

**Exploring the Risks and Impacts of
Climate Change on Australia:
Sectoral impacts
Land, Water and Nature**
*Australian Climate Roundtable
19 March 2020*



Topics

Time	Topic
09:00 am	Start
09:05 am	Welcome, Overview and Purpose
09:15 am	Climate change impact: Australia's water resources and dependent systems: Dr Chantal Donnelly, Leader, Water Investigations team, Bureau of Meteorology
09:35 am	Questions re: Presentation 1
10:00 am	Climate change impact: Australia's agricultural and natural systems: Professor Lesley Hughes, Department of Biological Sciences, Macquarie University
10:20 am	Questions re: Presentation 2
10:40 am	BREAK – mute if you keep Skype running
11:00 am	Facilitated discussion: Implications for the Australian Climate Roundtable
12:00 pm	Close

Overview and Purpose



Climate Change impacts on Water in Australia

*Chantal Donnelly, Bureau of Meteorology, March 2020
with thanks to Francis Chiew, CSIRO.*



Australian Government
Bureau of Meteorology

Contact: Chantal Donnelly
Chantal.donnelly@bom.gov.au

Talk Outline

1. Why is Water Important?
2. Australian hydroclimate and water resources characteristics
3. Across the water balance: What have we observed and what is projected ?
 - Rainfall, soil moisture, streamflow, flooding, flash flooding, groundwater
4. What might that mean for water impacted activities?



What's so important about water?

- *Supports life!*
- Extinguishes fires
- Supports industries
- Supports ecosystems
- Supports recreation, tourism
- Supports resources extraction
- Supports energy systems – cooling water
- Supports agriculture – dryland and irrigated
- Supports people – urban and rural drinking water supply

