Selecting quantitative water management measures at the river basin scale in a global change context

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One of the main challenges in the implementation of the Water Framework Directive (WFD) in the European Union is the definition of programme of measures to reach the good status of the European water bodies. In areas where water scarcity is an issue, one of these challenges is the selection of water conservation and capacity expansion measures to ensure minimum environmental in-stream flow requirements. At the same time, the WFD calls for the use of economic analysis to identify the most cost-effective combination of measures at the river basin scale to achieve its objective. With this respect, hydro-economic river basin models, by integrating economics, environmental and hydrological aspects at the river basin scale in a consistent framework, represent a promising approach. This article presents a least-cost river basin optimization model (LCRBOM) that selects the combination of quantitative water management measures to meet environmental flows for future scenarios of agricultural and urban demand taken into account the impact of the climate change.

The model has been implemented in a case study on a Mediterranean basin in the south of France, the Orb River basin. The water basin has been identified as in need for quantitative water management measures in order to reach the good status of its water bodies. The LCRBOM has been developed using GAMS, applying Mixed Integer Linear Programming. It is run to select the set of measures that minimizes the total annualized cost of the applied measures, while meeting the demands and minimum in-stream flow constraints. For the economic analysis, the programme of measures is composed of water conservation measures on agricultural and urban water demands. It compares them with measures mobilizing new water resources coming from groundwater, inter-basin transfers and improvement in reservoir operating rules. The total annual cost of each measure is calculated for each demand unit considering operation, maintenance and investment costs.

The results show that by combining quantitative water management measures, the flow regime can be improved to better mimic the natural flow regime. However, the acceptability of the higher cost of the program of measures is not yet assessed. Other stages such as stakeholder participation and negotiation processes are as well required to design an acceptable programme of measures. For this purpose, this type of model opens the path to investigate the problems of equity issues, and measures and costs allocation among the stakeholders of the basin.