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Modelling Tradeoffs Evolution in Multipurpose Water Systems Operation in Response to Extreme Events

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Abstract Text:

Multipurpose water resource systems are usually operated on a tradeoff of the operating objectives, which - under steady state climatic and socio-economic boundary conditions - is supposed to ensure a fair and/or efficient balance among the conflicting interests. Extreme variability in the system's drivers might affect operators' risk aversion and force a change in the tradeoff. Properly accounting for these shifts is key to any rigorous retrospective assessment of operators' behavior and the associated system's performance. In this study, we explore how the selection of different optimal tradeoffs among the operating objectives is linked to the variations of the boundary conditions, such as, for example, drifting rainfall season or remarkable changes in crop and energy prices. We argue that tradeoff selection is driven by recent, extreme variations in system performance: underperforming on one of the operating objective target value should push the tradeoff toward the disadvantaged objective.

To test this assumption, we developed a rational procedure to simulate the operators' tradeoff selection process. We map the selection onto a multi lateral negotiation process, where different multiple, virtual agents optimize different operating objectives. The agents periodically negotiate a compromise on the operating policy. The agent's rigidity in each negotiation round is determined by the recent system performances according to the specific objective it represents. The negotiation follows a set-based egocentric monotonic concession protocol: at each negotiation step an agent incrementally adds some options to the set of its acceptable compromises and (possibly) accepts lower and lower satisfying policies until an agreement is achieved. We apply this reiterated negotiation framework on the regulated Lake Como, Italy, simulating the lake dam operation and its recurrent updates over the last 50 years. The operation aims to balance shoreline flood prevention and irrigation deficit control in the downstream irrigated areas. The results of our simulated negotiations are able to accurately capture the operator's risk aversion changes as driven by extreme wet and dry situations, and to well reproduce the observational release data.

Topic Selection: Water Resources Management and Policy in a Changing World

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