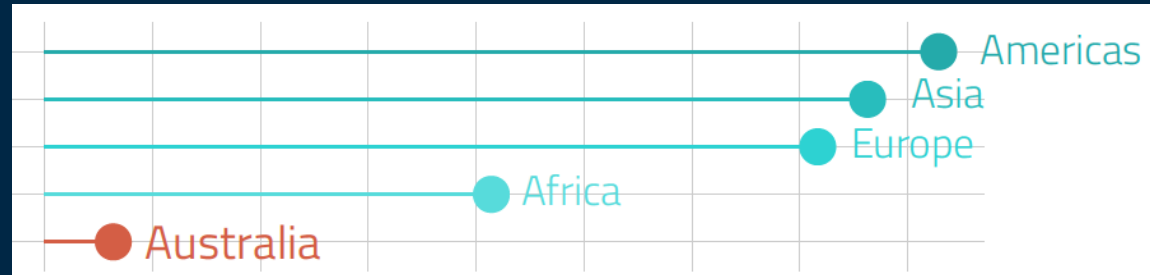




Australian Hydroclimate

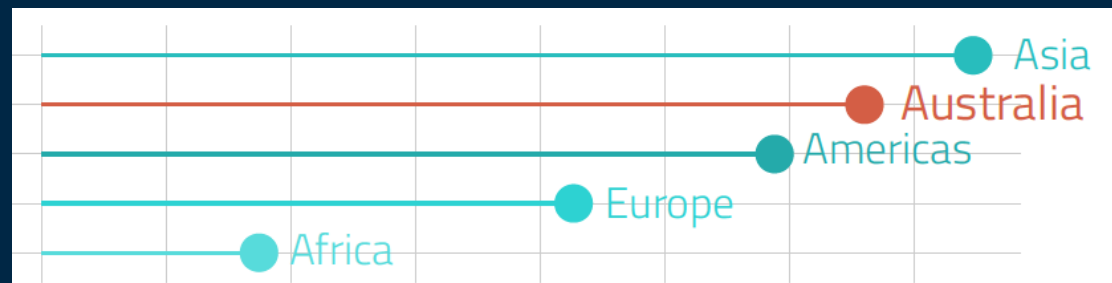
Driest inhabited continent

Water Availability
Annual streamflow per km²



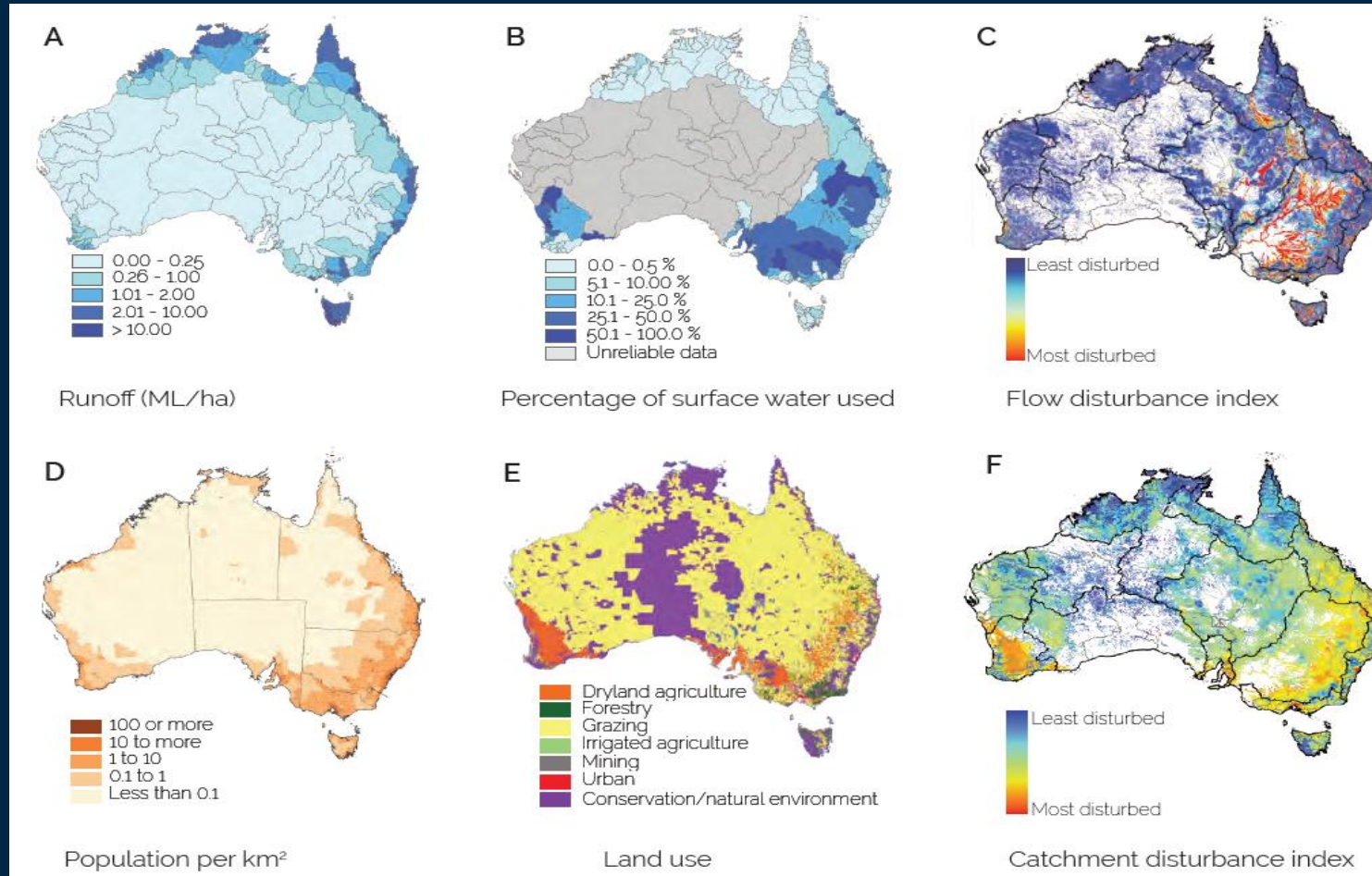
Higher per capita water use

Water Use
Daily consumption per capita



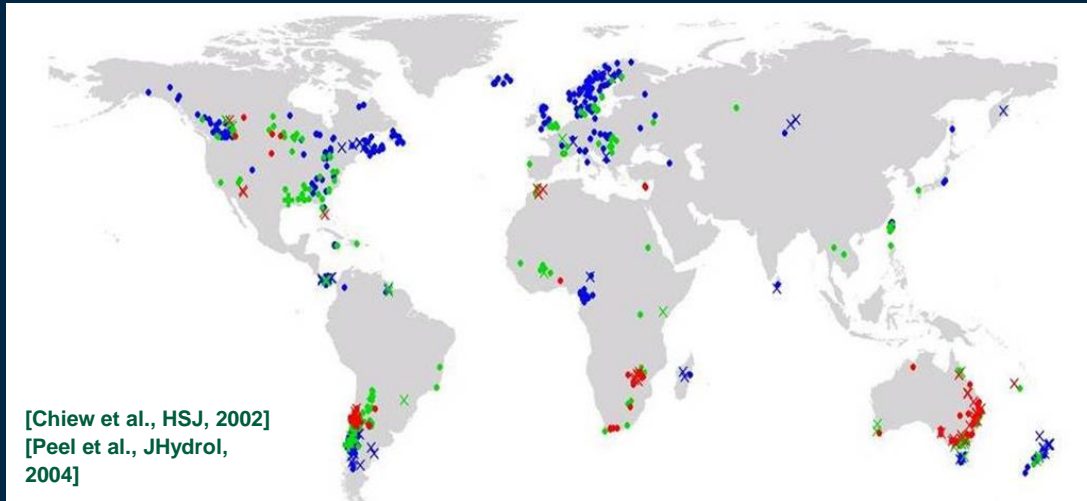


Australian Hydroclimate





Australian Hydroclimate



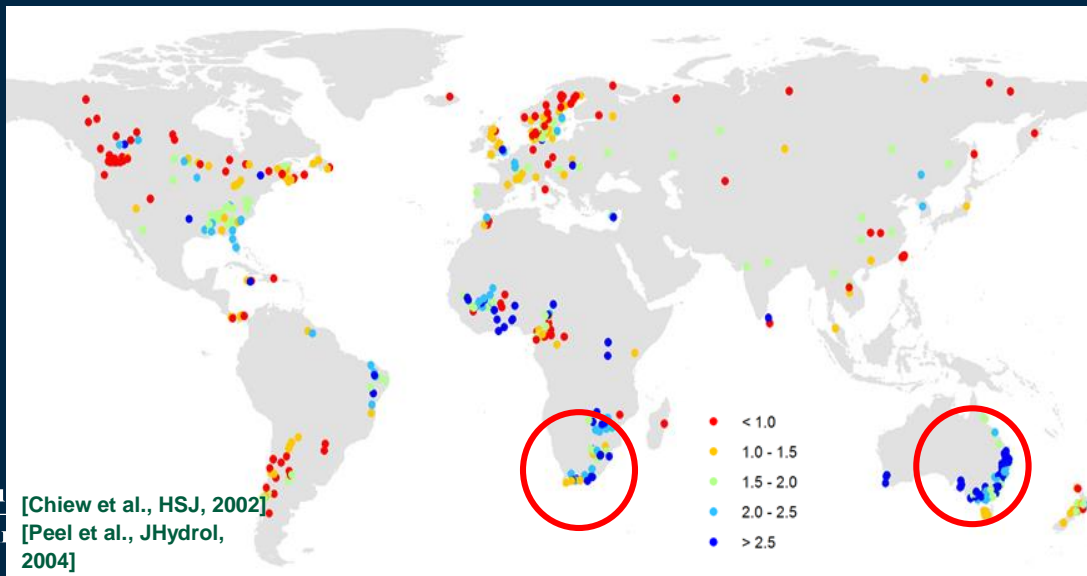
How different are our river flows from year to year?

Inter-annual variability

- low variability
- medium variability
- high variability

ENSO-streamflow teleconnection

- little teleconnection
- x strong teleconnection



How is a change in rainfall reflected as a change in streamflow?

Rainfall elasticity of streamflow

- < 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- > 2.5



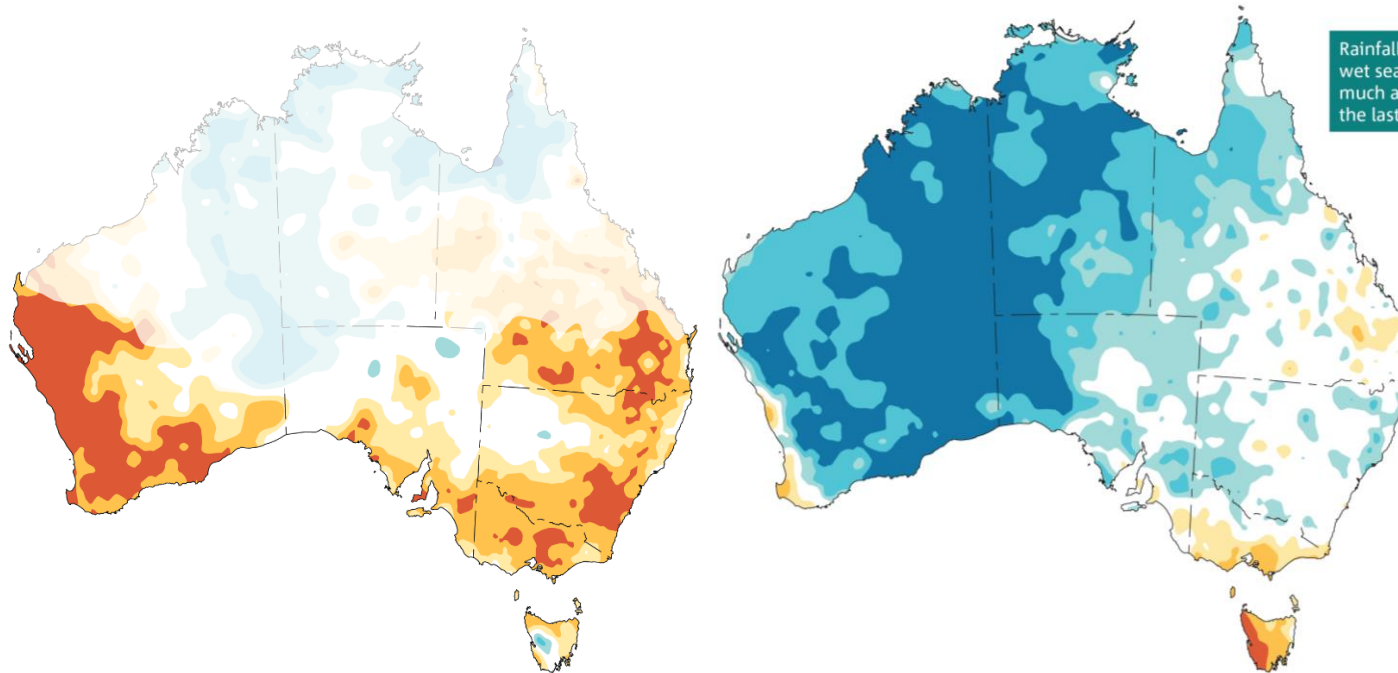
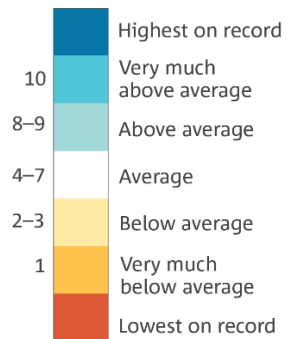


Rainfall

Observed Trends

Rainfall has been very low over parts of southern Australia during April to October in recent decades.

Rainfall decile ranges



Rainfall during the northern wet season has been very much above average for the last twenty years.

