Water futures under climate change and implications for irrigated agriculture in Australia

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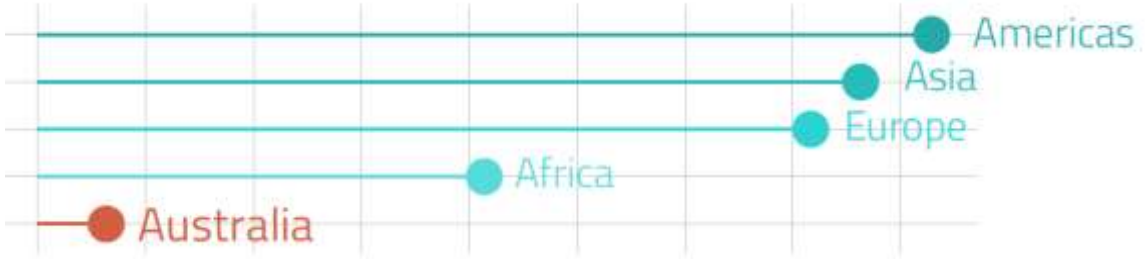
Talk Outline

- Australian hydroclimate and water resources characteristics.
- Future droughts and water availability in Australia.
- Implications on irrigated agriculture.
- Adaptation challenges and opportunities.

Driest inhabited continent

Water Availability

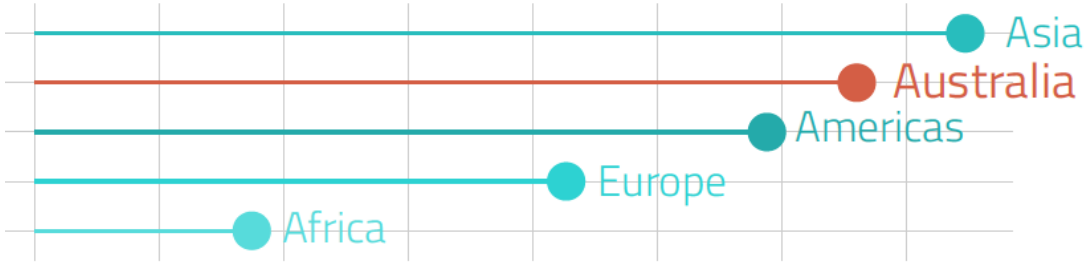
Annual streamflow per km^2



Highest per capita water use

Water Use

Daily consumption per capita

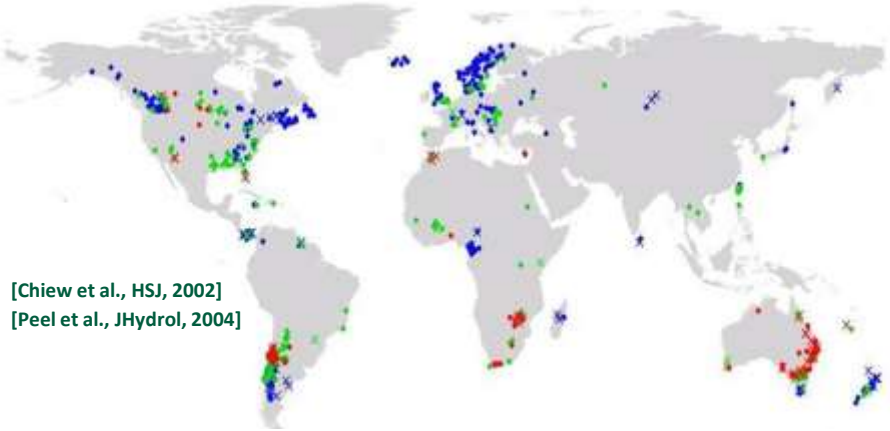


Rod Marsh for the Ian Potter Foundation and The Myer Foundation 2019
Sources: FAQ Aquastat and Chiew et al. (2006, 2007)

Australian hydrology is different

- Low runoff coefficient
- High inter-annual variability
- Reasonable predictability

