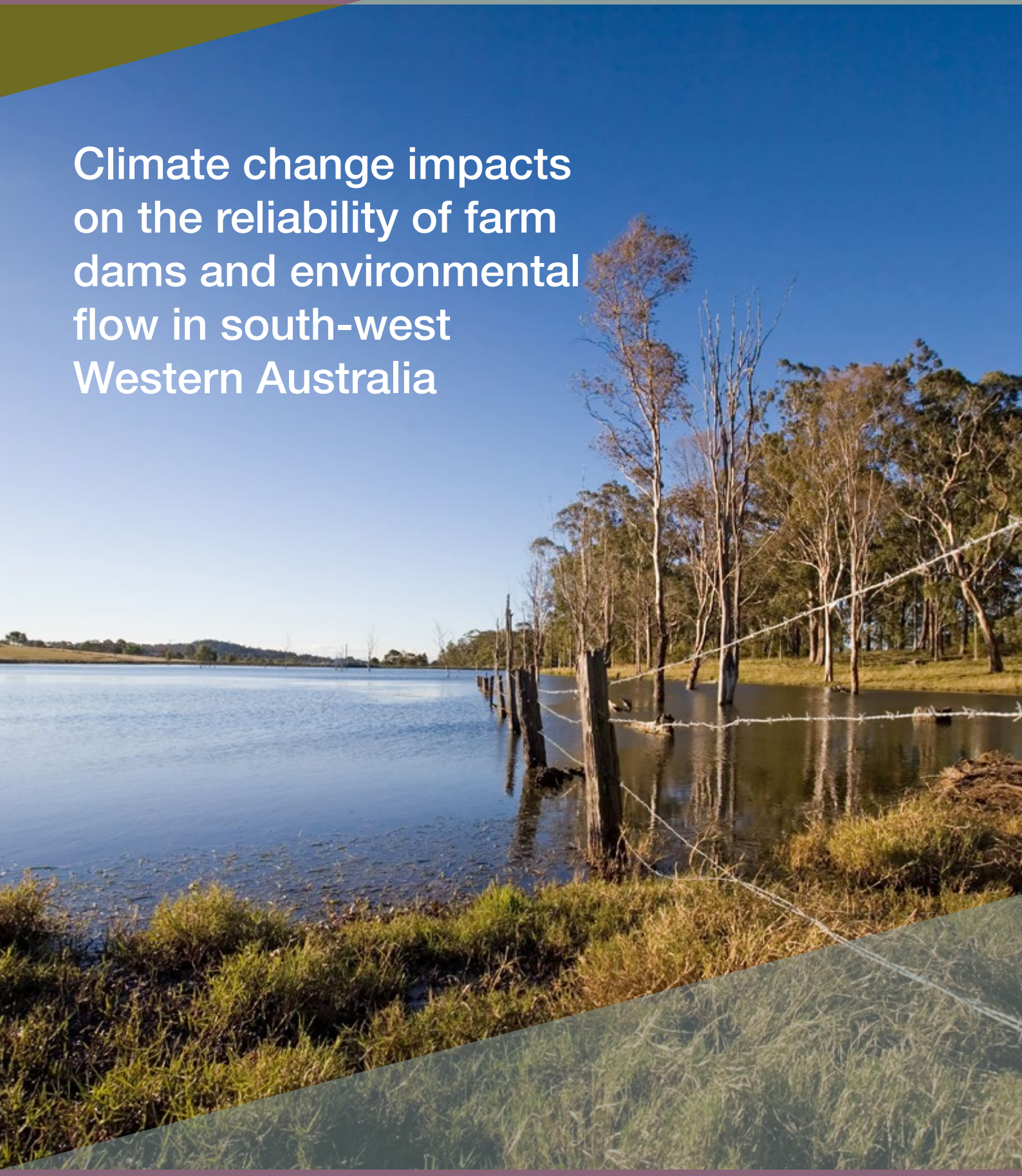
Government of **Western Australia**
Department of **Water and Environmental Regulation**

Earth Systems and Climate Change Hub
National **Environmental Science** Programme

Climate change impacts on the reliability of farm dams and environmental flow in south-west Western Australia



Continued rainfall declines together with a warming climate will increase water stress in south-west western Australia.
Image: iStock.com/timstarkey

> A warming climate, combined with a continued projected decline in rainfall, will decrease water availability in south-west Western Australia.

