Downstream impacts of irrigation

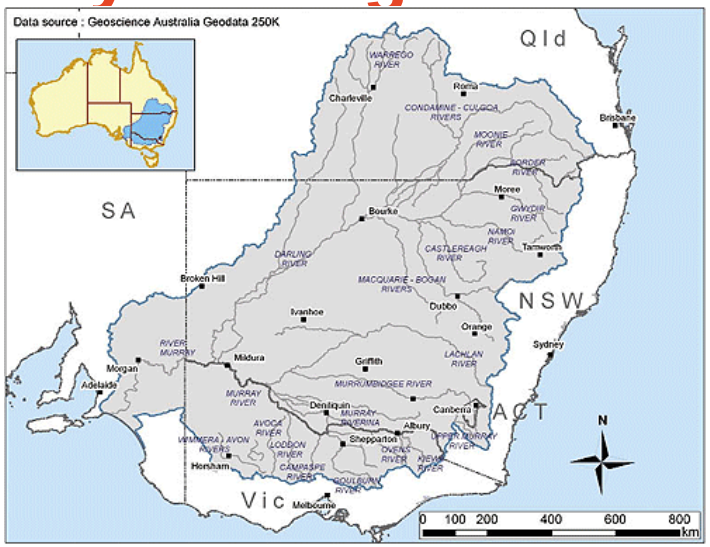
Lessons from environmental flow debate in Australia

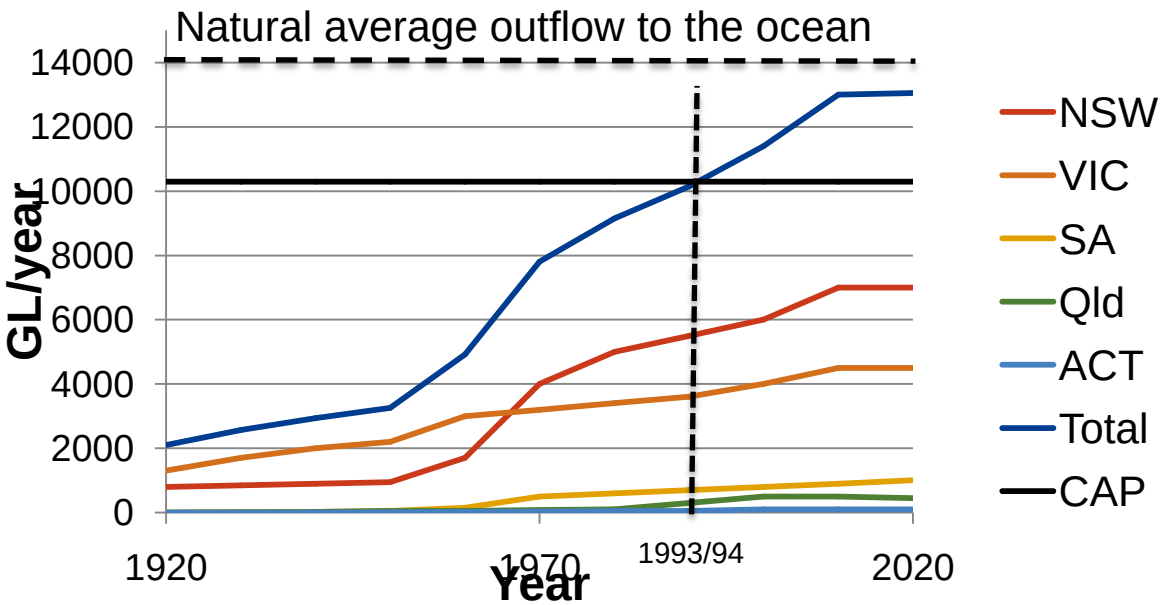
Presented by
A/Professor Willem Vervoort
Centre for Carbon Water and Food, Faculty of Agriculture and Environment

THE UNIVERSITY OF SYDNEY

Irrigation diversion in the Murray Darling Basin

- The Murray Darling Basin is Australia's main agricultural production area and largest river basin (1 mln km^2)
- Agriculture (Irrigation) uses 70% of the water
- This has severely affected volumes of flows

