

# Risk mitigation and human judgment in environmental watering under forecast uncertainty

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**Abstract:** Reservoir operations are increasingly challenged by the growing variability and non-stationarity of hydrological systems, due to climate change. Ensemble streamflow forecasts offer water managers probabilistic insight into future flows, enabling more adaptive decision-making. This is especially critical in highly variable systems like the Murray–Darling Basin (MDB), where unregulated flows can fluctuate dramatically over short time scales.

Environmental watering in the MDB often aims to deliver water to a downstream site up to a flow threshold to induce controlled inundation of riparian wetlands. An effective strategy could be to ‘piggyback’ reservoir releases on downstream tributary inflows, reducing the use of environmental allocations. Forecasts of these tributary inflows would be essential for aligning releases with natural flow peaks, but their utility would depend on their accuracy. Inaccurate forecasts create a risk of over-releasing water, leading to unintended impacts on riparian landholders.

Despite advances in ensemble prediction systems and artificial intelligence, forecast accuracy remains limited, particularly for extreme events. As a result, reservoir operations must adopt risk mitigation strategies to effectively manage the uncertainty this entails. This study investigates the potential effectiveness of risk mitigation strategies during simulated, forecast-informed environmental watering operations in the Murrumbidgee catchment. An ensemble streamflow forecasting model was developed and integrated with an optimisation framework to simulate thousands of environmental watering scenarios under a wide range of hydroclimatic conditions. Simulations were conducted with and without risk mitigation options and evaluated with a focus on the impacts of extreme high flow events, namely those in 2010 that included some of the highest flows on record. The study also discusses the role of human judgment in operational decision-making, particularly in synthesizing additional contextual factors alongside forecast information to better manage risks during extreme high flow events.

This research supports broader integration of forecasts into operational practices, emphasising the importance of combining risk mitigation strategies with human decision-making in complex water management systems.

**Keywords:** *Murray-Darling Basin, reservoir operation, risk mitigation, human judgement, forecast-based decision-making*