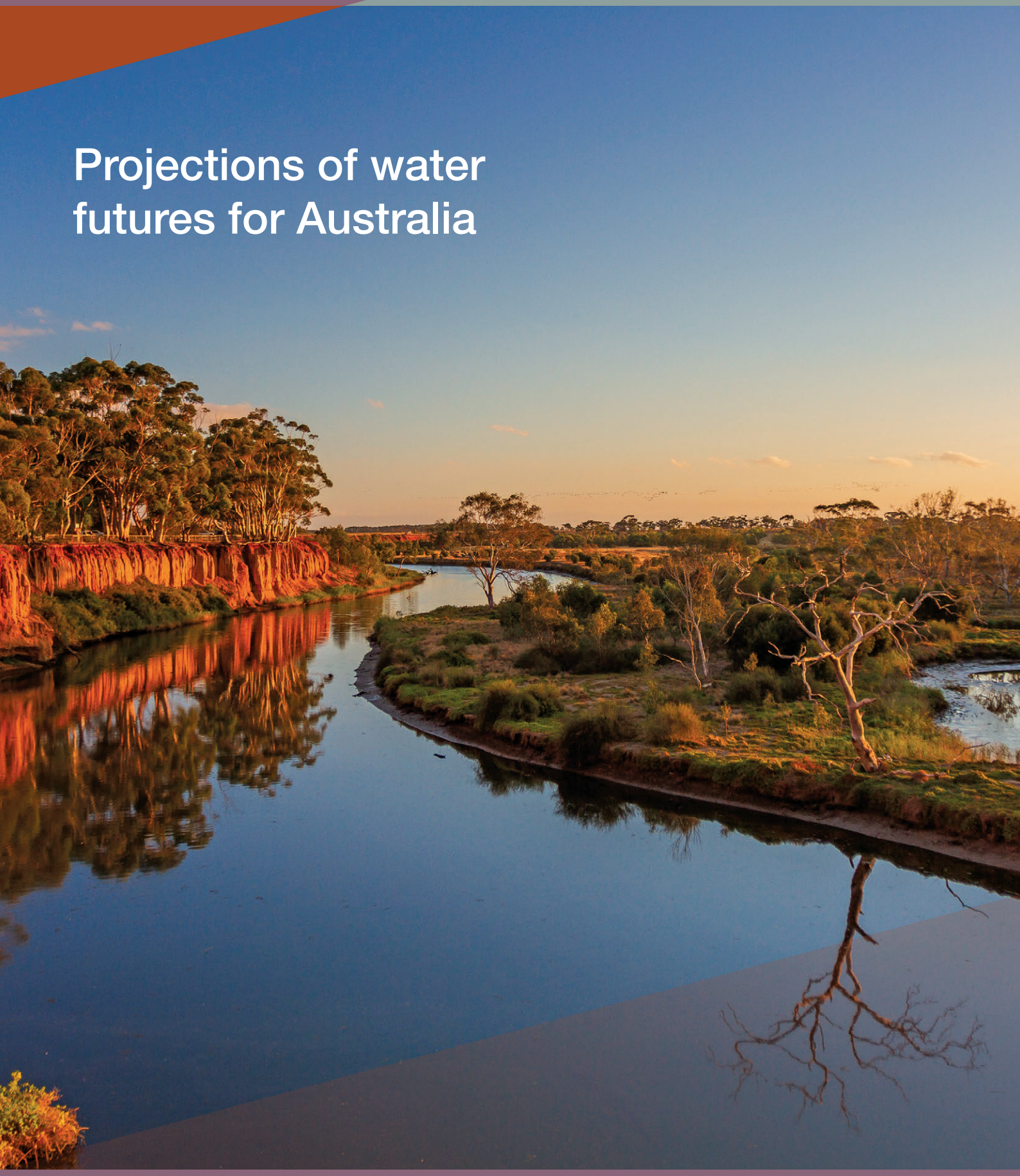
Earth Systems and Climate Change Hub

National Environmental Science Programme

Projections of water futures for Australia



Rainfall patterns are likely to change under a warmer climate, with consequences for water resources and river flows across Australia.
Image: iStock.com/Troy Longson

> Rainfall amounts and patterns are likely to change in Australia under a changing climate. This change will be amplified in catchment runoff and streamflow.

> Climate change projections of water futures can inform impact assessments, adaptation and investment options in the water sector.

> Determining which water variables are most important for use in water resource management ensures updated water future projections are appropriate for water management applications.

For many Australians, the future is going to be hotter and drier. Decision-makers across communities, agriculture, industry and the environment need to understand how climate change will impact future rainfall, temperature, evaporation and runoff to plan and manage their water resources accordingly.

