GRASSLANDS AND WATER?

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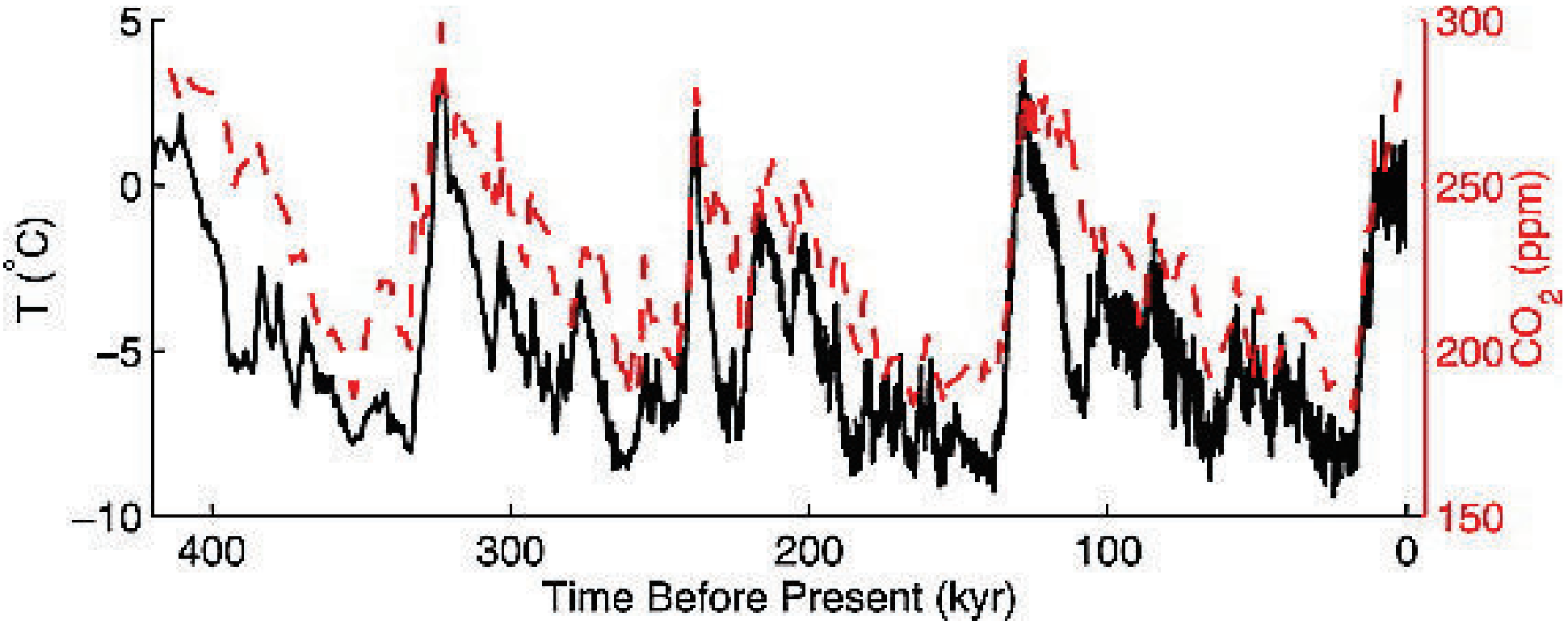
President of FOG
7th September 2021

Image: Bullan Mura grassland in drought, ACT © Jamie Pittock

Australian National University

Glacial cycles and carbon dioxide

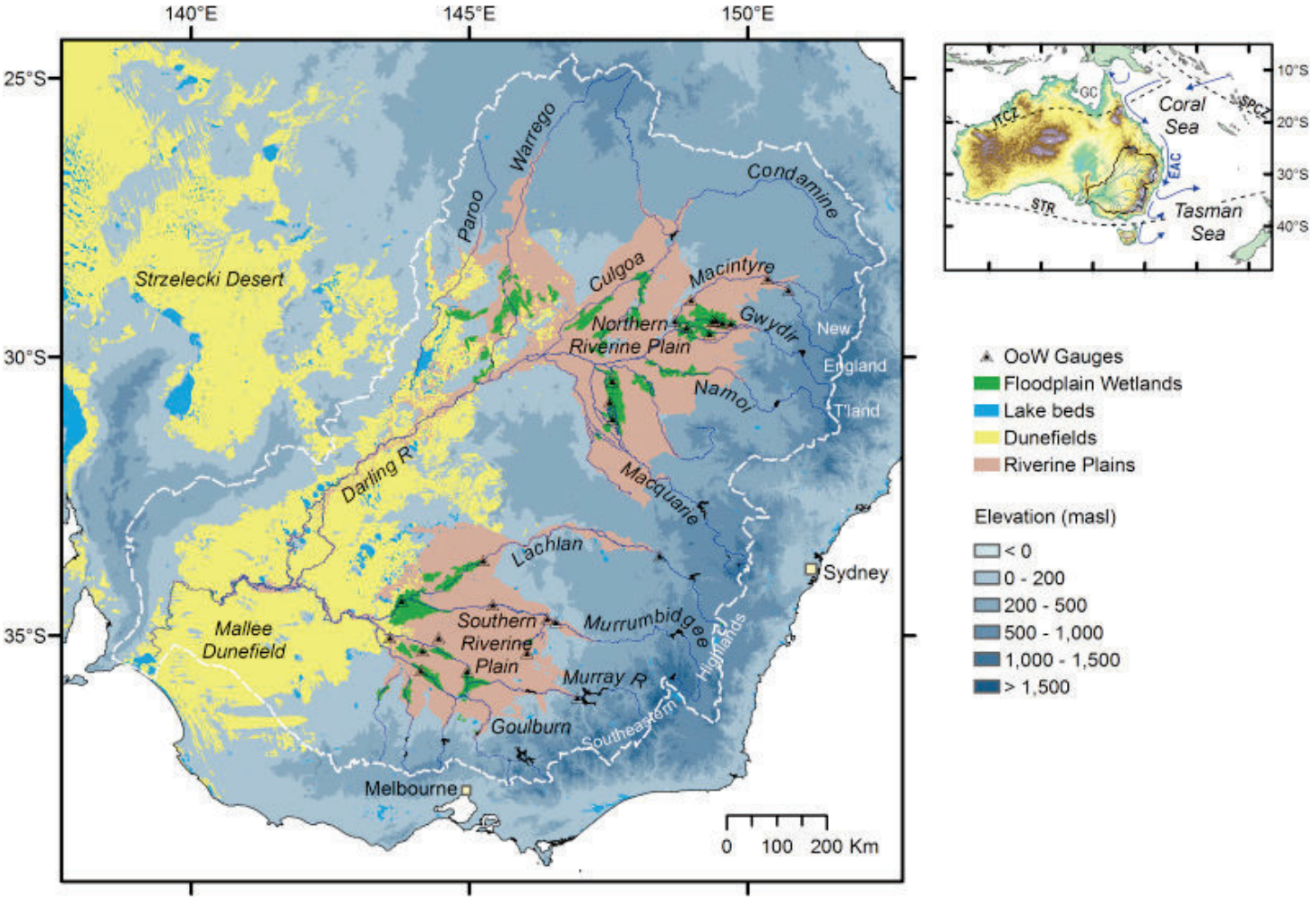


Geophysical Research Letters, 35(1), 2008, DOI: (10.1029/2007GL032071)

Sahul 21,000 yrs bp – arid, cooler, less evaporation? A grassland paradise?

