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Automatic measurement of bankfull widths from high resolution LiDAR DTMs: a new tool to analyze the link between hydraulic and morphological variables

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The study of the morphological characteristics of rivers and of their degree morphological alterations is a basis for a proper management of mountain watershed, and the availability of detailed topographic data is a key tool. Channel geometry and stream flow are interrelated and mutually interact with each other to create the morphology of a river system, and the dimensions of the bankfull channel. However, determining bankfull is not often a simple exercise particularly where the channel or watershed have been modified or the channel is unstable. The evaluation of channel geometry variability determined by hydrodynamic and geomorphological processes is usually reached through field surveys, or through visual interpretations of digital orthophotos. However these two approaches are challenged respectively by the inaccessibility of the areas under analysis, and by time and financial constraints, and by an unsufficient accuracy. It is therefore strategic to adopt new and more accurate methods to estimate channel geometries, based on the availability of high-resolution Digital Terrain Models (DTMs), such as the one derived from airborne laser scanner (LiDAR). In mountain areas many studies have explored the potential of LiDAR DTMs for the proper characterization of the network and the objective of this study is to highlight their potential in the automatic determination of values representative of bankfull widths.
The analysis is based on a topographic index (Elevation Percentile - EP) used to measure the variability of the elevation: channelized areas have EP values greater than convex areas. Values of EP are read along cross sections perpendicular to the thalweg, and by applying a statistical threshold to the EP it is possible to obtain the potential channel width at each point of the network. The geometries derived from this map are approximated due to the resolution of the DTM, but they show a good agreement with those detected in the field, with low values of RMSE, and the range of the estimated values is compatible with the surveyed ones. Relationships between bankfull channel dimensions (field-measured and automatically extracted) and their associated drainage areas are established and compared for some colluvial and alluvial channels, underlining how the high number of data obtained automatically from the DTM allows to have a support tool to analyze in detail the geometry of the channels, without the usual cost and time constraints associated with traditional field measurements