Robust projections of water futures are one way climate change science can help inform impact assessments, adaptation and investment options in the water sector.

Researchers in the Earth Systems and Climate Change Hub have established an integrated climate-water modelling framework that will inform the development of the next generation of national projections of key surface water and drought metrics.

Updated water resource and hydrological projections for decision-makers

Under a changing climate we can expect warmer temperatures with more extreme hot days, more extreme fire danger weather days and higher evaporation demand.

Rainfall amounts and patterns will also change, for example southern Australia will experience less winter rainfall, but more intense short-duration extreme rainfall. This change will be amplified in catchment runoff and streamflow resulting in significant impacts on water resources and river flow characteristics.

To help the water and related sectors adapt and respond to these challenges, researchers at the Earth Systems and Climate Change (ESCC) Hub have updated existing projections of water resource (or water availability) and have developed projections of hydrological characteristics across Australia.

These projections are sourced from hydrological modelling informed by outputs from the global climate models used in the national climate change projections, produced by CSIRO and the Australian Bureau of Meteorology.

The new projections will enable water and related industries to routinely access, interpret and incorporate hydroclimate projections to inform better planning, management and investment decisions.

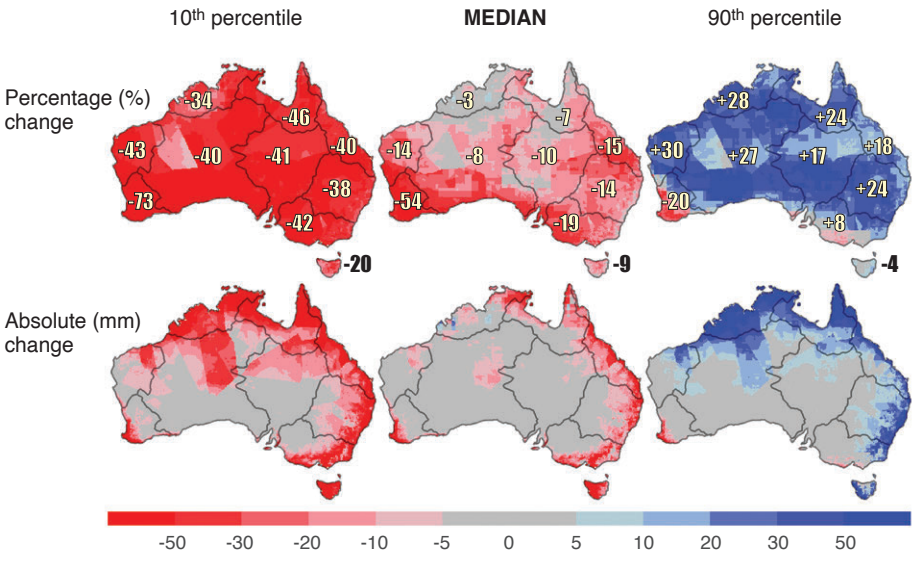


Figure 1: **Water future projections in action: Projected changes to mean annual runoff across Australia.** Median and 10th to 90th percentile range (i.e. 80 percent of the model results are in this range) are shown for a high emissions scenario (RCP8.5) for the period 2046–2075 relative to 1976–2005 for both percentage change and absolute change. Red colours indicate areas of Australia which will experience less runoff, while blue areas are projected to experience increased runoff.

Projections of drying in southern Australia

Recent observations show a current drying trend in southern Australia which is partly attributed to human-induced climate change.

This trend is particularly evident in the cool season when most of the runoff in the south occurs. Projections indicate this drying trend is likely to continue into the future.

This decline in future rainfall will be amplified in the percentage decrease in runoff in the region and accentuated by higher potential evapotranspiration. As a result, the gap between water supply and water demand will increase in southern Australia. Despite this clear background drying trend in southern Australia, climate variability will remain high in both southern Australia and across Australia into the future, with wet and dry years continuing to occur.

The observed drying trend in southern Australia is projected to continue into the future.
Image: iStock.com/itpow

Navigating hydrological metrics

Hydroclimate metrics are quantitative indices that are intended to capture key features of a hydrological system.

When calculated over multiple years, these metrics can inform monitoring of water system performance, evaluation of resource availability, vulnerability of ecosystems and communities, and assessment of climate and hydrological model skill. Consequently, there are a variety of hydrological metrics (beyond just the long-term averages) which are important for both water resource management and climate change impact research.

