Forests and rivers in an era of climate risks

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Forestry Australia Symposium Albury NSW 2022

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Why do our forested catchments matter for rivers?
Why forests our farms?

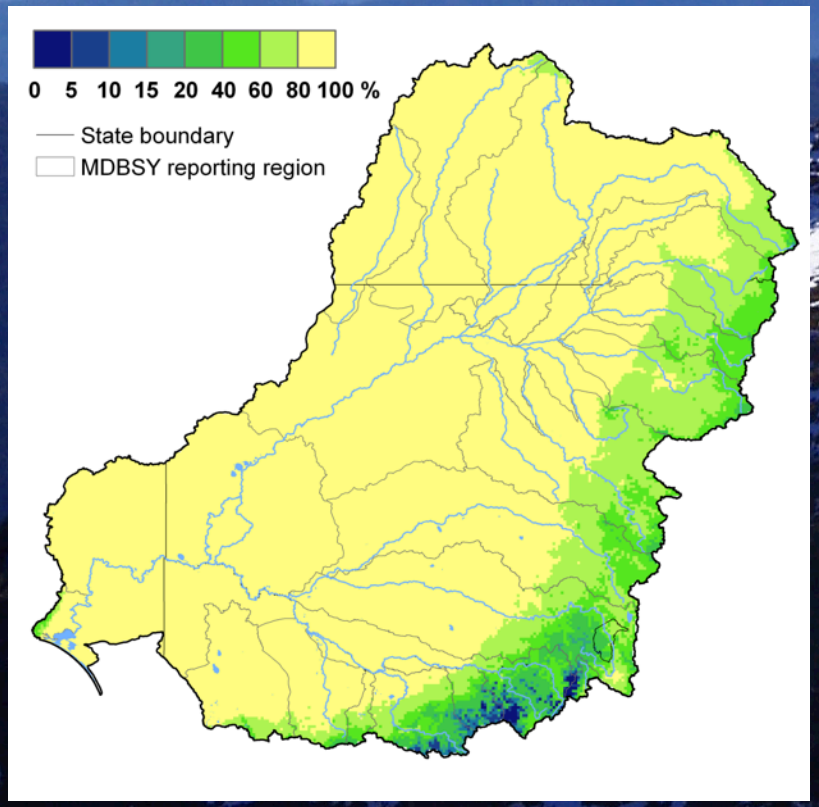
A long unproductive debate in Australia about impacts of forestry and plantation on water resources.

1. Trees are a crucial part of the water cycle
2. Australian streams evolved with and need riparian trees
3. Wet parts of the landscape grow good trees
4. We need to get away from landscape apartheid

Water from forests – is it their most valuable product (service)?

How will climate change impact this?
And can climate risks be managed?

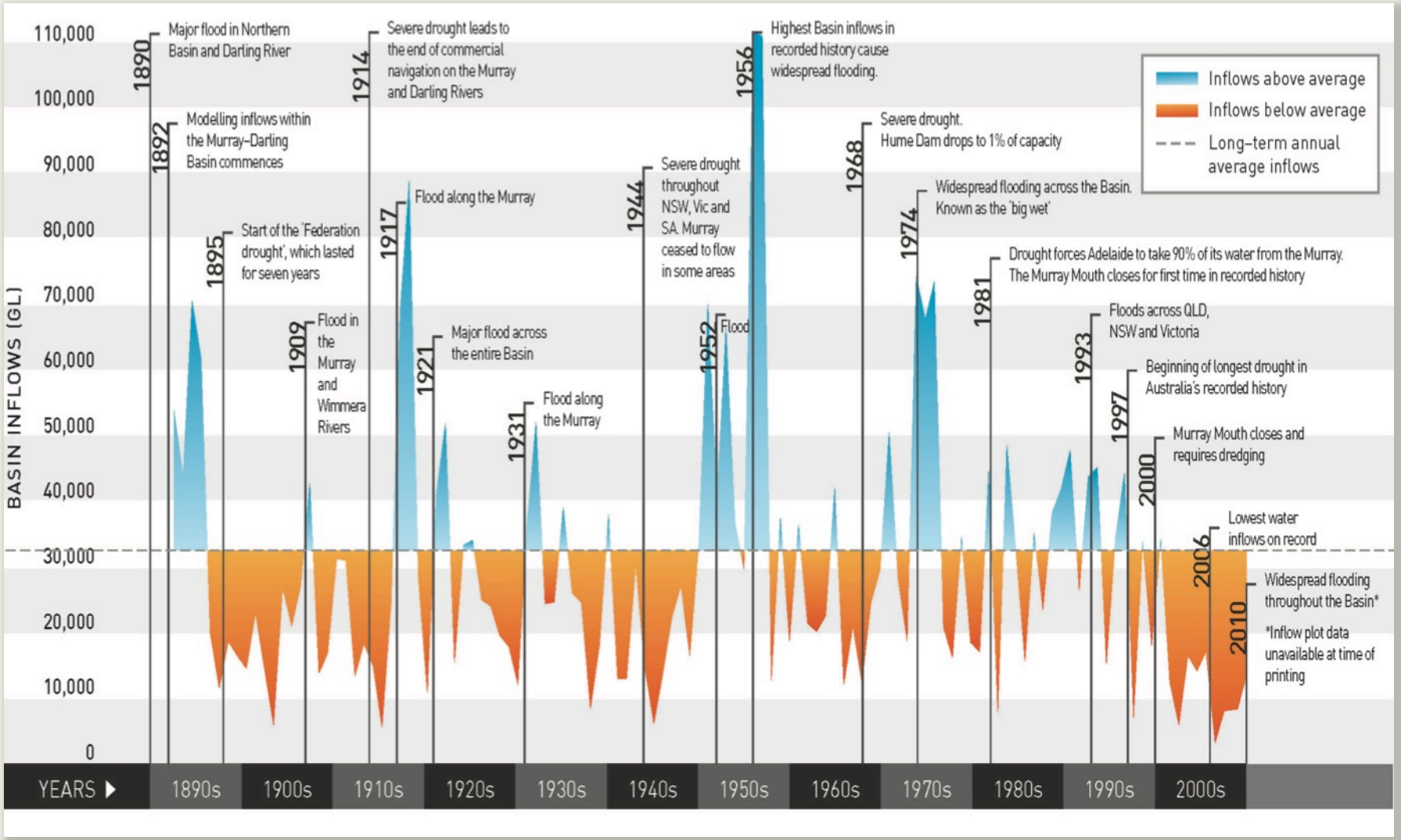
Less than 12% of MDB (by area) generates about two thirds of stream flow (Donohue et al 2011) − nearly all native forest − reafforestation on farm land will not change this significantly −but a changing climate is