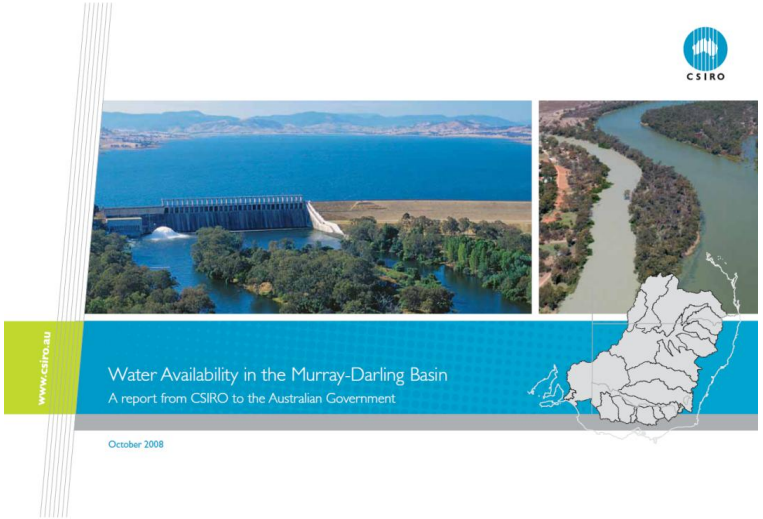




- 1993/94 limit on licences for extraction: the CAP
- Since then efforts to reduce the CAP
  - Water use efficiency
  - Licence buy back

CSIRO sustainable yields project and MDB plan 2012

http://www.csiro.au/en/Research/LWF/Areas/Water-resources/Assessing-water-resources/Sustainable-yields/MurrayDarlingBasin



- Additional water needed to sustain environment (wetlands and water dependent ecosystems).
- Plan aims at returning 2700 GL/yr, but buyback capped at 1500 GL/yr
- Increased role of “water markets”:
  - https://www.waterexchange.com.au/cgi-bin/zonetrade/TradingPlatform/Markets
- Agreement between state and commonwealth to “vary” the amount returned to the environment depending on climate

smh.com.au
The Sydney Morning Herald

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Plan pumps up to $148m into water buyback

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The buyback would make the state government the de facto owner of 19 farms along the Murrumbidgee river. *Photo: Nicolas Walker*

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The Sydney Morning Herald

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More water buybacks

February 24, 2012 Read later

Tom Arup

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Aerial view of where the Darling River meets the Murray River at Wentworth, NSW. *Photo: Darren Seiler*

THE federal government has launched another round of water buybacks from farmers in the southern reaches of the Murray-Darling Basin, with critics claiming the decision is a backflip from a promise to suspend the program until 2013.

Water Minister Tony Burke yesterday said the new round of buybacks would target only some sellers and not be a general tender.

Labor has committed to meeting the 2750 billion litres of water to be returned to the Murray-Darling's environment, under plans to save the river, through voluntary buybacks and water-saving infrastructure projects.

But Victorian Farmers Federation chief executive Andrew Broad yesterday said Mr Burke had broken a promise, made in November, to stay out of the Southern Basin water market until 2013.

TOM ARUP

How does irrigation extraction and irrigation development affect downstream rivers (locally and globally)

- Reduction in flow.
  - Q = Input – ET (long term equilibrium)
  - Any change in ET will decrease Q: shifting blue water (Q) to green water (ET)
- Flow inversion, timing mismatch between natural high flows and irrigation demands
  - Irrigation demand in summer, flows from Dam
  - Natural high flow in winter, stored in Dam
- Salinity, salt balance
  - Salt storage = Salt Input – Salt Output.
  - To manage salt storage, salt output needs to increase if input increases with irrigation water: Leaching Fraction
- Other water quality issues:
  - Blue Green Algae due to low flows
  - Acid sulphate soil exposure