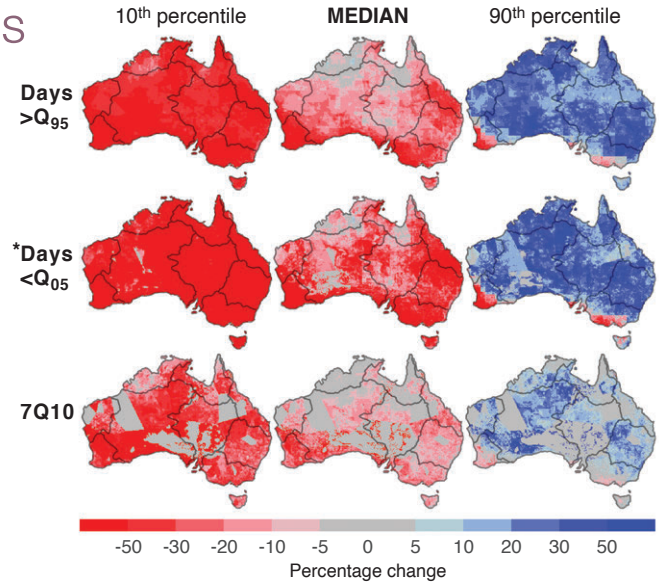
These metrics can be categorised into groups related to timing (e.g. snow melt onset), magnitude (e.g. maximum daily flow), extreme values (e.g. top percentiles of daily flows), variability (e.g. dry and wet years and multi-years), duration (e.g. low flow spells), and service and performance (e.g. change in water demand and supply).

With so many metrics available for use in climate projections of water futures, the challenge for researchers is to determine which metrics to deploy. To help simplify this challenge, Hub researchers conducted a review of the key variables used in water resource management. From there, they engaged with stakeholders from the water management sector to identify which key metrics were of value. Researchers then developed projections for some of these key hydrological metrics, including daily runoff percentile change, high flows and overbank inundation, drought frequency and time spent in low flows. These metrics were identified as particularly important for a range of applications, including river level threshold for pumping, water quality and river health and ecosystem function.

Water future projections

Under a warmer climate, Australia can expect:

- Higher temperatures and evaporation demand across the whole of Australia.
- More frequent and severe drought, particularly in southern Australia.
- A significant reduction in streamflow in southern Australia due to the decline in cool-season rainfall.
- A decline in mean annual runoff for south-east Australia (with the median projection indicating about a 20% decline for a 2°C average global temperature increase).
- Significant reduction in all streamflow characteristics in southern Australia – even more so for the low flow characteristics.
- Rainfall variability will remain high, with wet and dry years continuing to occur against a background drying trend.
- The direction of rainfall and runoff change is uncertain in northern Australia.
- Short-term extreme rainfall will become more intense, increasing flood risk in built-up urban areas and in northern and eastern Australia.



*For **Days<Q_{05}** the positive and negative in the scale is reversed so that red colours reflect an increase in the number of days with runoff less than Q_{05}

Q_{95} is the 95th percentile daily runoff and is a high flow indicator.

Q_{05} is the 5th percentile daily runoff and is a low flow indicator.

7Q10 is the lowest 7-day flow that occurs on average once every ten years.

Figure 2: **Projected change in high flow and low flow characteristics across Australia.** Median and 10th to 90th percentile range is shown for a high emissions scenario (RCP8.5) for the period 2046–2075 relative to 1976–2005.

Boosting water resources planning

The projections of water futures produced under the Earth Systems and Climate Change (ESCC) Hub are already informing impact assessments and development of adaptation options in the water and related sectors.

These include assessments of the impact of declining water resources on competing uses in south-eastern Australia, the impact of climate change on water resource development in northern Australia and vulnerability assessments in south-west Western Australia.

Research under the ESCC Hub is also informing the development of the next generation of national hydroclimate projections. These will utilise information from new global climate model runs produced for the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report, coordinated regional climate downscaling and improved hydrological models for impact assessments.

Despite advancements in climate change and climate-water modelling sciences, a large range of plausible future hydroclimate projections for Australia is likely to remain. This will bring challenges to water resource managers and decision makers as they look to manage Australia's variable water resources across our ecosystems, industries and communities.

Managers will need to consider a range of plausible water futures and develop management options that balance the cost of adaptation versus the risk from not adapting sufficiently and fast enough. It is therefore more important than ever that water resource managers and decision makers use climate change projections of Australia's water futures to make climate smart decisions.

>>> FURTHER INFORMATION

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- Additional details on water futures under a changing climate are available from the ESCC Hub website: http://nespclimate.com.au/water-resources-under-a-changing-climate-project-5-4/

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