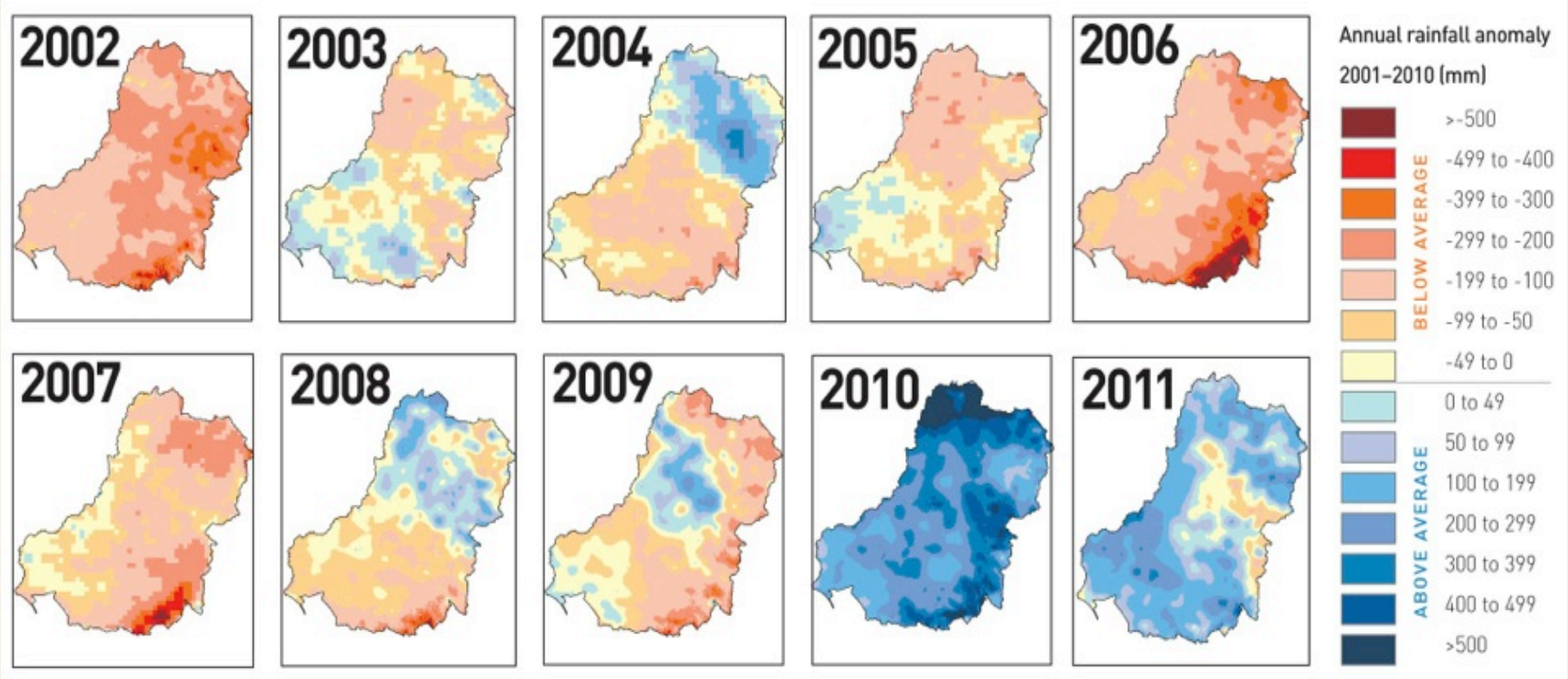
Similar south of the divide

Floods and droughts focus attention on water

Variability of inflows: 1895-2011

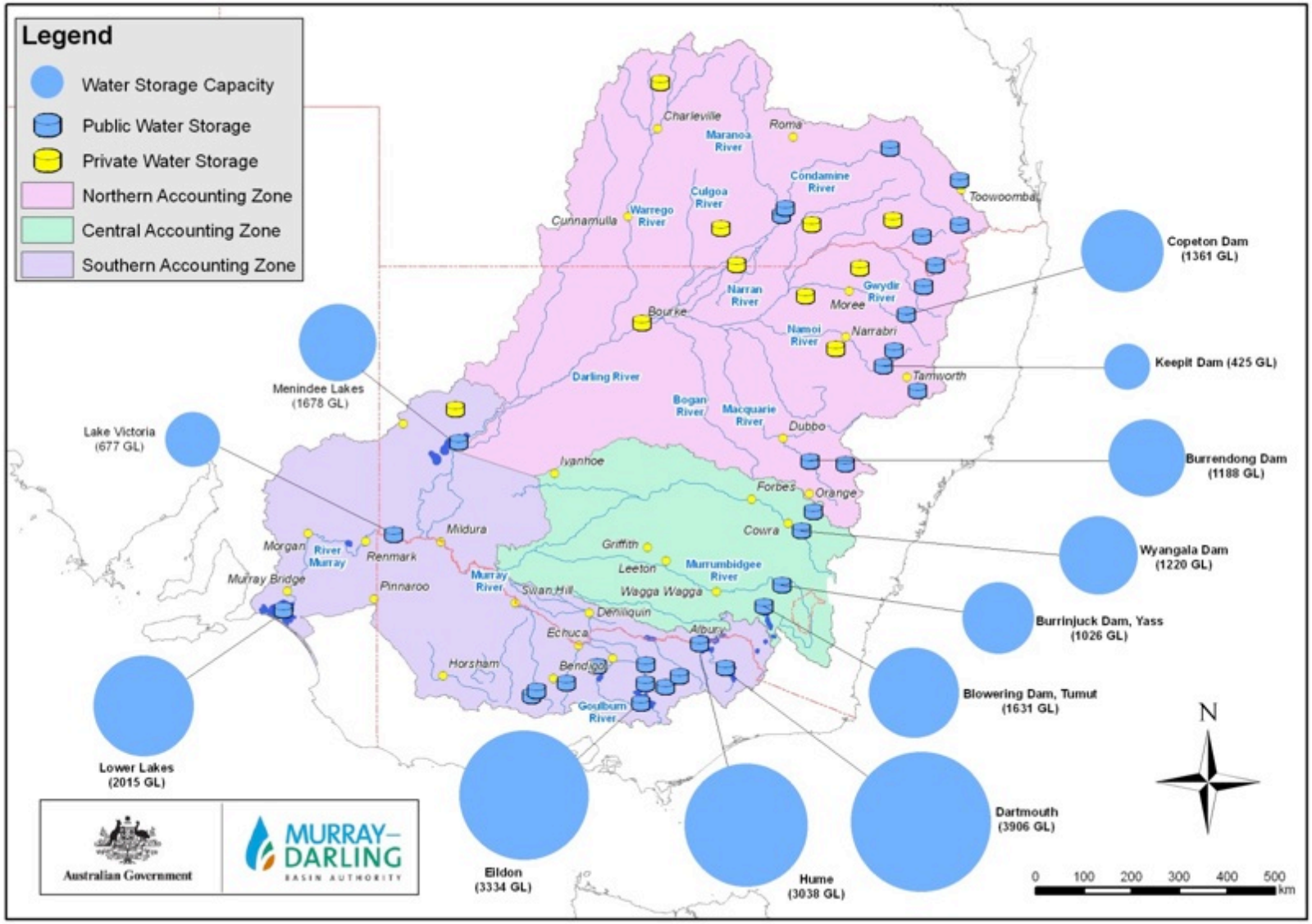


Climate is statistically ‘constructed’ using averages. But in Australia “all averages are lies” (Peter Cullen) variability is increasing with more extremes

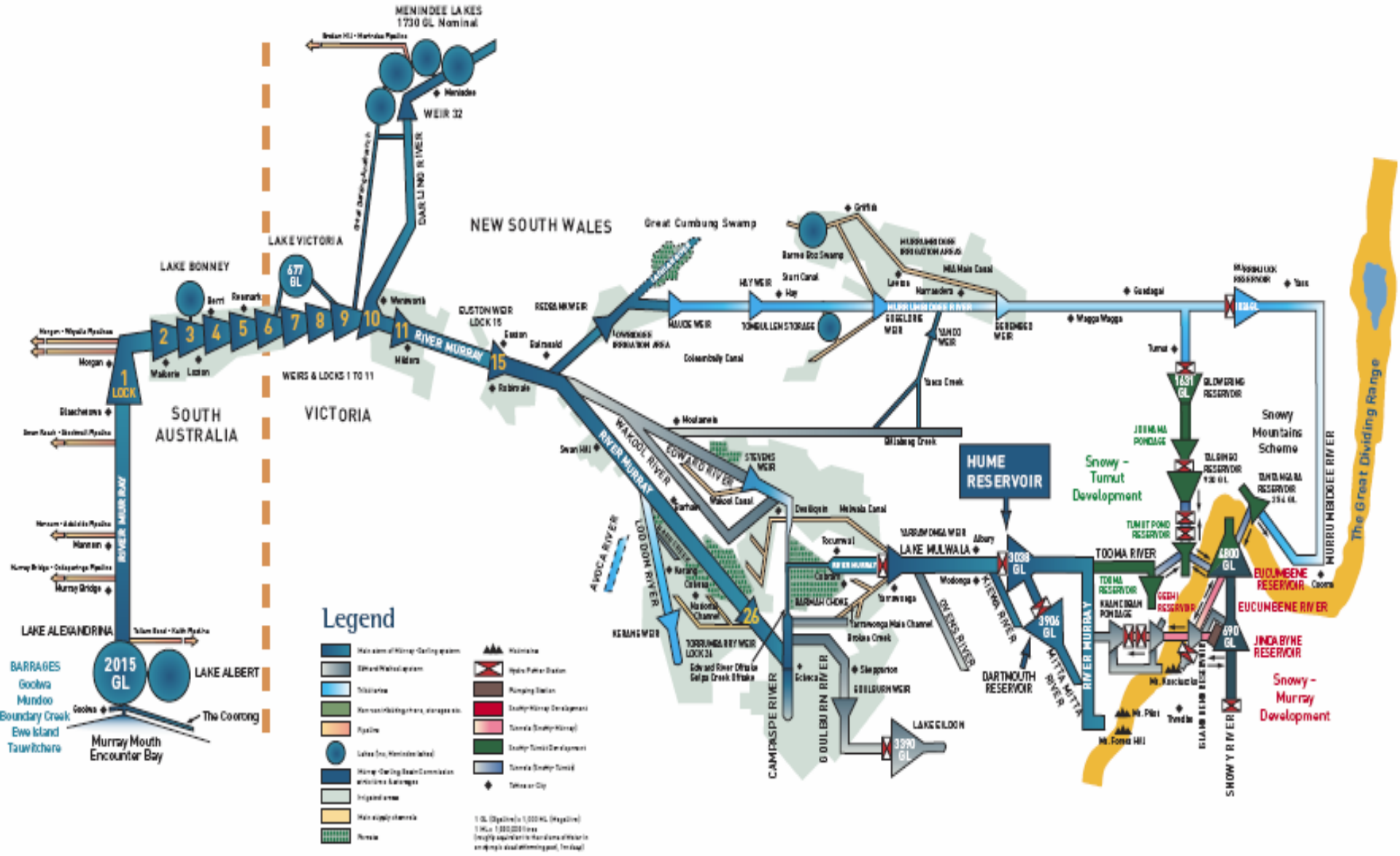



Lake Hume – east of here
– dams ‘smooth’ variability

Major storages on all tributaries



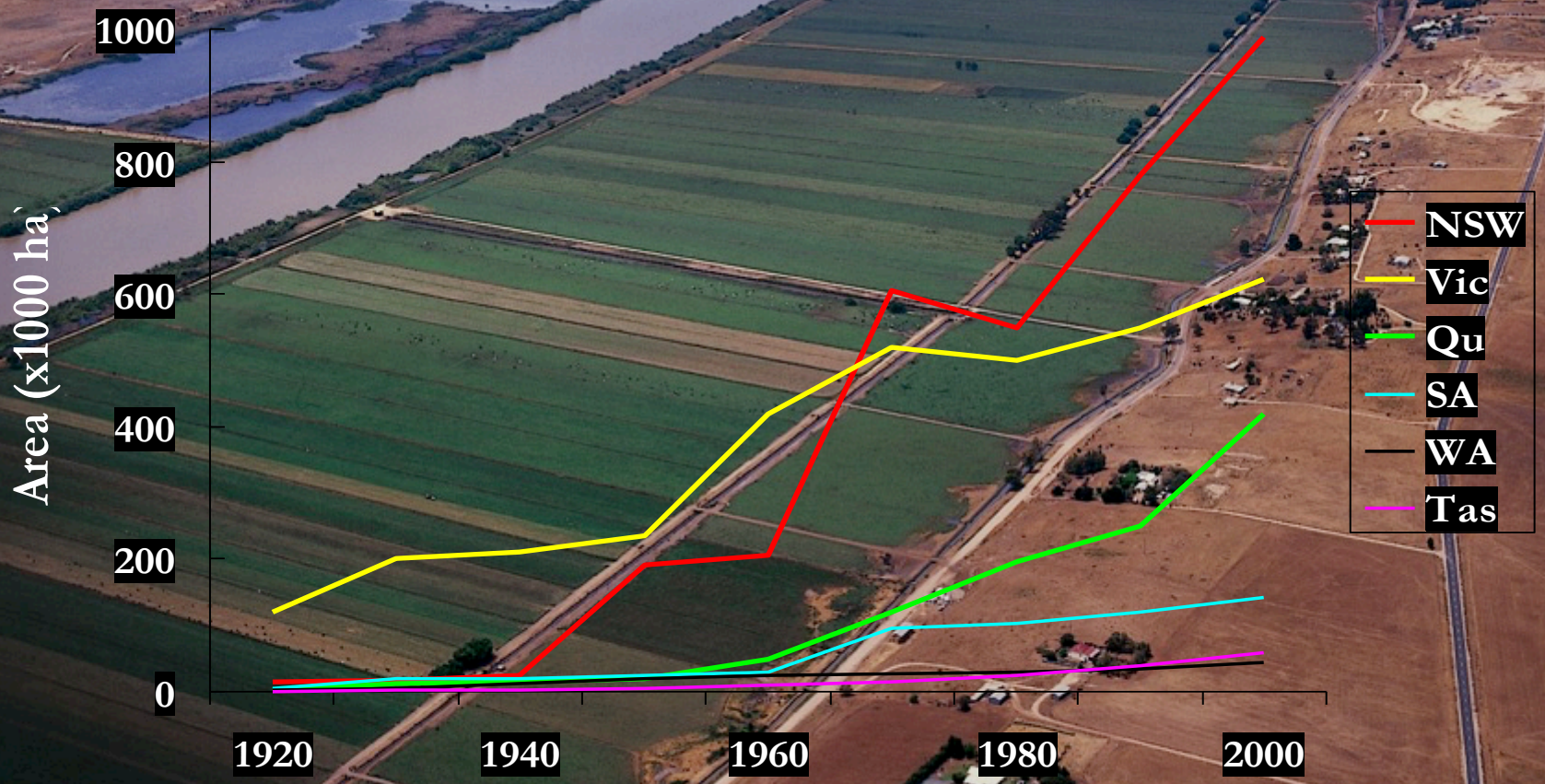
Mega plumbing - a fully regulated/engineered system