> Under the dry scenario investigated, fewer dams may be expected to completely fill in all years in the Wilyabrup Brook catchment. A reduction in trickle flows may lead to changes in ecological functions, water quality and water levels in pools.

The climate of south-west Western Australia has experienced a long term drying trend since the 1960s. Climate change projections indicate that rainfall will continue to decline across the region in the coming decades. Together with a warming climate, this will increase water stress in the region.

Long-term planning for water availability therefore needs to rigorously assess a range of plausible impacts of future climate change to better prepare and plan for the ongoing sustainability of south-west Western Australia water resources.

The Earth Systems and Climate Change Hub collaborated with the Western Australian Department of Water and Environmental Regulation to enhance understanding of the reliability of farm dams and environmental flows in the south-west Western Australia Wilyabrup Brook catchment for a range of climate change scenarios.

Knowledge exchange and co-design to support water resource managers

Water resource managers need accurate, up-to-date and fit-for-purpose climate change information. The projected future decline in rainfall on top of the impacts from the drying trend already experienced in south-west WA (SWWA) highlights the importance of considering future climate change in water resource management in the region.

The Earth Systems and Climate Change (ESCC) Hub has engaged with various stakeholders in Western Australia to better identify and understand their information needs.

Notably, researchers in the Hub have worked closely with Western Australia's Department of Water and Environmental Regulation (DWER) to co-design and co-implement an investigation into the reliability of water supply and environmental flow under climate change in the Wilyabrup Brook catchment.

In previous modelling experiments, DWER have explored how increases in farm dam storage might impact reliability of supply to existing farm dams under future climate using scaled rainfall and evaporation data. This co-designed case study expanded on the previous modelling, and investigated how sensitive streamflow and farm dam supplies are to varying patterns of daily rainfall and evaporation under current climate and future climate projections.

The reliability of water supply and environmental flow in the SWWA region is sensitive to a changing climate.
Image: iStock.com/Chien Huey Law

Understanding water futures in the SWWA Wilyabrup Brook catchment area

The Wilyabrup Brook catchment has a high density of self-supply farm dams. DWER use a farm dam model, built in eWater Source, to simulate streamflow into dams and the use and spill of water from farm dams.

The modelling helps DWER understand how often streamflow meets environmental flow thresholds and how often the catchment's farm dams fill.

To understand sensitivity to historical and possible future rainfall and evapotranspiration conditions, ESCC Hub researchers generated one thousand climate model simulations representing the current climate (1981 to 2010) and one thousand simulations representing a range of plausible future climate scenarios (2014-2043). These scenarios encompassed a wide range of rainfall conditions, with selected scenarios used as input to the farm dam model to assess sensitivity to rainfall change.

Figure 1: **Location of the Wilyabrup Brook Catchment.**

Informing water resource management

The climate change scenarios produced in this case study describe a future in which farm dam water supply reliability and environmental water flows are likely to be reduced in the Wilyabrup Brook catchment.

Without adaptive management, these impacts will have consequences for farm productivity and ecosystem health into the future.

The ESCC Hub research using these climate change scenarios validates the rigorous approach taken by water resource managers in the south-west region of Western Australia. It highlights the need for water managers throughout Australia to adequately consider and assess current and future climate risks when managing catchment water availability under a changing climate.

Assessing future reliability of farm dam water supply: key results

A noticeable decline in the proportion of dams filling.

While many farm dams still completely fill each year there is a reduction in the proportion of dams that fill under the future climate scenarios. Up to 30 % of dams fail to reach half their capacity in the driest year under some future scenarios compared to a maximum of 8% for the historical period.