Source: Bureau of Meteorology

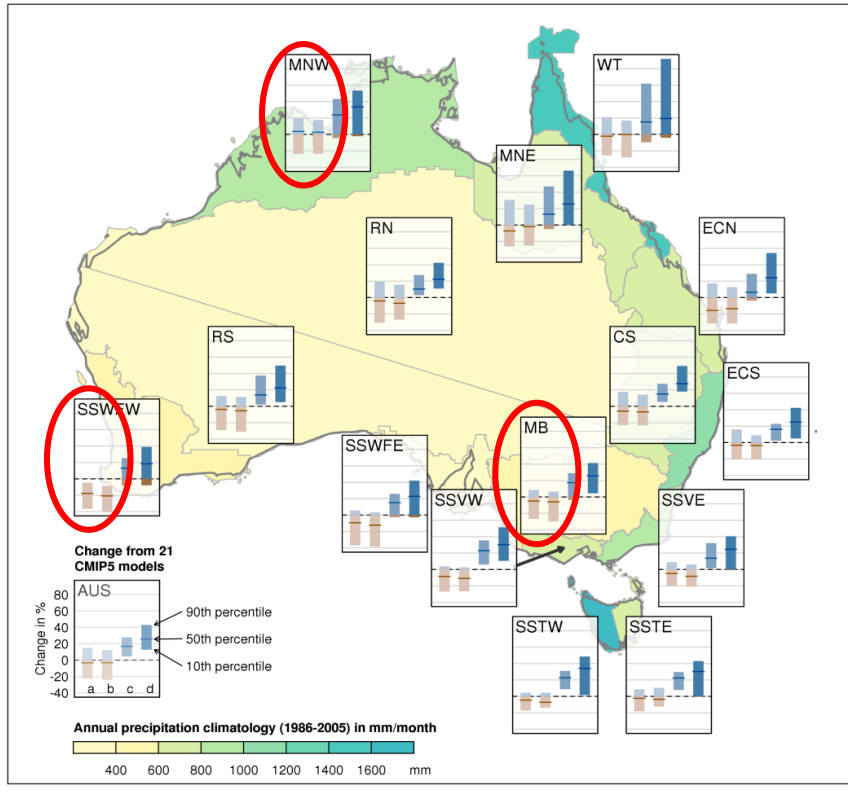
- Also, some evidence rainfall extremes are increasing



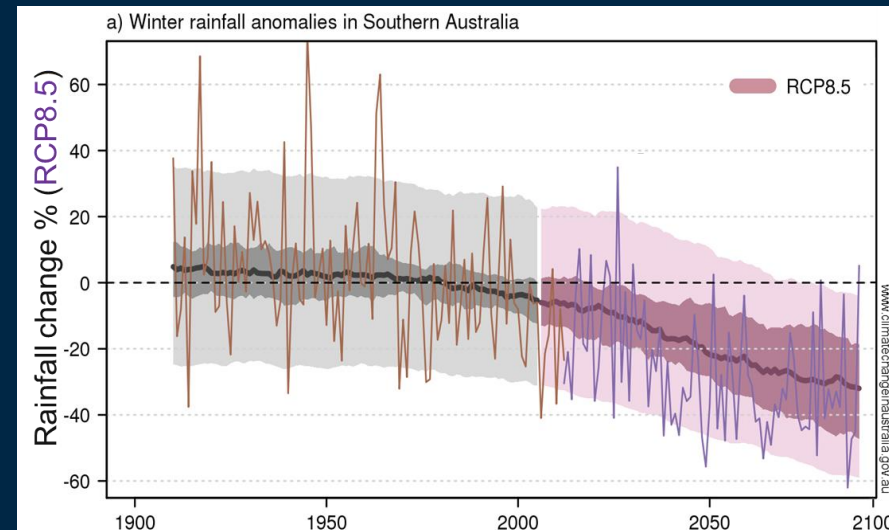


Rainfall Projected Changes

Projections for relative precipitation change from 1986-2005 to 2080-99 according to RCP8.5 for both the annual mean and annual extremes



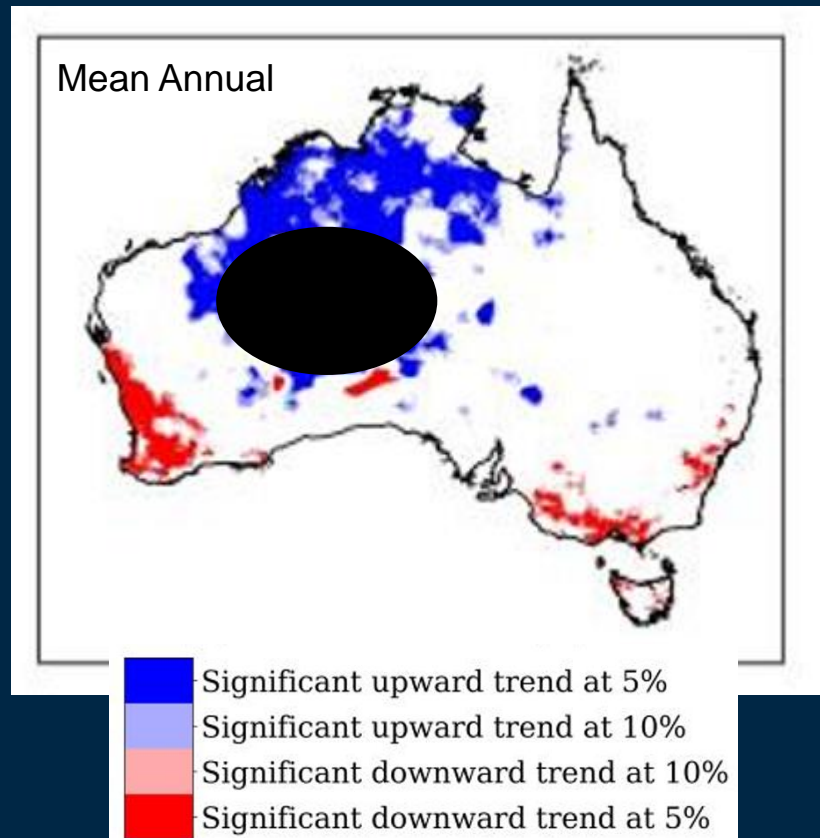
- Large range of changes to northern Australian rainfall – how will monsoon change?
- Drying trend projected to continue in southwest WA, southeastern Australia
- Winter rainfall declines also to continue in Southern Australia





Soil Moisture

Observed Trends



- Similar trends to rainfall
- But higher evaporation and plant evapotranspiration also contributes to drying.
- This is driven by hotter temperatures, but observed wind decreases may counteract - some uncertainty about how this will change in future.

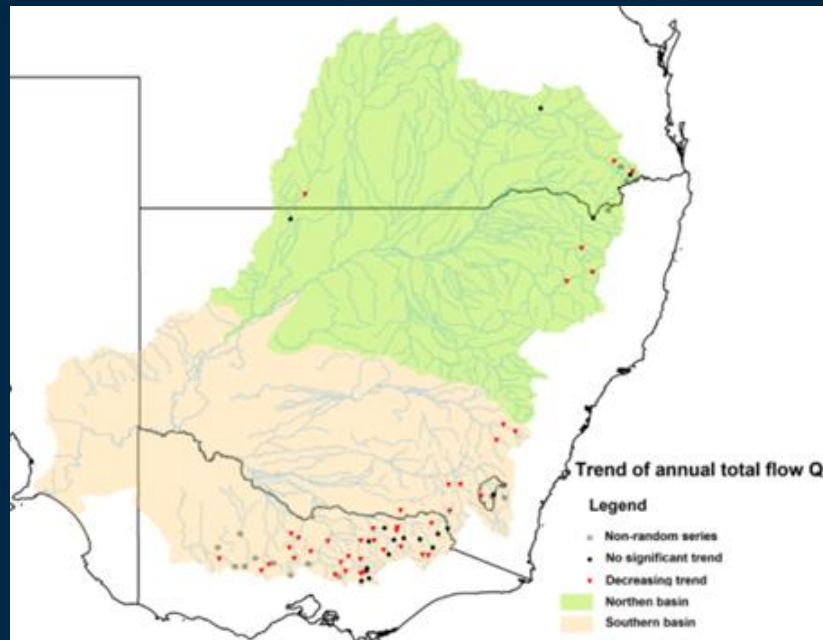




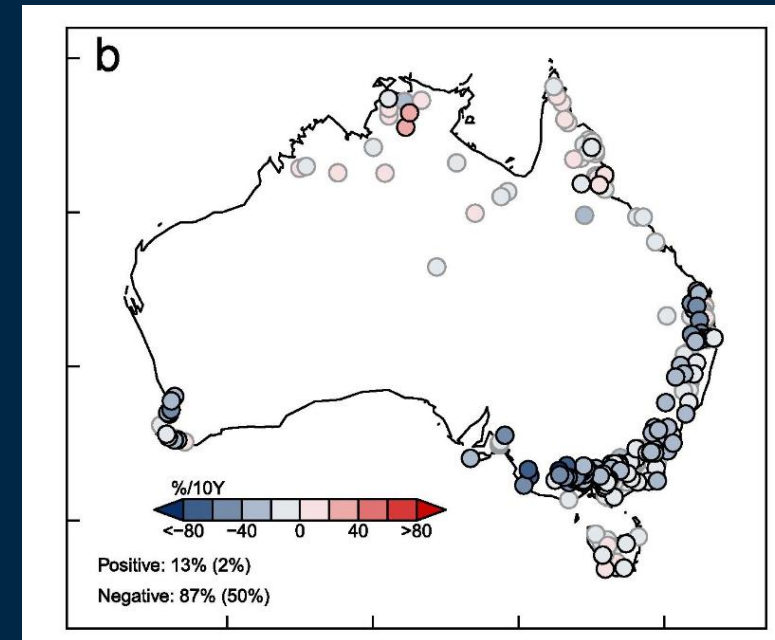
Streamflow

Observed Trends

- Mean streamflow is decreasing in many parts of the MDB
- Streamflow event sizes are decreasing in magnitude across most of Eastern Australia
- Drier catchment soils when it rains are decreasing the size of these inflow events