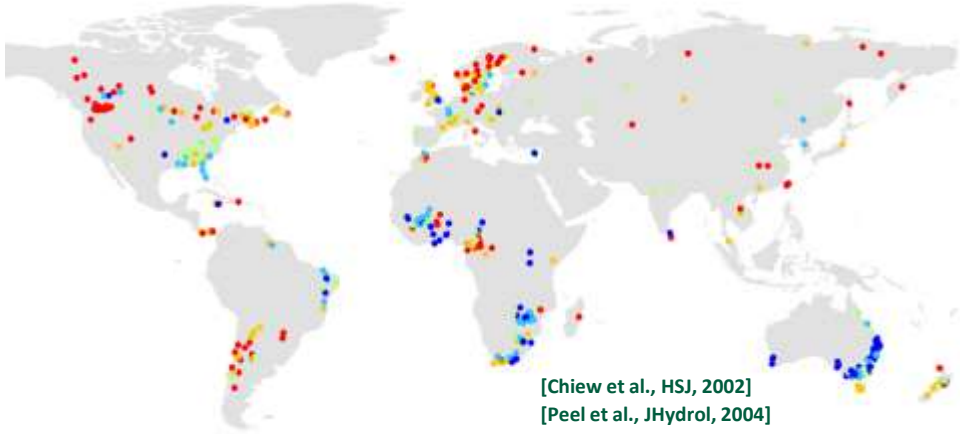
- Large amplification of rainfall change in runoff



[Chiew et al., HSJ, 2002]
[Peel et al., JHydrol, 2004]

Inter-annual variability
- low variability
- medium variability
- high variability

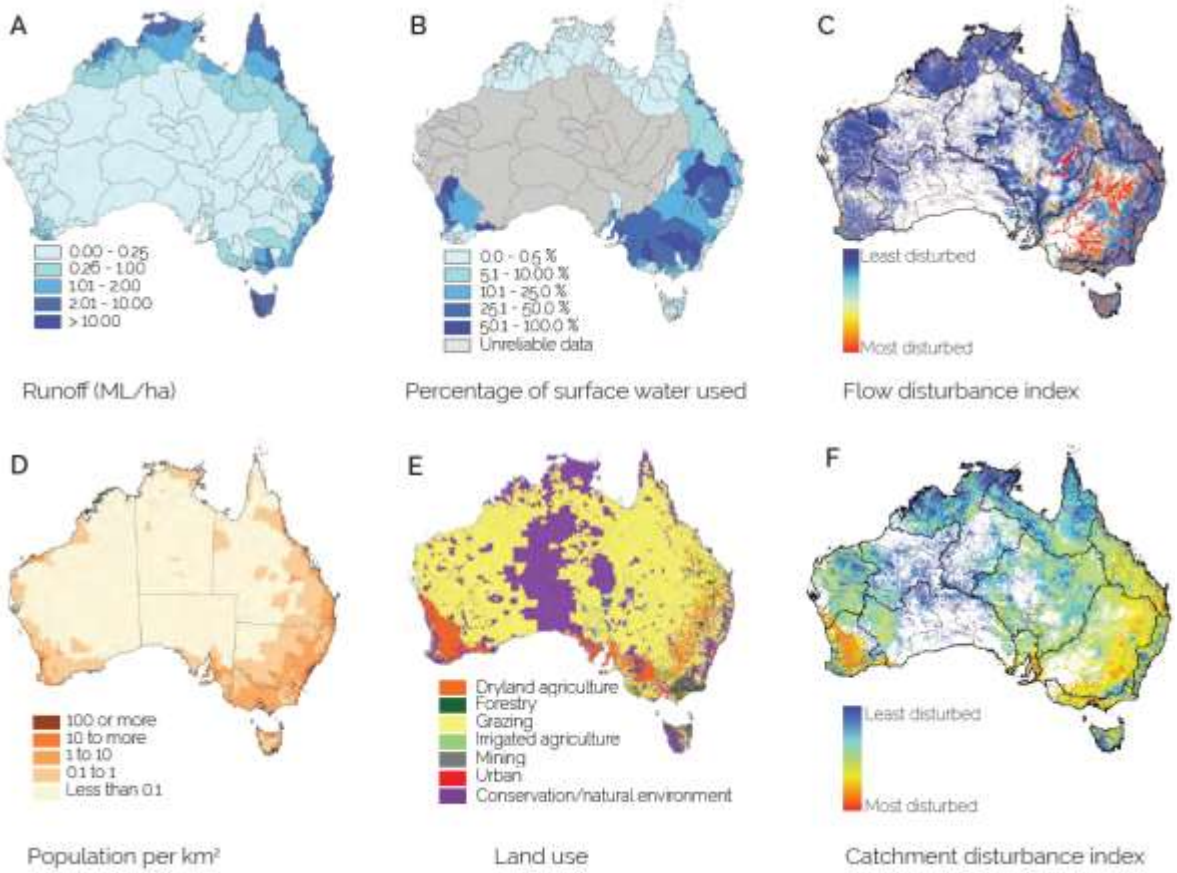
ENSO-streamflow teleconnection
- little teleconnection
- x strong teleconnection



