

# Understanding residual risks of forecast-informed river system operations

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**Abstract:** Ensemble forecasts of streamflow and other variables are becoming increasingly available by water managers generating their own products or through services provided by the Bureau of Meteorology. Ensemble forecasts are known to provide opportunities for improved decision-making by providing more robust estimates of the expected future streamflow and statistically reliable estimates of forecast uncertainties. However, the practical application of ensemble streamflow forecasts for operational decision-making is in its infancy. Some of the challenges in making use of ensemble forecasts include how best to use the complex information contained in forecast ensembles and methods to understand and mitigate the residual risks of forecast-informed operations.

Ensemble streamflow forecasts can be used in a range of circumstances in regulated river systems, for example to inform dam releases required to maintain connectivity during periods of low tributary inflows, or the delivery of environmental water by seeking to augment high tributary inflow events. The different applications of ensemble forecasts for decision-making in regulated river systems are associated with different objectives, that are characterized by different combinations of target flow rates and durations. The consequences of delivering actual flows that are different to the target flow are highly variable. In the case of augmenting high tributary inflow events, the consequences of exceeding instream flow targets can include unintended inundation of agricultural land and making roads impassable, while not reaching the target flow may reduce the desired environmental benefits of the flow event. Differences between the target and actual flow represent the residual risks associated with forecast-informed river operations. These residual risks can be influenced by attributes of forecasts and decision rules individually, and in combination, and need to be managed or mitigated when designing operational practices.

In this presentation we introduce and demonstrate an approach being used to assess the residual risks of forecast-informed environmental flow releases in regulated river systems. Our approach generates a long archive of retrospective forecasts of tributary inflows that reflect the characteristics of currently available operational forecasting systems. Decision rules are established and applied to the entire forecast archive to generate time series of forecast-informed dam releases that would be required to deliver a target flow. The forecasting model is then used to simulate the flow through the system using observed tributary inflows and the forecast-informed dam releases. Differences in the simulated and target flow at key locations within the river system are analyzed to provide an evaluation of the residual risks, characterized by the magnitude and likelihood by which the simulated flow exceeds target flow. Analysis is then undertaken to understand how the residual risk is impacted by seasonality, magnitude of tributary inflow and constraints on system operation. We conclude the presentation by summarizing the challenges of undertaking such analyses and the limitations of the insights gained.

**Keywords:** *Ensemble forecasts, forecast-informed decision making, residual risk*