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Estimating relative climatic change impact on groundwater of agricultural demand and recharge component in a multi-resources hydrological supply system: The case of the Fortore water supply system (South Italy)

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The occurrence of shortage events on a water supply system can be investigated through models that simulate hydrological processes by describing the atmosphere/surface water/soil/groundwater interfaces, water demand variability and management options for different uses.
However, when the supply system is fed by several water resources and dynamics changes of demand, it is necessary to develop models able to simulate the cause-effect mechanisms that involve not only the water budget physical processes, but also the choices of the users in terms of distribution of the demand among each resource and the actions implemented by the managers.
The proposed overall model merges: (i) a 1 km2 discrete monthly soil water mass balance model (G-MAT) to estimate recharge to the aquifer, soil water content and surface runoff; (ii) a stochastic model based on a multi linear regression of standard precipitation index (SPI-Q) to reproduce inflow to surface water storage; (iii) a simple monthly reservoir water balance model considering inflow, demands and storage volumes; (iiii) a simple groundwater lumped budget model that considers soil recharge and well extraction following the management rules of the water supply system and the available surface water storage. While we consider the only seasonal variability for domestically and industrial water demand, the agricultural demand is estimated on the base of the monthly soil water content.
The developed overall model has been implemented for the case study of the Fortore water supply system (Apulia region, South Italy), managed by the Consorzio di Bonifica della Capitanata. It allows to simulate the conjunctive use of the water from the Occhito artificial reservoir (160 Mm3) and from groundwater.
We successfully reproduce the Occhito dam level variability (both seasonal and inter-annual) as well as the observed groundwater depletion until the early 2000 and the following recover. The resulting model is able to monitor relative contribution of groundwater recharge non stationarity (mainly driven by precipitation variability) and associated agricultural water demand (driven by soil water content and thus by both evapotranspiration and precipitation non stationarity) to the aquifer stress. It also gives the opportunity to easily run impact scenarios on groundwater considering change in climate forcing, agricultural superficies, surface water storage or water supply management.