Improving irrigation water availability forecasting

A case study involving Australia's largest rural water corporation

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Background

Within Australia, water managers are responsible for delivering water at the appropriate time and amount according to water ordered by irrigators, whilst managing the water delivery system in a safe and sustainable manner. An underpinning factor that determines the behaviour of irrigators, and thus drives much of the system operations, is the amount of water available for ordering, otherwise known as water allocation. Water managers provide seasonal outlooks (i.e. forecasts) of water allocation, which help guide irrigators as to what their likely water allowance will be in the coming season. The common practice across the Murray-Darling Basin in Australia is to provide allocation outlooks with a range of climate scenarios for the upcoming irrigation season, based on observations of historical streamflow entering storages. Irrigators then suppose the likelihood of these different scenarios to make farm decisions (see Table 1). Table 1 shows an example of a high reliability water allocation outlook for the Goulburn System announced on 15 Oct 2019 from https://nvrm.net.au/. The scenarios of 'Wet', 'Average', 'Dry', and 'Extreme Dry' are based on the typical % allocation that occurred in the past under similar conditions. However the range of scenarios does not incorporate probabilistic information based on present climate conditions.

Table 1

Inflow conditions	Similar inflow season	16 December 2019	17 February 2020
Wet	2010/11	98%	100%
Average	2003/04	71%	81%
Dry	2008/09	57%	62%
Extreme Dry	2006/07	52%	54%

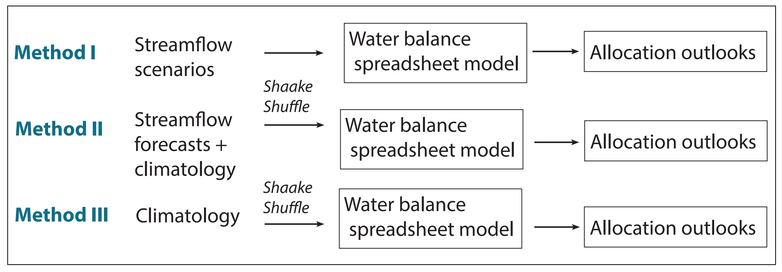
Research aims

This work aims to narrow the uncertainty and improve the accuracy of the allocation outlooks for Australia's largest rural water corporation - Goulburn Murray Water (GMW).

We compare the allocation outlooks generated using three different methods (see Figure 1):

- Method I: allocation outlooks are generated using streamflow scenarios as input
- Method II: allocation outlooks are generated using streamflow forecasts as input - the first three months of streamflow forecasts are followed by climatology forecasts for the following months
- Method III: allocation outlooks are generated using climatology forecasts for all months

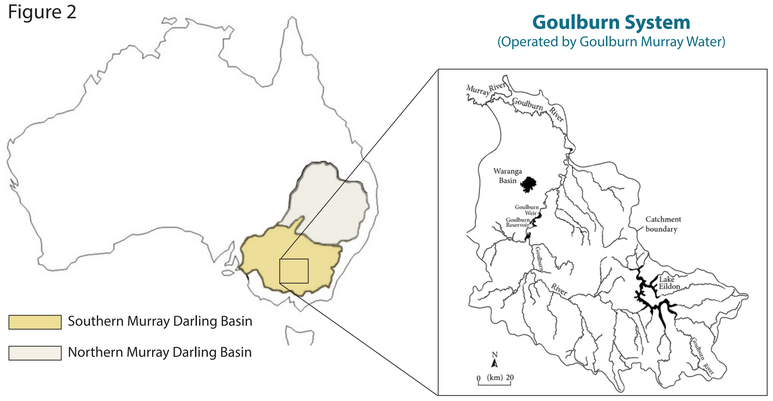
Figure 1



We apply our modeling to allocation outlooks for the 2017-18, 2018-19, and 2019-20 irrigation seasons for the Goulburn System (see Figure 2).

