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Solid transport in mountain rivers: monitoring techniques and long term assessment as flood prevention tools

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Floods are calamitous phenomena with an ever-increasing frequency around the globe, that often result in socio-economic damage and casualties. The role of the solid fraction in the river dynamic has been widely debated in the last decade and its importance is recognized as critical and not negligible in flood simulations as it has been evidenced that the severity of an event is often the result of the coupling of a flood wave with elevated solid transport rates. Nevertheless, assessing the quantity of sediment mobilized in a particular event is not feasible without a long term analysis of the river's dynamics and its morphological evolution since it is defined by past events. This work is focused on the techniques to improve knowledge about sediment production and transport through hydrological networks as a necessary component of a wise flood prevention planning.
In particular, a multidisciplinary approach that combines hydraulic and geological knowledge is required in order to understand the evolution of the river sediment and how it will influence the following critical event.
The methods are presented through a case study in Italy where a series of different approaches have been integrated to gain a comprehensive understanding of the problem: the sediment movement has been studied by a Eulerian as well as a Lagrangian approaches while hydraulic properties of the stream have been measured. The research started with an attempt to monitor sediment movements: in June 2016 300 sample pebbles, equipped with RFID (Radio Frequency IDentification) transponders, have been deployed in the river and tracked after every major rainfall event. The obtained data-set has been combined with a morphological analysis and a river flow discharge computed through PIV (Particle Image Velocimetry) method in order to identify the relation between a given rainfall event and sediment transport.
Moreover, critical sediment size has been estimated from field data using three approaches: two experimental performed in situ and one analytical using hydraulic modelling. A good correlation between the results of these approaches has been obtained, while the results of the solid transport analysis suggest that the migration of sediments appears to be affected to a large extent by the river bed morphology in addition to the physical properties of the pebbles.
Finally, a control section has been set up in a sedimentation basin which limits the further sediment migration to the downstream end of the river. Therefore, it was considered the perfect point to measure the final solid discharge of an event. Several bathymetric campaigns have been carried out to assess the gross quantity of material discharged in the pool. The use of a wireless Eco sounder has been tested along with a conventional GPR (Ground Penetrating Radar) in order to investigate the applicability of a low-cost tool for bathymetry survey in a fast and reliable way.