the groups, thus confirming the effectiveness of the approach. The possibility to identify areas with homogeneous behavior is fundamental to delineate the volume of possible new debris flow phenomena and therefore to produce reliable risk scenarios.