The ice age continent of Sahul. Damian O'Grady, Michael Bird

Quaternary glacial river discharges were 3–270 times equivalent modern rivers

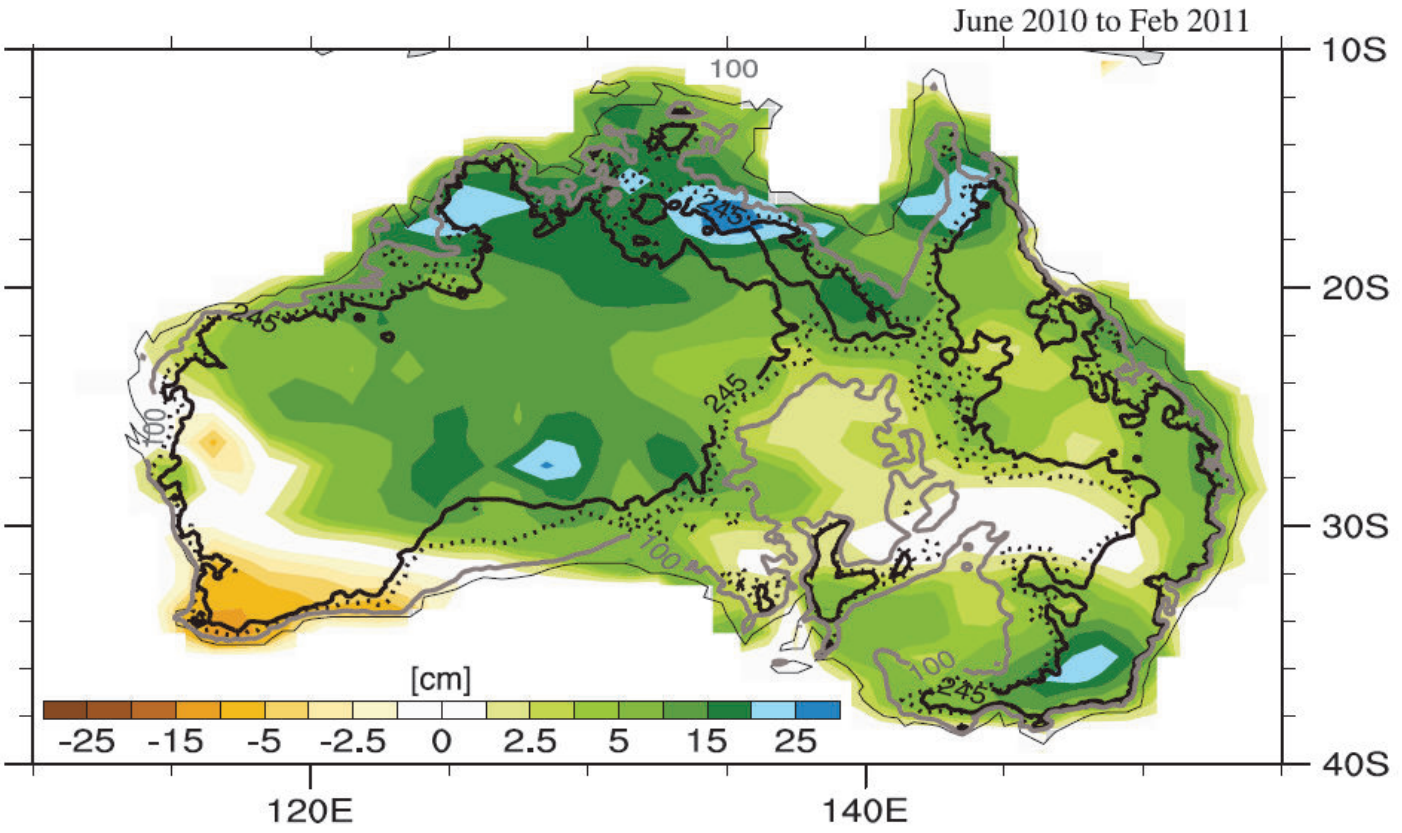


Source: Hesse et al. 2018 https://doi.org/10.1016/j.quascirev.2018.09.035

Massive variability in water in the landscape

The 2010-2011 La Nina, + SAM and – IOD contributed to lowering global sea levels by 7 mm in 2011.

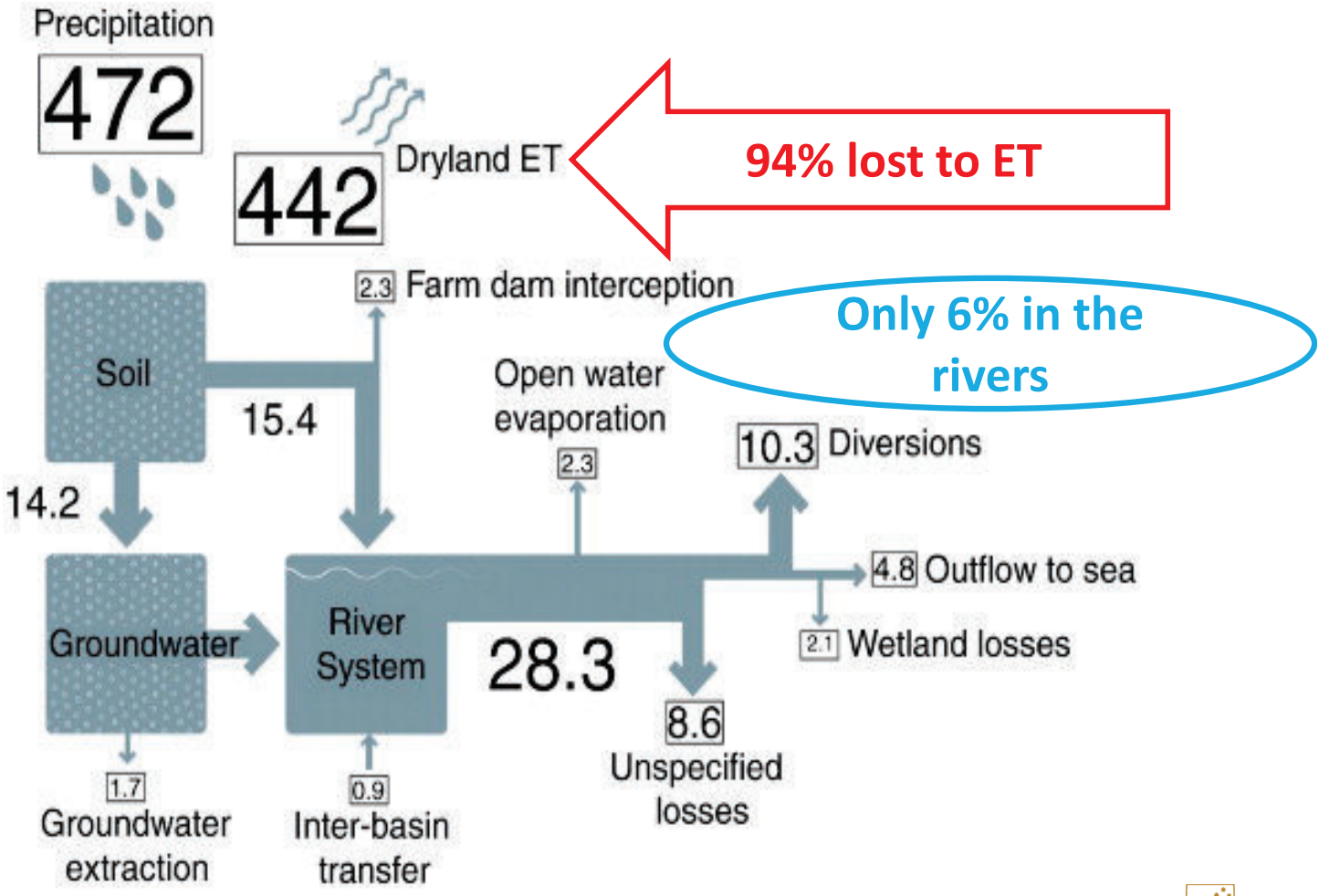
Source: Fasullo et al. 2013 doi:10.1002/grl.50834



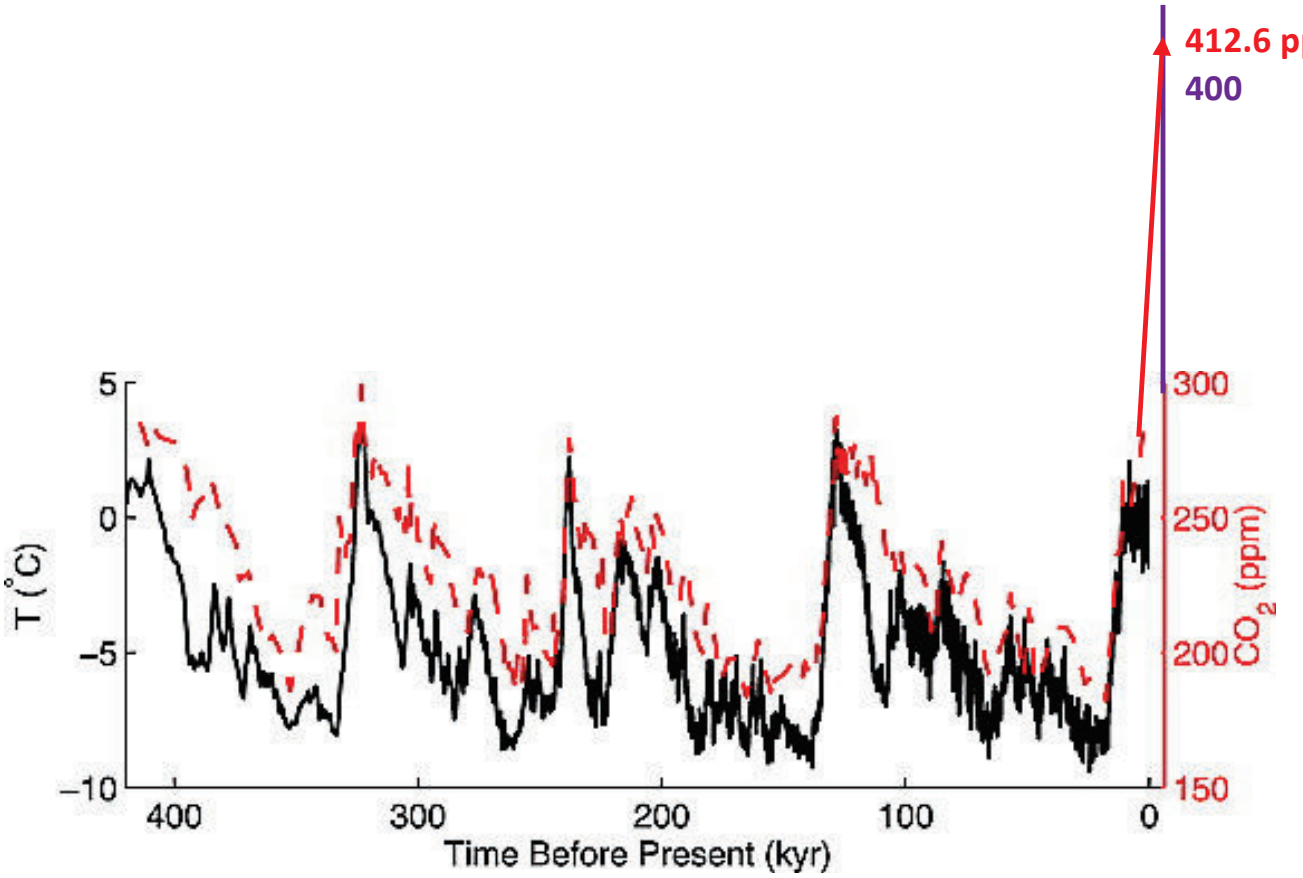
The change in mass in Australia: GRACECSR from June 2010 to Feb 2011. Contours represent land surface elevation isopleths (0 m, 100 m, 190 m, and 245 m).

