CONSERVATIVE SCHEME FOR NUMERICAL MODELING OF FLOW IN NATURAL GEOMETRY

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A numerical model is proposed to compute one-dimensional open channel flows in natural mountain streams involving steep, non-rectangular and non-prismatic channels and including subcritical, supercritical and transcritical flows.

The governing equations system is written in a conservative form and a resourceful reformulation of the source terms related to the channel topography allows to precisely balance the mass and momentum fluxes following the recent significant progress obtained by Schippa and Valiani (2002) and Capart et al. (2003).

The mathematical model is numerically integrated by means of an explicit finite volume scheme employing a predictor-corrector method.

The present method does not require the solution of the Riemann problem at each cell interface, the comprehension of the eigenvalues structure of the conservation laws and doesn't need any special additional correction to capture discontinuities in the solution.

The proposed numerical scheme is tested with various benchmark problems, including the idealized dam-break problem in a rectangular channel with dry and wet bed and the simulation of a flood wave in a real natural mountain channel, represented by the Versilia River in Tuscany (Italy) on a 8000 m long reach discretized by the topographical survey cross sections with a strong nonuniform grid ranging from 2 m to 264 m.

The numerical model shows good performances in all the various verification tests. The comparisons between numerical results and exact solutions reveal the scheme is stable, accurate, non-oscillating and monotone in the idealized dam-break problems with dry and wet bed (Fig. 1). Moreover the scheme results sufficiently robust to simulate a flood wave in a real river with irregular cross sections, strong nonuniform grids and several transcritical flows (Fig. 2).

Further developments are in progress to improve the treatment of sediment transport and mobile bed.

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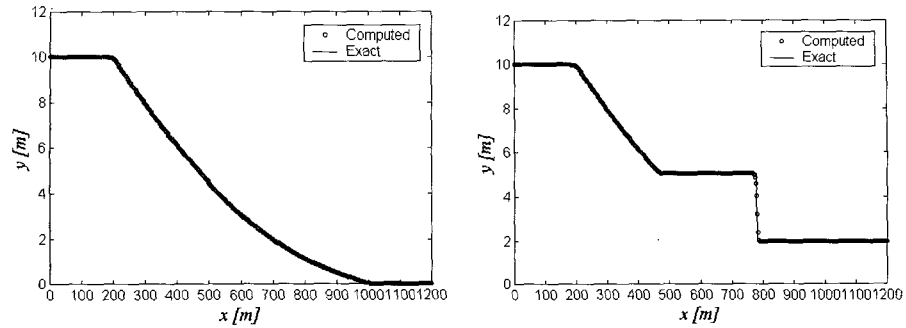

Fig. 1 Numerical solutions of dam-break problem in a horizontal, rectangular channel with no bed friction: (a) water surface profile with dry bed; (b) water surface profile with wet bed.

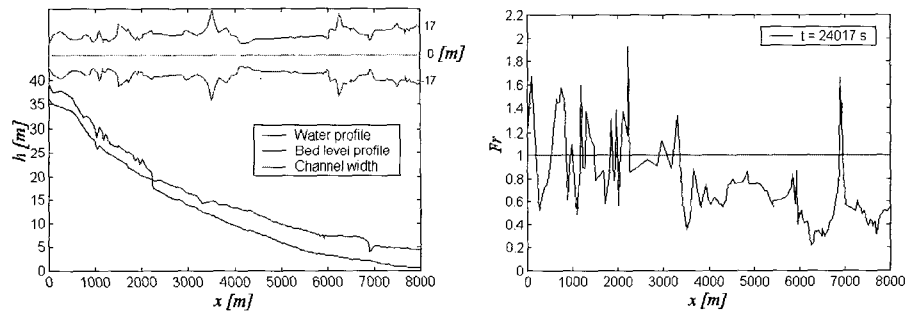

Fig. 2 Unsteady Flow in the Versilia River at t = 24017 s: (a) bed level profile and computed water level profile and water surface width variations; (b) Froude number profile along distance.