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On sediment transport modelling in mountain environments

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The transport of sediments within river basins involves a number of processes, from sediment production on the valley slopes, to sediment yield into the water courses, to final fluvial export. All these processes take place over a variety of spatial and temporal scales, posing significant limitations to the possibility to properly model the entire phenomenological chain. Despite the latter may be neglected if sediment conveyance at a certain section is the key result (as may be, for example, in studies of reservoir silting), modelling on-site processes requires by contrast a more space-detailed analysis. For example, flood-induced sediment transport may cause significant degradation or aggradation of the river bed, possibly leading to structure damage on one hand or to increased water levels on the other one.

The perspective taken in this work was indeed related with the large variations on bed elevation that may be expected during a single flood event. Therefore: only short terms were considered; an analysis of the estimated sediment yield from the slopes was necessary as proper boundary condition for the following migration in the water course; the evaluation of the morphologic evolution of the river was needed with suitable spatial resolution for individuation of specific reaches with largest aggradation or degradation. A comprehensive modelling was attempted with reference to the Rossiga valley, a 3.5 km2 basin located in northern Italy at an average altitude of 1200 m AMSL. Three large landslides are present in the downstream part of the catchments. The modelling involved: (1) estimation of the total rainfall for assigned return period and duration equal to runoff time by means of intensity-duration-frequency relationship; (2) evaluation of the flow hydrograph at a certain section of the river; (3) sediment yield to the same section, evaluated by MUSLE method for the contribution due to soil erosion and by empirical formulae for that due to the landslides; (4) modelling of the morphologic evolution of the river bed by a coupled Saint Venant – Exner approach. The most important feature of the modelling was that, though roughly, it tried to incorporate several relevant phenomena into a single chain.

In the absence of any monitoring system on the river site, results could not be directly validated, apart from a comparison with records of one past event. On one hand, the modelling performed here showed that extensive research is necessary for better prediction of each process involved. On the other hand, the whole chain is likely needed for engineering purposes. Therefore, the findings were discussed focussing onto (i) the feasibility of a joint modelling like that presented, in light of all the limitations imposed by the different nature of slope-devoted and river-devoted models and of the consequent incomplete interface between the first and the second ones; (ii) the sensitivity of the obtained results to some parameters, for an assessment of the reliability of the results within an uncertainty compatible with technical requirements.