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Recent Developments and Applications of Modelling Techniques to Support Resource Management in the Murray-Darling Basin

Ecohydrology

Water for a Healthy Country

Ian Overton, Susan Cuddy, Rebecca Lester and Tanya Doody

01/09/2010

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Wetlands


Rivers


Floodplains


Estuary

Ecohydrology

- What is Ecohydrology?
- Modelling Ecosystem Response
- Determining Water Requirements
- Environmental Water Management

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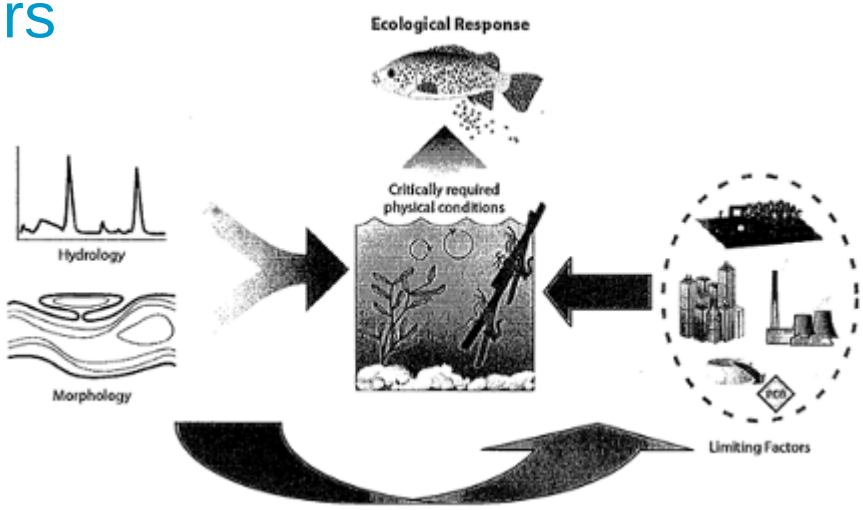
Ecohydrology

