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Reinforcement learning control of selective withdrawal reservoirs accounting for both quality and quantity targets

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Abstract: As water resources around the globe come under increasing pressure due to continuous population growth, economic development, and climate change, it is critical to adopt new management practices that lead to more efficient and sustainable use of the water resource, reconciling the demand for water by the human environment with the supply for water by the natural system. In such a context the integration of quality and quantity issues into the planning and management of water systems is emerging as a key issue. The impact of multi-purpose (e.g. hydropower generation and irrigation supply) reservoir operation on the downstream river water quality parameters has been extensively studied in the literature, and in several cases rational, optimization-based approaches have been adopted to derive optimal operation rules. However the potential effects of release management on reservoir limnology are still relatively unexplored. In fact, simulation-based, what if analyses from which to infer general management rules are generally preferred over the optimal design of management policies. In this paper, a reinforcement learning approach is developed and applied to design efficient management policies for selective withdrawal reservoirs with the purpose of meeting established water quality/quantity targets both in-reservoir and downstream. Structured design of experiment simulations are performed of a 1D coupled hydrodynamic-ecological model (DYRESM) to generate a learning dataset over which a daily management policy is trained using a fitted-Q algorithm based on extremely randomized trees. The approach is demonstrated on the management of Tono Dam, a Japanese artificial reservoir affected by water quality problems (turbidity and algal blooms) and used for multiple operational objectives, including drinking water supply, irrigation and hydropower production. Preliminary results indicate that a great control over reservoir limnology and release quality can be gained by effectively exploiting - through the management policy - the operational flexibility provided by the selective structure.

Keywords: *Reservoir Operation, Water Quality, Machine Learning, Selective Withdrawal Systems*

Abstract only