Drought and climate change in the MDB: a hydrological perspective

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Drought Symposium, Riverside
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Outline

• Sketch of the Murray-Darling Basin

• The Murray-Darling Basin Sustainable Yields project

• Past, present and future (climate change projected) droughts in the Murray-Darling Basin

• Policy implications
The Murray-Darling Basin

- An Australian icon
- ~1 m km²
- ~2 m people
- Major region for rainfed and irrigated agriculture
- Irrigation accounts for ~95% of diversions
- Over-allocated water, plans to return water to the environment
Rainfall and runoff characteristics

- Rainfall varies considerably from east to west
  - 2400 mm in SE
  - < 200 mm in west

- Most runoff from small area
- Only rivers in south are reliable
Growth in storage capacity & diversions

- Capacity major storages
- Average annual flow of all rivers (without-development)
- Average natural flow to the sea
- Total surface water diversions

Volume (GL)


Legend:
- Yellow line: Capacity major storages
- Green line: Average annual flow of all rivers (without-development)
- Blue line: Average natural flow to the sea
- Black line: Total surface water diversions
Murray-Darling Basin Sustainable Yields Project

- Water Summit: Prime Minister and First Ministers, Nov 2006
  - CSIRO to report progressively on sustainable yields of surface and groundwater systems within the MDB

- Estimate current and likely future (~2030) water availability in each catchment/aquifer and for the entire MDB considering:
  - climate change and other risks
  - surface-groundwater interactions

- Compare the estimated current and future water availability to that required to meet the current levels of extractive use

- Results reported for 18 regions and entire MDB through factsheets, summary brochures and technical reports.
Scenarios used in modelling

Historic climate (1895-2006) & current development

Recent climate (1997-2006) & current development

Future climate & current development

- 2030 climate based on 4AR IPCC results
- 3 global warming levels (low, mid, high)
- 15 global climate models
- We choose a high extreme, median and low extreme for reporting

Future climate & future development

- Future development
  - Commercial forestry plantations
  - Farm dams
  - Groundwater extractions
Methods - overview

Define climate scenarios

Define reporting regions and sub-catchments

Groundwater recharge modelling

Groundwater modelling and assessment

Rainfall-runoff modelling

River system modelling

Monthly water accounts

Environmental assessments

Reporting

SW—GW exchanges

inflows
A land of droughts….

- Droughts about every ten years
- Associated with El Nino
- Also long term cycles
... and flooding rains

“A land of drought and flooding rains” My Country Dorothea Mackellar

Bligh hopes to delay desalination plants

Sean Parnell
Sarah Elks

WATER restrictions in southeast Queensland are set to remain in place long-term as the Bligh government tries to delay the construction of new desalination plants and encourage homeowners to remain conservative.

Farmers may not be the only beneficiaries of the flooding rains that continue to inundate the state's southeast, leaving a multi-million dollar damages bill even if there is a long-term benefit for the agricultural sector.

Levees protecting the town of Dirranbandi were under pressure last night, as water continued to rise across a vast expanse of bush.

The townsfolk of Cunnamulla and Thallon were under threat, while emergency services in northern NSW geared up for the arrival of floods that have turned a formerly parched area the size of Victoria into an inland sea.

But just as governments have had to switch their assistance policies to cover flood instead of drought, so too have policy-makers changed their outlook for southeast Queensland, and they are now looking to save money and water.

When Traveston Dam, the last remaining piece of a water infrastructure package, was blocked by the federal government, Ms Bligh quickly rejected the construction of costly desalination plants in Brisbane and on the Sunshine Coast from 2016-2020.

Damage bill set to hit $1b as calls for help flood in

Eastern states battered by recent heavy rain, hail and storms face a damage bill of up to $1 billion – and it’s not over yet.

In NSW, Wagga Wagga and the Central Darling Shire have been declared natural disaster zones, with northern parts of the state preparing for significant run-off from the Queensland floods.

White said it was lucky no one was killed in that state’s storms, which saw several people taken to hospital.

“This was one of our wildest weekends of severe weather and the hailstorm event in Melbourne was the largest recorded in Melbourne’s history,” he said yesterday.

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Assessing drought

- Variables assessed
  - Runoff (system inflows)
  - Storage
  - Flows
  - Diversions
- Long dry runs
- A dry run is a run of years of less than median
- Assessed changes to length and severity
- In the five regions: N-S trends
Assessing drought - eg runoff in Condamine

- Reflects general pattern of drought in the MDB
- Climate change dry extreme projection drier than historic
- Projection uses scaled historic, hence similar pattern
- Long dry runs with reference to historic median

More, longer and more severe dry runs
Runoff long dry runs

• Climate change projections show more, longer and more severe dry runs
• Impacts greater in south
• Dry extreme and median projections show great impacts
• Wet extreme similar to historical
Impacts on storages, diversions and flows

- Diversions least affected
- Flows most affected
- Allocation rules favour diversions
Current drought in detail - runoff

- Not proven to be climate change
- Runoff dramatically down (especially 2006/7)
- Temperature increase
- Reduced autumn rain, reduced autumn and winter runoff

**Graphs:**

- Rainfall: Monthly rainfall comparison for different years (1895-2006, 1936-1945, 1895-1904)
- Runoff: Monthly runoff comparison for different years (2006/07, 2007/08, 2008/09, 2009/10)

**Graph Legend:**

- Long Term Average
- Average, last 10 years
- 2006/07
- 2007/08
- 2008/09
- 2009/10
Current drought in detail - storages, diversions and flows

- One good flow event 2000/1
- Very dry year 2002/3 saw storage and flow reduce, but only modest reduction in diversion
- 2003/4 - 2005/6 saw near median inflow, diversions help up, storage recovered slightly, low flows - “praying for rain”
- The exceptionally dry year 2006/7 saw everything crash - yet to recover
Could we have managed differently? - model

• A back-of-the-envelope spreadsheet water balance model

• Illustrative only - for discussion (don’t believe it)

• Based on a rule which says diversion a function of water in dam plus this year’s inflow

• The myriad actual rules seem to lead to emergent behaviour broadly consistent with this simple rule
Could we have managed differently? - Speculative results

- Attempt to give environmental flows in either 2003/4 or 2005/6, by reducing storage to historic minimum
- 2003/4 does not achieve median flow (not much good for the environment except locally)
- 2005/6 gives modest environmental flow
- Both at the cost of extra pain for irrigation
- Little other flexibility
- Repeat - this is speculation for discussion
Policy implications

• Extremely challenging, may be more so in future
• No easy fixes (more large dams irrelevant, for example)
• Downstream migration of irrigation (current trend) would leave irrigation vulnerable to projected longer and more severe droughts, due to extra river losses in dry years
• Upstream migration of irrigation would leave irrigation less vulnerable to droughts
• Improving irrigation (hydrological) efficiency may help, but
  • Amounts to be saved may be modest
  • Need to account for return flows
  • May not be economically efficient - purchasing entitlement better
Further implications

- In recent drought there was insufficient water for either environment or irrigation. Current expectations could not be met. We cannot return water to the environment and keep irrigation in its current form.
- Recent drought in some ways different to past droughts - the past may not be a reliable guide to the future.
- Need to consider scenarios outside the range of past experience, including climate change scenarios.
- Policy and management must cope with future droughts possibly more extreme than recent.
Murray-Darling Basin Sustainable Yields Project

funded by
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www.csiro.au/partnerships/SYP.html