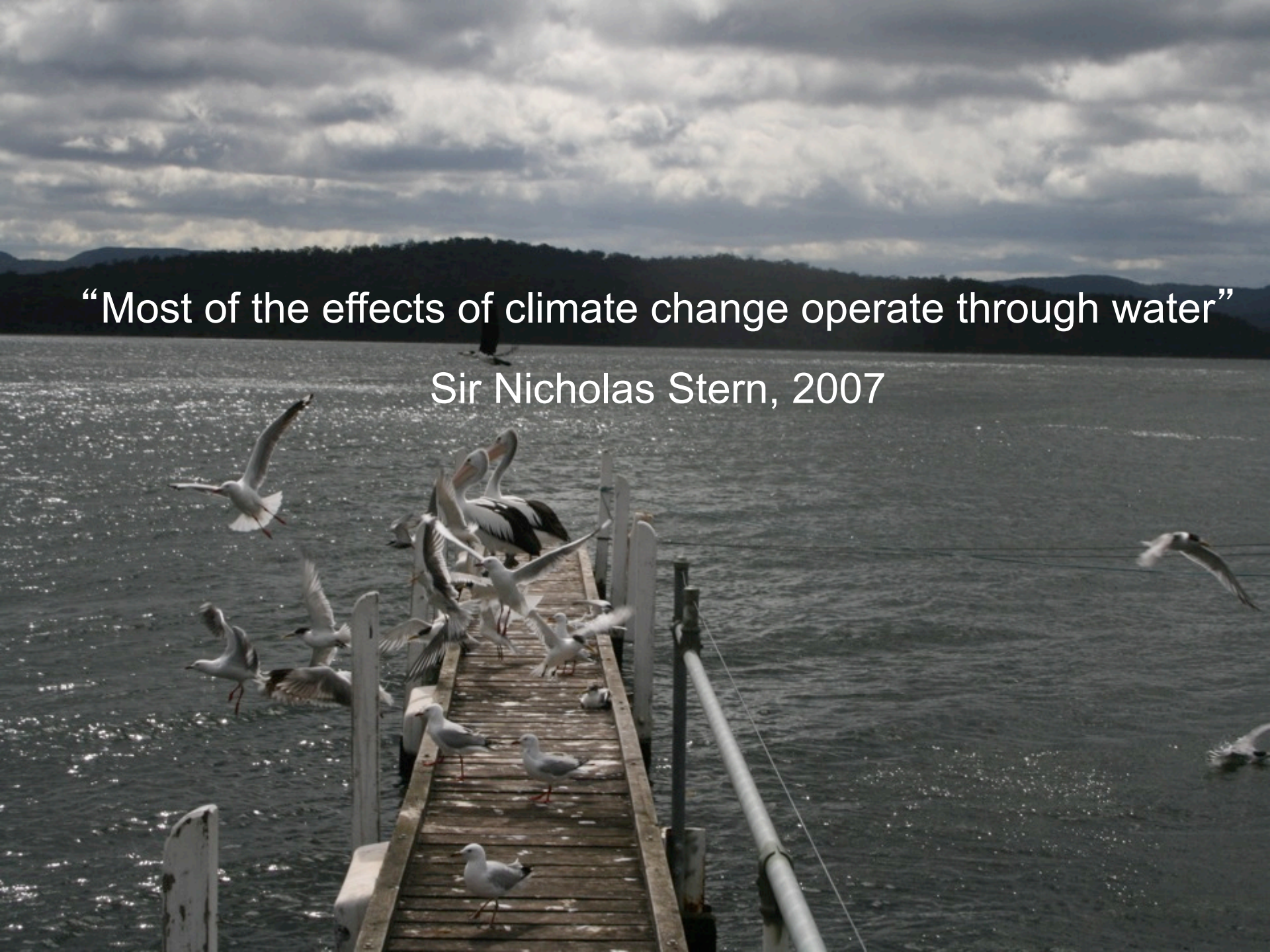



Irrigation supports intensive production

Irrigation – 70% of water used in Australia - most in MDB

Produces more than half the profit of Australian Agriculture & Horticulture, from 0.5% of land (NLWRA 2002)




“Most of the effects of climate change operate through water”
Sir Nicholas Stern, 2007


MASS
EXTINCTION
BUSH
FIRES
SEVERE
DROUGHT
NEXT 100 YEARS

Climate change is greatest yet most uncertain threat to water resources in the MDB

Up to 4400 GL/year or %40 reduction in flows in 20 years (CSIRO 2006)

Compounding impacts

Climate change

?

Higher evaporation. More farm dams as surface water availability reduces?

?

Increased demand for groundwater as surface water availability reduces?

?

Greater irrigation efficiency as surface water availability reduces?

?

Increased forest evapo-transpiration due to higher temps?

?

Higher frequency and intensity of bushfires due to higher temps and worse droughts?

Initial estimates of stream flow Impacts

(20 year timeframe)

Risk Factor	Likely Estimate (GL/y)	Highest Estimate (GL/y)	Source
Climate change	1,100	4,400	CSIRO (2006)
Increased farm dam construction	250	2,500	EarthTech (2003)
Bushfires (River Murray Fires - 2003)	859	1,237	SKM (2006)
Returned irrigation flows	500	1000+	Webb, McKeown (2007)
Increased groundwater extraction	275	550	EarthTech (2003) & REM (2006)
Afforestation/ land-use change	65	150	Dowling, Zhang and Parsons (2007)

Recently reviewed Pittock et al forthcoming

Reviews of afforestation impacts

Any conceivable scale of reafforestation in high and medium rainfall regions will not markedly decrease river flows − a furphy

Crops and pastures use water too. There is competitive pressure to use available water in dryland agricultural production

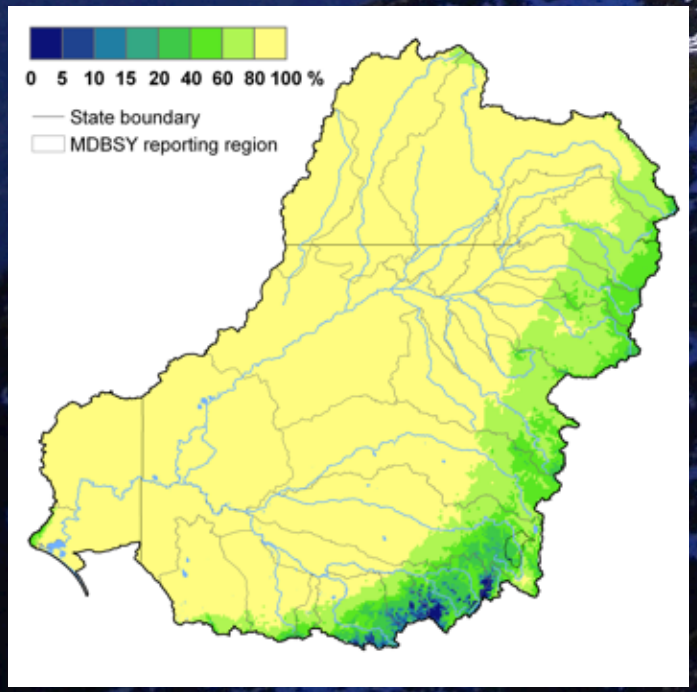
Climate change will alter forested catchments changing quality, quantity (water yield) and regulation (flow rates and timing)

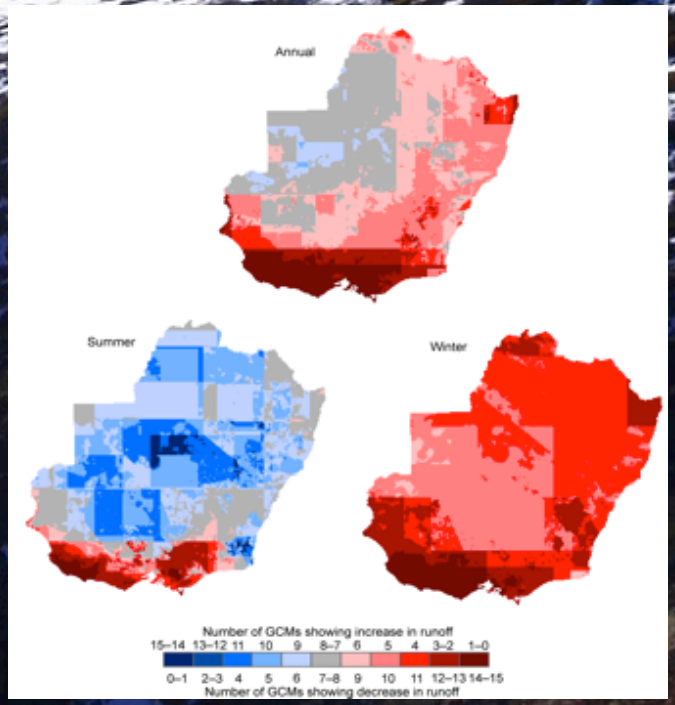
- Valuable water resources
- Critical for urban, agricultural and environmental uses
- River health influenced by climate change, landuse, bush fires, landuse and water resources policies and practices