Trends in mean average streamflow in the MDB



Trends in 'peak flows' (events occurring on average 5 times/year) (Wasko et al. 2019)





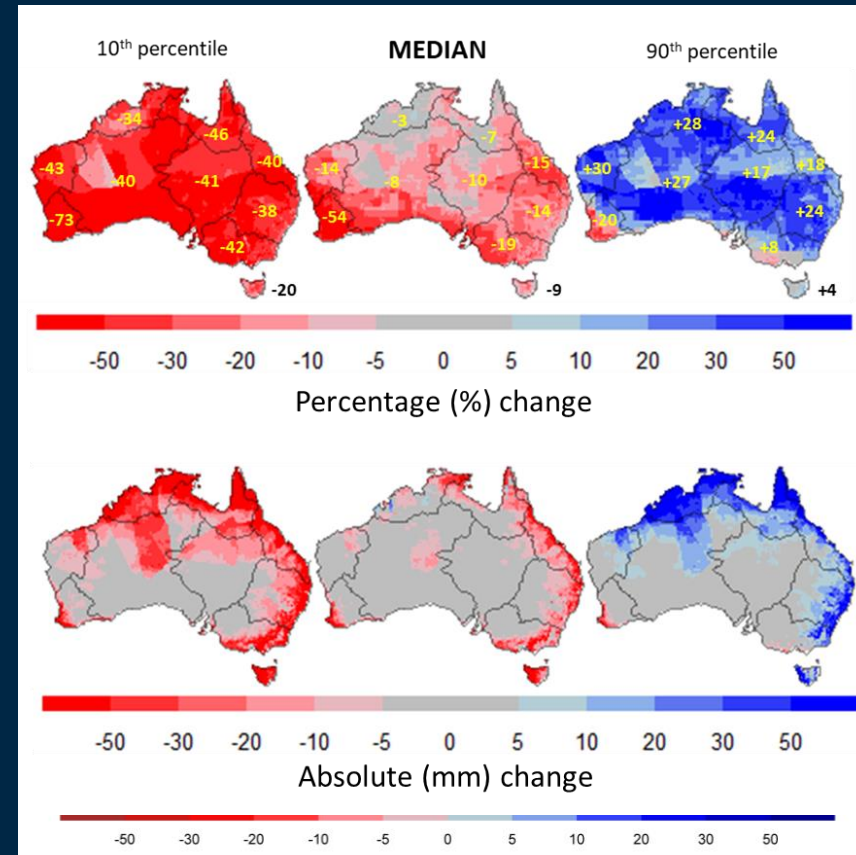
Streamflow

Projected Changes

Projections

- Nationally large range of possible futures!
- High confidence that runoff decreases in SW-WA, Tasmania
- High confidence in Winter runoff decreases (as seen for rainfall)
- Trends in runoff, generally similar to rainfall but amplified
- The MDB will be drier by 2030

Projections from 42 CMIP5 (IPCC AR5) GCMs, 1 HM



Percentage change in future mean RUNOFF
(RCP8.5, 2046–2075)





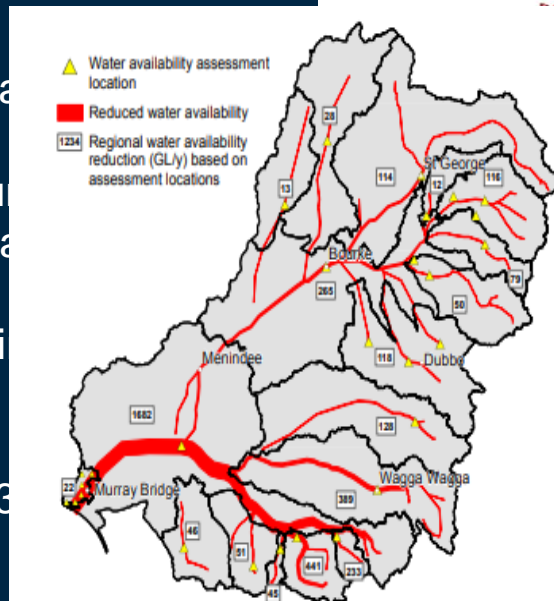
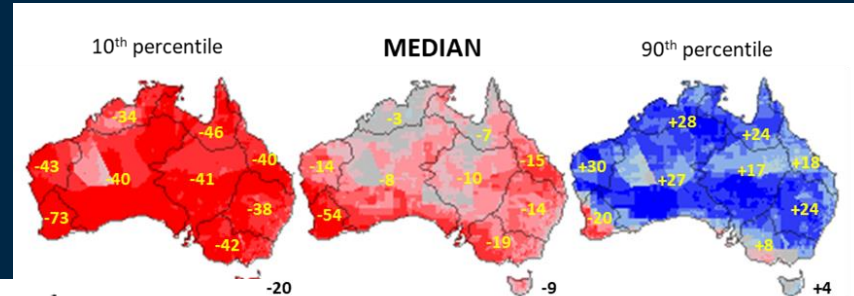
Streamflow

Projected Changes

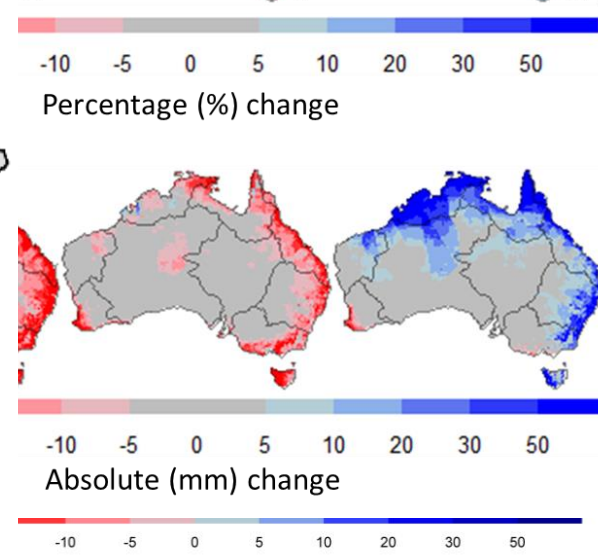
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Projected streamflow 2030s (CSIRO 2010)



Change in future mean RUNOFF (RCP8.5, 2046–2075)

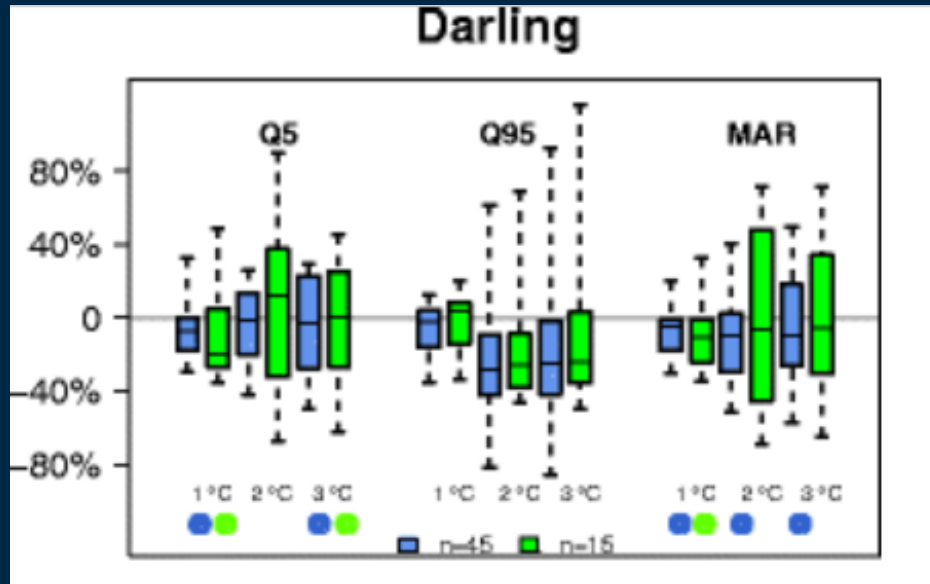




Streamflow

Projected Changes

How does the level of global warming impact on streamflow changes?