[Chiew et al., HSJ, 2002]
[Peel et al., JHydrol, 2004]

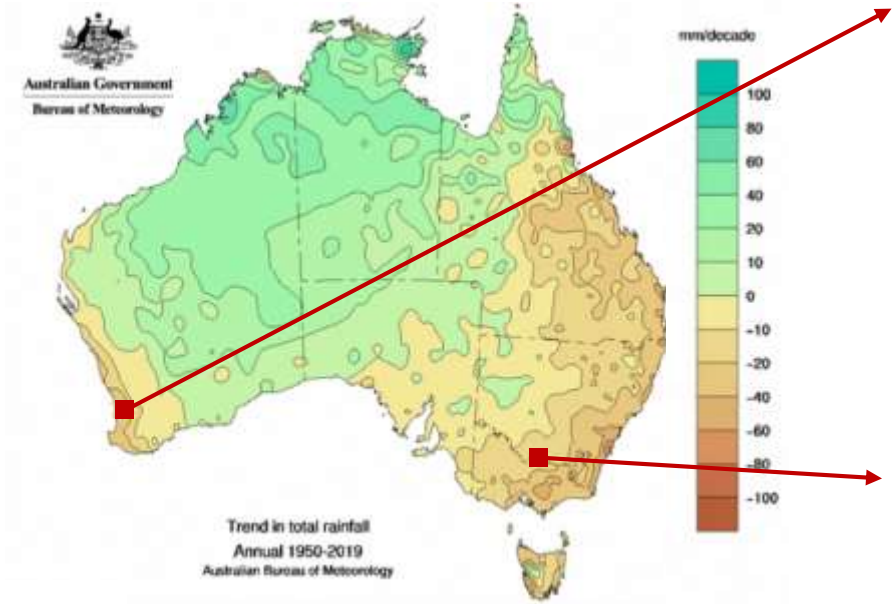
Rainfall elasticity of streamflow
- < 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- > 2.5

Water availability and water use in Australia



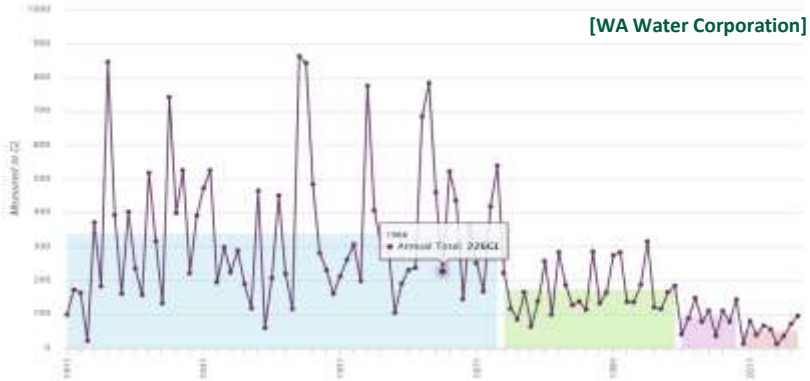
Drying trend ….. amplified in the streamflow

Rainfall trend (1950 to present)



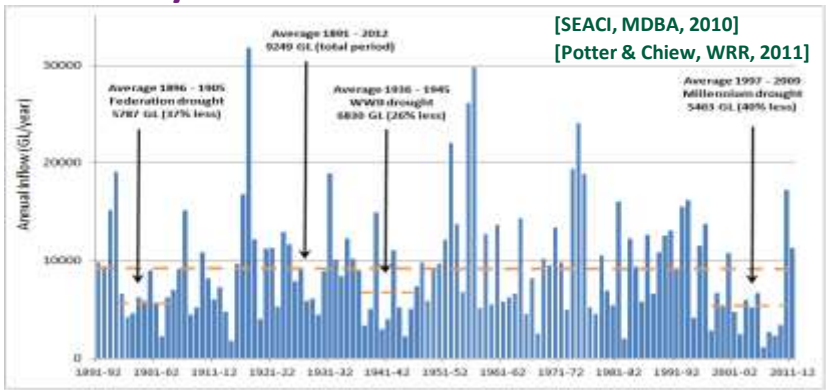
Inflows to Perth Dams

[WA Water Corporation]

