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Hydro-geological process chain for building a flood scenario

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Flash-flood events in mountain environments are often related to the transport of large amounts of sediment from the slopes through the stream network. As a consequence, significant morphological changes may occur in rivers during a single, short-duration event, with possibly significant effect on the water elevation. An appropriate hazard evaluation would therefore require the thorough modelling of the flood-related phenomena and of their interconnection.
In this context, this work is focused on an attempt of integrated modelling of event-scale water and sediment transport processes for a reference case-study of the Mallero basin in the Italian Alps. The area of the catchments is about 320 square km, the main stream being almost 25 km long and having slopes in the range from 1 to 40 %. A town (Sondrio) is present at the downstream end of the river. In 1987, Sondrio was at risk of inundation due to a combined effect of relatively high discharge and aggradation of the river bed up to 5 m (almost equal to the bankfull depth in the in-town reach).
A 100-year flood scenario was produced including (i) a sediment supply model, (ii) a one-dimensional, hydro-morphologic model of the river bed evolution, and (iii) an estimation of the outflowing discharge at river sections where the bank elevation was exceeded by water. Rainfall-runoff transformation was not included into the modelling chain as the 100-year water hydrograph was already available from previous studies. For the sediment production model, a downscaling in time of the Gavrilovic equation was attempted using rainfall estimation from depth-duration-frequency curves, which furnished values in reasonable agreement with some available data. The hydro-morphologic model, based on the Saint-Venant and Exner equations, was preliminarily calibrated against data for bed aggradation measured in 1987. A point of separation was chosen at an appropriate location in the basin, and the sediment yield estimated upstream of this point was used as an upstream boundary condition for the hydro-morphologic model, under a simplifying hypothesis of process separation that would be later discussed. Particular attention is indeed necessary when dealing with the interface between the geologic and hydraulic processes, where models lack consistency between their respective spatial and temporal scales. Uncertainty was dealt with by sensitivity analysis.
Modelling results are discussed in terms of the validity of the separate models as well as of the approach for their integration. In general, the importance of antecedent conditions of the river reach is highlighted, which suggests to apply long-term analysis prior to short-term modelling of the event.