Murray-Darling Basin water budget

Approximate water budget for the Murray-Darling Basin in mm/year under development conditions prior to the 2012 Basin Plan (Leblanc et al. 2012)



And now there is climate change …

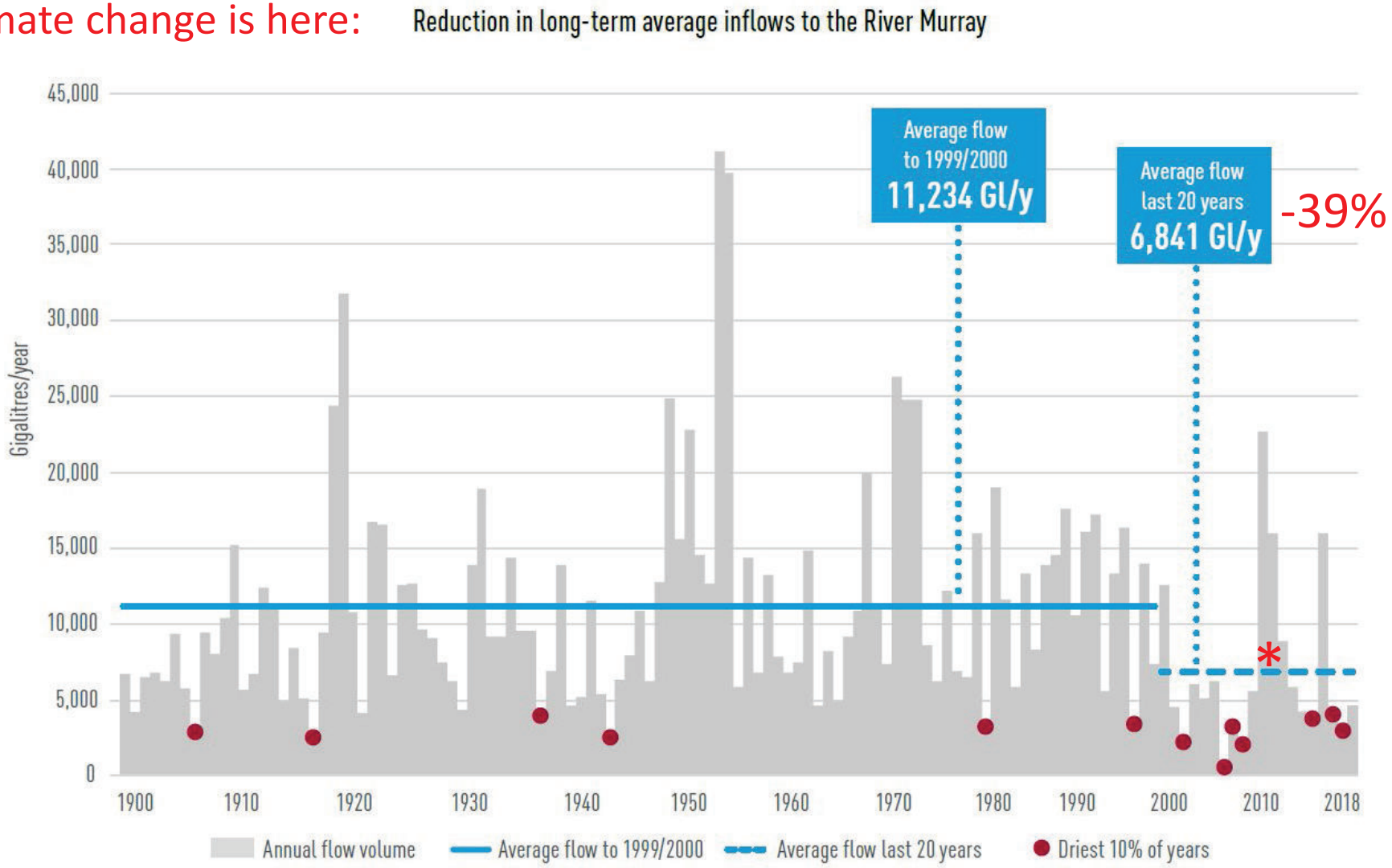


Australia's climate has warmed on average by 1.44 ± 0.24 °C since national records began in 1910

Sources:
http://www.bom.gov.au/state-of-the-climate/australias-changing-climate.shtml
https://www.co2.earth/daily-co2

Geophysical Research Letters, 35(1), 2008, DOI: (10.1029/2007GL032071)

Climate change is here:



* = adoption of Basin Plan

Source: MDBA, 2020. *The Basin Plan 2020 evaluation*, Murray-Darling Basin Authority, Canberra.

Climate change, bugs, fire, snowgums and rivers

More frequent fire:

- **Greater evapotranspiration from regrowth forests**
- **Increased sedimentation**

Loss of peat swamps

Longicorn wood-borer & die back
(https://www.saveoursnowgum.org)

Snowgum die back = 15% less runoff

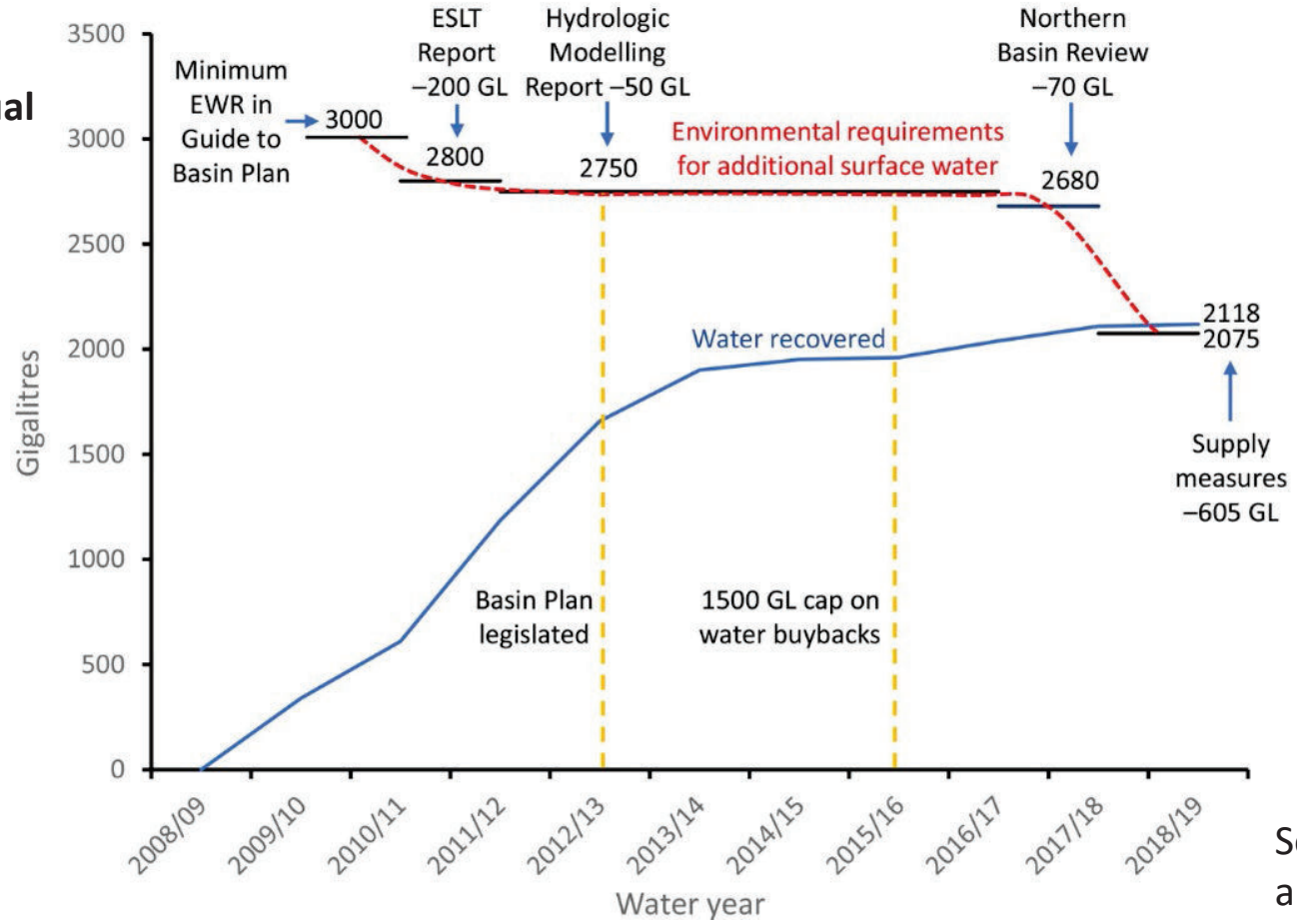
(Costin et al.)

Reduced snow melt, more erratic river flows

M-D Basin Plan water for the environment

Long term average annual water yield

E-water needed



E-water being allocated

Source: Grafton et al. 2020

Changing the landscape changes water yield

- Australian agreement to incorporate “inflow interception” activities into cap and trade water markets.
- Intercepted water use “equates to almost one quarter of all the entitled water on issue in Australia” (NWC 2010).

Farm dam, ACT. © J Pittock

Policy promises vs implementation

National Water Initiative 2004:cl.55-57

- By 2011 significant interception activities in water systems that are fully allocated, overallocated or approaching full allocation would be recorded and new activities would require a water access entitlement.
- A threshold level of interception by significant activities was to be determined.
- Leaves it to the states to determine what is 'significant'

NWI 3rd Biennial Assessment 2011 (p9)

"Jurisdictions have not fulfilled their commitments to manage water interception effectively. Water interception outside NWI-consistent entitlement and planning frameworks poses an increasing challenge to the integrity of water management. […] the water reform framework is compromised and the confidence that water entitlement holders have in the security of their rights risks being eroded."