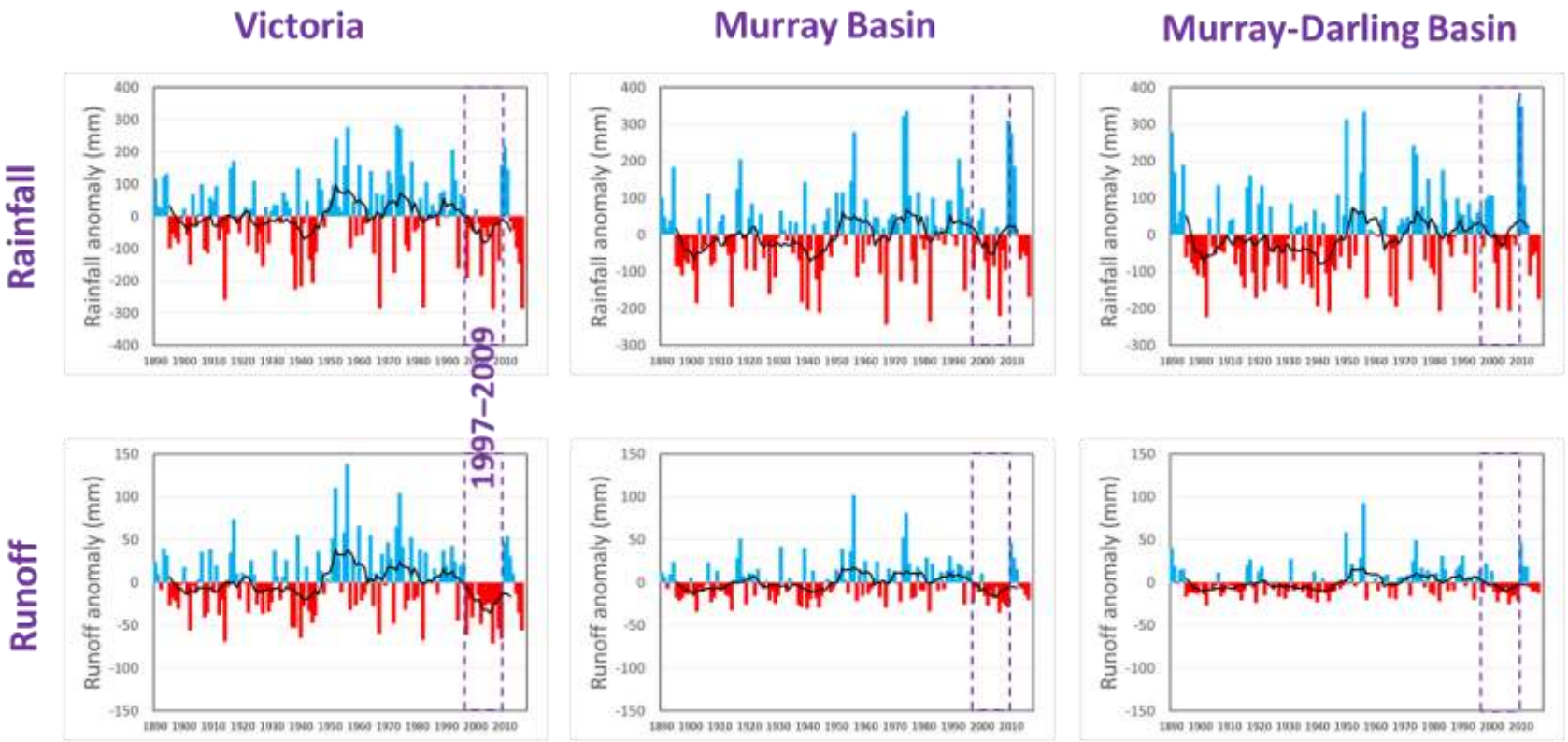


Murray River Basin inflows

[SEACI, MDBA, 2010]
[Potter & Chiew, WRR, 2011]