Flow impacts of regulation

Freshwater Biology (2003) **48**, 1147–1160

Droughts and anti-droughts: the low flow hydrology of Australian rivers

T. A. MCMAHON*,† AND B. L. FINLAYSON*,‡
*Cooperative Research Centre for Catchment Hydrology, and Centre for Environmental Applied Hydrology, The University of Melbourne, Victoria, Australia
†Department of Civil and Environmental Engineering, The University of Melbourne, Victoria, Australia
‡School of Anthropology, Geography and Environmental Studies, The University of Melbourne, Victoria, Australia

VAN DIJK ET AL.: CAUSES AND IMPACTS OF AUSTRALIA'S RECORD DROUGHT

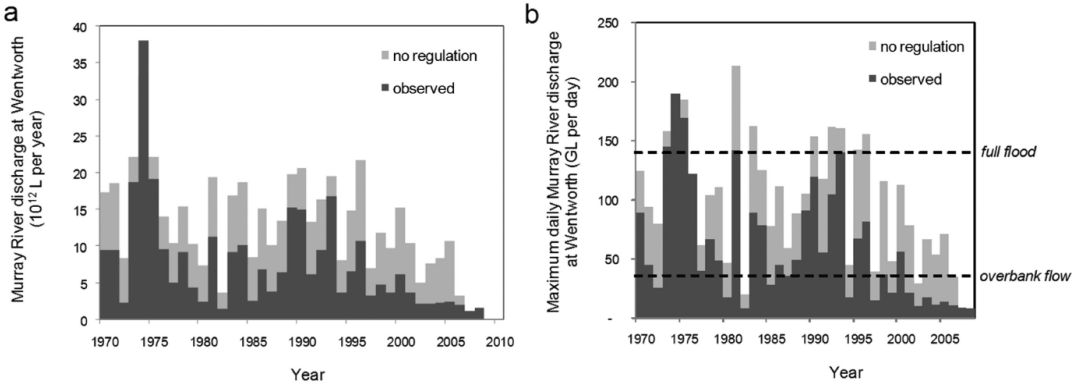


Figure 4. (a) Annual total flow and (b) annual maximum daily flow in the Murray River at Wentworth (see Figure 1b for location) as observed and as estimated to have occurred in the absence of river regulation.

