Scheduling and adaptation of London's future water supply and demand schemes under uncertainty

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The changing needs of society and the uncertainty of future conditions complicate the planning of future water infrastructure and its operating policies. These systems must meet the multi-sector demands of a range of stakeholders whose objectives often conflict. Understanding these conflicts requires exploring many alternative plans to identify possible compromise solutions and important system trade-offs. The uncertainties associated with future conditions such as climate change and population growth challenge the decision making process. Ideally planners should consider portfolios of supply and demand management schemes represented as dynamic trajectories over time able to adapt to the changing environment whilst considering many system goals and plausible futures. Decisions can be scheduled and adapted over the planning period to minimize the present cost of portfolios while maintaining the supply-demand balance and ecosystem services as the future unfolds. Yet such plans are difficult to identify due to the large number of alternative plans to choose from, the uncertainty of future conditions and the computational complexity of such problems. Our study optimizes London's future water supply system investments as well as their scheduling and adaptation over time using many-objective scenario optimization, an efficient water resource system simulator, and visual analytics for exploring key system trade-offs. The solutions are compared to Pareto approximate portfolios obtained from previous work where the composition of infrastructure portfolios that did not change over the planning period. We explore how the visual analysis of solutions can aid decision making by investigating the implied performance trade-offs and how the individual schemes and their trajectories present in the Pareto approximate portfolios affect the system's behaviour. By doing so decision makers are given the opportunity to decide the balance between many system goals a posteriori as well as justify the choice of their final plan to interested parties. We will also discuss how the choice of scenarios to represent future conditions affects the search outcomes.