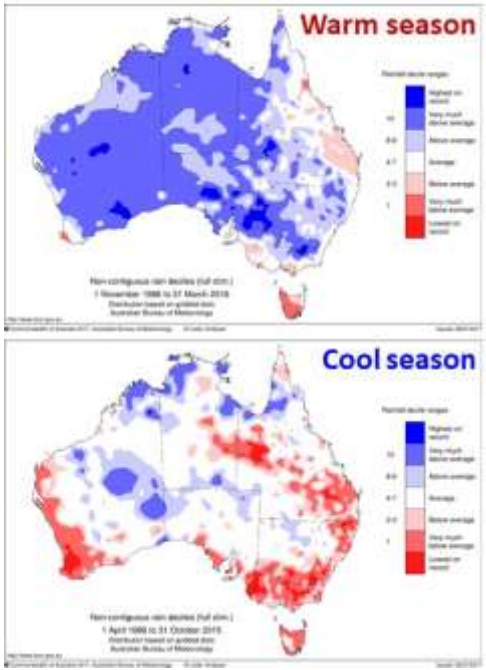
Hydroclimate variability and the Millennium drought



[Zheng et al., 2019]
[Whetton & Chiew, MDB Book, 2020]

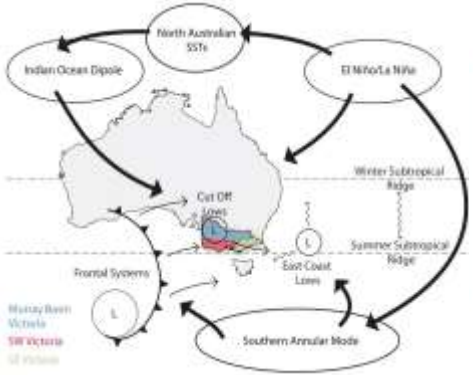
Declining winter rainfall and water availability in south-east Australia

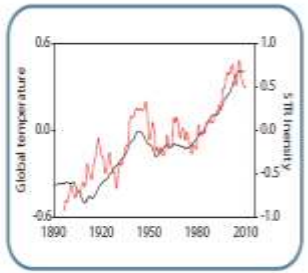
Rainfall Decile (1986–2015 relative to long-term average)



[SEACI, 2012]
[Hope et al., VicCI, 2016]
[Potter & Chiew, WRR, 2011]

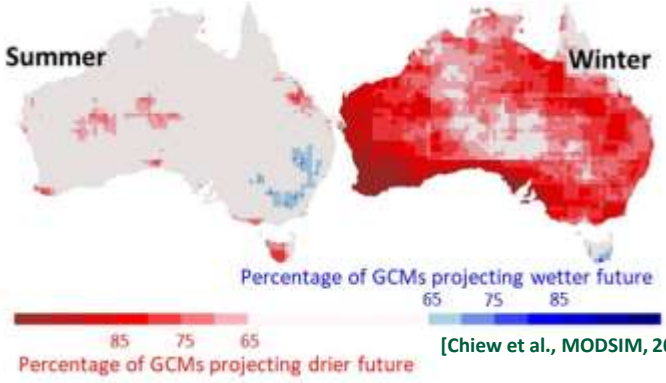
Expansion of Hadley cell and poleward shift in winter rainfall systems