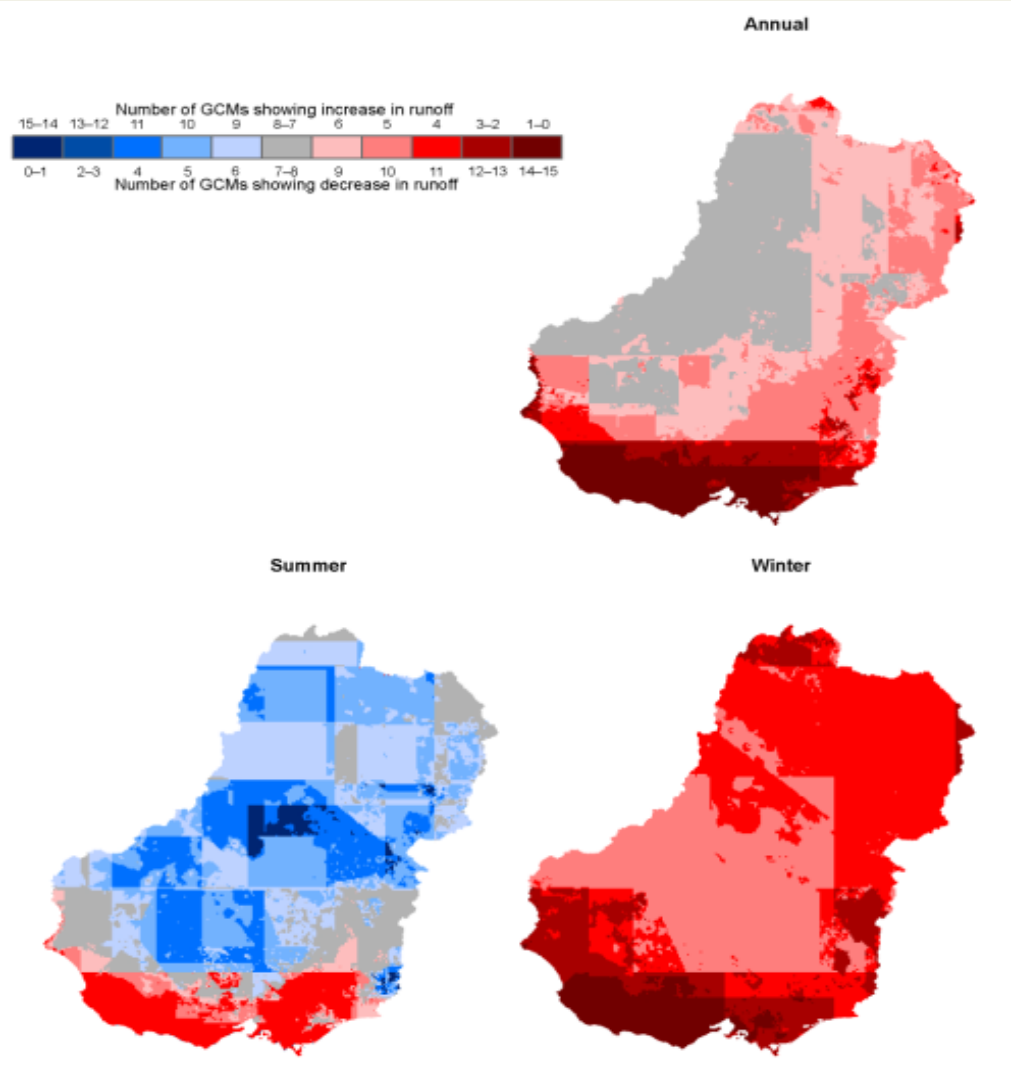
Fundamental changes in forested catchments could reduce runoff (R) and flows in the rivers?

Reduced precipitation (P)
More evapotranspiration (ET)
Higher temperatures
CO2 fertilisation
Changes in rainfall seasonality−less cool season and more summer rain
Fires, droughts, successional change, regrowth impacts

Majority of models show drying trends, declining runoff and reduced flows– including in high yielding uplands

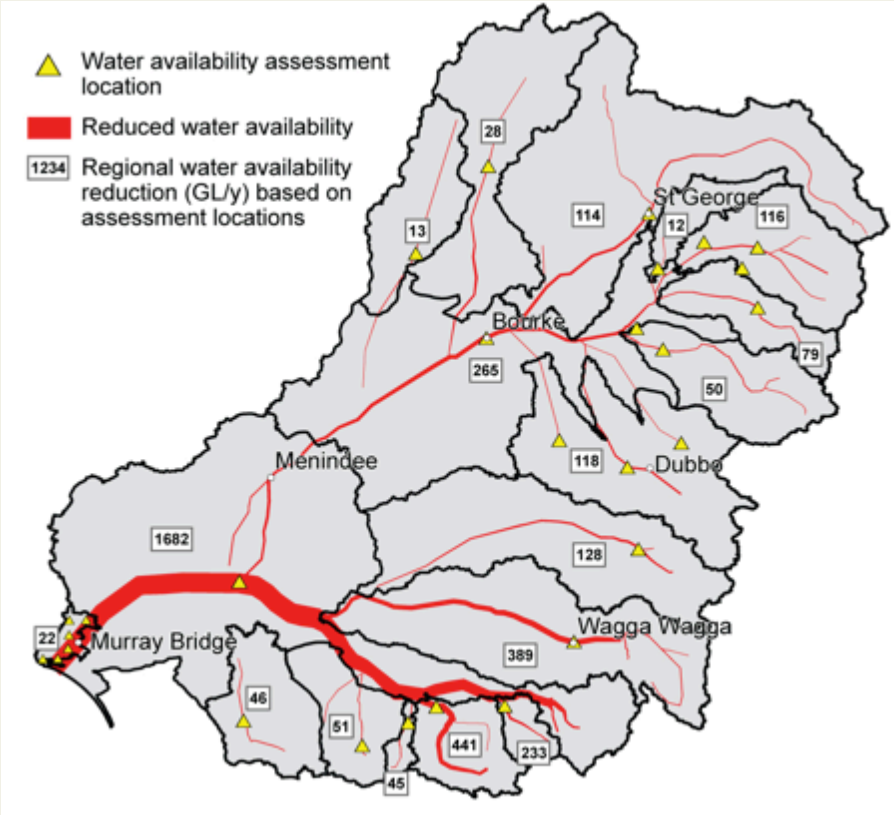


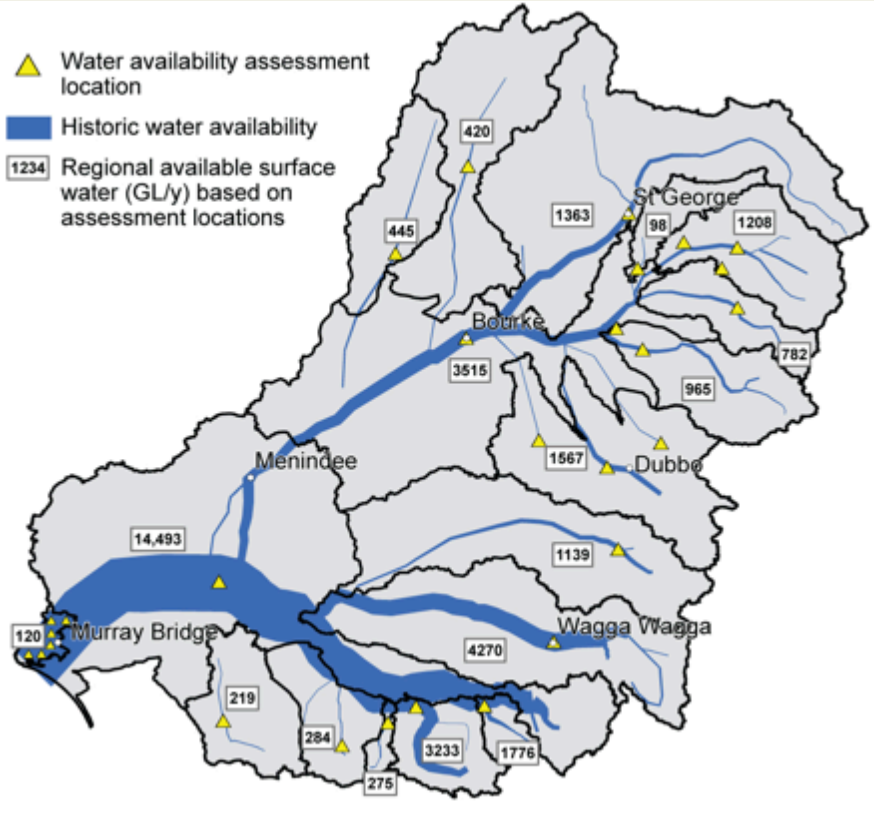




Number of climate models (out of 15) showing increases or deceases in run-off (from CSIRO 2012).

Emphatic warnings that MDB could be severely impacted by climate change (CSIRO 2008, 2010, 2012)



