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Geomorphic change detection in small Alpine basins using LiDAR DTMs

Beatrice Goldin (1), Marco Cavalli (1), Francesco Comiti (1), and Lorenzo Marchi (2)

(1) National Research Council, Research Institute for Geo-Hydrological Protection, Padova, Italy (beatrice.goldin@irpi.cnr.it), (2) Faculty of Science and Technology, Free University of Bozen-Bolzano, Bolzano, Italy

Morphological change evaluation of earth surface is an important task in environmental monitoring. Methods devoted to the assessment of geomorphic changes can be used to identify geomorphologically unstable areas, to quantify processes intensity and to compute sediment budgets. Digital elevation models (DEMs) built from repeated topographic surveys can be used to produce DEM of Difference (DoD) maps and to estimate volumetric changes through time. Nowadays LiDAR technology provides digital models representative of the bare earth surface (Digital Terrain Models – DTMs) at high spatial resolution and over large spatial extents, thus contributing to the increase of accuracy of morphometric and volumetric measurement of varying surfaces.
In this study, high-resolution DTMs derived from airborne LiDAR data acquired in different years (2006 and 2011) were used in order to characterize sediment transport processes such as debris flows and bedload transport in two small Alpine basins. Two DTMs (2 m resolution) were derived for the Gadria and Strimm catchments (Vinschgau-Venosta valley, Autonomous Province of Bozen-Bolzano, Italy). These basins, which cover, respectively, areas of 6.3 and 8.5 km^2, have been chosen due to their contrasting morphology and because they feature different types and intensity of sediment transfer processes: Gadria channel is characterized by frequent occurrence of debris flows (almost one debris flow per year), whereas Strimm is essentially a bedload stream. A method based on fuzzy logic (Wheaton et al., 2010), which takes into account DTM uncertainties, was used to derive the DoD of the study area. The comparison between the 2006 and 2011 DTMs permitted the assessment of morphometric changes at the basin scale over the 5 yrs period. The results of DoD analysis are consistent with field observations of erosion and sediment transport. Besides, the DoD proved useful to identify the relationship between erosion, deposition or no-change areas and geomorphometric parameters (e.g. slope, curvature, upslope area) relevant for topographic evolution of the landscape.

References: Wheaton J.M., Brasington J., Darby S. E., Shear D. A., 2010. Accounting for uncertainty in DTMs from repeat topographic surveys: improved sediment budges. Earth Surface Processes and Landforms, 35, 136-156.