

Adaptive operation policies for reservoir management in a changing world

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Abstract: Reservoirs are essential infrastructure, supplying water for domestic, industrial and irrigation uses. Due to long-term climate and water demand changes, the performance of reservoirs may decrease throughout their lifespan, potentially requiring interventions such as reservoir expansion and/or water demand reduction. However, these interventions are often expensive and result in prolonged social and environmental disruptions. Consequently, there is a need to explore opportunities to enhance reservoir performance before these interventions are necessary. Adapting reservoir operation policies, which are functions to assist in making water release decisions, to cater for changed future water availability and demand conditions could best utilise the capacity of existing reservoir systems and potentially delay costly or disruptive interventions.

In this study, the benefits of adapting reservoir policies as part of long-term reservoir management are demonstrated for a proposed water supply reservoir in the Northern Territory, Australia. This is done by directly optimising parameters (weights and biases) in an artificial neural network (ANN)-based reservoir operation policy model through a multi-objective robust optimisation framework with the aim to identify operation policies that can perform well under various plausible future conditions.

Results show that the utilisation of adaptive operation policies can effectively manage future decadal changes in water availability and demand. Such policies generally show better performance, with lower water supply deficit and water storage violation values, compared to operation policies that remain stationary in the future, especially when the future is drier with increasing water demand (Figure 1). These changes in system performance can be explained by analysing the changes in the characteristics of ANN-based operation policy. For example, operation policies that adapt to conditions in the 2030s tend to release more water, leading to a significantly lower water supply deficit but a slightly higher water storage violation. Furthermore, the narrower performance range of adaptive operation policies compared to that of fixed operation policies indicates reduced performance uncertainty, which allows us to schedule additional interventions strategically, ensuring they are neither too late nor too soon.

In summary, adaptive operation policies can provide various benefits for long-term reservoir management and ensure a reliable and secure source of water supply in a changing world.

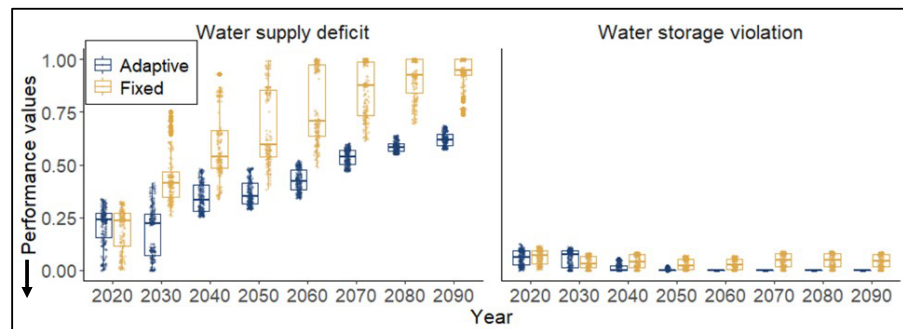


Figure 1. Policy performance values evaluated over decadal periods under the scenario with decreasing water availability and increasing water demand.

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