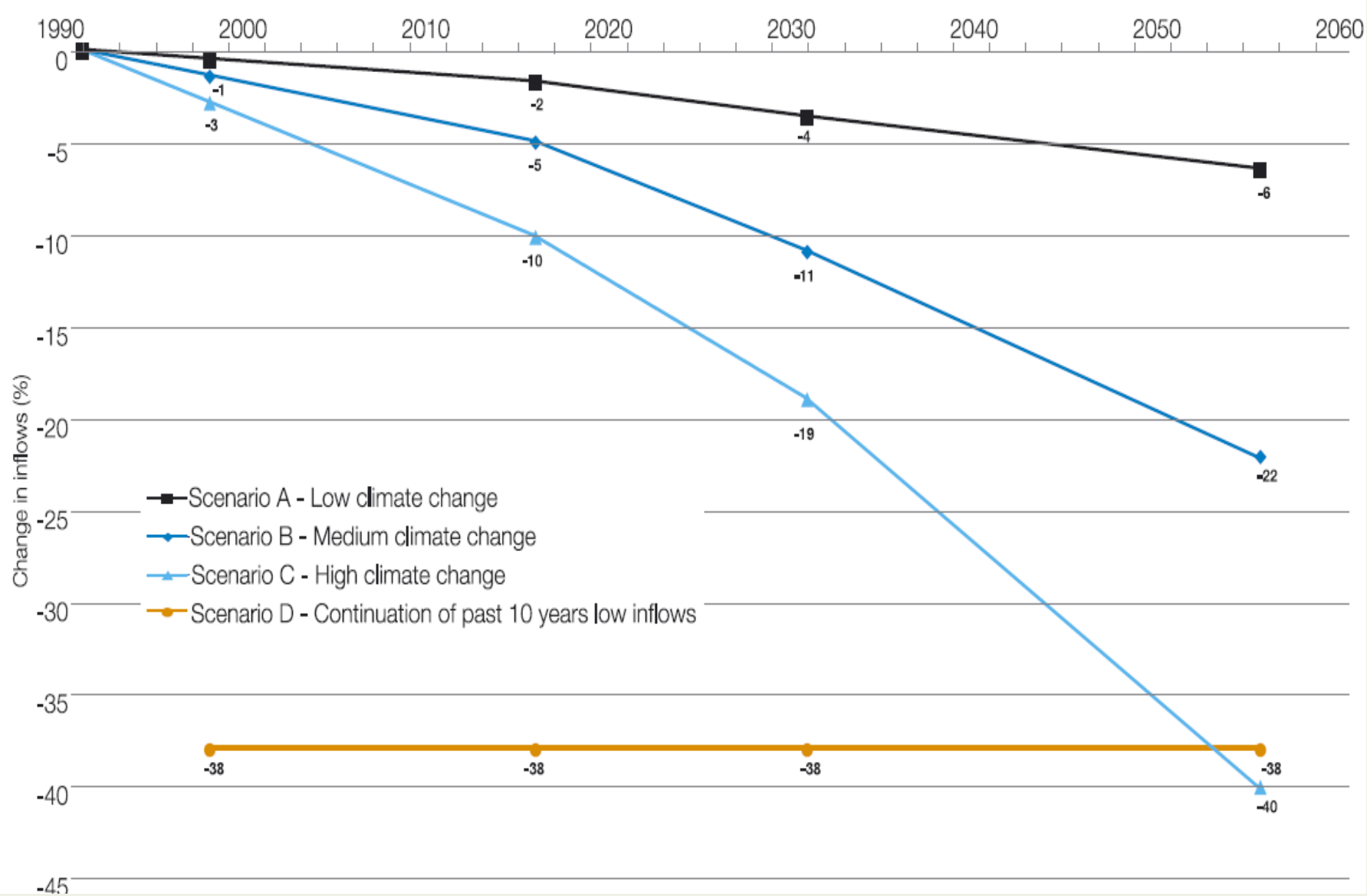


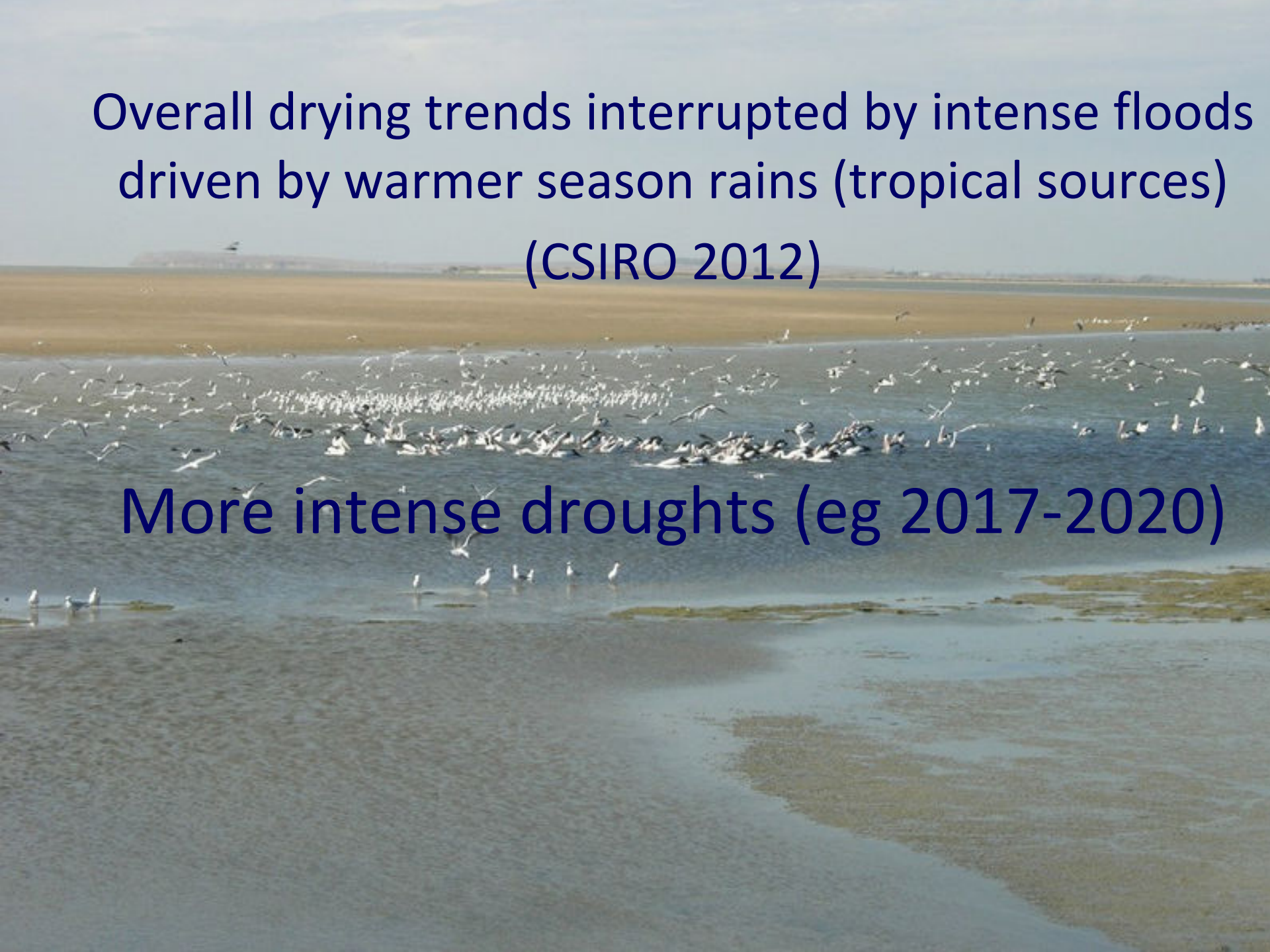
CSIRO (2008) median reductions in water availability by 2030

Impact of Climate Change: Victorian 2055 estimates
(Source DSE 2008)

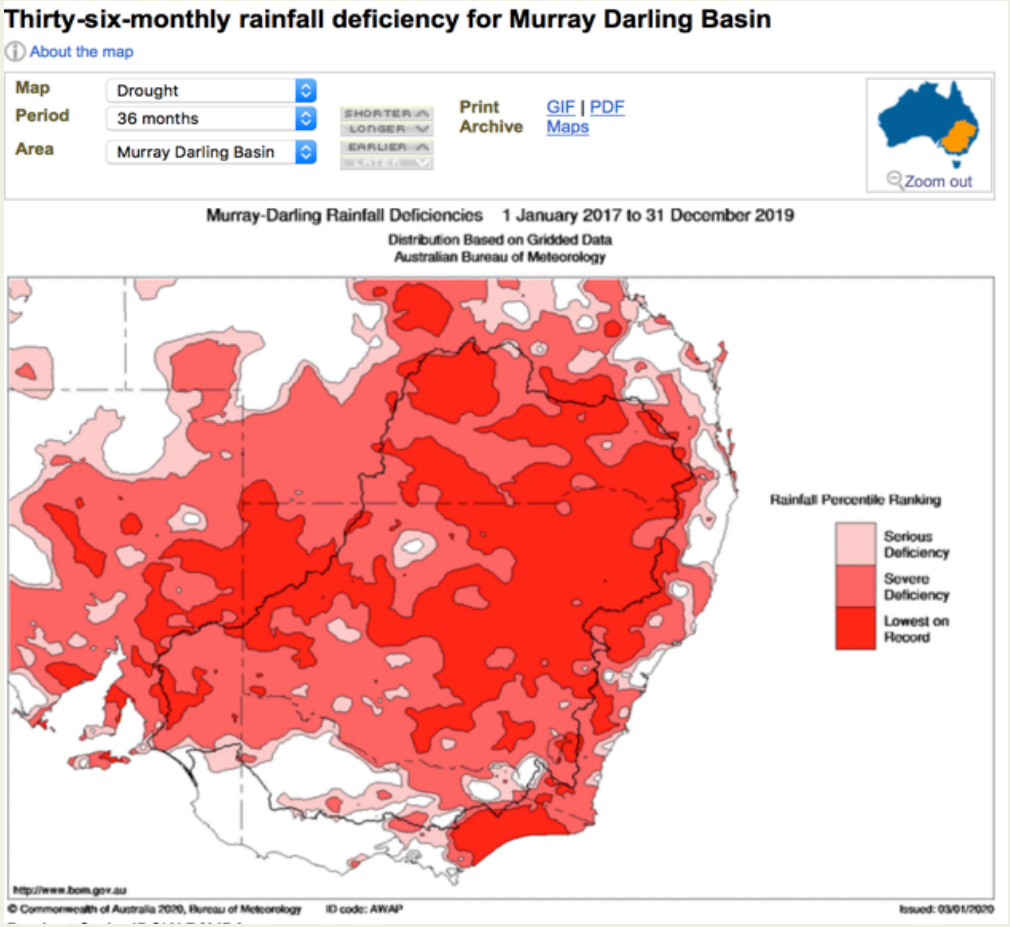
Valley	reduction in total inflows	reduction in allocations	reduction in environmental flows
Murray	- 33%	- 10%	- 44%
Broken	- 46%	- 6%	- 66%
Goulburn	- 36%	- 23%	- 55%
Campaspe	- 67%	- 45%	- 84%
Lodden	- 70%	- 67%	- 73%