Gosling et al. 2017. Climatic Change

- Average flows (MAR) decreasing at 1 C and 2 C, uncertainty gets larger, the higher the warming
- High flows (Q5) – no clear signal
- Low flows (Q95) decreasing, more at 2 C and 3 C than at 1 C





Flash Flooding Projected Changes

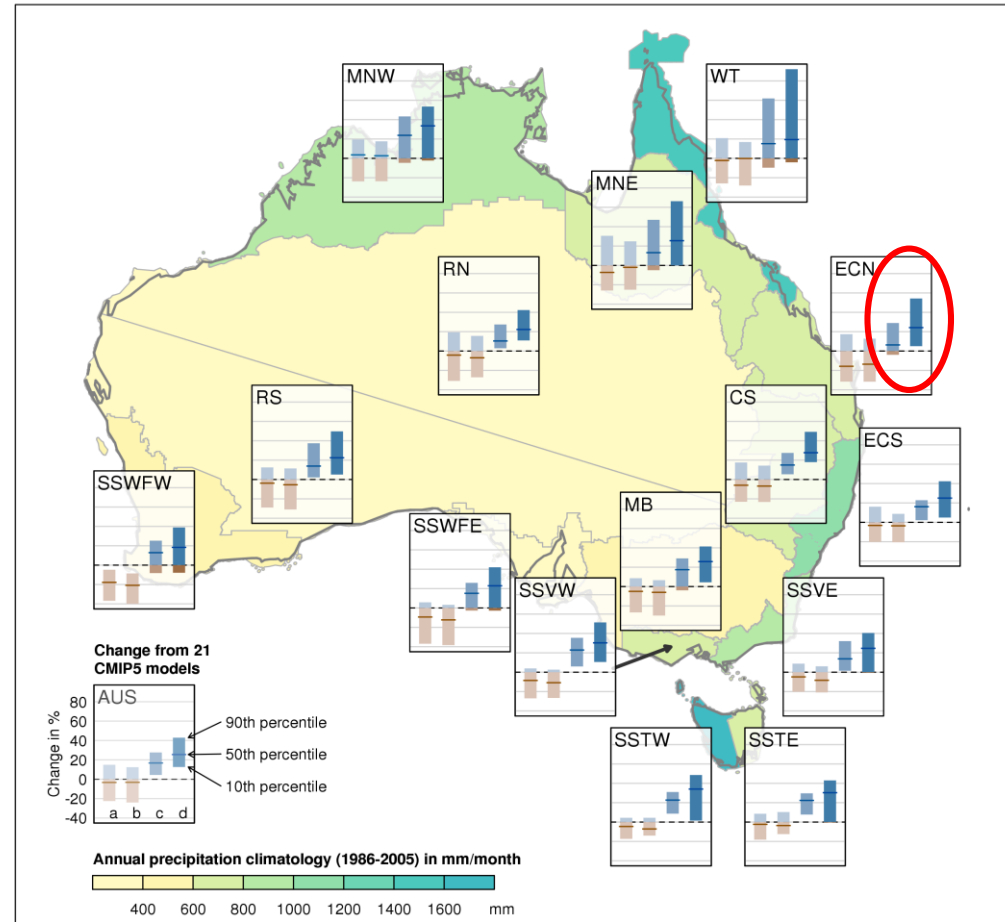
- While mean rainfall will decrease (a), extreme rainfall (c & d) will increase (*high confidence*)

Extreme rainfall is a predictor for flash flooding

- More work required on climate change impacts on flooding in Australia!

- (a) all 42 GCMs
- (b) subset of 21 GCMs
- (c) wettest-day-in-year
- (d) 1-in-20-year rainfall

Projections for relative precipitation change from 1986-2005 to 2080-99 according to RCP8.5 for both the annual mean and annual extremes





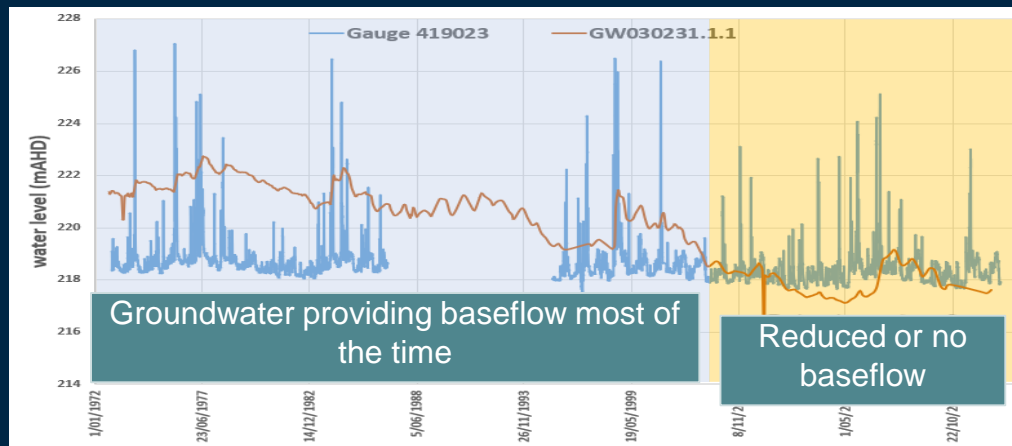
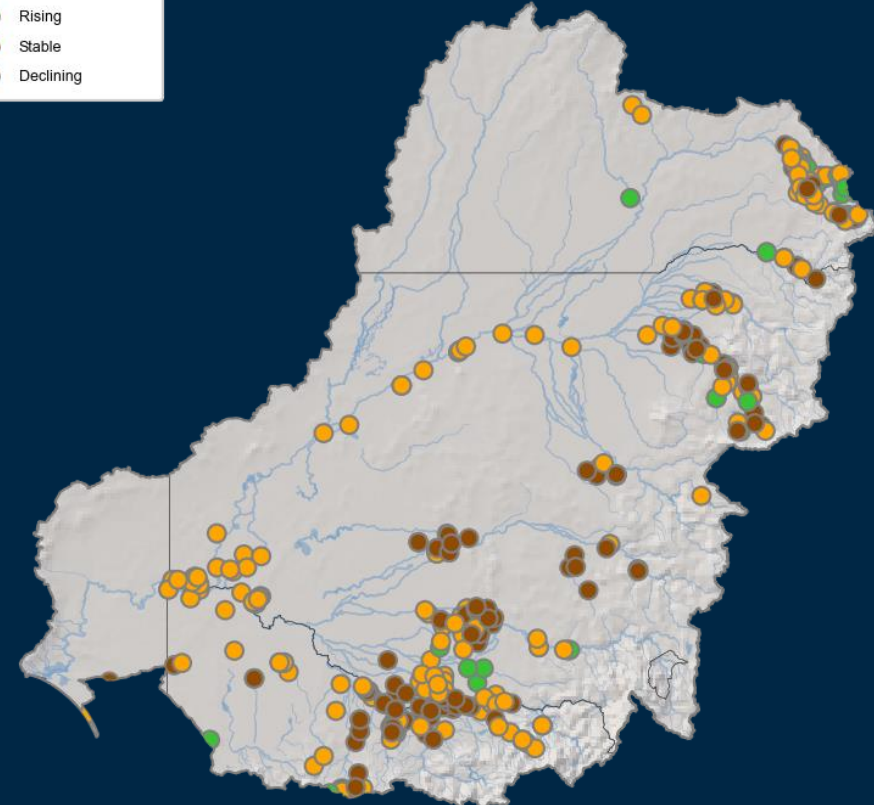
Groundwater

Observed Trends

- Groundwater levels in MDB have decreased over the past 20 years
- Consistent with the decrease in Winter rainfall in the southern basin
- Post millennium drought – connectivity to Groundwater lost in some areas

Groundwater trend:
20 year - 1999-2019

- Rising
- Stable
- Declining



Variations in river level and groundwater over time



Some Key Messages

- Soil moisture is currently decreasing in southwest and southeast of Australia.
- Mean rainfall and runoff is currently decreasing and somewhat likely to continue decreasing in southwest and southeast of Australia.
- *But*, annual variability is large (can mask or enhance climate change impacts in the short-term). Variability may increase.
- Winter rainfall and runoff is projected to decrease in major agricultural regions (*high confidence, SE Australia*).
- As a result Winter runoff and streamflow likely to decrease.
- For nearly all regions, flash flood risks will increase.
- Groundwater in the MDB is decreasing and might be expected to decrease going forward.