This decline in reliability is particularly noticeable for the driest year of each simulation.

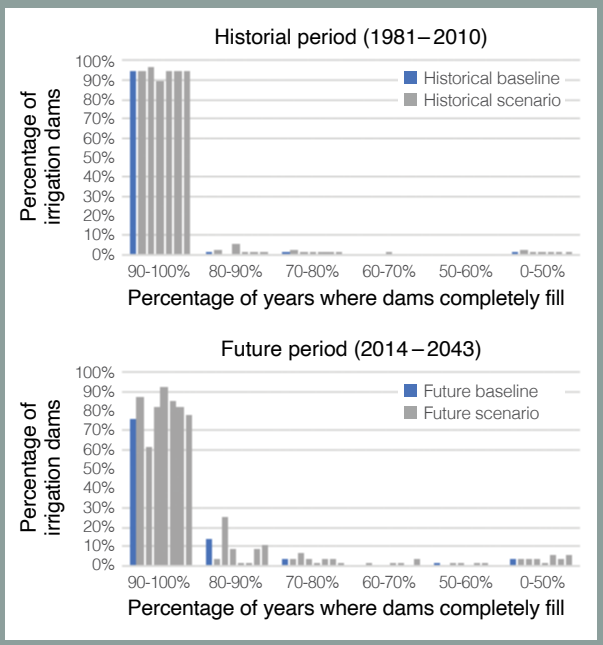


Figure 2: **Noticeable decline in the proportion of dams filling.** The proportion of irrigation dams and the corresponding percentage of years where the dams completely fill for the historical period (top) and the future period (bottom).

Assessing future reliability of farm dam water supply: key results

The number of days with sufficient trickle flow and flow large enough to inundate fringing vegetation is likely to decrease in the future under a warmer climate.

Two thresholds of environmental flow were assessed:

- A trickle flow of 1ML/day and above: This is enough to serve the ecological function of maintaining pool water quality and permanence; and
- A flow of 34.6ML/day and above: This inundates fringing vegetation resulting in the maintenance of water quality (temperature and dissolved oxygen) in the dry season and habitat for macro-invertebrates in the transition between wet and dry seasons.

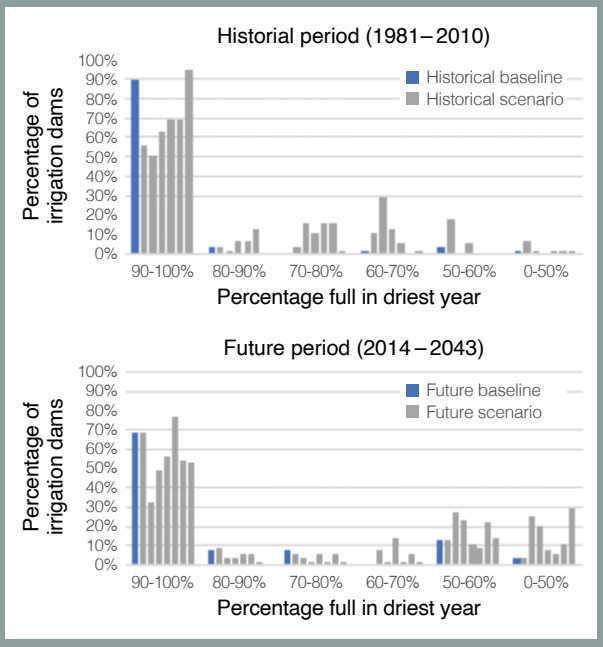


Figure 3 (RIGHT): **More dams fail to exceed 60% capacity in the driest years under future climate scenarios.** The proportion of irrigation dams and the corresponding maximum storage percentage in the driest year of each simulation using empirical and stochastic climate inputs. The historical period is shown on the top, and the future period on the bottom.

