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Improving hydraulic modelling using remote sensing-derived flood extent data

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In view of the recent and serious flood events occurred during the latest years in Italy, and worldwide, the interest towards accurate methodologies for the evaluation of flood prone areas is drastically increased. In particular, the matter is related to the forward planning, the civil protection activity (e.g. hydraulic risk warning systems), as well as the assessment of the hydraulic structures behaviour during severe hydrometeorological conditions. This aspect is well underlined by the recent European directive 2007/60/EC on the assessment and management of flood risk which requires from each member state: (i) a preliminary flood risk assessment, (ii) flood hazard maps and flood risk maps, and (iii) flood risk management plans.
In order to address these issues, the use of coupled hydrologic and hydraulic models can be a valuable tool also for real-time applications, such as flood risk mitigation and warning activities. However, it is well-known that uncertainties in modelling, observations and output can greatly limit the reliability of these models. Over the last decade, there have been major advances in the field of remote sensing, particularly for microwave remote sensing, as well as its integration within the hydraulic modelling. In fact, incorporating satellite data in flood forecasting systems might have the potential of significantly improving hydraulic model performances. Space-borne microwave remote sensing with its nearly all-weather, day and night capabilities, seems to meet the demand for a worldwide, near real-time flood monitoring system. Due to the specular backscattering characteristics of active radar pulses on plain water surfaces and the resulting low signal return, the use of Synthetic Aperture Radar (SAR) data for high-resolution flood mapping is relatively straightforward. Moreover, nowadays, high spatial resolutions ($\sim$1 m) can be achieved with available TerraSAR-X, COSMO SkyMed and Radarsat-2 SpotLight modes.
In this study, the benefit of using SAR images in a context of hydraulic modelling addressed to hydraulic risk assessment was investigated by considering a recent flood event that occurred at the end of November 2010 in central Italy. In particular, extensive flooding took place in two fairly small sub-catchments of the Upper-Middle Tiber River (Italy), named Genna (96 km2) and Caina (230 km2), respectively. For the two rivers, one- and two-dimensional hydraulic models were applied along the main channel and calibrated considering a large set of historical flood events occurred in the last 20 years. As discharge is known only at the outlet of the catchment, the boundary conditions are provided by a storm-based rainfall-runoff model of semi-distributed type calibrated through the same flood events. Therefore, the use of SAR-derived flood extent in the calibration and validation of the hydraulic models was highlighted. Specifically, the possibility to calibrate the Manning roughness based on satellite imagery only was investigated considering the differences arising by the use of 1D or 2D approaches. This application on small-medium sized catchments (<250 km2) contributes to strengthen the value of remote sensing data.