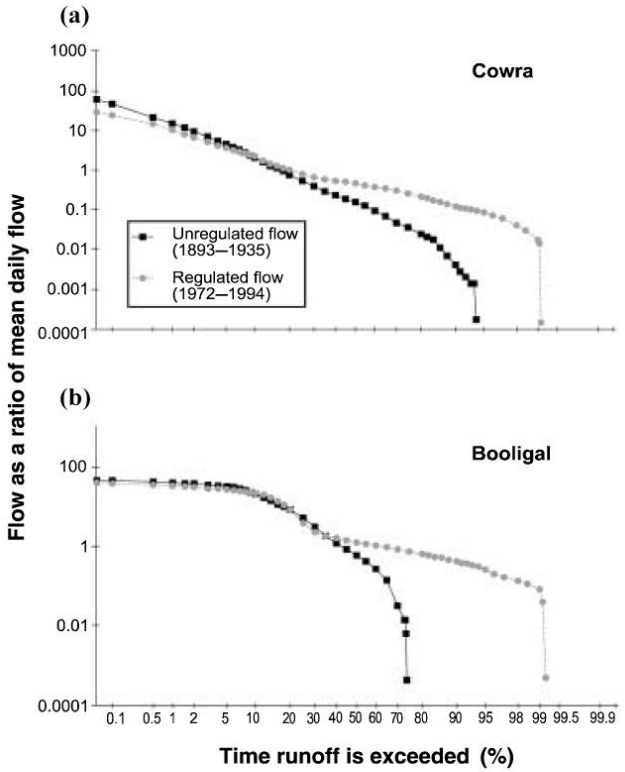


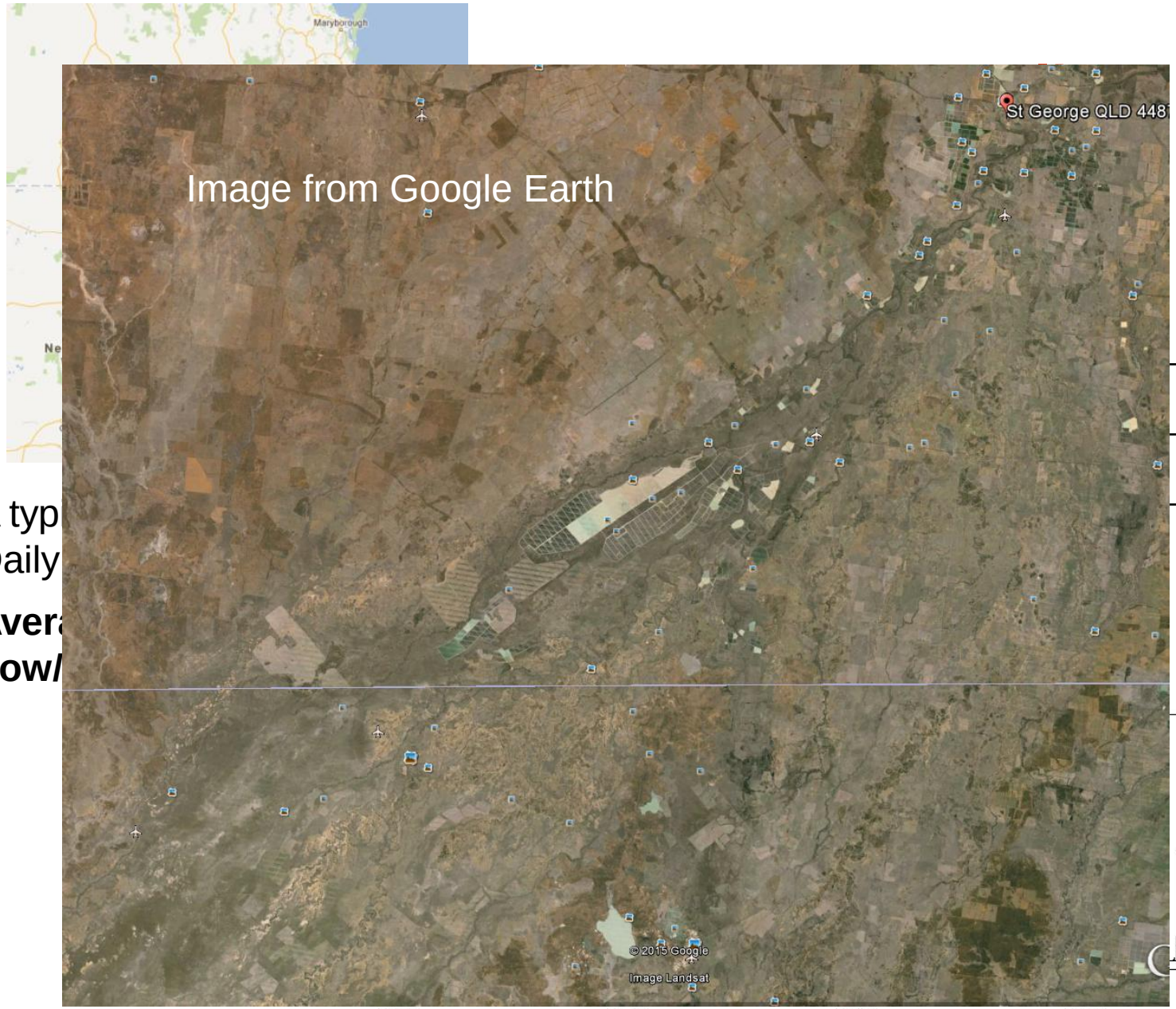
Fig. 8 Daily flow duration curves for Lachlan River at (a) Cowra and (b) Booligal for regulated and unregulated conditions.

Increase in low flows
Decrease in high flows

Impact greater in drought

What future effects might be a problem

- Currently a major push to protect
  - RAMSAR wetland sites
  - Lower lakes (exit point of system)
- Climate change predictions for Australia
  - Increasing and worsening drought
  - More intense rainfall
- Storage problem will increase, demand for irrigated agriculture will increase, pressure on ecosystems will increase
- How do we deal with data scarcity and data uncertainty?:
  - Gauge measurements up to 20% uncertainty
  - Low density of gauging stations on 1 mln km^2
  - Semi-arid, anastomising, highly variable rivers
  - We work at very large scales!