Legislation in SA, limited policies in VIC, NT & TAS, no action in NSW, QLD & WA

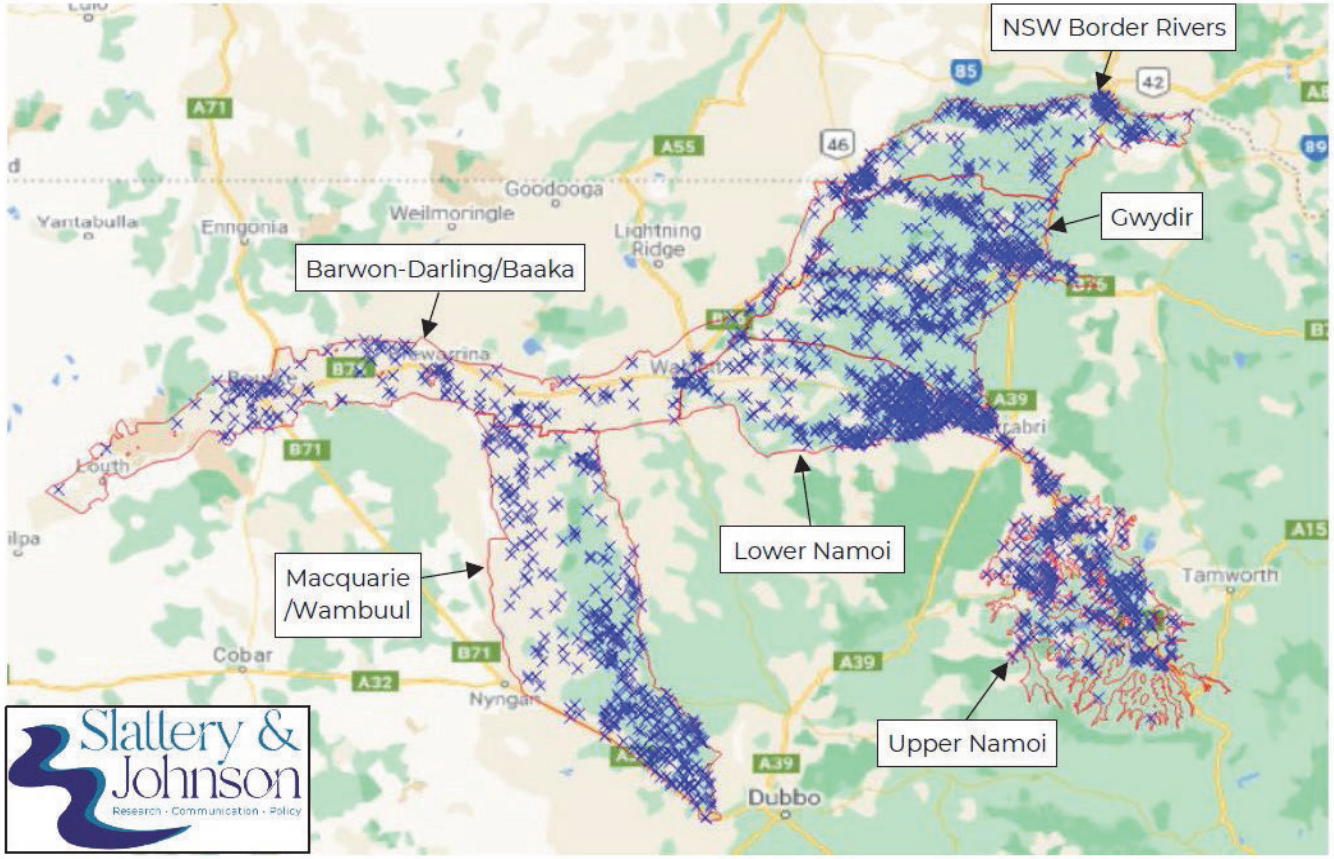
Regulating flow reduction - South Africa

- 1972 Afforestation Permit System
- 1998 National Water Act
- s36 An SRA is “the use of land for afforestation […] for commercial purposes” or any other activity that “is likely to reduce the availability of water in a watercourse … significantly”.
- 1999 Stream Flow Reduction Allocations Water Licensing System & cooperative governance licence assessment committees

Measuring streamflow reduction, Eastern Cape.
© J Pittock 2011

Floodplain harvesting in northern NSW

Figure 5 shows all the identified on-farm storages, represented as blue crosses.



The capacity of on-farm storages (X) increased by 142% (2.4 times) between 1994 and 2020, from 574 GL in 1993/94, to 1,395 GL in 2020.

The Basin Pan allows 46.3 GL take.

The number of on-farm storages has increased from 400 in 1988, to 1,833 in 2020. (Slattery & Johnston 2021).

