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# Robustness and regret under structural and contextual uncertainty: a multi-objective perspective

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Modelling and optimisation of water resource systems is affected by a range of uncertainties that are hard to be characterized statistically, such as 'structural uncertainty' about the most adequate system representation or 'contextual uncertainty' about the definition of the system boundaries. These uncertainties will unavoidably impact the actual performance of optimization results, should they be implemented in reality. In this study, we use the real-world example of a two-reservoir pumped storage system in the UK to demonstrate how to quantify the impact of such uncertainties on optimised reservoir operating policies. As we find that structural and contextual uncertainties significantly affect the optimisation results, we then ask the question of whether it is possible to identify operating policies that are robust to such uncertainties. The term 'robust' is broadly applied to mean solutions of optimisation problems that perform well under, or in spite of, these uncertainties. While an active literature field, little has been done to study robustness while explicitly preserving the multi-objective nature of water management problems. To expand on this point, we believe there is a need for a robustness metric that is able to compare sets of Pareto solutions that does not require an objective-by-objective comparison and is not measured on a solution-per-solution basis. In this work we create such a metric, termed 'hypervolume-regret', and use it to both evaluate the efficacy of 'robust optimization' and to understand the impact of the different sources of uncertainties under examination.