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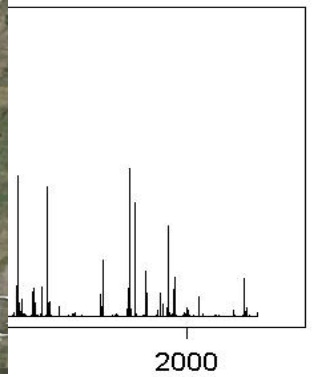
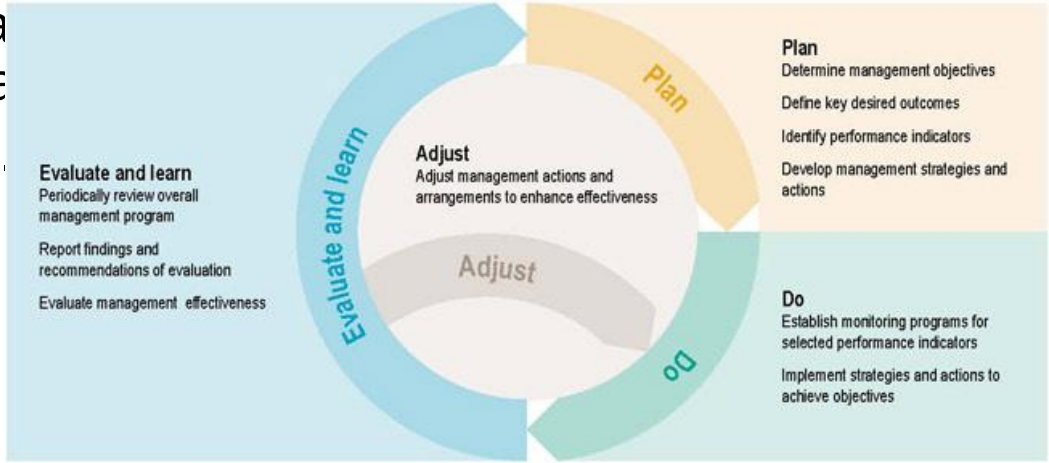


Date

Current MDB Environmental Water

http://www.mdba.gov.au/what-we-do/environmental-water

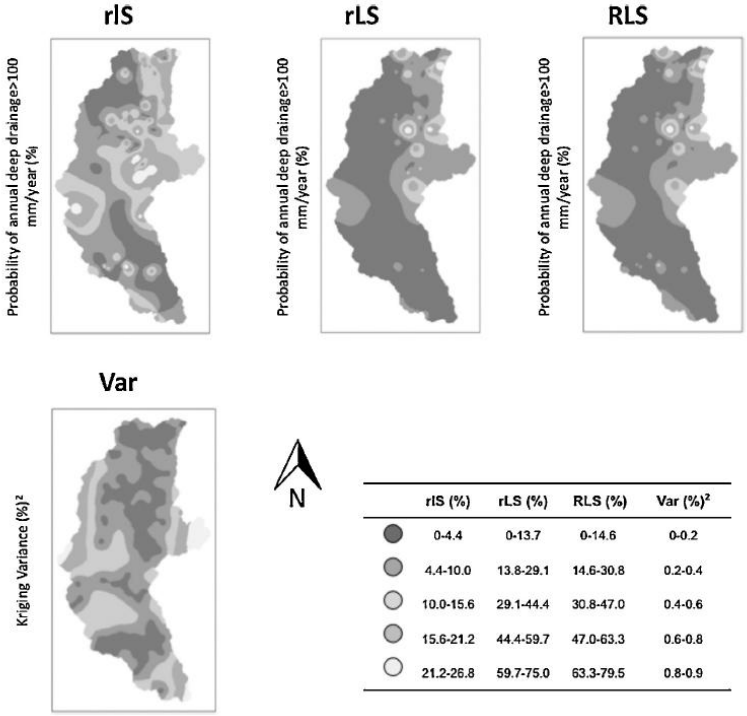
- Focuses on improving the resilience of the rivers, wetlands and floodplains and plants and animals related with it.
- Driven by “Environmental Watering plan”, which is based on Adaptive management
  - Overall environmental objectives (Water Act 2007);
  - Targets for measuring progress (Part of the Basin Plan), watering of selected wetland sites, based on expert panels;
  - Monitoring, evalua
    measured and eva
  - Learning by doing.