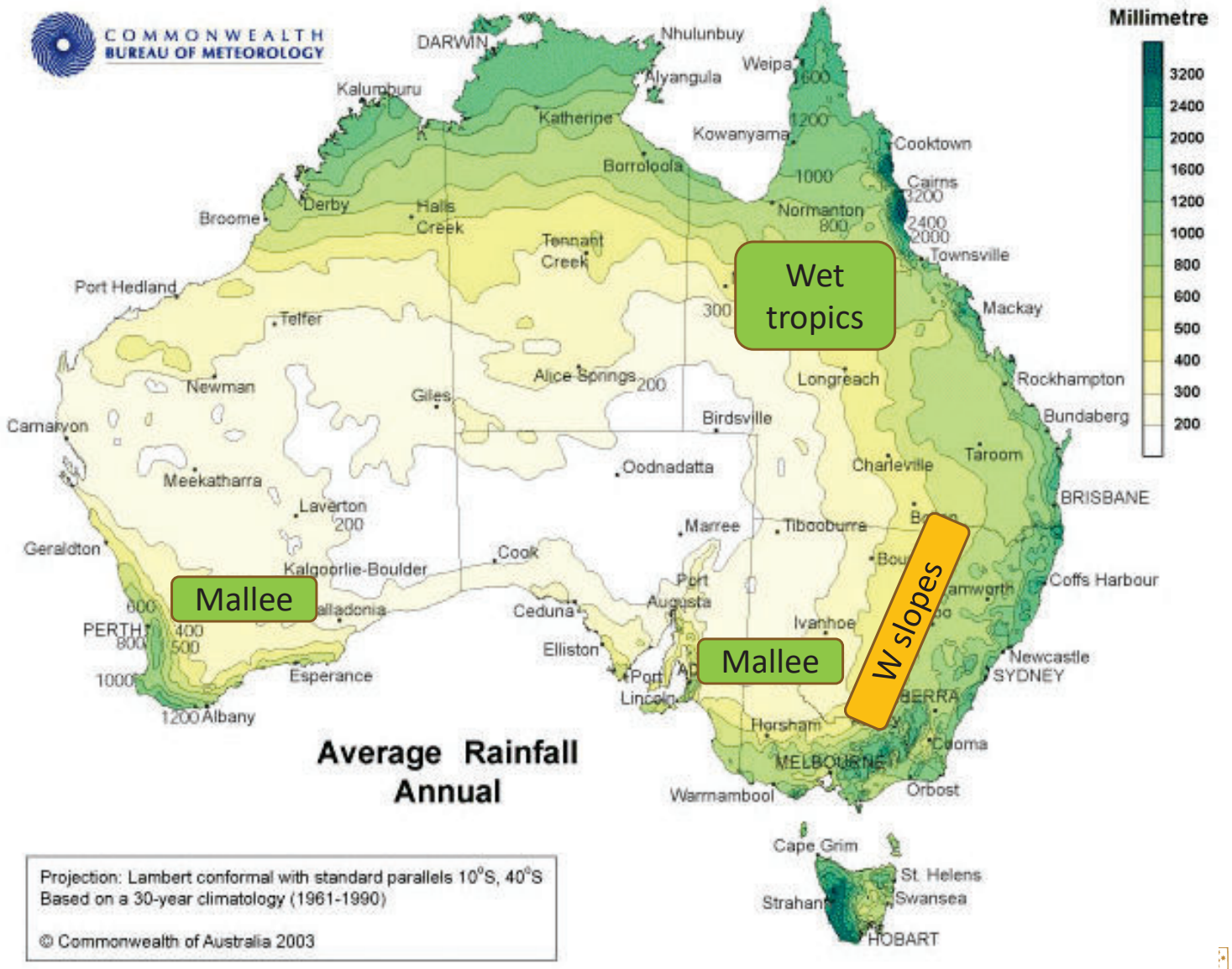
Carbon farming impacts on water

Plantation, western Victoria, (c) J Pittock 2010

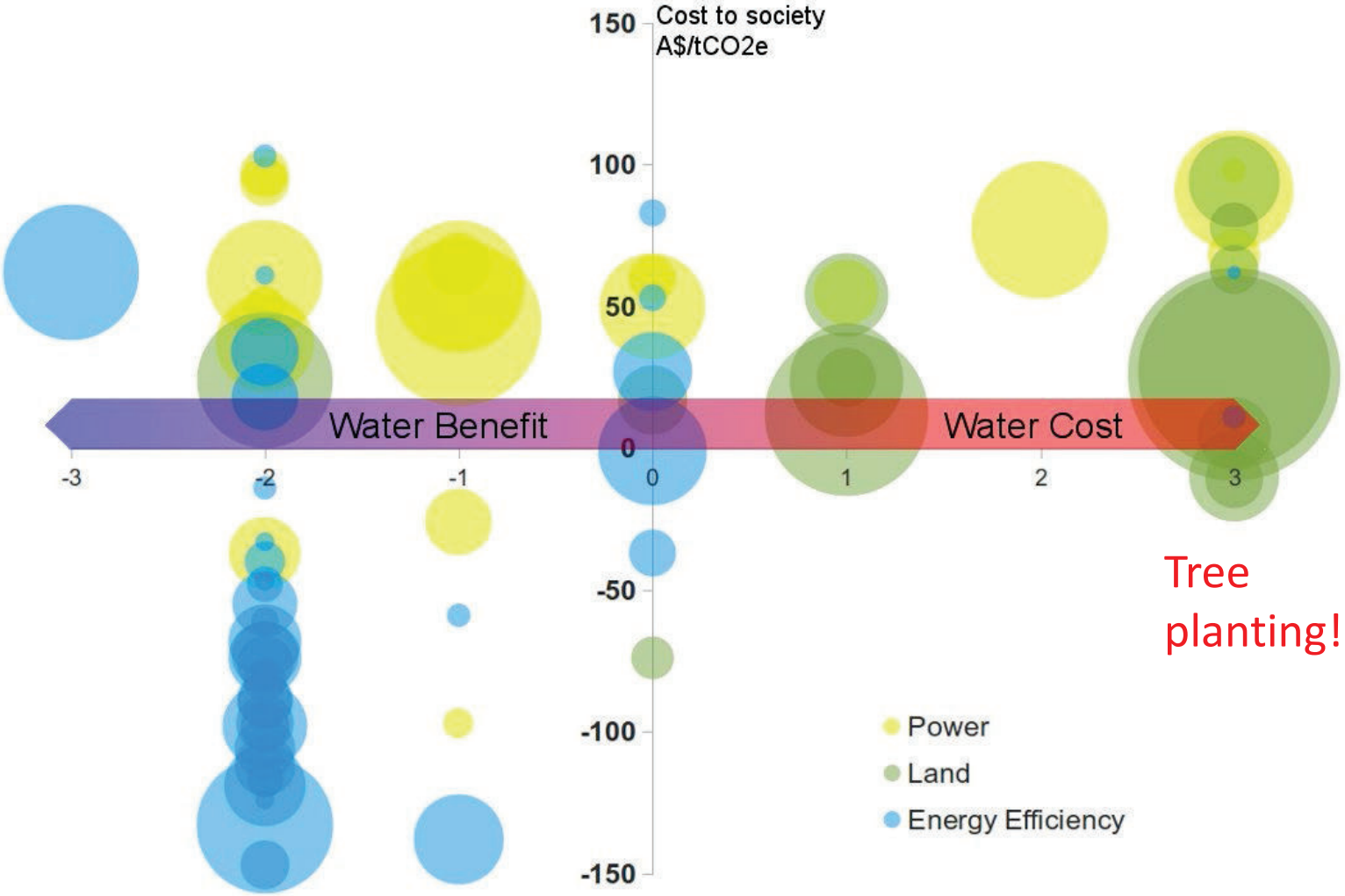
- Carbon Credits (Carbon Farming Initiative) Act 2011.
- Landholders can trade credits for “additional” carbon sequestration activities using approved “methodologies”
- DCCEE estimate 336 000 – 689 000 ha in ‘non-commercial’ plantings
- 393 – 1,026 GL/yr surface water use
- Up to A$2.05 billion in value of water at $2,000/ML

15

Regulated in 600 mm/yr + areas?



Climate change mitigation impacts on water



Tree planting!

Source: Wallis, P.J., et al. (2014). The water impacts of climate change mitigation measures. Climatic Change

Factors in grasslands that may diminish runoff?

Changes in rainfall (Potter and Chiew 2011):

(1) Reduction in autumn and winter rainfall

(2) Increase in annually averaged daily mean and maximum temperatures

(3) A reduction in high rainfall years

(4) Changes in the daily distribution of rainfall amounts and rainfall sequencing.

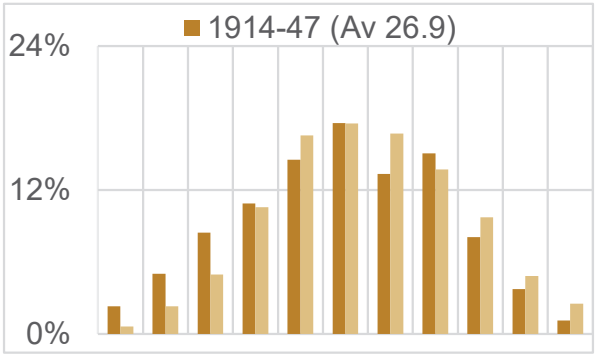
Image: Bullan Mura grassland in drought, ACT © Jamie Pittock

Changes in Canberra temperature 1914-2018

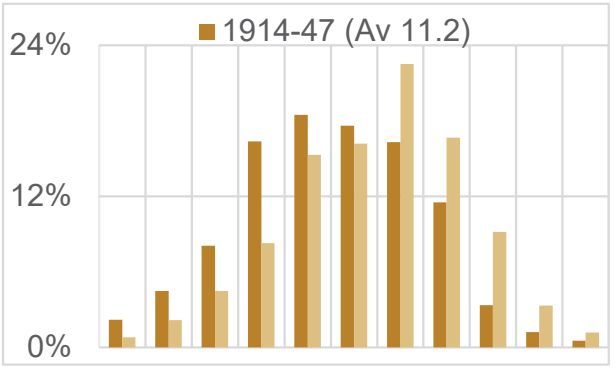
Temperature distribution changes from 1961-90 values

Source: Davis and Lindesay (in prep.)

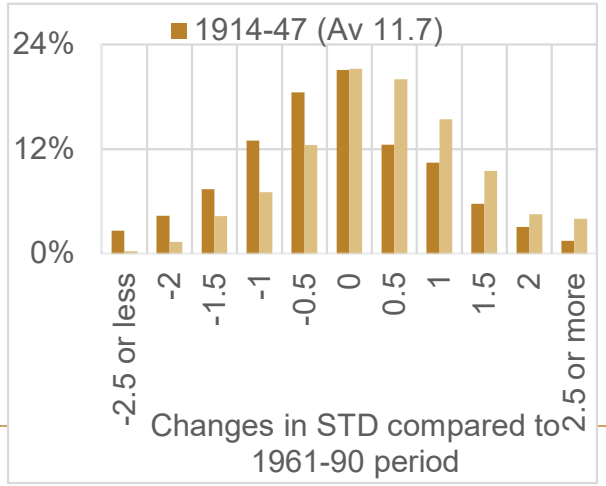
Dec-Feb TMax



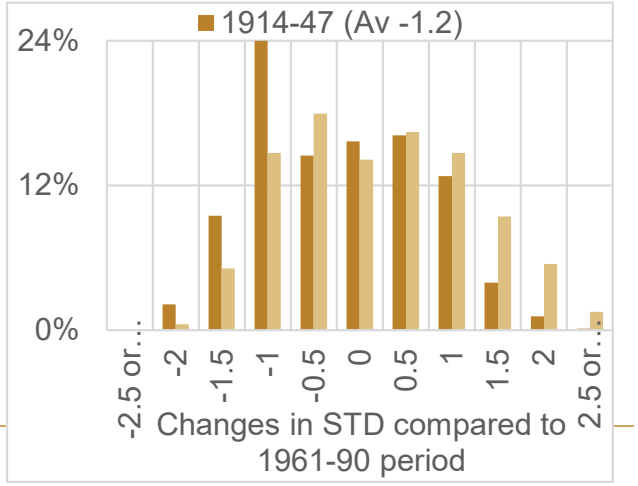
Dec-Feb TMin



Jun-Aug TMax



Jun-Aug TMin

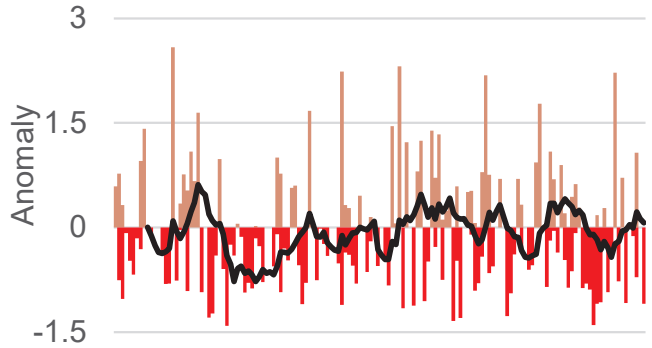


Changes in Canberra rainfall 1871-2018

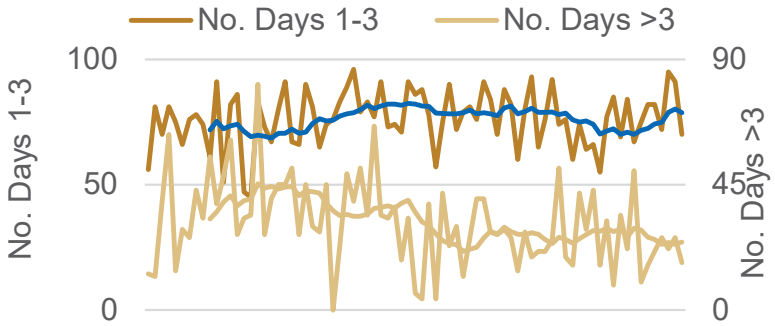
Anomaly from 1961-90 average

Source: Davis and Lindesay (in prep.)

