Applications of real-time weather forecasts in hydrology: the case studies for irrigation water needs and river floods

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Abstract

Nowadays coupling meteorological and hydrological models, it is recognized by scientific community as a necessary way to forecast extreme hydrological phenomena, in order to active useful mitigation measurements and alert systems in advance. The development and implementation of a real-time forecasting chain with a hydro-meteorological operational alert procedure for flood and drought events is described in this study.
In particular, the research group of the Water Science and Engineering of Politecnico di Milano develops and coordinates innovative projects for floods and drought damages reduction, as adaptation instruments to climate change in collaboration with national and international research institutes.
In order to run hydro-meteorological simulations and forecasts, we use a flood forecasting system which comprises the physically based rainfall-runoff hydrological model FEST-WB, developed by the Politecnico di Milano, and different meteorological models as the Weather Research and Forecasting (WRF) provided by the Universitat de les Illes Balears and Epson Meteo Center, the BOLAM and MOLOCH models by ISAC-CNR and the probabilistic COSMO-LEPS model by ARPAE.

Smart irrigation

The European SIM project (Smart Irrigation Modelling) has as main objective the parsimonious use of agricultural water through an operational web tool to reduce the use of water, fertilizer and energy keeping a constant crop yield.
The instrument provides in real-time the present and forecasted irrigation water requirements at high spatial and temporal resolutions with forecast horizons from few up to thirty days, according to different agronomic practices supporting different level of water users from irrigation consortia to single farmers. It combines the state of the art of satellite monitoring, meteorological forecasts and hydrological modelling allowing a smart irrigation that identifies the right amount of water at right time needed for optimal crop production. In this study we show how the instrument allows to quantify the impacts on water saving and on economic and environmental benefits with specific indicators which are computed for the different levels of end-users in the Capitanata Consortium (Puglia, southern Italy).

Flood forecast

The SOL (Seveso-Olona-Lambro) project provides an operative web dashboard for real-time flood forecast system for Milano and the municipalities along the Seveso, Olona and Lambro rivers. The project has as main objective the reduction of flood damages in dense urbanized area, allowing citizens, enterprises and authorities, according to their own responsibility, the activation of the preventive protection actions. This raises the territory flood awareness, preparedness and resilience according to the guidelines of the EU Flood Directive (2007/60) also up taken in the flood risk mitigation design criteria of government structure "Italia Sicura" which foresees a balance between structural and non-structural approaches. SOL is synergic to the Civil Protection system due to an information procedure citizen oriented for the people living or working in probable flooded area.
The SOL system allows knowing in advance of 24-36 hours how the rainfall forecasts from different meteorological models produce dangerous floods respect to the maximum river reach discharge capacity, considering the soil moisture conditions and the river hydraulic structures. This activity is complementary to the monitoring of water level which are inadequate for most of the Italian rivers where the flood time formation is shorter than the preventive protection action activating time. In this analysis, we show several years of our experience in scientific and operative fields and how early warning systems are an effective complement to structural measures for flood control in Milan city.