What are the great unknowns?

- Thresholds for dependent vegetation:
  - How much water can be shared with humans?
  - What are ecological thresholds across 1 mln km^2
  - Understanding groundwater and water uptake of groundwater dependent trees (Vervoort & van der Zee, 2012; Holland et al.)
  - Better understanding of flow variability and drought
  - Seasonal Forecasting (Montazerolghaem et al. 2015) and climate change (see the excellent BOM website: www.bom.gov.au)
- Connectivity and impact of irrigation
  - Managing palaeochannels and deep drainage (e.g. Bennett et al. 2013; Vanags & Vervoort, 2014)
  - Long term salinity and sodicity (e.g. Shah et al. 2014)
  - Water use efficiency impacts
  - Impacts of water trading, especially space-time

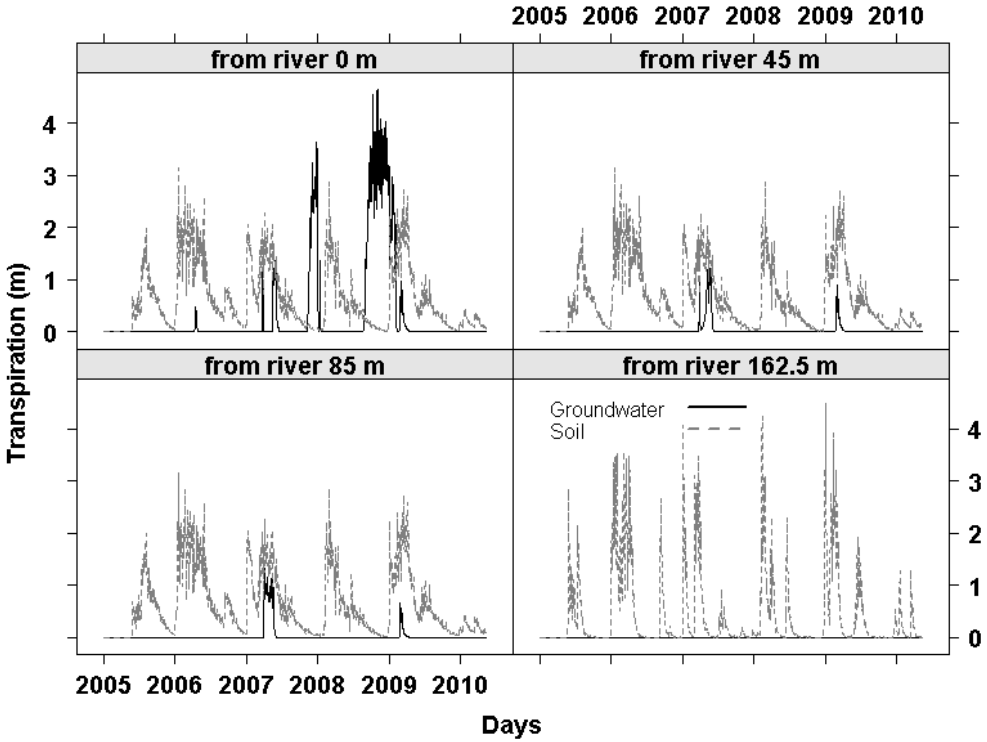
Deep drainage Risk



	rIS (%)	rLS (%)	RLS (%)	Var (%)²
	0-4.4	0-13.7	0-14.6	0-0.2
	4.4-10.0	13.8-29.1	14.6-30.8	0.2-0.4
	10.0-15.6	29.1-44.4	30.8-47.0	0.4-0.6
	15.6-21.2	44.4-59.7	47.0-63.3	0.6-0.8
	21.2-26.8	59.7-75.0	63.3-79.5	0.8-0.9

