Geophysical Research Abstracts
Vol. 17, EGU2015-9858, 2015
EGU General Assembly 2015

Improving the effectiveness of real-time flood forecasting through Predictive Uncertainty estimation: the multi-temporal approach

Silvia Barbetta (1), Gabriele Coccia (2), Tommaso Moramarco (1), and Ezio Todini (3)

(1) National Research Council, Research Institute for Geo-Hydrological Protection, Via Madonna Alta 126, 06128 Perugia, Italy , (2) Princeton University, Princeton, NJ, (3) BiGeA — University of Bologna, Via Zamboni 67, 40126 Bologna (Italy)

The negative effects of severe flood events are usually contrasted through structural measures that, however, do not fully eliminate flood risk. Non-structural measures, such as real-time flood forecasting and warning, are also required. Accurate stage/discharge future predictions with appropriate forecast lead-time are sought by decision-makers for implementing strategies to mitigate the adverse effects of floods. Traditionally, flood forecasting has been approached by using rainfall-runoff and/or flood routing modelling. Indeed, both types of forecasts, cannot be considered perfectly representing future outcomes because of lacking of a complete knowledge of involved processes (Todini, 2004). Nonetheless, although aware that model forecasts are not perfectly representing future outcomes, decision makers are de facto implicitly assuming the forecast of water level/discharge/volume, etc. as "deterministic" and coinciding with what is going to occur.
Recently the concept of Predictive Uncertainty (PU) was introduced in hydrology (Krzysztofowicz, 1999), and several uncertainty processors were developed (Todini, 2008). PU is defined as the probability of occurrence of the future realization of a predictand (water level/discharge/volume) conditional on: i) prior observations and knowledge, ii) the available information obtained on the future value, typically provided by one or more forecast models. Unfortunately, PU has been frequently interpreted as a measure of lack of accuracy rather than the appropriate tool allowing to take the most appropriate decisions, given a model or several models' forecasts.
With the aim to shed light on the benefits for appropriately using PU, a multi-temporal approach based on the MCP approach (Todini, 2008; Coccia and Todini, 2011) is here applied to stage forecasts at sites along the Upper Tiber River. Specifically, the STAge Forecasting-Rating Curve Model Muskingum-based (STAFOM-RCM) (Barbetta et al., 2014) along with the Rating-Curve Model in Real Time (RCM-RT) (Barbetta and Moramarco, 2014) are used to this end. Both models without considering rainfall information explicitly considers, at each time of forecast, the estimate of lateral contribution along the river reach for which the stage forecast is performed at downstream end. The analysis is performed for several reaches using different lead times according to the channel length.

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