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MODELLING TO SUPPORT CLIMATE ADAPTATION IN THE MURRAY-DARLING BASIN, AUSTRALIA

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ABSTRACT

Many models exist to assess the hydrological impacts of climate change. Some models even exist to assess the hydrological impacts of climate adaptation options. There are however a much smaller number of models designed to assess the impacts of climate adaptation options on socio-economics, the community and the environment more widely. A current program of work known as MD-WERP – the Murray-Darling Water and Environment Research Program, seeks to improve the understanding and representation of key processes in models used to underpin Basin analysis and planning. We are working with policy makers and water managers in Australian State and Federal governments to assess the impacts of climate change and climate adaptation options on hydrological, ecological and socio-economic outcomes in the Murray-Darling Basin (MDB). This will allow the Murray-Darling Basin Authority to consider a wide range of adaptation options in the review of the Murray-Darling Basin Plan scheduled for 2026.

1 INTRODUCTION

The vast majority of global climate models, as well as understanding of changes in global and regional circulation patterns suggest a drier future for the Murray-Darling Basin with consequently longer and more extreme droughts. The climate adaptation options to be assessed therefore are primarily those that minimise the impacts of drier conditions on the environment, irrigators and the Basin community, along with models that allow assessments of trade-offs between these disparate water users to be made.

The models that are required to assess these adaptation options need to be diverse, covering not only things such as changes in rainfall and hydrological response, but also climate adaptation options in river system operations, conjunctive use of groundwater and surface water, water trading and allocation, and consequent impacts on the environment, irrigators, basin communities and First Nations groups.

2 METHODS

There are four themes in MD-WERP. The hydrology theme seeks to understand the impacts of climate change on hydrological response, the ecological theme seeks to understand the impacts of climate change on ecology, while the socio-economic theme seeks to understand the impacts of climate change on social and cultural systems. Integral to the entire program however is the climate adaptation theme. This theme seeks to assess the ability of a variety of climate adaptation options to mitigate the negative consequences of climate change (primarily a reduction in water availability) on the quadruple bottom line of ecology, economics, social systems and cultural systems (primarily First Nations groups).

Carrying out this assessment requires a toolkit of models, some of which may be linked, and some of which may stand alone to assess the outcome of climate adaptation options on one particular response variable. Although many such models already exist, not all are currently able to capture the key processes and may therefore require modification to be fit for purpose. A key aspect of the theme therefore is related to investigating and updating the foundational science underpinning these models.

This foundational science project aims to understand and characterise the manifestations of climate change on water supply, demand and management in the MDB, directly through the effects of reductions in rainfall on river flows and indirectly through other threats (e.g. increased threat of bushfire). In 2021/22, the project synthesised the indirect effects of climate change and prioritised detailed investigations, generating plausible hydro-climate futures consistently across the MDB to support an assessment of values and vulnerabilities across the Basin. It also assessed the impact of farm dams on hydrologic response, as well as assessing how the incorporation of these farm dams into hydrological models may improve our understanding of the impact of climate change on hydrology. This aspect will be explored further here.

3 RESULTS

The farm dam analysis first required the generation of a new data set on estimated construction dates of all farm dams. This was done via remote sensing of water bodies which gave the construction date, location, and area of farm dams. A relationship was then developed between farm dam area and farm dam volume based on Malerba et al. (2021).

To assess the impacts of farm dams on runoff, the GR4J rainfall-runoff model, widely used across Australia (Vaze et al. 2011) was calibrated, with and without the addition of the CHEAT1 farm dam model (Cetin et al., 2009). Calibration results showed that under both configurations, 75% of catchments had a Nash-Sutcliffe efficiency (NSE) of greater than 0.6 and an overall bias of less than 5% indicating a reasonable fit to observations. While NSE was similar in both configurations, bias was considerably less when the CHEAT1 model was included, showing that it improves the representation of observed hydrologic response.

Overall, farm dams led to a reduction in mean annual flow of 15% and an increase in low-flow days of 50 days per year, a considerable impact. Under climate change (represented by a reduction in rainfall of 10%) without farm dams included, mean annual flow was reduced by 30-35% and there was an increase in low-flow days of around 30 days per year. The addition of farm dams increased the reduction in mean annual flow by an additional 3% but did not have any additional impact on the number of low-flow days per year.

4 CONCLUSION

The farm dam analysis carried out as part of MD-WERP has generated a new data set on estimated construction dates of all farm dams across the MDB, and also provided new insights on the role of farm dams in intercepting landscape runoff under current and future climates.

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