Deep drainage risk varies in space
Depends on uncertainty in input variables

Water uptake by vegetation



Water uptake from connected groundwater is a function of distance of the stream

The use of new data

- Satellite data to better understand water balance of a catchment
- Soil Moisture and ET data for model calibration to improve water resource planning
- Increase model certainty

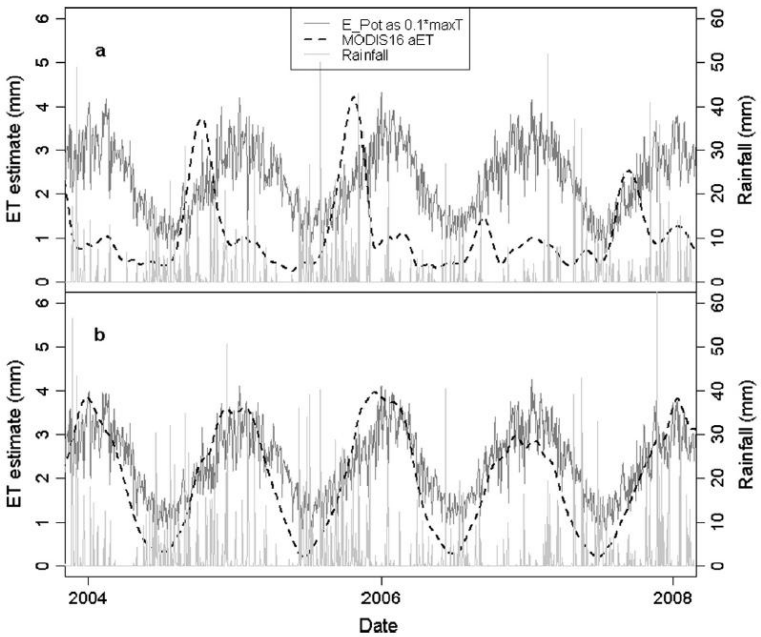
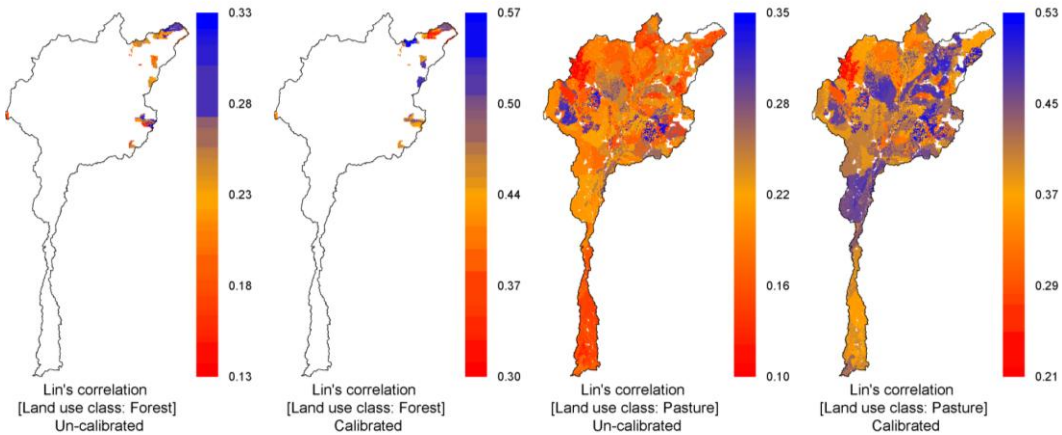


Fig. 9. Comparison of observed MODIS derived *ET* and maximum temperature observations for Goodradigbee and Jugiong catchments.



Conclusions

- Irrigation and irrigation development will always impact downstream ecosystems and other users
- Changes in flow timing, quantity and distribution
- Salinity impacts are also unavoidable, simple salt balance
  - Exacerbated in a high salt environment
- Large spaces and low data density makes assessment of impacts difficult
- New data and new tools might improve assessing impact
- Identification of thresholds is crucial and needs to be more than location or species specific
- Impact of climate change?