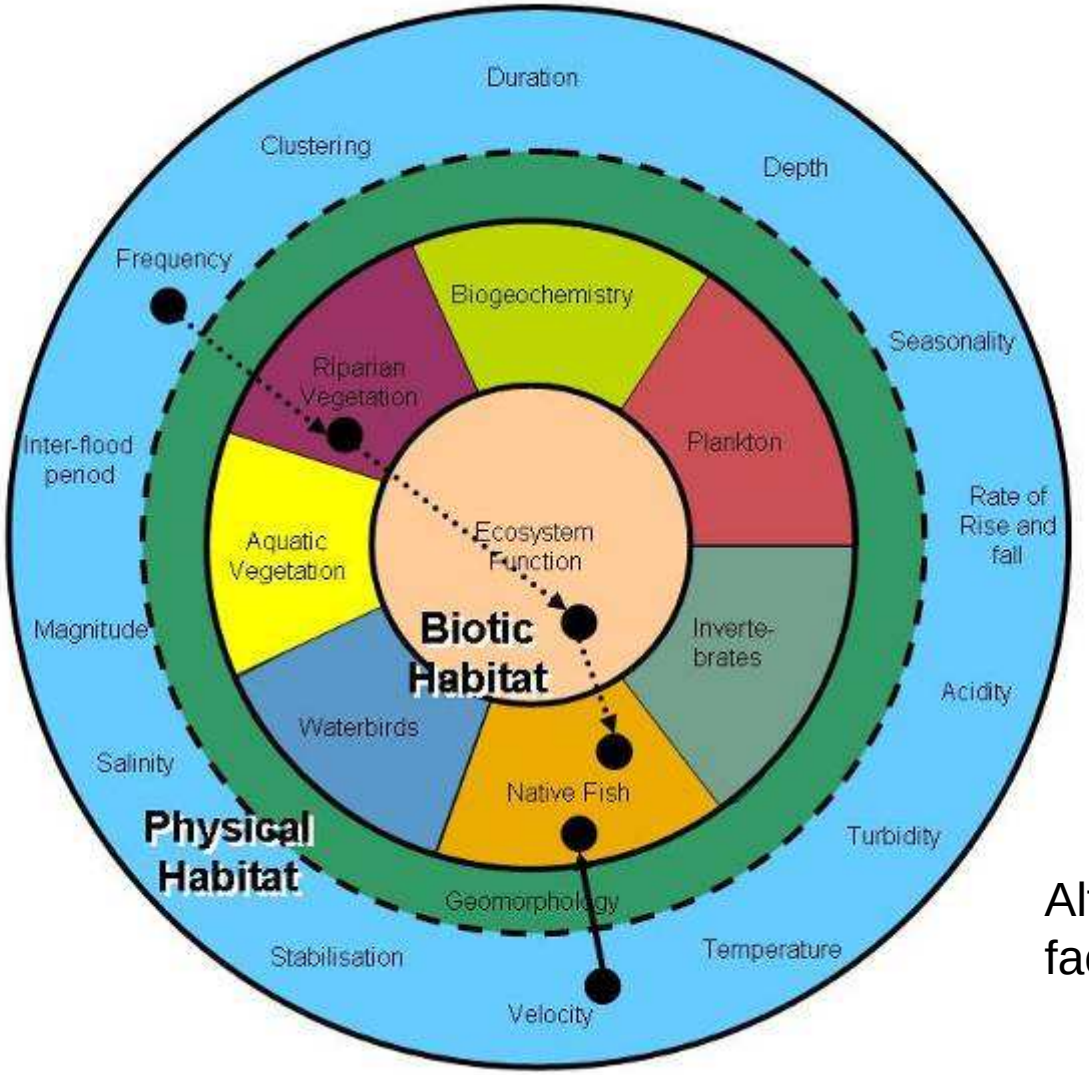
In the context of environmental flows

- Understanding, modelling and predicting ecological response to changes in hydrology
- Hydrology is the major driver
- Altered by geomorphology and habitat
- Influenced by other factors
- Spatial and temporal



Poff and Zimmerman 2007

Ecosystem Responses



Direct and indirect responses

Altered by external factors

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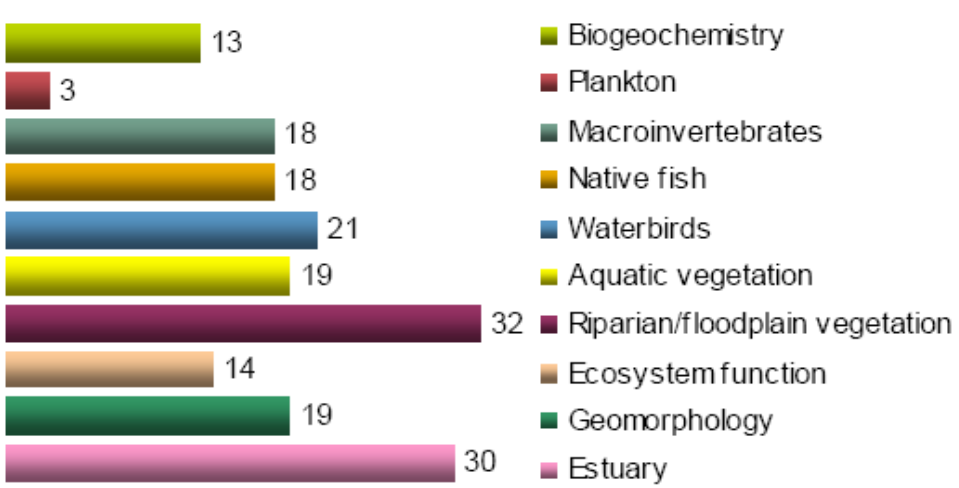
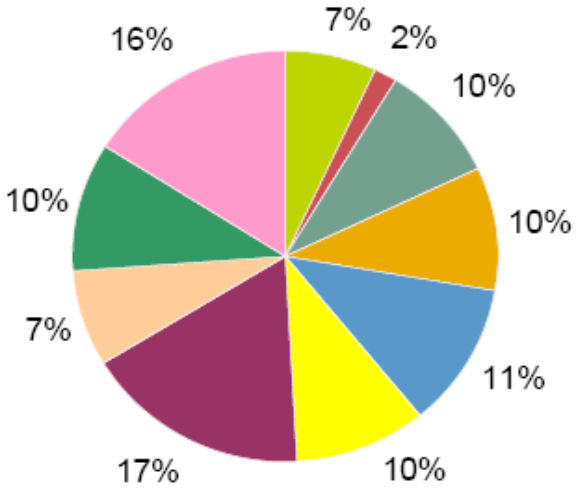
Ecosystem Responses

