

Benefits of economic criteria for water scarcity management under global changes: insights from a large-scale hydroeconomic framework

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Global changes are expected to exacerbate water scarcity issues in the Mediterranean region in the next decades. In this work, we investigate the impacts of reservoirs operation rules based on an economic criterion. We examine whether they can help reduce the costs of water scarcity, and whether they become more relevant under future climatic and socioeconomic conditions. We develop an original hydroeconomic model able to compare future water supply and demand on a large scale, while representing river basin heterogeneity.

On the demand side, we focus on the two main sectors of water use: the irrigation and domestic sectors. Demands are projected in terms of both quantity and economic value. Irrigation requirements are computed for 12 types of crops, at the 0.5° spatial resolution, under future climatic conditions (A1B scenario). The computation of the economic benefits of irrigation water is based on a yield comparison approach between rainfed and irrigated crops. For the domestic sector, we project the combined effects of demographic growth, economic development and water cost evolution on future demands. The economic value of domestic water is defined as the economic surplus.

On the supply side, we evaluate the impacts of climate change on water inflows to the reservoirs. Operating rules of the reservoirs are set up using a parameterisation-simulation-optimisation approach. The objective is to maximise water benefits. We introduce prudential parametric rules in order to take into account spatial and temporal trade-offs.

The methodology is applied to Algeria at the 2050 horizon. Overall, our results show that the supply-demand imbalance and its costs will increase in most basins under future climatic and socioeconomic conditions. Our results suggest that the benefits of operating rules based on economic criteria are not unequivocally increased with global changes: in some basins the positive impact of economic prioritisation is higher under future conditions, but in other basins it is higher under historical conditions.

Global changes may be an incentive to use valuation in operating rules in some basins. In other basins, the benefits of reservoirs management based on economic criteria are less pronounced; in this case, trade-offs could arise between implementing economic based operation policies or not.

Given its generic nature and low data requirements, the framework developed could be implemented in other regions concerned with water scarcity and its cost, or extended to a global coverage. Water policies at the country or regional level could be assessed.