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Evaluating a novel 2D hydro-morphological modelling approach for a rapid estimation of flood extent and water depth: the REFLEX model.

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Nowadays many hydraulic models are available in literature with different numerical implementation of mathematical simplification of Navier-Stokes equations. However, it is difficult to find a suitable model which is both slim to reduce computation time and versatile to allow a rapid estimation of flood hazard at multiple locations. Most of the traditional hydraulic models requires in fact a dedicated effort to be initialized over a particular basin.
In the present study we present an innovative 2D hydro-morphological model, called REFLEX (Rapid Estimate of FLood EXtent), developed for a rapid identification of flooded areas of major rivers. The REFLEX model is an expansion of the HAND approach (Nobre et al., 2011), designed as a reliable and slim tool able to provide rapid inundation mapping, constraining the possible geo-morphological flood extent with the available flood volume. Several applications of REFLEX are possible: i) on-the-fly estimate of water depths from breach/overtopping outflow; ii) linkage to an hydrological chain to implement a large-scale (country to continental level) operational flood early warning system; iii) water depth estimation from satellite-derived flood extent maps.
The REFLEX model starts from an initial streams and basins delineation derived from a DEM. The Strahler method is then used to order each stream and corresponding sub-basin. Concerning the floodplain delineation, the Height Above the Nearest Drainage (HAND) methodology is adopted to derive from topography the relative soil gravitational potentials. A HAND map is created for each river order, starting from the lowest one. Finally flood extent and depth information are derived for each sub-basin merging sequentially the HAND maps, using an optimised flood water stage resulting from a water balance between the volume underlying the HAND maps and the flooded water volume. In an operational chain setting, the input flooded volume can be estimated in real-time from an hydrological or 1D-hydraulic model.
The limitations on floodplains, where the grid-based watershed delineation is more delicate, have been solved implementing the D-infinity approach, in order to increase the level of dispersion of flow direction over flat areas, and developing a coastal expansion methodology able to attribute the pixels falling outside of the main watershed to the nearest, and most coherent, basin.
In order to validate the REFLEX model a preliminary comparison of the results obtained over a surveyed basin in Northern Italy has been conducted. The aim of this study is to evaluate the results of this simplified flood modelling approach with respect to different geo-morphological models, fully-2D models and observations acquired during historical flood events.