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Coupling hydrologic and hydraulic modelling for reliable flood risk mitigation activities in the Upper-Medium Tiber River basin

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In view of the recent and serious flood events occurred in latest years in Italy, the interest towards accurate methodology for the evaluation of flood prone areas is continually increasing. In particular, this issue is related to urbanization planning activities, civil protection actions (e.g. hydraulic risk warning systems), and the assessment of hydraulic engineering structures behaviour during severe hydrometeorological conditions. In Italy, following the publishing in the late 90's of many laws and regulations concerning hydraulic risk assessment matters, a widespread flooding areas mapping have been carried out (Italian Basin Authorities "PAI" plans). In case of limited availability of historical peak flow data, the flood prone areas estimation was based on the application of hydrologic and hydraulic modelling separately. Moreover, the recent directive 2007/60/EC on the assessment and management of flood risks requires from each member state: preliminary flood risk assessment (within December 2011), flood hazard maps and flood risk maps (within December 2013), flood risk management plans (within December 2015).

In order to prevent and control flood events in medium-small river basins (e.g. Upper Tiber River basin, Central Italy), the use of hydrologic models coupled with hydraulic ones can be a valuable tool also for real time applications, such as flood risk mitigation and warning activities of the Italian National Warning System Network (composed by regional "Functional Centres" coordinated by the National Civil Protection Department).

In this context, two significant flood events occurred in November 2005 and December 2008 in the Umbria Region territory were considered. In this area a hydrometeorological network, characterized by a high temporal and spatial resolution, is operating in real time. Different coupled models were considered to reproduce the selected events, in order to test and compare their reliability and efficiency. Specifically, two semi-distributed models (MISD model and HEC-HMS model) and two hydraulic models (DHI-MIKE11 and HEC-RAS) were chosen and applied in the Tiber River at Monte Molino section (5270 km2). After the calibrating procedure, the models were used to produce floodplain maps and then for the delineation of dynamic flood hazard and risk scenarios, useful for real-time risk management.

The proposed calibration procedure was found to be characterized by a strong reliability due to the fact that a lot of information are available for the two chosen events. In particular, there were detailed hydrometeorological data, such as rainfall records in most of the pluviometric stations located in the basin and hydrometric levels collected in more than one point along the main channel reach. Moreover, from the local "territorial presidium" it was possible to collect non-instrumental information, such as the number and location of embankment failures and other direct observations. Lastly, for these events remote sensing observations of actual flooded areas were also available. Together with hydrometric recorded levels and computed discharges (disposing of reliable rating curves yearly controlled), these last information were extremely useful during the calibration process.

Final results showed how useful this tool is for reliable flood risk mitigation activities (mapping and risk assessment as well as real time applications) especially when inundations occur.