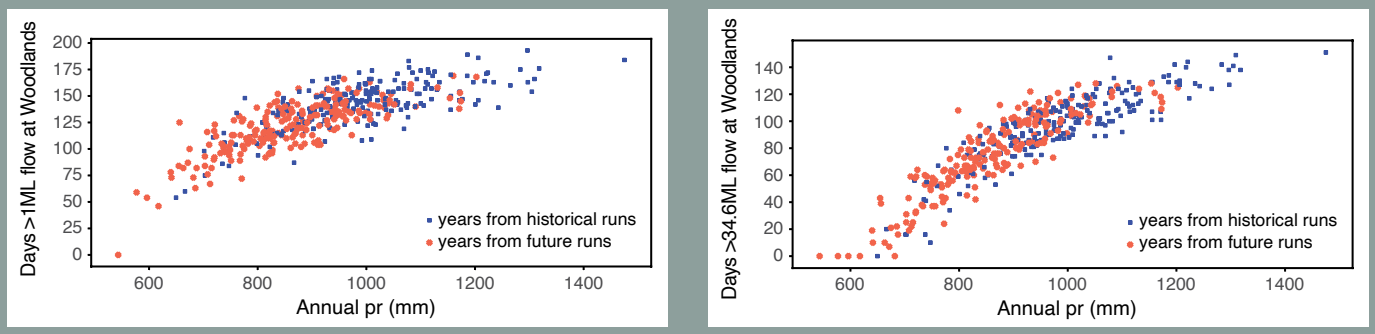


Figure 4: **Trickle flow (1ML/day) and inundation flow (34.6ML/day) are likely to decrease in the future.** Simulated days above 1ML (left) and 34.6ML (right) flow thresholds at the Woodlands stream-gauge point.

>>> FURTHER INFORMATION

- CSIRO and Bureau of Meteorology. 2015. Climate Change in Australia Information for Australia's Natural Resource Management Regions: Technical Report, CSIRO and Bureau of Meteorology, Australia. www.climatechangeinaustralia.gov.au
- Fu GB, Chiew FHS, and Shi X. 2018. Generation of multi-site stochastic daily rainfall with four weather generators: a case study of Gloucester catchment in Australia. Theorical and Applied Climatology, 134. https://doi.org/10.1007/s00704-017-2306-3
- Green A and Donohue R. 2015. Determining the environmental flow for Wilyabrup brook, Department of Water, Government of Western Australia, Environmental Water Report No. 28. https://www.water.wa.gov.au/__data/assets/pdf_file/0004/7960/109746.pdf
- Hope P, et al. 2015. Southern and South-Western Flatlands Cluster Report, Climate Change in Australia Projections for Australia's Natural Resource Management Regions: Cluster Reports, eds. Ekström, M. et al., CSIRO and Bureau of Meteorology, Australia. https://www.climatechangeinaustralia.gov.au/media/ccia/2.2/cms_page_media/168/SSWFLATLANDS_CLUSTER_REPORT.pdf
- Kirono DGC, Round V, Heady C, Chiew FHS and Osbrough S. 2020. Drought projections for Australia: Updated results and analysis of model simulations. Weather and Climate Extremes, 30. https://www.sciencedirect.com/science/article/pii/S2212094720300645
- NESP Earth Systems and Climate Change Hub. 2018. Climate challenges for water resources management in Western Australia: workshop summary. Earth Systems and Climate Change Hub Report No 6, NESP Earth System and Climate Change Hub, Australia http://nespclimate.com.au/wp-content/uploads/2016/03/NESP-ESCC-Hub-SWWA-workshop-report-July-2018.pdf

Highlighting the utility of climate change projections

While this co-produced analysis concentrated specifically on assessing future reliability of farm dam water supply in the Wilyabrup Brook catchment in SWWA, it showcases how climate change projections can be used more broadly in conjunction with decision-makers to delve deeper into specific climate risks identified as high priority. This information can then be incorporated into decision-making and management activities to better prepare for the future under a drying and warming climate.

This research was led by ESCC Hub **Project 5.4: Water futures under climate change**

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