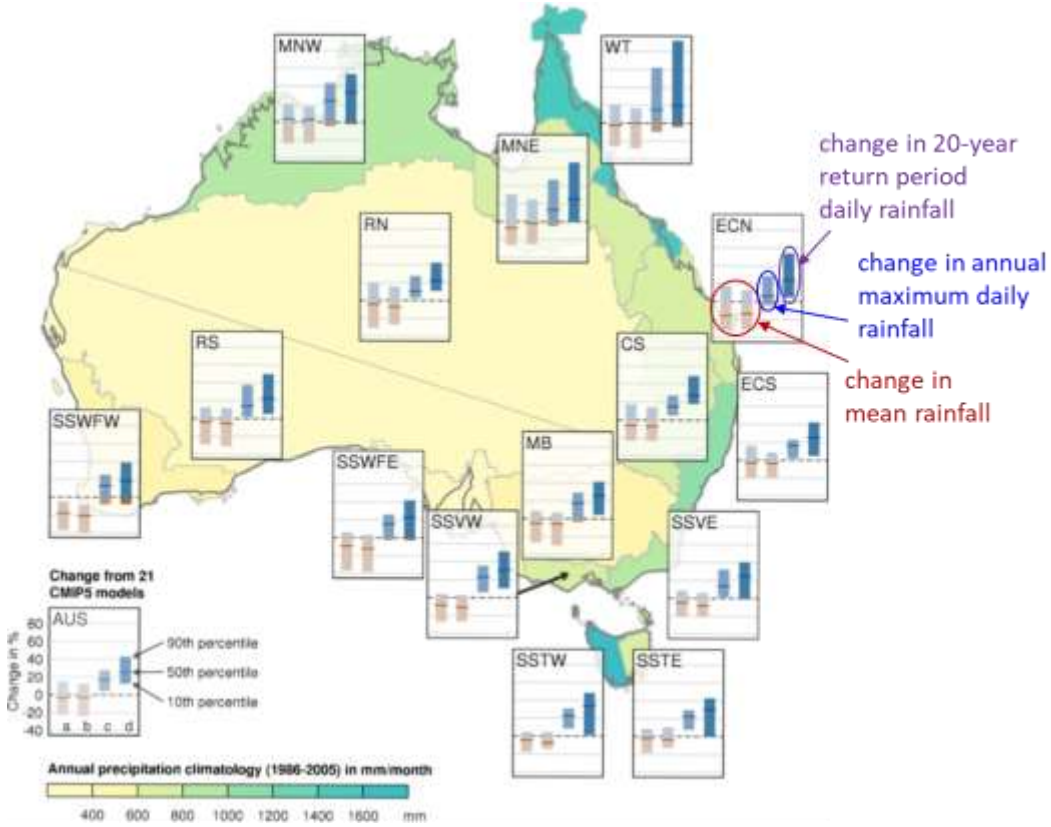
[SEACI, 2012]
[Timbal & Hendon, WRR, 2011]
[Post et al., Earth's Future, 2014]

Direction of change in future rainfall projected by 42 CMIP5 GCMs



[Chiew et al., MODSIM, 2017]

