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Flood Propagation and Breach Evolution Coupled Model

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A 1-D flood propagation model and a breach evolution model have been combined to create a coupled flood-breach model that can be used either as an analysis or a prediction tool. The flood wave propagation is carried out by a fixed bed mathematical scheme built on an original formulation of shallow water equations. The main feature of the proposed formulation is the elimination of the direct influence of local bottom slope on the numerical solution, which translates in a computational stability incensement and in an application field enlargement. As a confirmation of the achieved versatility, the mobile bed breach evolution scheme is also based on the proposed form of shallow water equations, combined with a solid mass continuity relation. The whole model is numerically implemented with the MacCormack numerical scheme. The proposed breach evolution model is characterised by the homogeneous treatment of the system composed by the upstream reservoir, the breach channel and the downstream reach, which differs from the most breach models available in the scientific literature. The whole system is in fact handled with the balance equations, without using specific flow relations or internal boundary conditions, as, for example, the weir flow hypothesis on the breach entrance and the reservoir level linking by means of a simple mass continuity equation. Moreover, the breach evolution is related only to the flow regime and to the ground geotechnical characteristic, without bounding a priori its shape or longitudinal slope. In this work, the presented model is applied to the 1990 Reno flood and levee breakage reproduction and analysis. During this flood event, a piping initiated failure lead to the levee collapse and to the consequent countryside inundation on the downstream Reno reach. Damages entity was however reduced by the action of a transversal barrage located a few kilometres upstream the breach site. This barrage, named Opera Reno, has the function to reduce the Reno flow on the

downstream reach, by deviating a discharge part into an artificial channel named Cavo Napoleonico, which brings it to the river Po. In the course of the examined episode, the Opera Reno weir gages have been completely closed, following the alarm spread at the moment of the piping initiation sighting. This action considerably reduced the later breach development, but at the same time severely tried out the Cavo Napoleonico levees stability, requiring a consistent maintenance work after the event passing. The presented work has not only the aim to reproduce the flood and breakage event, but also to analyze the role of the barrage protection operation. In particular, the research will be concentrated on the hypothesis of a partial Opera Reno weir gages closure, in order to reduce the structural damages on the Cavo Napoleonico channel slopes, without increase the inundation damages at the breach site.