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A coupled hydrological-hydraulic modeling framework for flood scenarios mapping and prediction: the case study of Basento river (Southern Italy)

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A robust flood modeling framework is essential for managing flood risk under global and climate change. This is also consistent with the requirements dictated by the recent European legislation on flood risk protection of the territory (Floods Directive 2007/60/EC).

Flood hazard hydrodynamic variables (water depth, flow velocity, flood extent evolution) can be computed using numerical flood models, which represent a well-established approach for flood risk analysis. At one hand, in recent years, hydrological/hydrodynamic modelling of flood events has seen exponential improvements, thanks to the development of increasingly reliable and efficient numerical methods, the increased computing power and innovative geomatic techniques. On the other hand, this kind of models often include substantial uncertainties such as input data, mathematical structure of the model, hydrologic response mechanisms, calibration strategies, contributing to discrepancies between observed and simulated data.

The aim of the research, realized in the framework of the ODESSA (On DEmand Services for Smart Agriculture) project (financed by the European Regional Development Fund Operational Programme 2014-2020 of Basilicata Region), is to implement an operational framework on the Basento basin in Basilicata (Southern Italy) that is based on the cascade use of a physically-based and lumped hydrological model AD2 (Fiorentino & Manfreda, 1999), for the estimation of flood hydrographs and a two-dimensional hydraulic model FLORA2D (Cantisani et al., 2014), for the evaluation of the hydraulic characteristics during a flood event.

The calibration methodology of the hydrological model exploits the use of physical information in order to reduce the initial range of the parameters set and an automated optimization procedure, based on genetic algorithm (GA), for searching the set of optimal parameters by comparing the data observed in situ during the December 2013 historical event. A set of flooded maps during the 2013 historical events extracted from diverse multitemporal SAR images has been used for the purpose of calibration of the hydraulic model. Moreover, a validation of the hydrological and hydraulic models has been performed on the March 2011 event in order to verify the adaptation of the values of the model parameters, selected during the calibration phase, in an additional

scenario.

The results show the reliability of the models in both calibration and validation phases, i.e. the hydrological model reach a Nash-Sutcliff efficiency coefficient from 9.86 to 0.91 and the hydraulic model, using a confusion matrix (Scarpino et al. 2018), shows, in all cases, an accuracy around 70%. Considering the significance of the outcomes, the cascade models have been used to simulate future event scenarios for given return times but also for short-time flood forecasting.

Reference

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