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Consequences of the climate change on water scarcity in the Mediterranean basin

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The main purpose of the study is to evaluate the impacts of climate change on water resources while taking into account man-made reservoirs and changes in reservoir operating rules. Mediterranean basins are already characterized by an important temporal and spatial variability of water resources, and climatic models, despite the uncertainty, are indicating a change in precipitation regime with an increased drought risk. The regional assessment of change in water scarcity prevents using detailed data at the water basin level. Instead a generic model is constructed, based on information available at a regional scale. The steps of our methodology are:
1) Localisation and projection of water demands
2) Localisation of reservoirs and computation of available water quantity at each site
3) Determination of links between reservoirs and demands
4) Determination of operating rules
All the existing reservoirs are localized on the basis of the International Commission of Dams and Reservoirs. Runoff is taken from the outputs of climatic models from the European program CIRCE. Sub-basin flow accumulation zone of each reservoir is determined based on a Digital Elevation Model (hydro1k), and the available quantity of water at each site is computed.
On the demand side, domestic water use, cooling of power plants for electricity production, manufacturing and irrigation demands are taken into account. Future domestic demand is computed based on exogenous scenarios of population and wealth changes, using the WATERGAP2 methodology. For cooling and manufacturing processes, scenarios of modification of electricity production and added value are assumed, as well as water use intensities based on historical data and scenarios of technological progress, still using the WATERGAP2 methodology. In the case of irrigation, current irrigated areas , taken from the Global Map of Irrigation Areas and current productions, taken from agromaps are used. Crops phenology is determined based on the growing degree days method and irrigation is set to the quantity of water needed to fill the deficit between evapotranspiration and effective precipitation.
To determine the links between supply and demand, in absence of precise informations, a cost minimisation is performed. Each demand is associated with a reservoir, and the cost corresponding with this link takes into account the distance between the demand and the reservoir stream, and the height climbed up along the path to stream. The total cost is minimized, while checking that the mean demands may be satisfied by the mean runoff in the resulting network.
Operating rules are determined by minimizing the risk of non satisfaction of forecasted demands. For reservoirs in series, first upper demands are satisfied and the most downstream reservoir is first emptied. For reservoirs in parallel, a fitted generalization of the space rule is used, such that the probability of spill is minimized.