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A fuzzy post-processing approach for applying pan-European hydrological forecasts to a Mediterranean river basin management

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The use of hydrological forecasts obtained from continental impact models, i.e. the pan-European E-HYPE hydrological model developed by the Swedish Meteorological and Hydrological Institute (SMHI), has many advantages: it provides a consistent framework for inflow forecasting, enables assessments at the pan-European scale and makes it possible to acquire hydrological forecasts in ungauged basins. However, its use at the river-basin scale may depend on the regional setup (local calibration of parameters, including representation of human impacts). Since continental models cover very different regions with diverse hydrological (and meteorological) processes and data availability, their setup is not always straightforward and hence it cannot guarantee that results are adequate at regional scales.

In here we present an alternative approach to use pan-European hydrological forecasts from the E-HYPE model at the regional scale without the need for re-calibration. Our approach focuses on post-processing E-HYPE's forecasts using fuzzy logic. The E-HYPE results are adapted to the regional scale using fuzzy rule-based (FRB) systems. These systems transform "raw" hydrological forecasts from E-HYPE into bias-adjusted hydrological forecasts able to be used at the regional scale. For each location in which bias-adjusted forecasts are desired, forecasts from E-HYPE in neighbouring areas are selected as inputs of a FRB system, being its output the hydrological forecast at the given location. The FRB systems are trained and validated using the E-HYPE results corresponding to the historical meteorological forcing and the historical discharge records available.

The proposed approach is applied in the Jucar River Basin, a Mediterranean basin in Eastern Spain. Its seasonal operation during the irrigation season (May to September) relies on a simple forecast derived from expert judgement of recent trends employed by the system operators to schedule reservoir releases and deliveries to the agricultural demands. The fuzzy post-process is applied to foresee discharges for the upcoming May – September period in several sub-basins of the Jucar river, based on E-HYPE forecasts in neighbouring locations issued in May 1st. The results obtained show that the E-HYPE hydrological forecasts in the Jucar river basin, before the fuzzy bias adjustment, have a higher skill than the meteorological forecasts used to generate them (in here ECMWF System4 seasonal forecasts). However, its direct use would be very challenging due to limited (occasionally unavailable) process understanding at such spatial scale, since historical discharges depart from E-HYPE results to the historical meteorological forcing.

After the fuzzy bias adjustment, the skill of the hydrological forecasts shows a slight decrease, however forecasts could be used in further assessments. We can conclude that the fuzzy bias-adjustment process is able to partially solve the model setup limitations that pan-European hydrological models may have in some specific regions. However, it comes at the cost of losing some forecasting skill, so model re-calibration (fine tuning) or the build-up of detail models at the basin scale, if possible, would be preferable.

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