MODELLING UNSTEADY FLOW OVER MOVABLE BED IN MOUNTAIN STREAMS

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Abstract
The research presents a 1D finite volume model for the solution of the Shallow Water equations coupled with sediments dynamics, in channels with irregular geometry. The main features of the model are as follows:
• Well balanced numerical scheme: steady states are correctly reproduced up to the 2nd order of accuracy.
• Implementation of different Riemann solvers: Roe solver (Roe, 1981) and Osher solver (Engquist and Osher, 1981)
• Coupled solution of solid and liquid phases dynamics: accurate modelling of abrupt transitions in flow and bedload transport conditions.
• Implementation of different boundary conditions.
• Capabilities of modelling fixed bed reaches within movable bed streams: modelling of interactions between concrete structures and sediments dynamics (culverts, inline structures etc.).
The proposed model has been applied to the Fosso del Frantoio, a mountain stream located in the town of Mulazzo, Northern Tuscany, Italy. The area was hit by a major flood on Oct 25th, 2011 and it suffered severe damages. The employment of the model for the post-flood restoration project allowed the assessment of interactions between the morphodynamics of the river during extreme events and the designed structures for protection.
A reliability assessment of the structures efficiency has been performed, that is, a “classical” evaluation of water levels during extreme events coupled with the estimation of river bed elevation changes. With this approach, potential risks associated to intense bedload transport, such as sediments filling of manufacts, excessive erosion or deposition and the efficiency of inline structures (silt-check dams) can be evaluated.
The whole process led to an enhanced design of hydraulic repairs and to a better allocation of public money needed to alleviate the hydraulic risk in the area.