Study area

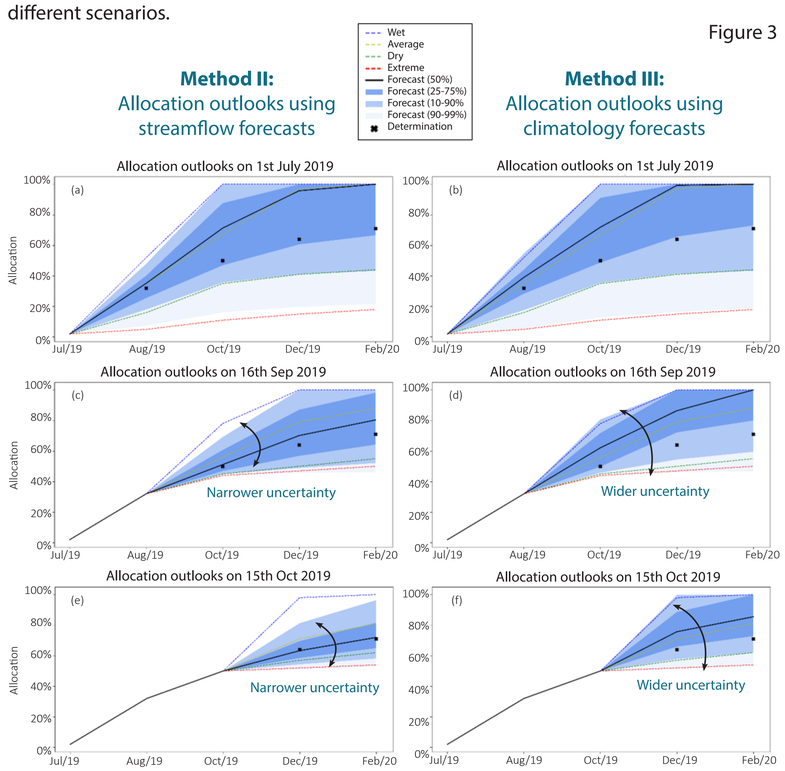
Figure 2



Uncertainty of allocation outlooks

Figure 3 shows a comparision between allocation outlooks generated using all three methods. Method I is shown in all figures by the dashed lines, which represent the different scenarios.

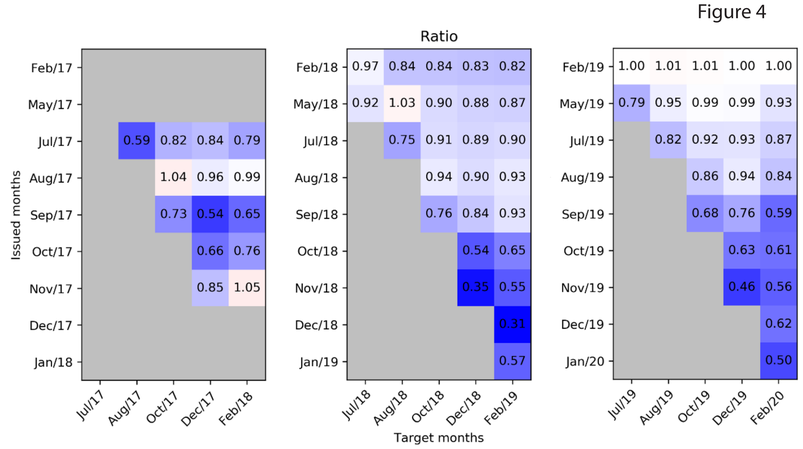
Figure 3



Sharpness of allocation outlooks

The ratio of the uncertainty band of the allocation outlooks generated using Method II and Method III are shown in Figure 4. The x-axis shows the different forecast months, and the y-axis shows the forecast issued months. From the results, it is clear to see that most of the ratio values are smaller than 1. Ratios for the first target month are generally smaller than the later months. The ratios also become smaller from the beginning to the end of the irrigation seasons. Overall, it can be seen that the uncertainties in the allocation outlooks using streamflow forecasts (Method II) are sharper compared to climatology forecasts (Method III).

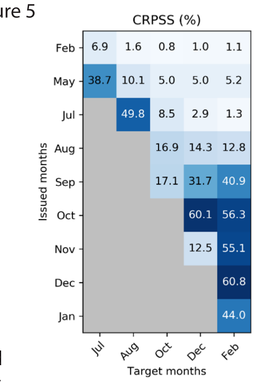
Figure 4



Accuracy of allocation outlooks

The CRPS skill scores of the allocation outlooks using streamflow forecasts (Method II) for the three irrigation seasons are shown in Figure 5. The CRPS skill scores are all positive for different months. This demonstrates that the allocation outlooks using streamflow forecasts are more skillful and accurate compared to using climatology forecasts. The forecasts for the first month and later irrigation seasons are especially skillful.

Figure 5



Conclusion

Results show that the uncertainty, sharpness, and accuracy of the allocation outlooks have been significantly improved when our new method (Method II) is validated over the last three seasons in comparison to other methods.

This work demonstrates the potential of improving water availability forecasts by combining hydroclimatic forecasting expertise together with local system knowledge.

See also: https://hepex.inrae.fr/irrigation-outlook/