Some broader impacts/trends that we see

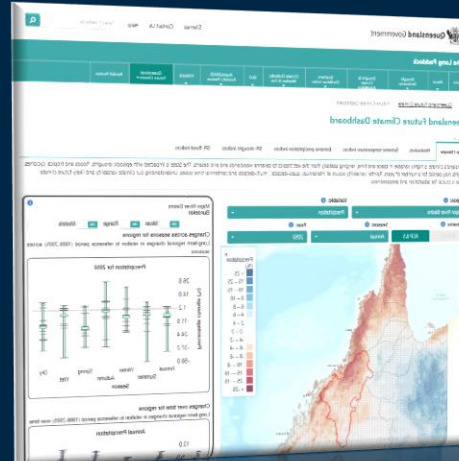
- Water Market – value of water as a commodity is increasing.
- Water entitlements are shifting to higher value crops.
- Dryland agriculture in some regions will need to adapt to changing rainfall and soil moisture timing and amount.
- Increased investments into resilient drinking water sources will be needed.
- Possibly investments into resilient water production in other sectors.
- Cost of adaptation could be relatively high – conflicting needs of drought and flood adaptation.
- Some environmental assets may not survive.



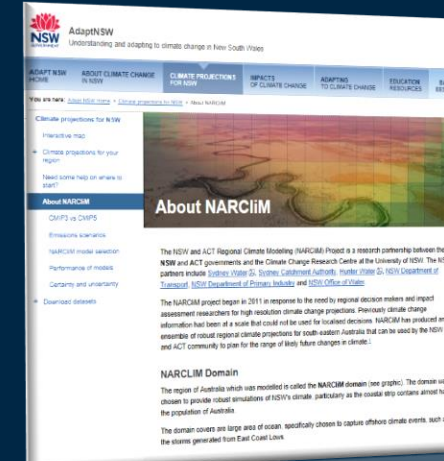
How can I explore where this affects me and my business?



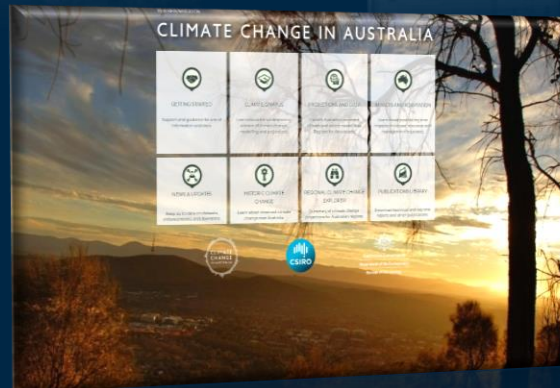
www.bom.gov.au/state-of-the-climate



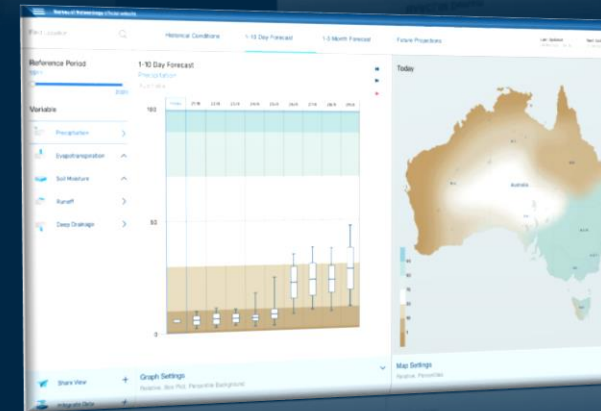
<https://app.longpaddock.qld.gov.au/dashboard/>



<https://climatechange.environment.nsw.gov.au/Climate-projections-for-NSW/interactive-map>



www.climatechangeinaustralia.gov.au



www.bom.gov.au/water/landscape Future Climate projections available late 2020



Australian Government
Bureau of Meteorology

Similar portals available in other states

Thanks for your attention

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www.bom.gov.au/water/landscape

www.csiro.au/state-of-the-climate

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www.climatechangeinaustralia.gov.au



Australian Government
Bureau of Meteorology



Climate Change Impacts on Natural Systems



Lesley Hughes

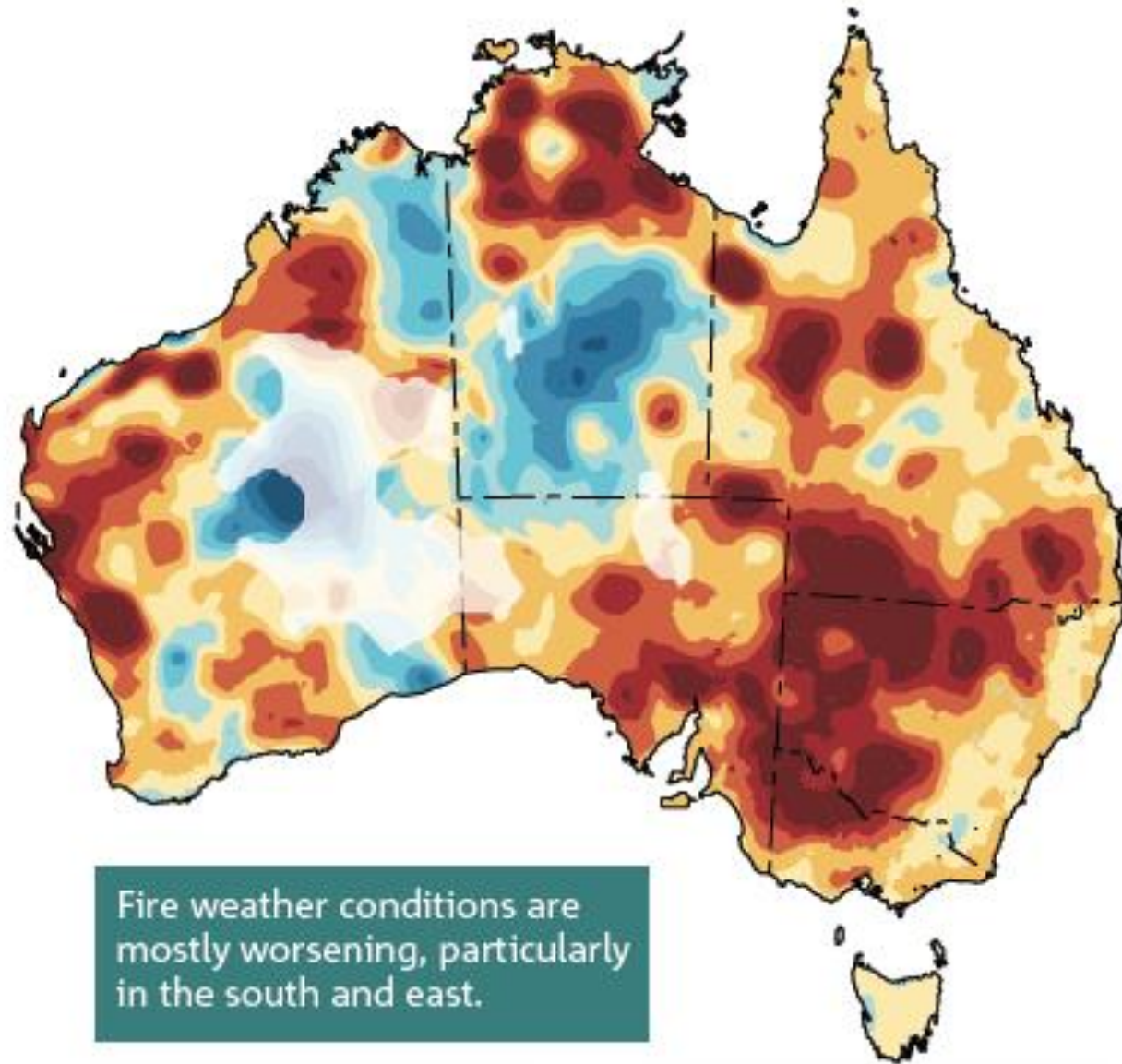
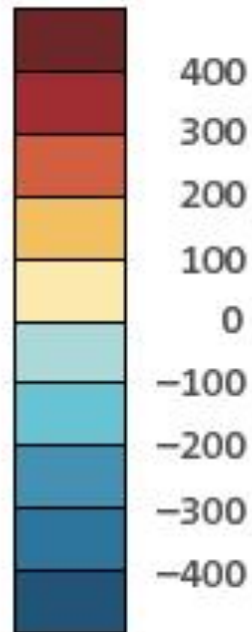


MACQUARIE
University



Observed trends in Forest Fire Danger Index (1978 – 2017)

Forest Fire
Danger Index
points/decade



Fire weather conditions are mostly worsening, particularly in the south and east.

