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Assessing impact of water allocation, environmental and economic outcomes under climate change and adaptation options: Macquarie catchment case study

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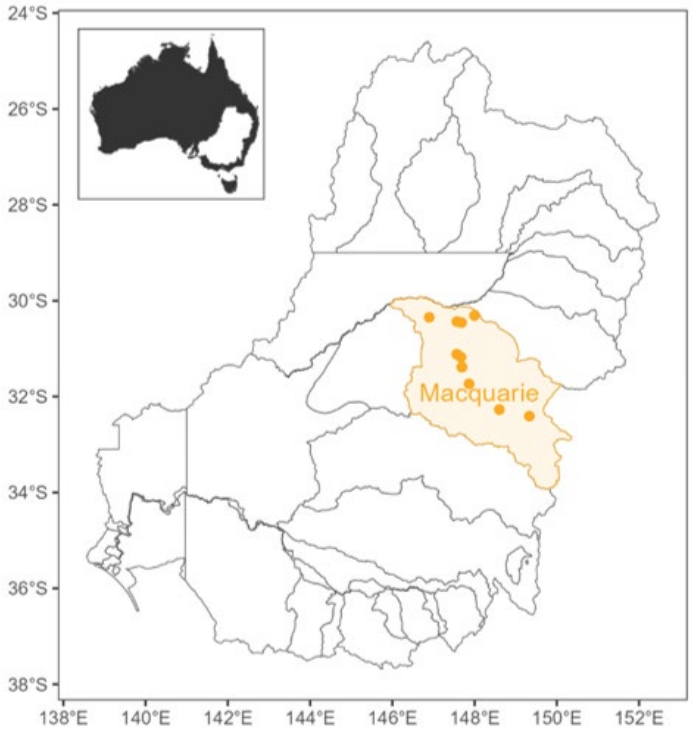
Introduction

Water resources in the Murray–Darling Basin must meet both environmental and economic needs. This poses a significant challenge in the context of climate change. Environmental and economic needs can conflict, which may require tough trade-offs. These decisions should be guided by an understanding of how environmental and economic needs will be affected. This understanding should come from integrated assessments that consider both the environment and economy together, in a way that cause and effect can be identified. These assessments need to address key questions such as:

- how vulnerable are Basin outcomes to flow-related impacts of climate change?
- how effective are available options to adapt to climate change?



We used a case study in the Macquarie catchment to assess our ability to undertake integrated assessments. We examined the combined effects of climate change and climate variability on:

- key ecological values
- irrigated agricultural economic benefits.

We then examined the potential impacts of adaptive management strategies.

Method

We modified existing modelling tools where possible. Using these tools, we modelled hydrology, water allocations, and assessed environmental outcomes under a number of climate scenarios.

We developed a new modelling tool to assess agricultural economic outcomes.

We used these modelling tools to assess six possible climates. Three of the investigated climates are shown in Figure 2. We then tested several options for adapting the volume and delivery of environmental water. For example, this included changing the water flow delivery pattern or timing to improve environmental outcomes. We wanted to see how effective each option would be at reducing the impacts of climate change.

Results

Under severe climate change ecological goals were rarely achieved but economic outcomes were less affected. Annual cropping was most at risk due to its reliance on general security water allocations (see Hot and Dry; Figure 2). In this severe scenario, the general security reliability was very low. Water delivery ability (which declines when dam levels drop below the off-take) and general security resilience (a measure of years with <80% water allocation) were highly variable. This indicates that more and longer periods of low water allocations would occur as well as frequent periods when water would not be able to be delivered to high-security entitlement holders. Under this severe climate change scenario, the investigated adaptation options had little impact.

Under more moderate climate change scenarios (see Just Hot; Figure 2) outcomes were similar to those under historical climate. Here, adjusting flow delivery patterns was as effective at maintaining environmental outcomes as modifying the total licensed volume of environmental water. Adjusting flow delivery patterns also did not negatively affect irrigated agriculture. This suggests that environmental water management can improve ecological results. It can do this while supporting key economic activities under moderate climate change. This highlights the ongoing need for environmental water management.