Future scenario like the Millennium drought

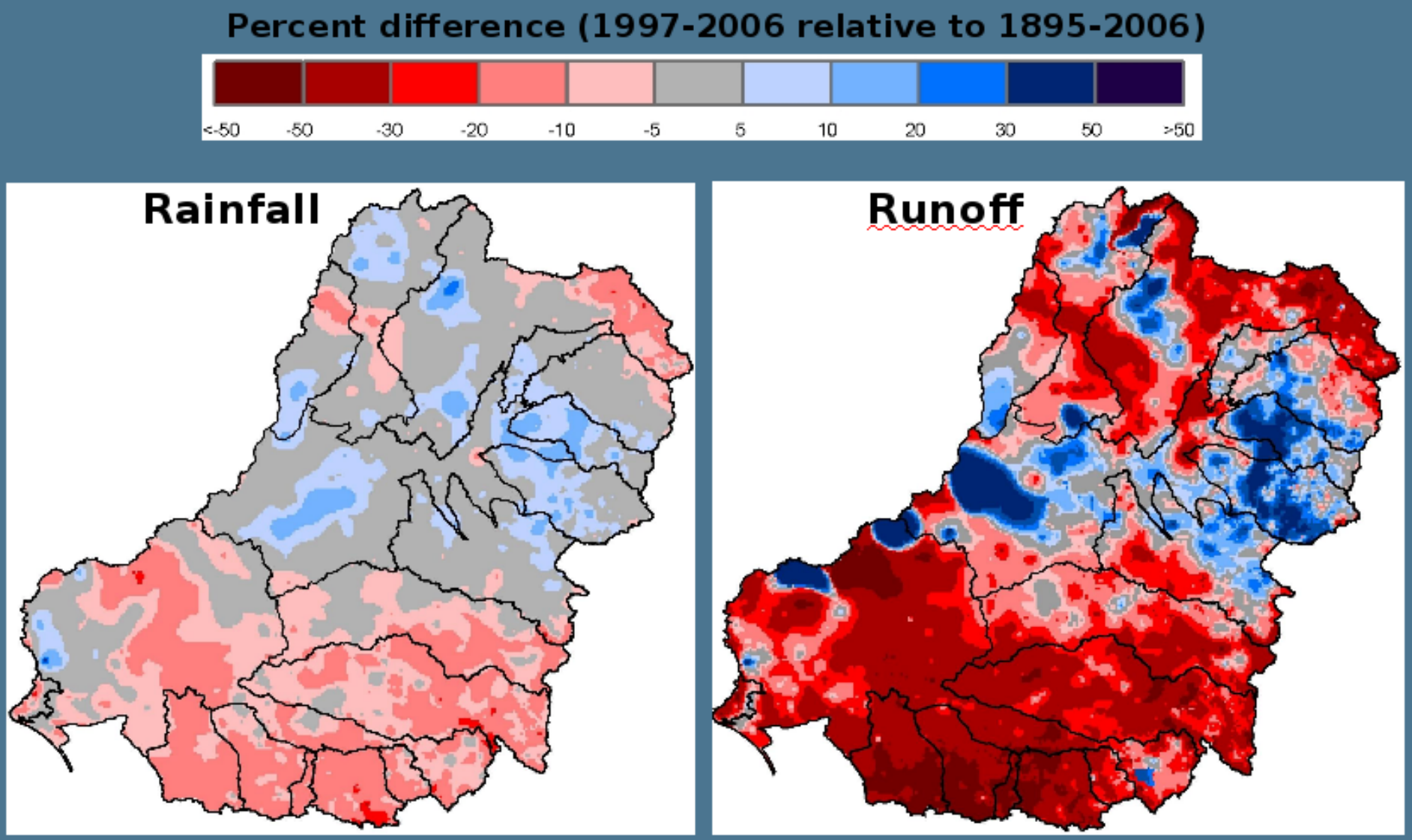



Overall drying trends interrupted by intense floods driven by warmer season rains (tropical sources) (CSIRO 2012)
More intense droughts (eg 2017-2020)

Unprecedented drought conditions in the central and northern MDB. BOM (2020)



Amplification - decreases in runoff



Crude water balance - MDB

ET = 94% of P precipitation
6% = R (runoff, rivers, wetlands)
2% = Flows to Murray mouth under zero irrigation
(Roderick and Farquhar 2009)

What if ET goes up under higher temperatures and Co2 and P goes down - ?

How do Eucalyptus forests respond to higher temperatures?

Is 1 degree increase in daytime maximums significant for forest water use?

Roderick and Farquhar (2011) calculated sensitivity of Basin flows to changes in P or ET.

- A 1% increase in ET alone could result in 18% reduction in stream flow.
- A 10% reduction in precipitation combined with an increase in evaporative demand of approximately 7% results in approximately 40% reduction in runoff. (Roderick and Farquhar 2011)

Carbon dioxide fertilisation

Plants photosynthesise more efficiently in a higher carbon atmosphere. Under some conditions they not only grow more per unit of water, but also use more water, particularly in water stressed environments (Roderick and Farquhar 2011).

Carbon dioxide fertilisation makes photosynthesis more efficient per unit of water demonstrated by increasing growth and ‘greening’ of shrub lands in semi-arid environments, including in the MDB (Donohue et al 2013).

Increased evapotranspiration (ET) due to carbon dioxide fertilisation could be reducing stream flows in the MDB by up to 28% (Ukkola et al., 2016).

Forests are changing
Declining precipitation, higher cool season temperatures and CO2 fertilisation could be combining to significantly reduce stream flows.

Australia needs more research to determine how water balances are changing and effecting flows.

One clear message

"Stationarity is dead"

Changes in climate and catchment processes require new thinking about governance and risk

Develop capacity for policy under uncertainty

Use scenarios to plan for extremes

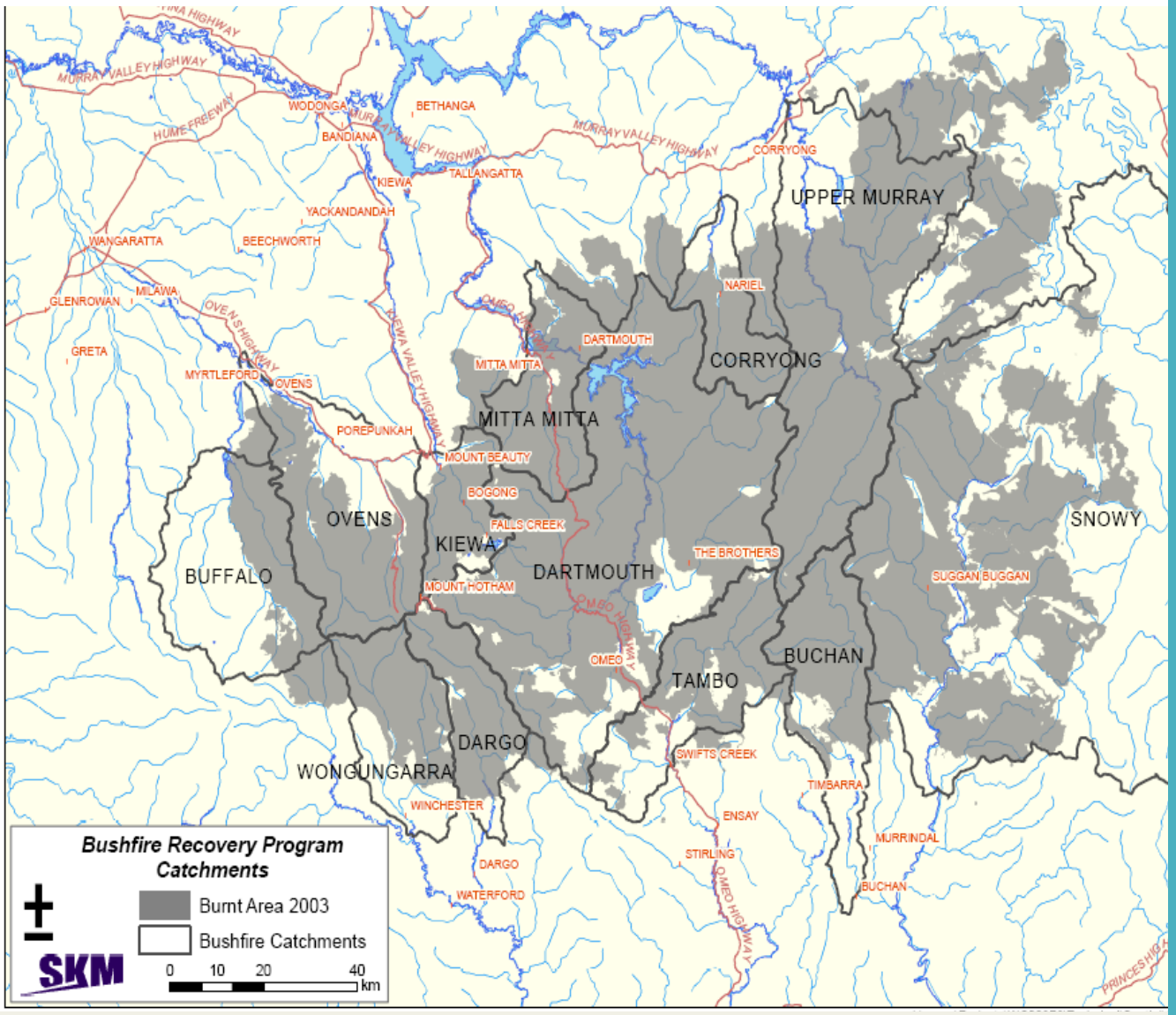
Bushfires

2006 CSIRO study found increased bushfire risk across SE Australia from climate change

Key finding	2020	2050
Fire-weather risk likely to increase in SE Australia	4 – 25%	15 – 70%
Annual average of very high to extreme fire danger days in Canberra (presently 23.1 days)	25.6 – 28.6 days	27.9 – 38.3 days

