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Highlighting landslides and other geomorphological features using sediment connectivity maps

Giulia Bossi, Stefano Crema, Marco Cavalli, Gianluca Marcato, and Alessandro Pasuto
CNR-IRPI, National Research Council of Italy, Research Institute for Geo-Hydrological Protection, Padova, Italy
(giulia.bossi@irpi.cnr.it)

Landslide identification is usually made through interpreting geomorphological features in the field or with remote sensing imagery. In recent years, airborne laser scanning (LiDAR) has enhanced the potentiality of geomorphological investigations by providing a detailed and diffuse representation of the land surface. The development of algorithms for geomorphological analysis based on LiDAR derived high-resolution Digital Terrain Models (DTMs) is increasing. Among them, the sediment connectivity index (IC) has been used to quantify sediment dynamics in alpine catchments. In this work, maps of the sediment connectivity index are used for detecting geomorphological features and processes not exclusively related to water-laden processes or debris flows.

The test area is located in the upper Passer Valley in South Tyrol (Italy). Here a 4 km2 Deep-seated Gravitational Slope Deformation (DGSD) with several secondary phenomena has been studied for years. The connectivity index was applied to a well-known study area in order to evaluate its effectiveness as an interpretative layer to assist geomorphological analysis. Results were cross checked with evidence previously identified by means of in situ investigations, photointerpretation and monitoring data.

IC was applied to a 2.5 m LiDAR derived DTM using two different scenarios in order to test their effectiveness: i) IC derived on the hydrologically correct DTM; ii) IC derived on the original DTM.

In the resulting maps a cluster of low-connectivity areas appears as the deformation of the DGSD induce a convexity in the central part of the phenomenon. The double crests, product of the sagging of the landslide, are extremely evident since in those areas the flow directions diverge from the general drainage pattern, which is directed towards the valley river. In the crown area a rock-slab that shows clear evidence of incumbent detachment is clearly highlighted since the maps emphasize the presence of traction trenches and reverse slope.

In the second scenario, rockfall activity is more evident since the collapse path induces scars in the slope that locally are identified as flow paths, moreover the presence of the block remnants creates an obstruction (i.e. a sink) for the algorithm. On the other hand, the presence of a smaller rotational landslide at the toe of the DGSD is more detectable in the map derived from the first scenario that shows a rapid change in slope together with a high drainage concentration.

An integrated approach that assists the geomorphologic analysis based on aerial images and shaded relief maps with an IC map has proven to be a valuable tool as it allows to highlight different gravitational processes.