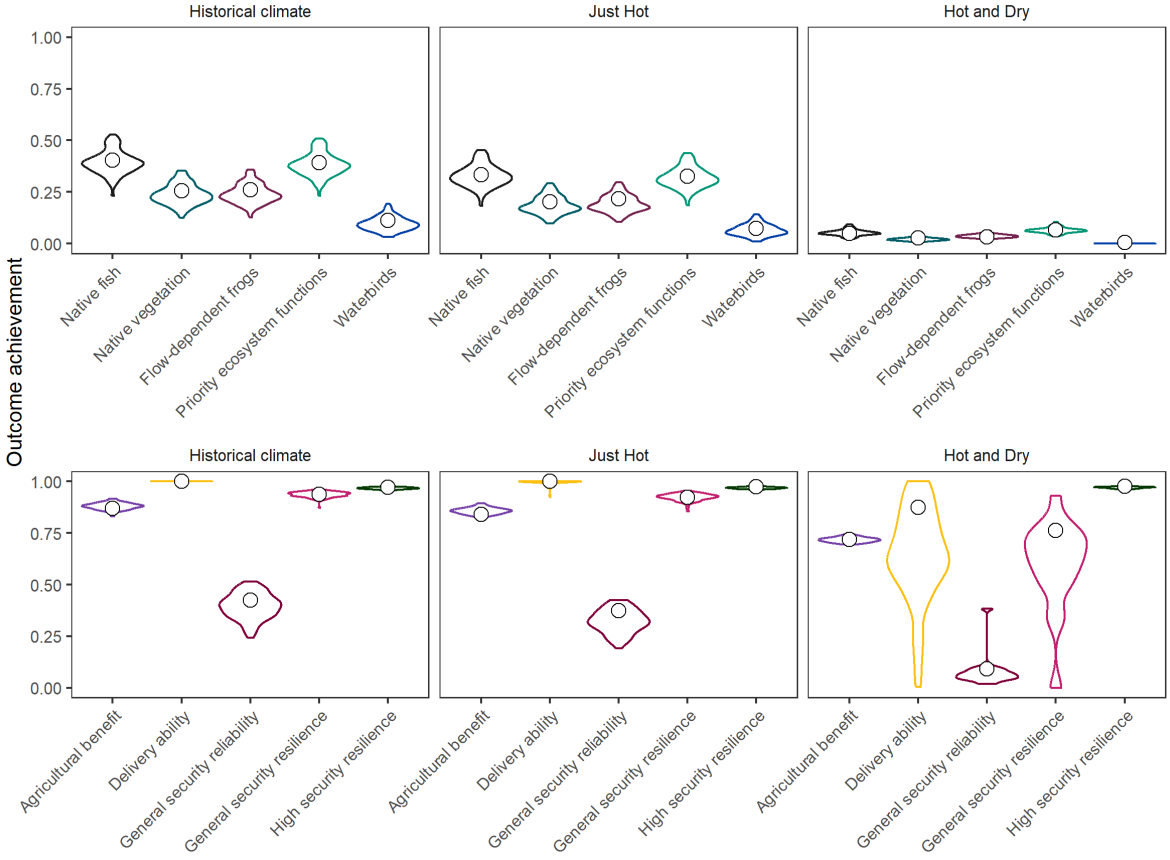


Figure 2. Distribution of environmental outcomes (top) and water allocation and economic outcomes (bottom) for each of three climates. The climates modelled include historical daily rainfall and potential evaporation (Historical), historical daily rainfall with 1.07 times daily potential evaporation (equivalent to 2°C warming; Just Hot) and 0.8 times historical daily rainfall and 1.07 times daily potential evaporation (Hot and Dry).

The dots illustrate the mean for the outcome for that scenario while the violins illustrate the distribution of values over the multiple random runs.

Conclusion

Existing modelling tools enabled the assessment of:

- future climates
- water allocations
- environmental outcomes.

We developed new tools to assess the response of economic outcomes to climate change. This approach could not assess cultural and social outcomes.

We assessed how climate change and variability could affect the Macquarie catchment. We used existing and new modelling techniques to study the impact of climate change on water allocation, the environment, and the economy. We also assessed the effectiveness of options for adaptation. This demonstrates important capability to support the Basin planning process.