Source: CSIRO 2006

In the Millennium drought nearly all high rainfall catchments burnt

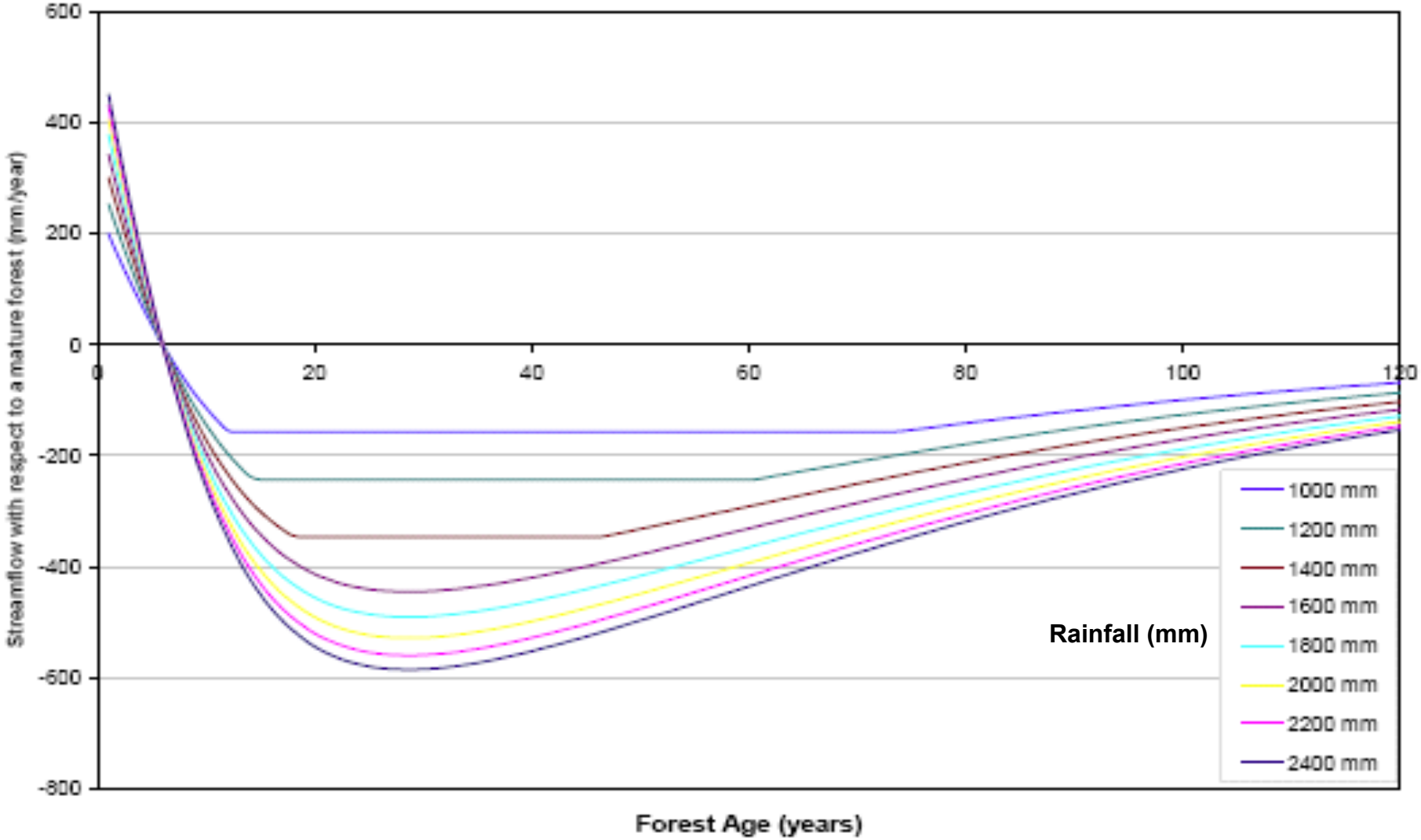


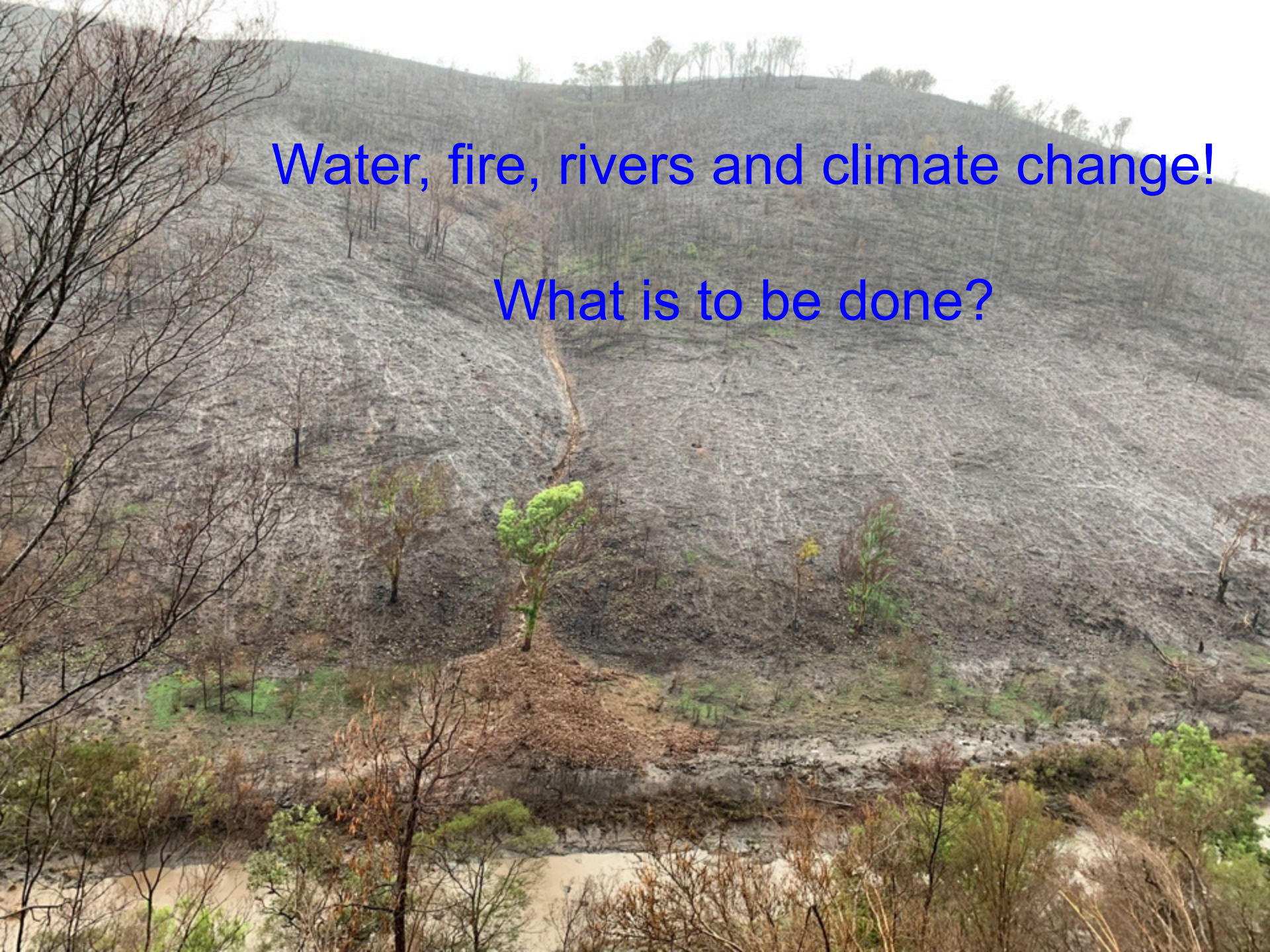
Reduction in yield:

Vic 2003 fires: Reductions of up to 1237 GL/y in 20 years

In the Millennium drought nearly all high rainfall catchments of South-eastern Australia burnt – eg 2002/3, 2006/7 and 2009

Impact of Bushfires on Streamflow (mountain ash)




Water, fire, rivers and climate change!
What is to be done?

Fire risks from a water perspective - Intensified risks to water quality and aquatic systems (streams, lakes, reservoirs, wetlands, estuaries)


These rivers supply lakes, estuaries and wetlands
of great significance

High nutrients in runoff can result in algal blooms in rivers, lakes and estuaries. After the 2006–07 fires in Victoria burnt >32% of the catchment there was an unprecedented *Synechococcus* algal bloom in the Gippsland Lakes, lasting almost a year.
This was attributed to the extremely high nutrient loads in the flood, after the fires.

These events are well known and have been experienced before.

And could occur again – the triggers are not so well known.

High quality water sourced from Victoria's mountainous forests may be their most valuable product (and service).

These ecosystem services are difficult to value.
Over 13000 studies but findings rarely applied in policy decisions
Laurans and Mermet (2014).
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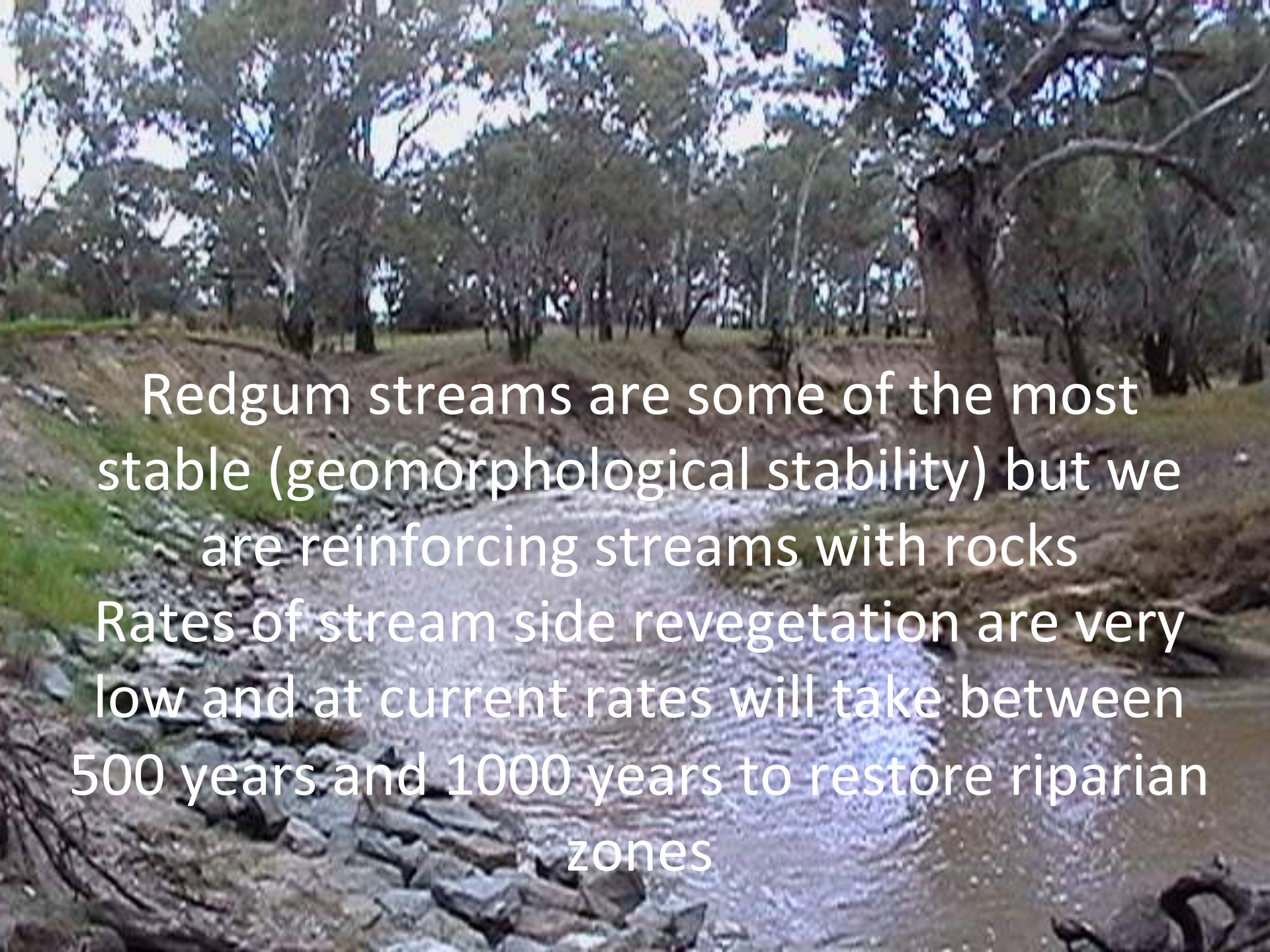
Moving downstream to the agricultural landscapes