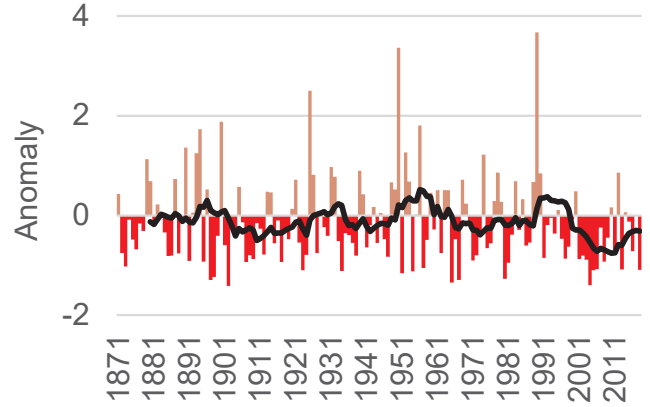
Annual



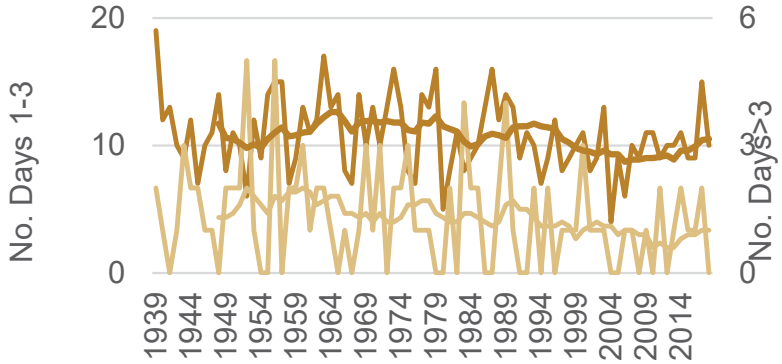
Annual 1-3 day events vs 3+ events



Autumn



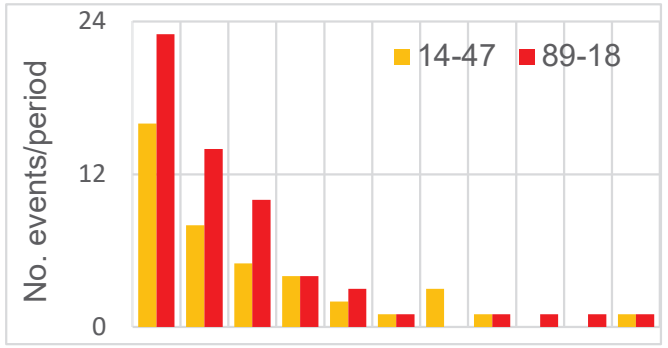
Autumn 1-3 day events vs 3+ events



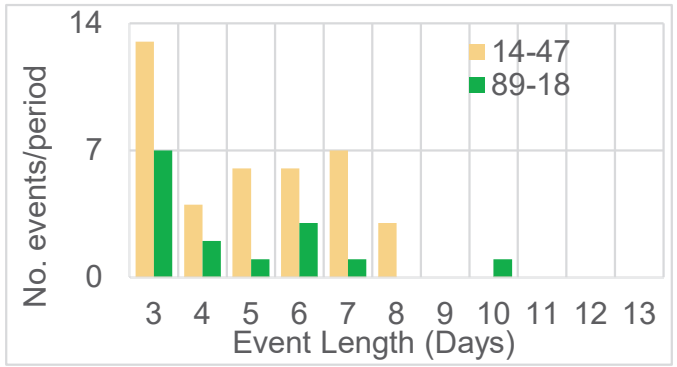
Changes in heat and cold events Canberra

Source: Davis and Lindesay (in prep.)

Heat Events



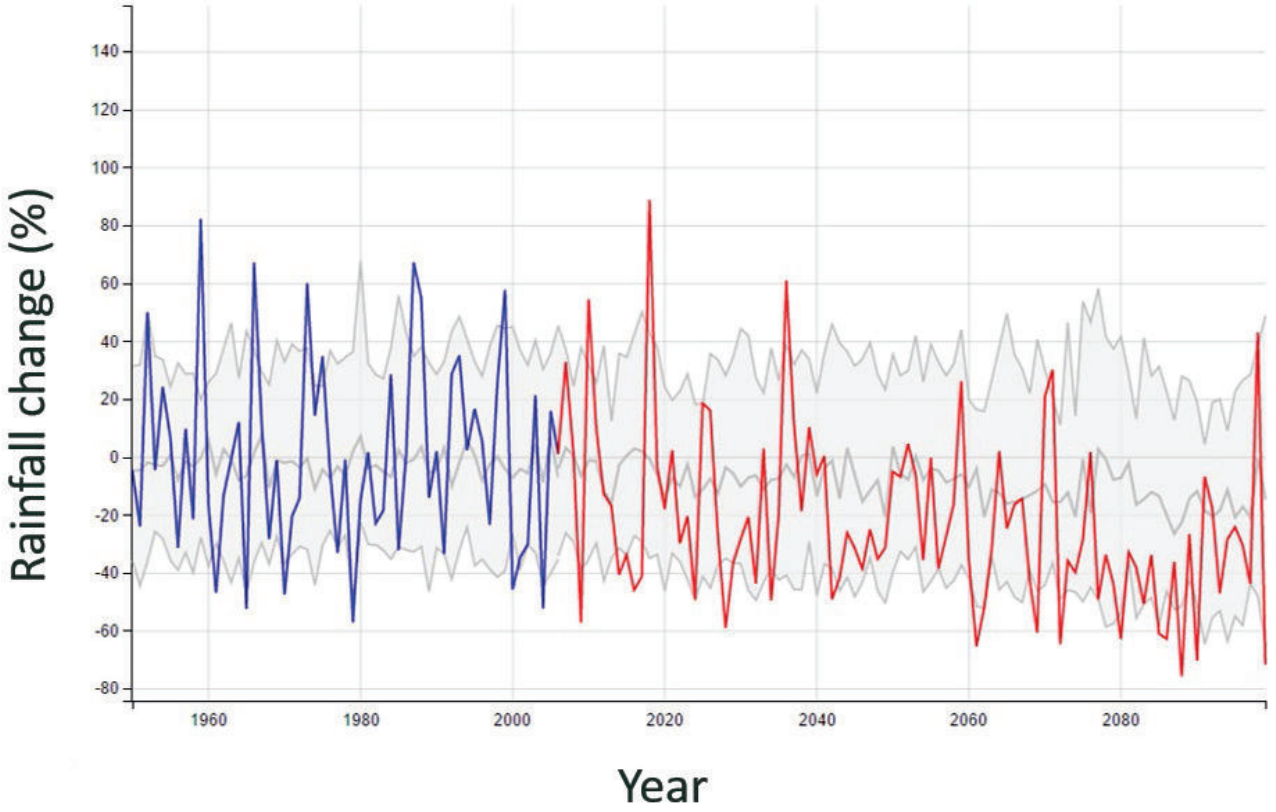
Cold Events



Changes from 1961-90 values

	61-90	14-47	% change	89-18	% change
No. HW events	35	41	17%	59	69%
No. HW days	162	201	24%	279	72%
HW Days>33.4	152	182	20%	262	59%
All Days>33.4	286	334	17%	442	55%
HW Days>36.4	42	51	21%	110	162%
All Days>36.4	54	67	24%	135	150%
HW Nights>17.9	39	23	-41%	74	90%
All Nights>17.9	117	70	-40%	178	52%
Cold events	33	37	12%	15	-55%
Cold event days	151	180	19%	69	-54%
Cold event Days<-5.9	128	151	18%	57	-55%
All Days <-5.9	292	319	9%	137	-53%
Cold event Days -5.9 to -3.9	18	29	61%	8	-56%
Days -5.9 to -3.9	433	691	60%	380	-12%

Projected change in winter rainfall



Source: https://www.climatechangeinaustralia.gov.au/en/projections-tools/time-series-explorer/

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CO_2 fertilisation of plant growth (Potter and Chiew 2011)

Soil water holding capacity:

(1) Fauna ecosystem engineers

(2) Regenerative agriculture

(3) Biochar – soil carbon

Image: Eastern Bettong digging, Mulligans Flat, ACT © Catherine Ross

Landscape scale impacts of British occupation

Occupation changed soils, vegetation and hydrology with:

- Grazing and clearing vegetation
- Soil erosion and compaction
- Extinction of faunal ‘ecosystem engineers’