Projected changes in rainfall

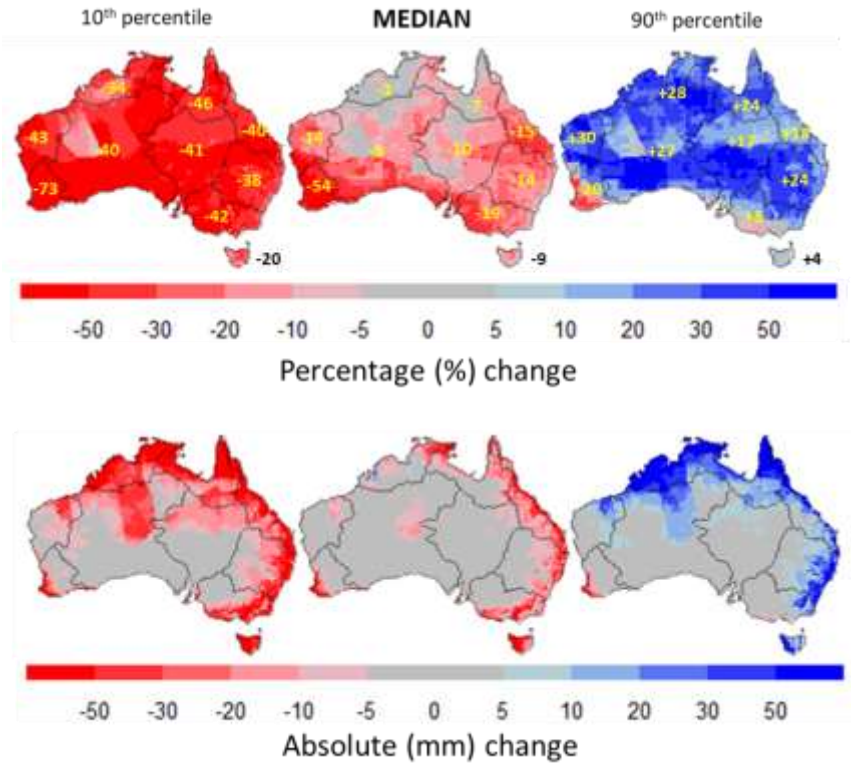


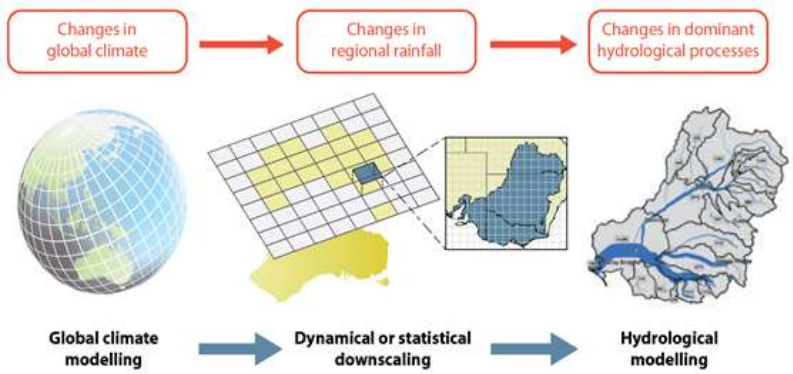
2080–2099 relative to 1976–2005 for RCP8.5 [NRM projections]

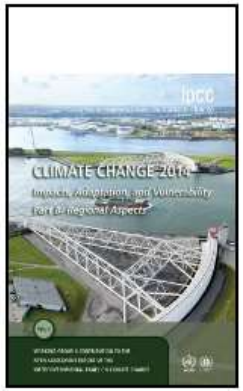
[CSIRO and BoM, NRM Projections, 2015]
www.climatechangeinaustralia.gov.au

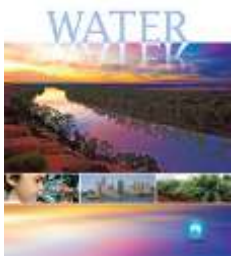
Future runoff projections for Australia

Change in mean annual runoff for ~2°C global average warming (relative to 1986–2005)









[Chiew et al., WRR, 2009]
[Chiew & Prosser, Water Book, 2011]
[Teng et al., JHydrometeorol, 2012]
[Zheng et al., MODSIM, 2019]

Climate change impact on global runoff

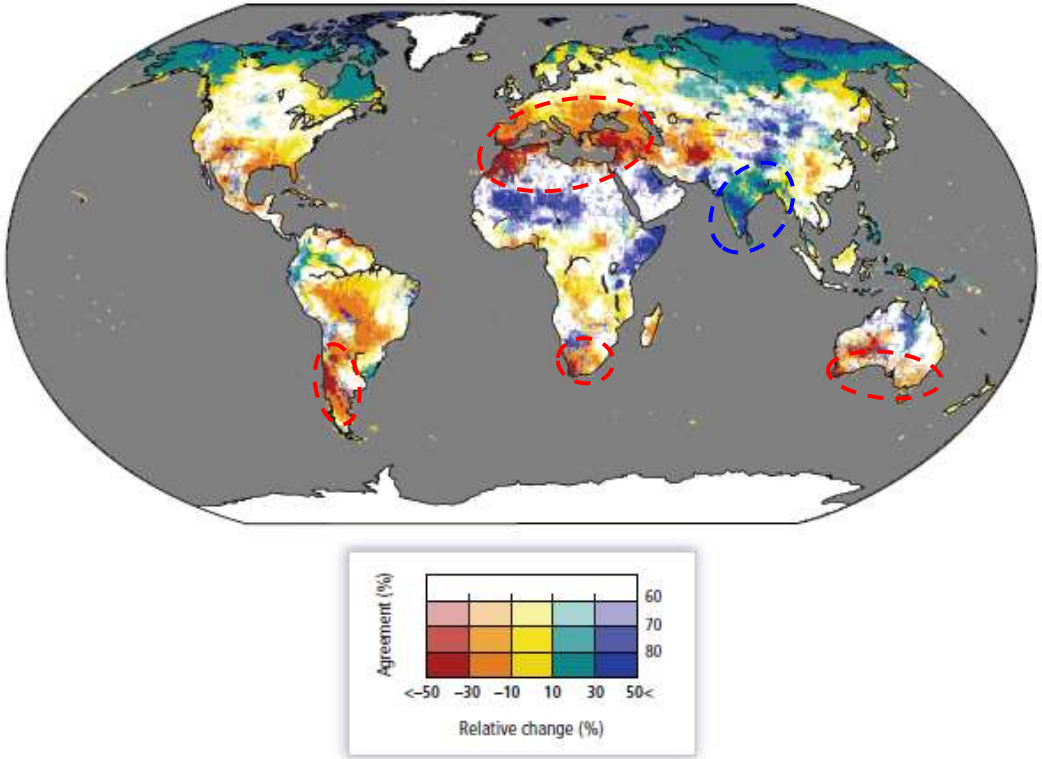
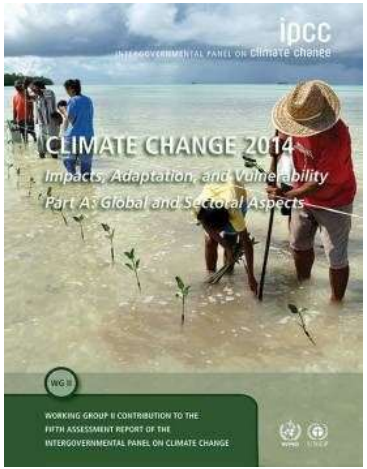
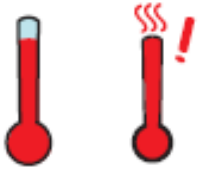