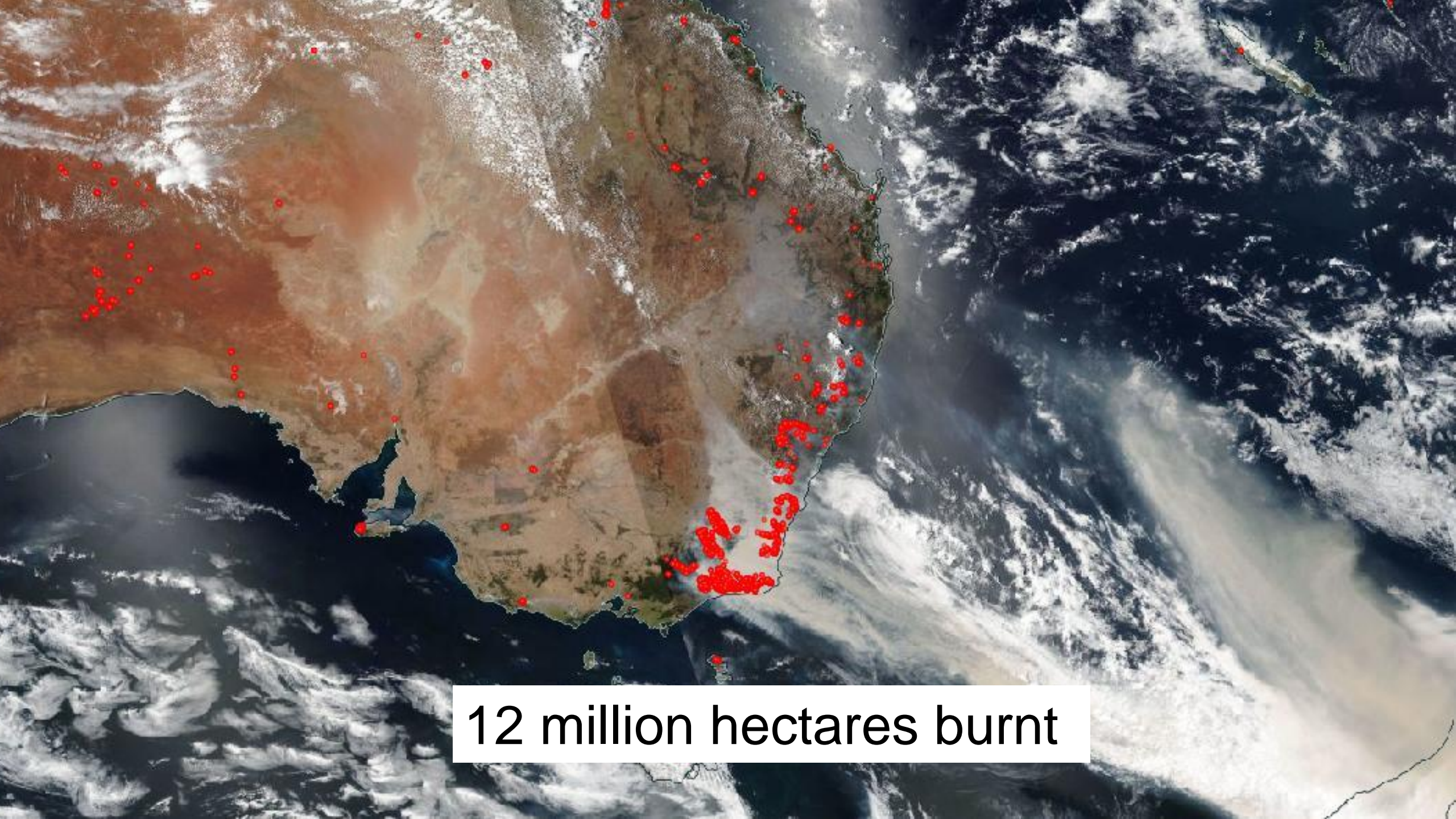
Source: Bureau of Meteorology

Fires penetrating into new ecosystems





World Heritage Area, Tasmania



12 million hectares burnt

- **>1.25 billion vertebrates killed (mammals, birds & reptiles)**
- **Many threatened species have lost most or all of their habitat**





80% Blue Mountains World Heritage Area burnt





50% Gondawan rainforests burnt

But wait...there's more

Coral reefs are bleaching



- Bleaching in 2016/17 & 2017/18 → up to 50% loss coral cover on GBR

- GBR worth ~\$6 billion p.a.
- Provides 60,000-70,000 jobs





Mangroves dying

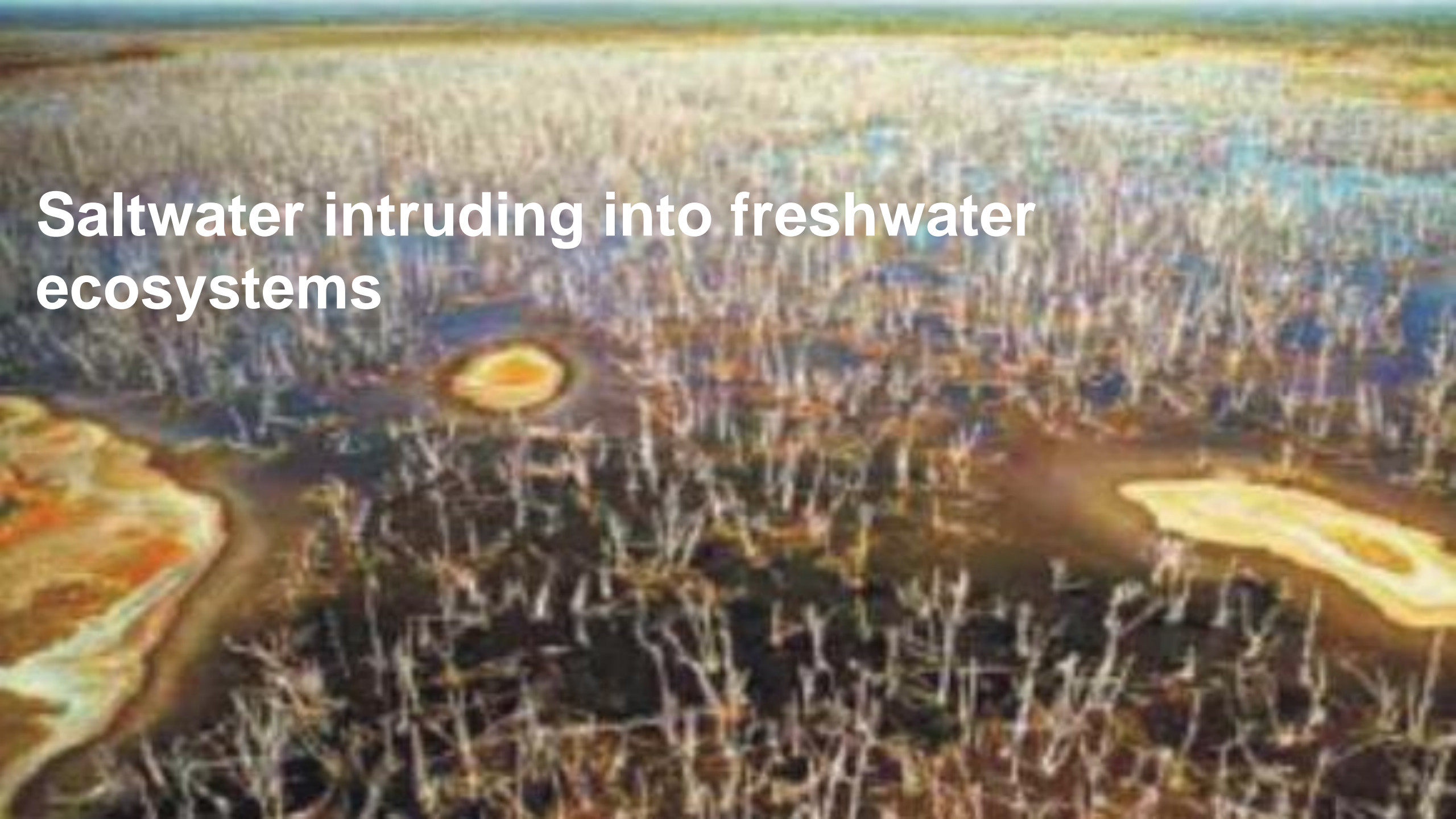


River red gums affected by drought & salinity

Massive fish mortality in Menindee Lakes



Saltwater intruding into freshwater ecosystems





Most of Kakadu floodplain <0.5m asl

An aerial photograph of a mountain range. The peaks are covered in snow, and the surrounding slopes are dark green with sparse snow patches. A valley with a winding road is visible in the foreground. The text "Snow cover & duration declining" is overlaid in white on the left side of the image.

