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DEM-based Approaches for the Identification of Flood Prone Areas

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The remarkable number of inundations that caused, in the last decades, thousands of deaths and huge economic losses, testifies the extreme vulnerability of many Countries to the flood hazard. As a matter of fact, human activities are often developed in the floodplains, creating conditions of extremely high risk.
Terrain morphology plays an important role in understanding, modelling and analyzing the hydraulic behaviour of flood waves. Research during the last 10 years has shown that the delineation of flood prone areas can be carried out using fast methods that relay on basin geomorphologic features. In fact, the availability of new technologies to measure surface elevation (e.g., GPS, SAR, SAR interferometry, RADAR and LASER altimetry) has given a strong impulse to the development of Digital Elevation Models (DEMs) based approaches. The identification of the dominant topographic controls on the flood inundation process is a critical research question that we try to tackle with a comparative analysis of several techniques.
We reviewed four different approaches for the morphological characterization of a river basin with the aim to provide a description of their performances and to identify their range of applicability. In particular, we explored the potential of the following tools. 1) The hydrogeomorphic method proposed by Nardi et al. (2006) which defines the flood prone areas according to the water level in the river network through the hydrogeomorphic theory. 2) The linear binary classifier proposed by Degiorgis et al. (2012) which allows distinguishing flood-prone areas using two features related to the location of the site under exam with respect to the nearest hazard source. The two features, proposed in the study, are the length of the path that hydrologically connects the location under exam to the nearest element of the drainage network and the difference in elevation between the cell under exam and the final point of the same path. 3) The method by Manfreda et al. (2011) that suggested a modified Topographic Index (TIm) for the identification of flood prone area. 4) The downslope index proposed by Hjerdt et al. (2004) that quantifies the topographic controls on hydrology by evaluating head differences following the (surface) flow path in the steepest direction. The method does not use the exit point at the stream as reference; instead, the algorithm looks at how far a parcel of water has to travel along its flow path to lose a given head potential, d [m]. This last index was not defined with the aim to describe flood prone areas; in fact it represents an interesting alternative descriptor of morphological features that deserve to be tested.
Analyses have been carried out for some Italian catchments. The outcomes of the four methods are presented using, for calibration and validation purposes, flood inundation maps made available by River Basin Authorities. The aim is, therefore, to evaluate the reliability and the relative errors in the detection of the areas subject to the flooding hazard.
These techniques should not be considered as an alternative of traditional procedures, but additional tool for the identification of flood-prone areas and hazard graduation over large regions or when a preliminary identification is needed.

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