Figure 3-4 | Percentage change of mean annual streamflow for a global mean temperature rise of 2°C above 1980–2010 (2.7°C above pre-industrial). Color hues show the multi-model mean change across 5 General Circulation Models (GCMs) and 11 Global Hydrological Models (GHMs), and saturation shows the agreement on the sign of change across all 55 GHM–GCM combinations (percentage of model runs agreeing on the sign of change) (Schewe et al., 2013).



[IPCC AR5 WG2 Chapter 3 on Freshwater Resources]

Climate change impact on agriculture



Higher temperature and more very hot days may increase heat stress.
Reduction in number of cold days may lead to inadequate winter chilling.

Higher temperature will increase irrigation water demand.

Higher extreme storm intensity may increase damage to crop and infrastructure.

Higher CO_2 will increase yield but may reduce quality.

Decline in water availability and more severe drought spells (where/when this happens) will significantly impact agriculture.

Policies and investments in water reform

Improving irrigation water use efficiency

Real-time hydrometeorology

Water trading shifting water to higher value use

[Kirby et al., 2013]

BoM Water Information

[BoM, 2016]

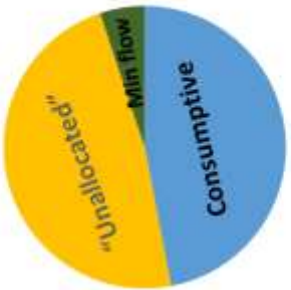
Augmenting water supply

Water buyback for the environment

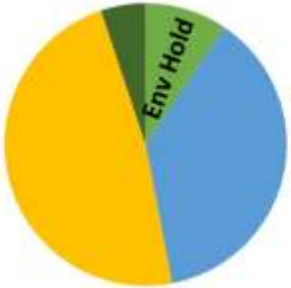
[MDBA, 2011–2014]

Climate change, water availability, and water use

Water availability and water sharing



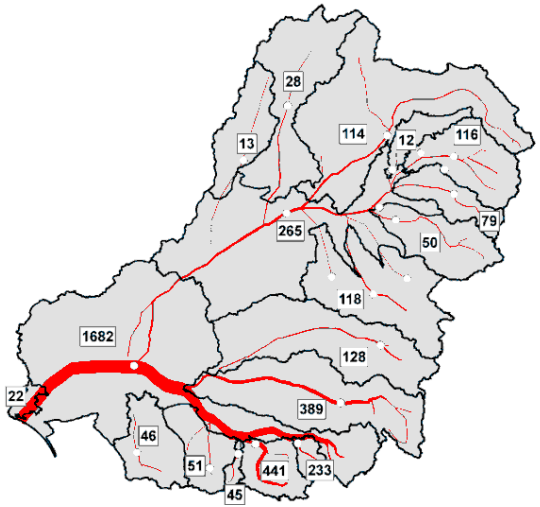
Pre-Basin Plan



Basin Plan

Basin Plan under climate change?

Decline in water availability is potentially greater than the volume of water recovered for the environment under the Basin Plan.



Summary – Challenges and opportunities

"Transformative adaptation" National Outlook

Market instruments, Policies

Innovation in irrigated agriculture

- Enhanced water use efficiency
- Enhanced crop breed
- New technology
- Better agriculture practice/mix

Thank you

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