Snow cover & duration declining



Kelp forests declining

Shark Bay seagrass



Jarraah forest dieback due to heat and drought



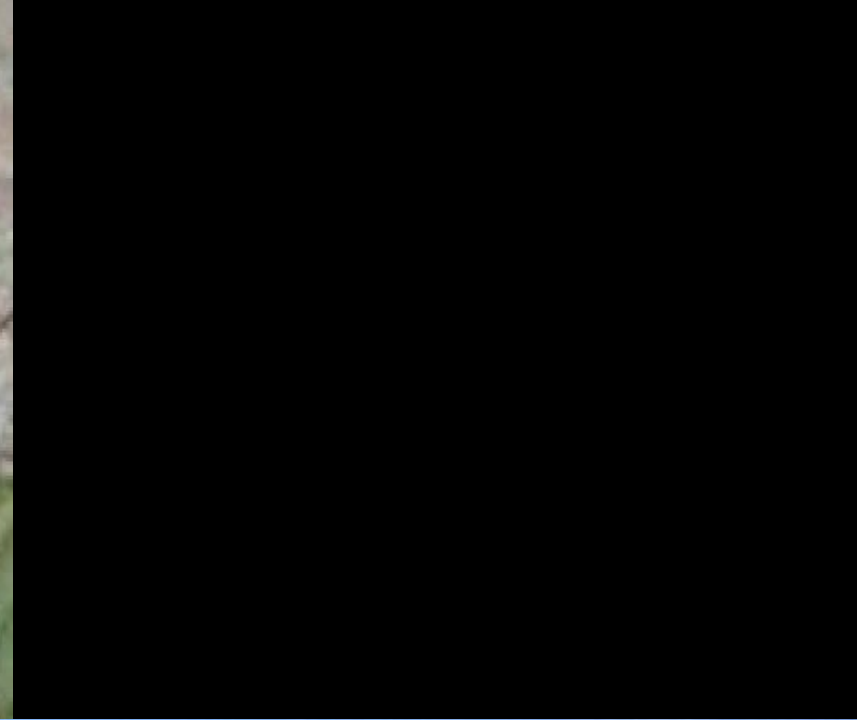
Wildlife





**Turtles
feminizing**

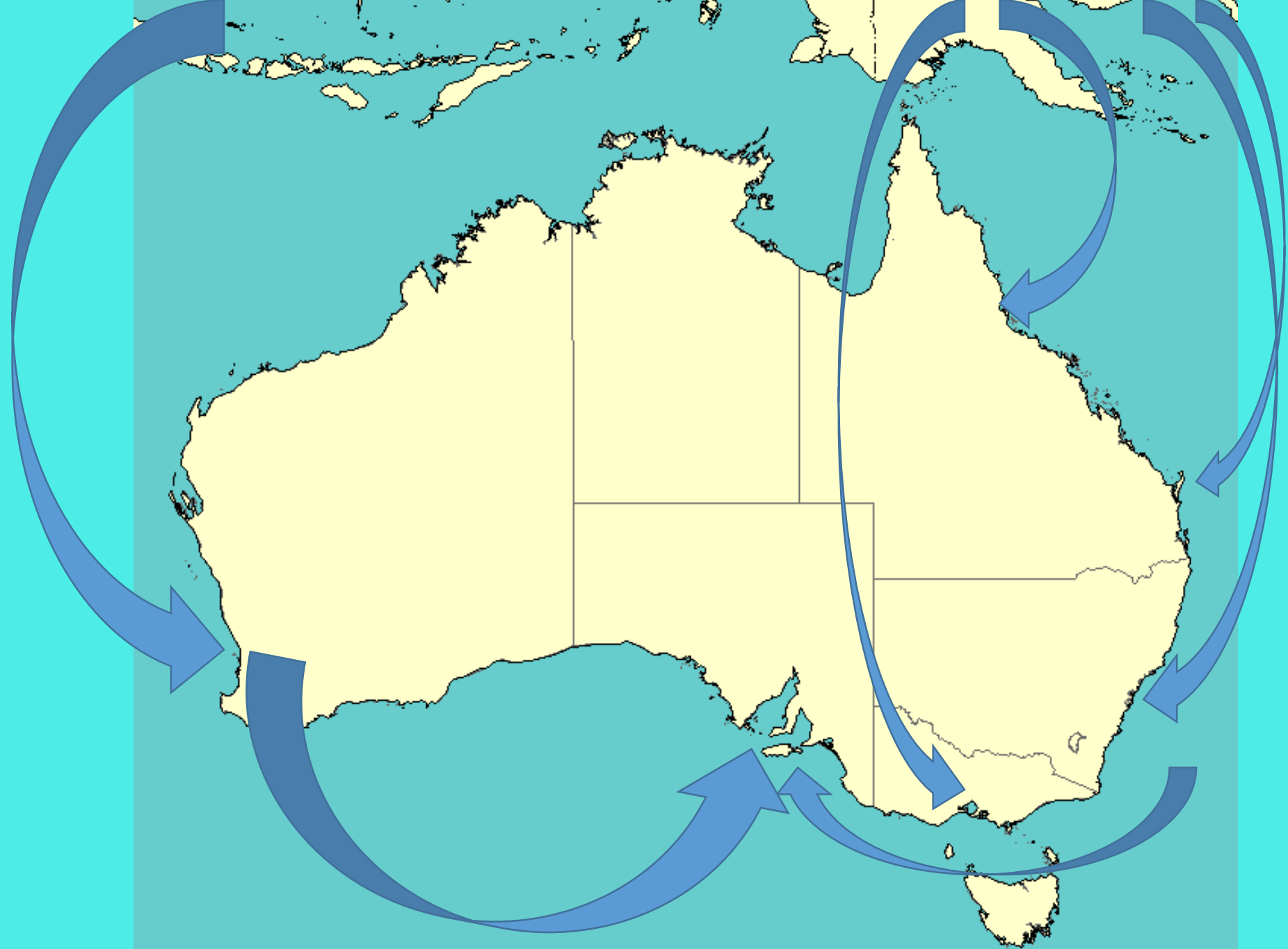




We are losing species



International visitor survey (Tourism Australia 2017)





Australian Government

“The attractiveness of certain tourism destinations may change depending on the extent and nature of climate change in that area” (Climate Change Guide for Australian tourism operators 2009)



Tourism 2020 plan: notes that tourism businesses need to *“engage in climate change adaptation through the CSIRO Climate Change Adaptation project”*

ICONS AT RISK: CLIMATE CHANGE THREATENING AUSTRALIAN TOURISM



www.climatecouncil.org.au/

COMPOUND COSTS: HOW CLIMATE CHANGE IS DAMAGING AUSTRALIA'S ECONOMY





**THIS IS WHAT
CLIMATE CHANGE
LOOKS LIKE**

<https://www.climatecouncil.org.au/resources/ecosystems-report/>

Break

Mute your microphone



Discussion: implications for the Australian Climate Roundtable



Discussion questions (1)

- Initial Roundtable reactions to presentations
- Participants – with respect to your sectors/orgs:
 - Are there risks/impacts we haven't discussed yet?
 - How do the impacts discussed play out for you/constituents?
 - What areas would you like to know more about?
- Some important impacts can't be meaningfully translated to \$. How best to describe?

Discussion questions (2)

- What do water/land/ag impacts mean for mitigation opportunities?
 - Eg bioenergy, biosequestration, livestock feed shift, plant based meats
- Thinking about resilience to water/land/ag impacts:
 - How do these affect resilience to other events (drought, ag market trends, greenfields development)
 - What do measures to increase resilience look like?

Close



Close

- Next workshop set for Monday 27 April 9am-12pm
 - Again by video
 - Topic is Sectoral Impacts: Health, Communities and Infrastructure
- Welcome feedback on the format and process to:
 - Tennant.reed@aigroup.com.au
 - Rachael.Wilkinson@aigroup.com.au