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The 2D diffusive shallow water model: validation against experimental data and integration with a 1D module to simulate a meandering river expansion.

P. Prestininzi

pprestininzi@uniroma3.it - Dipartimento di Scienze dell Ingegneria Civile, Università Roma Tre, Via Vito Volterra 62 - 00146, Rome, Italy, phone number +390657333417, fax number +390657333441

Extreme hydrologic events are increasingly investigated and numerically simulated by means of complete 2D Shallow Water Equations. While the effectiveness of this conceptual model has been proven several times, its numerical integration needs accurate schemes that still require an amount of computational effort. The use of less accurate numerical methods does not justify the complexity of the full dynamic SWE model as they lower the overall correctness of the prediction. An approximation of the full SWE consists in neglecting the inertial terms, degrading the original hyperbolic to a parabolic model (PSWE). The effects of such a choice on simulating real flood events are still not clear. Several conclusions are drawn in this work investigating the behaviour of the PSWE compared to experimental data taken from the Toce physical model (CADAM project). It resembles a dam break event in a steep valley, in which many transitions across critical flow together with multiple reflections occur and whose dynamic is not fully described by the PSWE model. Analysis of results allows to state that the parabolic approximation, even if it fails to reproduce some local phenomena such as high frequency oscillation, bores and run-up, is capable to simulate the propagation of such an impulsive wave over complex topography. The model is able not only to predict the general development of the event, but also to describe inundation arrival times, water levels' distribution and local peak values with precision comparable to other full dynamic numerical models on most parts of the domain. This is due to both the parabolic assumption, which intrinsically allows an easier treatment of wet–dry interfaces, and to the numerical scheme, which adequately deals with such transitions. This can be stated in view of the high impulsiveness of the considered test case. Local discontinuities are proved to have a small influence on the overall dynamic of the event: the application of models which make use of some approximations of the underlying physics is thus justified, and enforced by the minor computational effort they require. This analysis suggests that the PSWE model may effectively reproduce the principal features of an inundation event, even in cases - such as the one examined - for which the diffusive approximation may seem unrealistic.
A numerical analysis of a flood event in a meandering reach of Tiber River (Italy) is proposed as well. The study is aimed at assessing the effects induced by the construction of a complex road infrastructure on the floodplain inundation. The 2D PSWE model is linked to a 1D full dynamic module to properly and efficiently simulate both the riverbed and the floodplain flow and to correctly account for complex flow exchanges. This numerical approach allows a quantitative examination of different scenarios and proves to be an effective tool in the decision process within an infrastructure design framework.