Using vegetation for priority landscape outcomes

- Water quality
- Salinity
- Biodiversity
- Production
- Cultural values
- Carbon sequestration



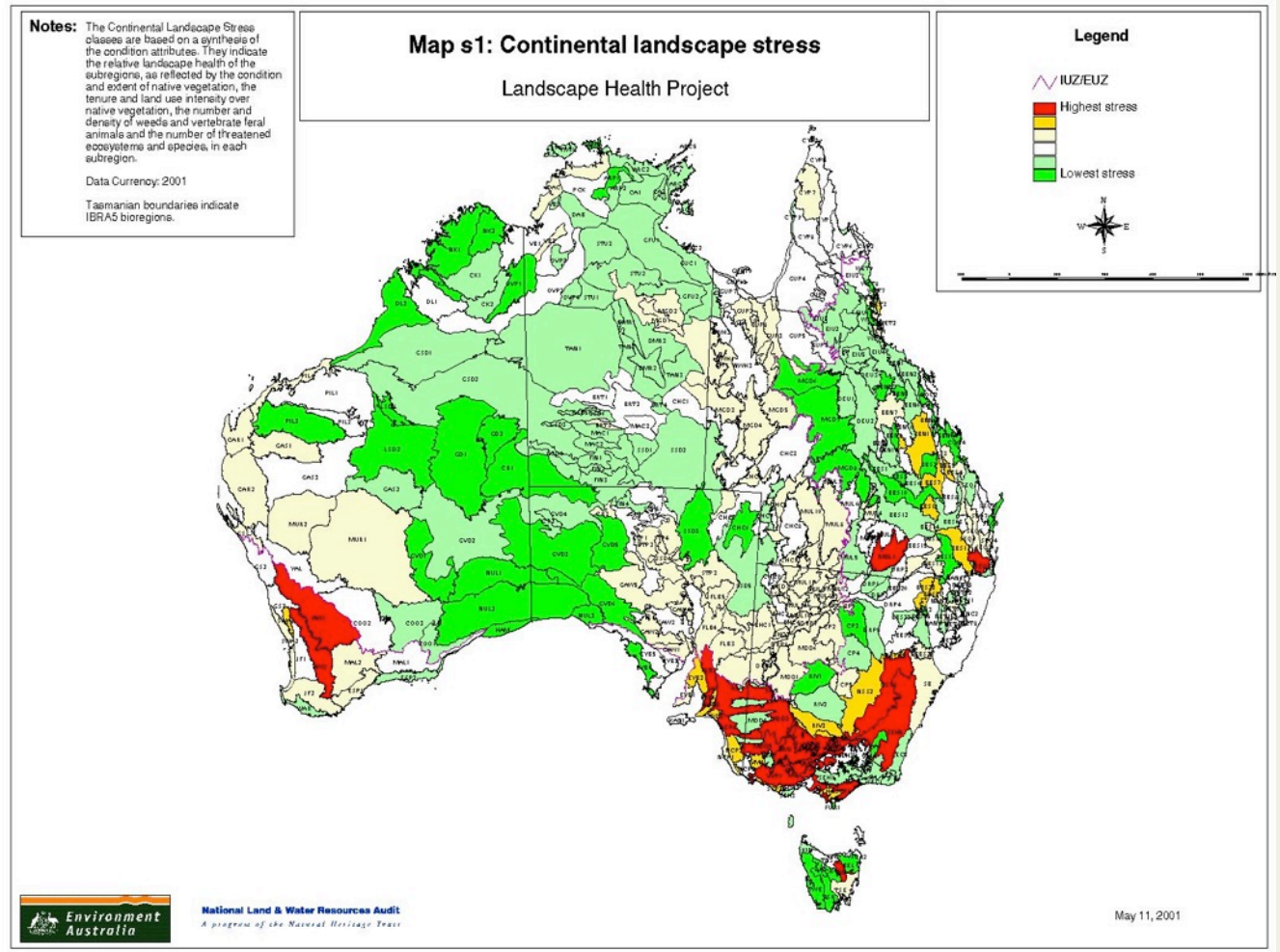
Redgum streams are some of the most stable (geomorphological stability) but we are reinforcing streams with rocks

Rates of stream side revegetation are very low and at current rates will take between 500 years and 1000 years to restore riparian zones

Creeks are not just drains but habitat for unique, iconic species that result of 60 million years of separate evolution and 60,000 years of cultural landscape management

Catchment managers confront some massive issues

- Water quality
- Extinction
- Climate change
- In SHORT A "LANDSCAPE CRISIS" in agricultural regions?



Floodplains and streams

Connecting fragmented landscapes. Over 70000 kilometres of redgum streams in the MDB. Most degraded. Opportunity for huge forest resource, on fertile stream sides (eg 70k x 50metres = 700000 hectares)

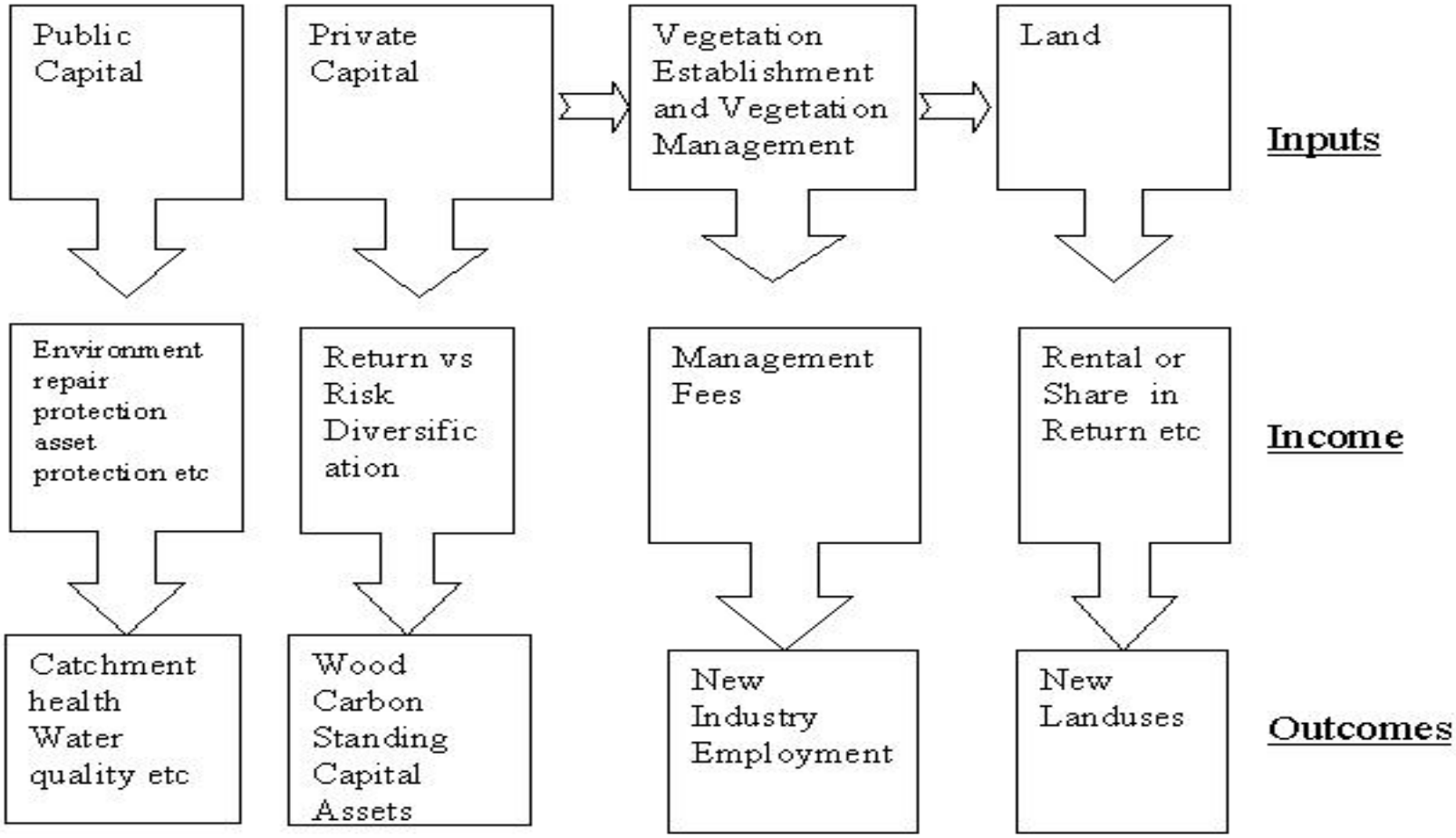
We need multipurpose forests for carbon and catchment management?

Publications:

Landuse change in Goulburn-Broken Catchment

Public private partnerships for reforestation?

Existing Landuse
Cost Of Change




Firewood, fuel, bioenergy, carbon,
biomaterials, bio refineries?

Designing landscapes? Creating new mosaics? Integrating regeneration, conservation plantings and farm forestry?

If we care for:

- Country
- Water
- Biodiversity
- Carbon reduction
- People

We will change the way understand and manage forest


We need to farm our forests and
forest our farms

More information

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