Our current grasslands have been systematically impacted

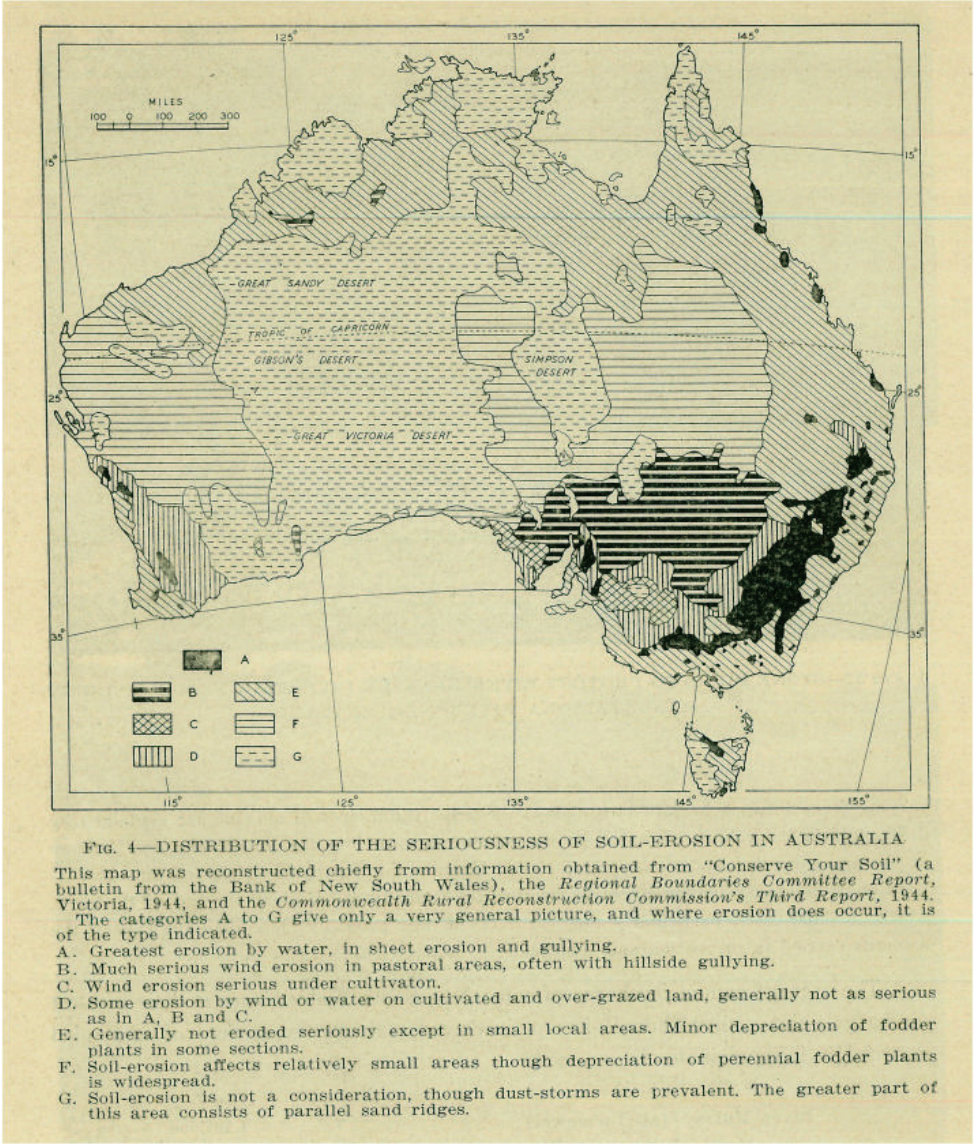


FIG. 4—DISTRIBUTION OF THE SERIOUSNESS OF SOIL-EROSION IN AUSTRALIA

This map was reconstructed chiefly from information obtained from “Conserve Your Soil” (a bulletin from the Bank of New South Wales), the *Regional Boundaries Committee Report*, Victoria, 1944, and the *Commonwealth Rural Reconstruction Commission's Third Report*, 1944. The categories A to G give only a very general picture, and where erosion does occur, it is of the type indicated.

A. Greatest erosion by water, in sheet erosion and gullying.
B. Much serious wind erosion in pastoral areas, often with hillside gullying.
C. Wind erosion serious under cultivaton.
D. Some erosion by wind or water on cultivated and over-grazed land, generally not as serious as in A, B and C.
E. Generally not eroded seriously except in small local areas. Minor depreciation of fodder plants in some sections.
F. Soil-erosion affects relatively small areas though depreciation of perennial fodder plants is widespread.
G. Soil-erosion is not a consideration, though dust-storms are prevalent. The greater part of this area consists of parallel sand ridges.

Map of the ‘Distribution of the seriousness of soil-erosion in Australia’ by Professor John MacDonald Holmes (1946).

Our grasslands and soils can be better managed, but what about the water?

Source: ABC Australian Story: Greg Nelson

Restoring ecosystem engineers

"Re-introducing ecosystem engineers to grassy ecosystems of south-eastern Australia: a boon for agriculture, biodiversity and ecosystem processes?

Digging marsupials, such as bandicoots, potoroos and bettongs, have been all but lost ...

Digging marsupials are often considered 'ecosystem engineers' because they disturb large quantities of soil as they forage, which has the effect of recycling organic matter and nutrients, dispersing spores and seeds, and creating spaces in the soil that increase water infiltration and improve soil structure."

LaTrobe University, 2018

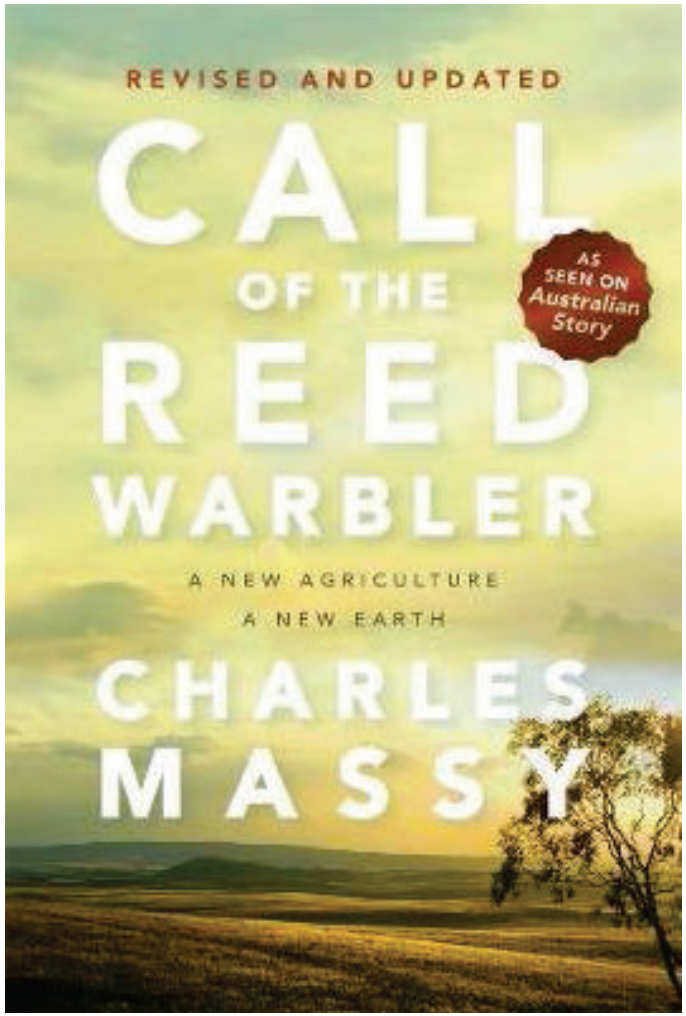
Image: Eastern Bettong digging, Mulligans Flat, ACT © Catherine Ross

Regenerative agriculture

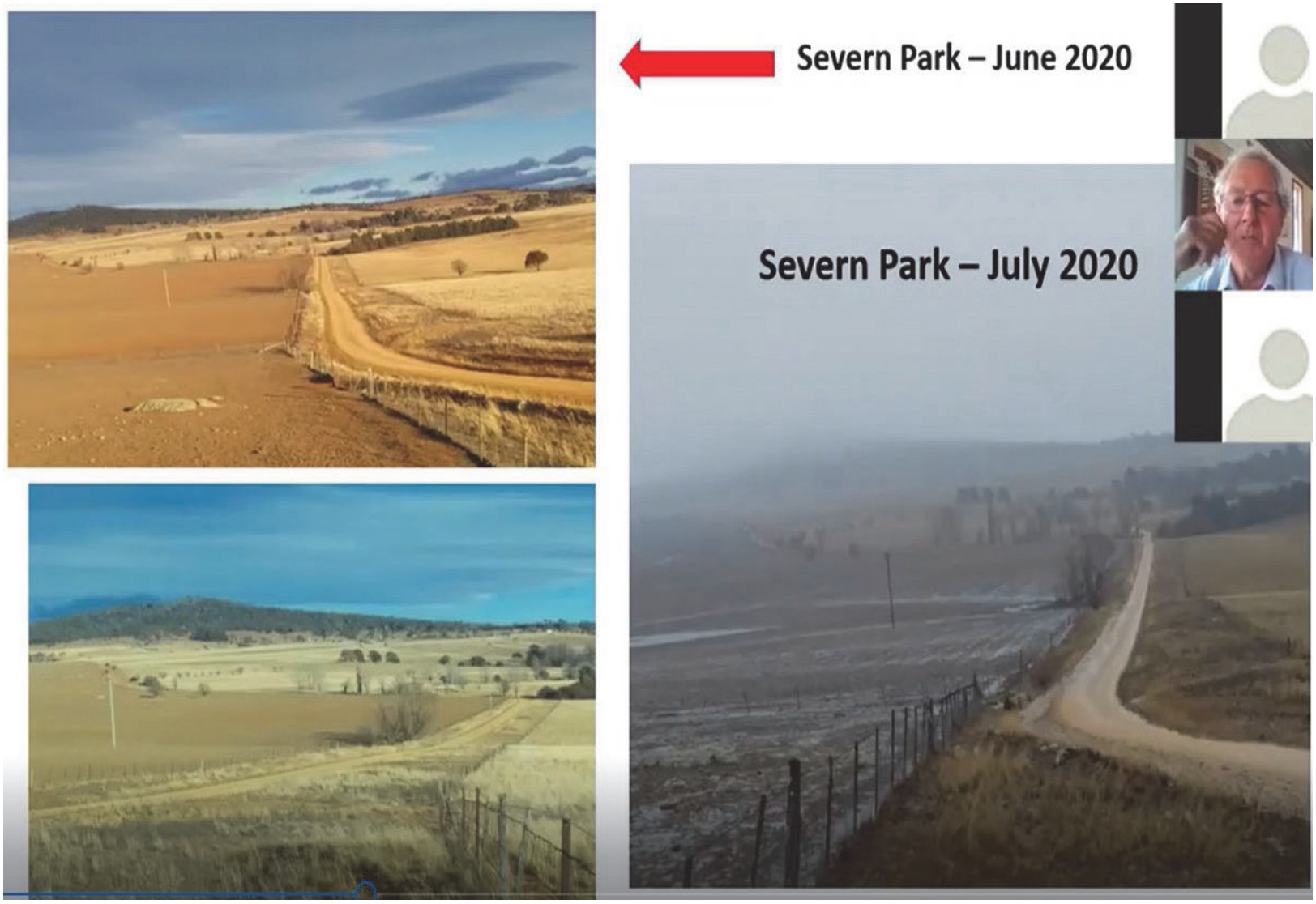
Regeneration International (2017):

