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How to quantify uncertainty in water allocation models? An exploratory analysis based on hypothetical case studies

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Abstract Water allocation models are the principal tools used to build water sharing plans in regulated river systems across Australia. These models associate components describing the physical system (e.g. rainfall–runoff transformation and flow routing) and the management rules (e.g. operation of dams and irrigation extractions). In a context of growing pressure on water resources, the uncertainty associated with these highly parameterised models needs to be quantified in a defensible and transparent way. This paper is an exploratory analysis based on the application of two uncertainty methods to hypothetical river system case studies. First, a simplified model structure is developed by using existing characteristics from six regions of the Murray-Darling basin. Each model contains a schematic representation of the region with: (1) one upstream storage, (2) ungauged and gauged tributaries inflows, and (3) one downstream irrigation extraction point. Second, the model outputs (streamflow) are corrupted and an alternative model is calibrated based on the corrupted data using the standard least-squares method. Finally, the uncertainty in the output is generated using two uncertainty post-processors and compared with the uncorrupted ("true") outputs using deterministic and probabilistic scores. The uncertainty post-processor based on the empirical distribution of the residuals proved simple yet effective, especially when compared to the more advanced bootstrapping method. It performed systematically better when applied to the stored volumes in the reservoir. However, the predictive uncertainty was greatly improved by the bootstrapping method to assess the uncertainty on streamflow. This highlights the important differences that can occur in the uncertainty analysis for a multivariate model.

Key words water allocation models; synthetic experiments; uncertainty assessment; calibration; bootstrap