



## **Adding flexibility to the search for robust portfolios in non-linear water resource planning**

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To date robust optimisation of water supply systems has sought to find portfolios or strategies that are robust to a range of uncertainties or scenarios. The search for a single portfolio that is robust in all scenarios is necessarily suboptimal compared to portfolios optimised for a single scenario deterministic future. By contrast establishing a separate portfolio for each future scenario is unhelpful to the planner who must make a single decision today under deep uncertainty. In this work we show that a middle ground is possible by allowing a small number of different portfolios to be found that are each robust to a different subset of the global scenarios. We use evolutionary algorithms and a simple water resource system model to demonstrate this approach.

The primary contribution is to demonstrate that flexibility can be added to the search for portfolios, in complex non-linear systems, at the expense of complete robustness across all future scenarios. In this context we define flexibility as the ability to design a portfolio in which some decisions are delayed, but those decisions that are not delayed are themselves shown to be robust to the future. We recognise that some decisions in our portfolio are more important than others. An adaptive portfolio is found by allowing no flexibility for these near-term “important” decisions, but maintaining flexibility in the remaining longer term decisions. In this sense we create an effective 2-stage decision process for a non-linear water resource supply system. We show how this reduces a measure of regret versus the inflexible robust solution for the same system.