- “Regenerative Agriculture” describes farming and grazing practices that, among other benefits, reverse climate change by rebuilding soil organic matter and restoring degraded soil biodiversity – resulting in both carbon drawdown and improving the water cycle.
- “increasing both water holding capacity and sequestering carbon”
- “increase water percolation, water retention, and clean and safe water runoff”

https://regenerationinternational.org/why-regenerative-agriculture/



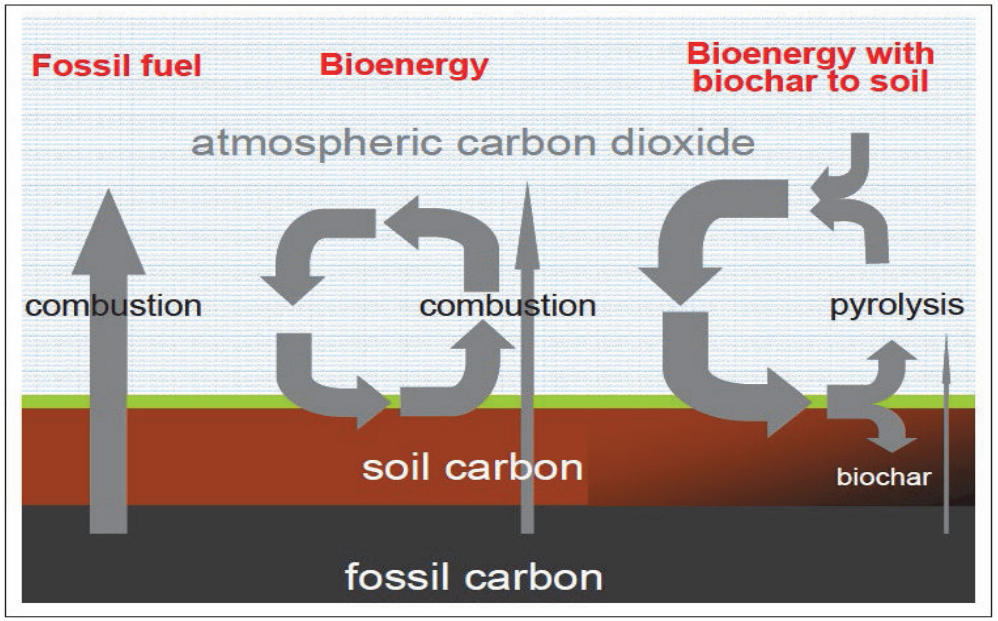
Severn Park, Bobundara Monaro tablelands, mid-2020



Images:
© Charlie Massy

Biochar to increase soil carbon

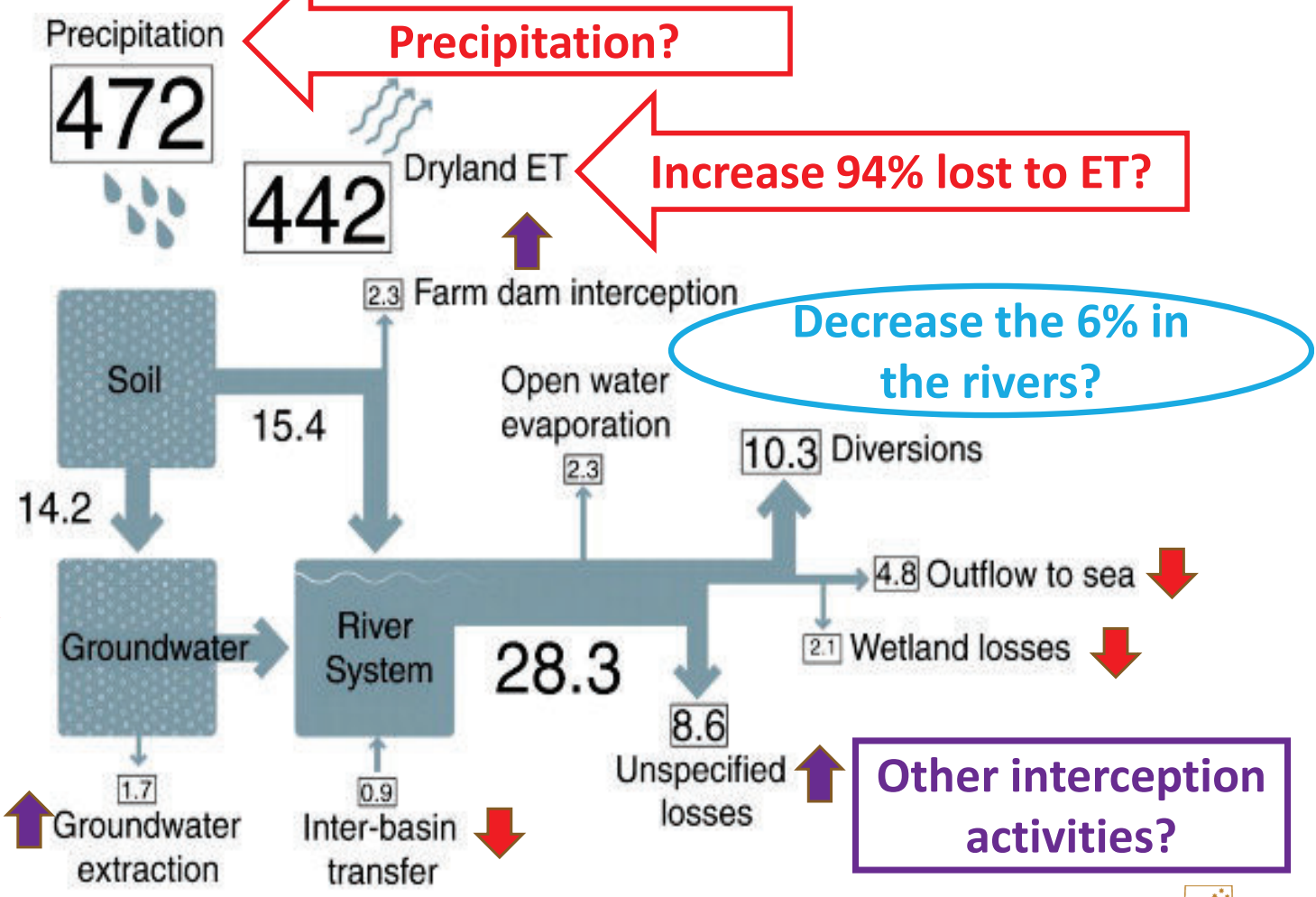
- Charcoal produced by heating organic material by pyrolysis.
- Biochar can remain in soils for hundreds to thousands of years.
- Results in "improved soil structure and water-holding capacity" and may "increase crop yields at lower rates of fertiliser use" (Ag WA).
- Biochar is deemed an 'additional' carbon farming practice for the Federal Government's Emissions Reduction Fund.
- Not yet economically viable.



Use of biochar for net carbon sequestration (CSIRO 2009)

So, what happens to the water?

Approximate water budget for the Murray-Darling Basin in mm/year under development conditions prior to the 2012 Basin Plan (Leblanc et al. 2012)



Precipitation?

Increase 94% lost to ET?

Decrease the 6% in the rivers?

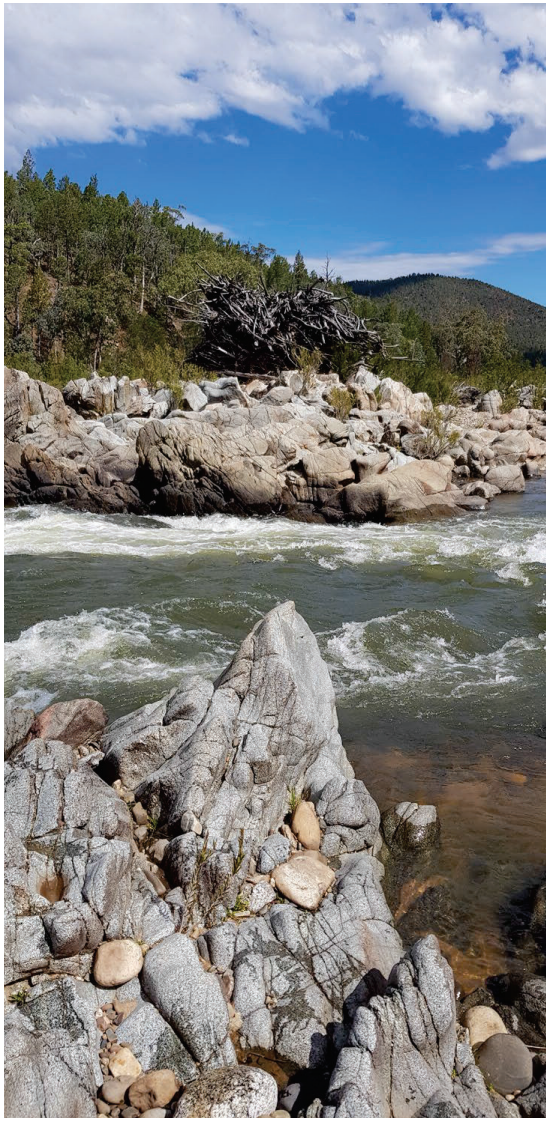
Increase the 3% to groundwater?

+ human use without strong regulation

Other interception activities?

Conclusions

1. **Water is becoming more scarce with climate change in temperate Australia**
2. **Climate change impacts are direct and also from societal responses to climate change**
3. **Levels of runoff is highly influenced by land use**
4. **Trees can aid water yield (snow gums) but mostly diminish it**
5. **Grasslands have higher water yields**
6. **Changes to broadacre management of grasslands will have major implications for water yields**
7. **Temporal and sectoral value judgements and trade-offs?**



THANK YOU

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