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Design of an efficient water pricing policy integrating resource opportunity costs at the river basin scale. Contribution to the EU Water Framework Directive.

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This paper presents a methodology for the simulation of different water pricing policies linked to water availability (or relative scarcity) in the basin, and the definition of efficient water pricing policies that include the marginal economic value of the resource at the basin scale, sending the users a signal of the economic value of the resource and the opportunity costs.

The approach is based on the practical assessment of the marginal resource opportunity cost (MROC) of water resources at the basin scale through hydro-economic models at the basin scale. The MROC is estimated using two approaches: simulation (according to current priorities and the system's modus operandi) and economic optimization. The first approach entails the use of two modules of the DSS AquaTool (Andreu et al., 1996): a priority-based simulation module and the economic evaluation module. The simulated monthly supply together, the functions of the economic value of water for different uses, and the variable operating costs are inputs for the economic evaluation model. This module approximates the MROC value by comparing economic results of the base case simulation with the simulated results providing an additional unit of water at each time period in the selected location. The economic optimization approach maximizes the net economic value of water used during the optimization period.

The results obtained from the economic evaluations serve as a starting point for the design of pricing policies whose effect is analyzed by means of the simulation model. Improved economic efficiency resulting from the application of pricing policies is assessed by comparing the results obtained by simulating the current operation of the system (based on priority rights) and that obtained with the simulation of the pricing policy. The results from the optimization model indicate the maximum attainable economic efficiency, which serves as a benchmark. The distance between the simulated benefits with the current management and maximum benefits obtained from the optimization show the profit margin that can be bridged with pricing policies.

An efficient pricing policy can be defined with a step function from the average values of the MROC from either simulation or optimization for different ranges of reservoir storage volumes. In a synthetic case study that has been used for testing the methodology, a step pricing schedule derived from average MROC values from the simulation model has led to economic benefits that already capture 80% of the gap of total net economic benefits between management without pricing and the economically optimal management. The pricing policy proposal is translated in the DSS Aquatool into a set of constraints that restrain the maximum demands to be met in the simulation in the corresponding time step, depending on the state of the system. Different pricing policies have been tested, including as a variable not only the reservoir storage but also information on previous inflow values to further characterize the temporal dimension of the economic value of water in the system. The relative efficiency of the different pricing policies depends on many factors that are inherent to the complexity of the system, such as: the time-dependent structure of the inflow time series and the statistical droughts properties of the system, configuration and infrastructure characteristics of the system, regulatory capacity, etc. The methodology for the design of efficient pricing water might be implemented for any simulation model of a water resources system, once the relevant demand curves have been defined.

The methodology has been applied to a synthetic an to a real case study (Mijares River basin, in Eastern Spain), what has allowed to analyze the gains in terms of economics efficiency of the application of different pricing policies (step price schedule based on MROC from simulation and optimization, dynamic and seasonal prices depending on storage and inflow, etc.). The results show that the methodology is useful for establishing efficient pricing policies that enhance economic benefits and contribute to a more efficient resource allocation in time and across the different competing uses of the system. This can be a relevant contribution for the definition of the new pricing policies required in the WFD.

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