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Simulation based decision-making using water and demand forecasts: Hume Dam

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Abstract: Water supply dams store water for delivery to downstream sites. Dam operators are tasked with deciding on the dam releases, in real-time, given downstream demands and constraints. The presence of downstream tributary inflows augmenting the mainstem flow complicates the problem as they can be highly uncertain, particularly in times of high rainfall. Further, where the downstream demands are uncertain, their uncertainty can also confound the problem. One way to mitigate these difficulties is to incorporate probabilistic flow and demand forecasts into the decision-making process to assist with quantifying the uncertainties. Such forecasts provide some foresight of the future timing and magnitudes of flows and demands, and thus, have the potential to guide dam operators to more optimal release decisions. However, how best to apply them varies between different systems as each system is unique in not only its physical characteristics and the available forecasts, but also the technical expertise accessible to dam operators.

In this present study, we investigate how ensemble flow and demand forecasts can be applied to inform the release from Hume Dam, on the Murray River, for delivery to Lake Mulwala, about four days downstream of the dam. For this, we develop three forecast-based decision rules. Each rule receives as input ensemble tributary inflow and diversion demand forecasts, and yields as output ensemble forecasts of the excess and shortage in the water supplied to Lake Mulwala and given that, a recommendation on the Hume Dam release. The first and second rules are based on the means and medians, respectively of the output ensemble forecasts, while the third rule is based on predictions of risk as per the output forecasts.

An advantage of the decision rules is that they rely on simulations of the system (as opposed to optimisation of the system). They are thus, relatively easy to implement and troubleshoot, which makes them suitable for operationalisation. We simulate the three decision rules on a rolling basis under various scenarios, then analyse the results to gain new insights into the following questions: (i) Which of the decision rules is best for managing Hume Dam for water supply and under what conditions? (ii) How does the lead time length of the input inflow and demand forecasts influence the results? (iii) What is the value, in terms of the system performance, of improving the input demand forecasts? (iv) What is the value, again in terms of the system performance, of allowing larger values of the rate of change in the Hume Dam release (which is currently capped to prevent bank slumping)? We hope this work is of interest to dam operators seeking guidance on how best to apply water and/or demand forecasts to their day-to-day decision-making.

Keywords: *Murray-Darling Basin, reservoir operation, ensemble streamflow forecasting, forecast-based decision-making*