100 management plans
187 ecology-flow hypotheses





Number and percentage of management hypothesise used in management plans across the nine functional areas and the estuary.

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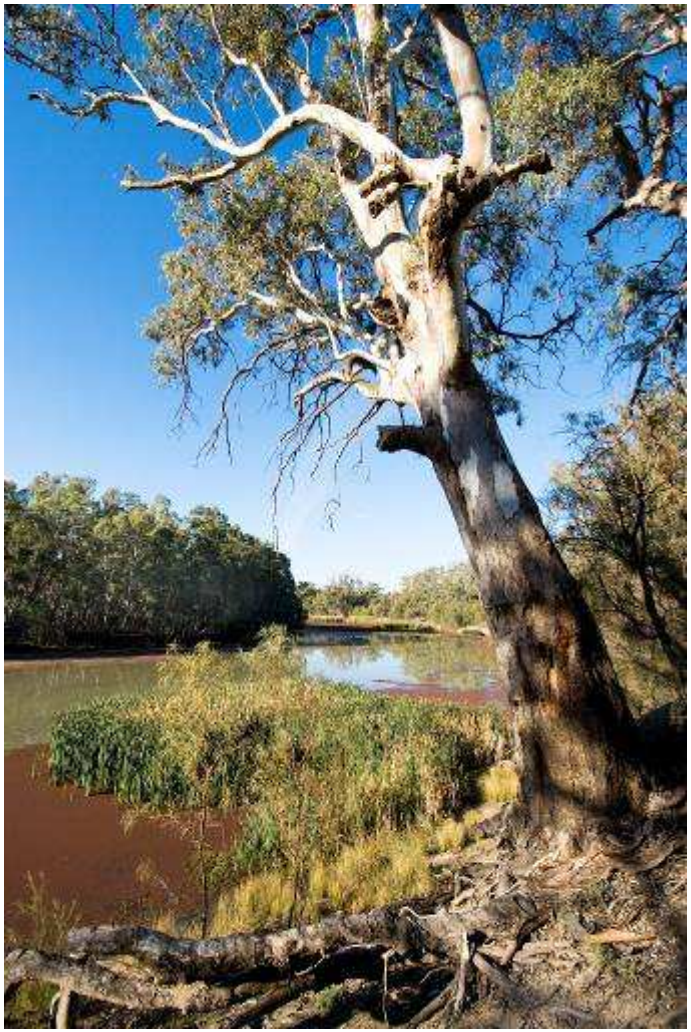
Red Gums

Ecological objective	Maintenance of red gum community
Magnitude	Flood. 5,000 to 70,000 ML/Day
Frequency	1:1-2 years
Inter-flood	No more than 5 years
Duration	4-7 months and no more than 24 months
Seasonality	Winter-spring (extending into summer for regeneration with a wet winter-spring following)



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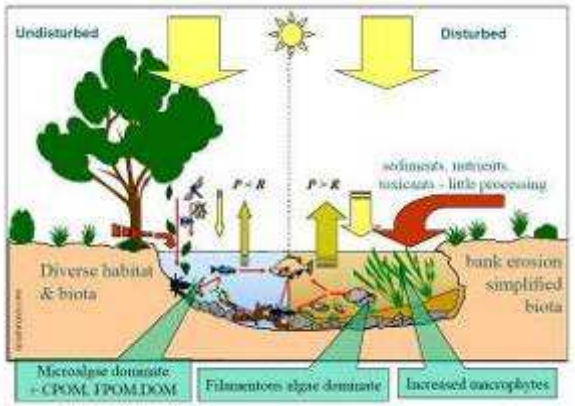
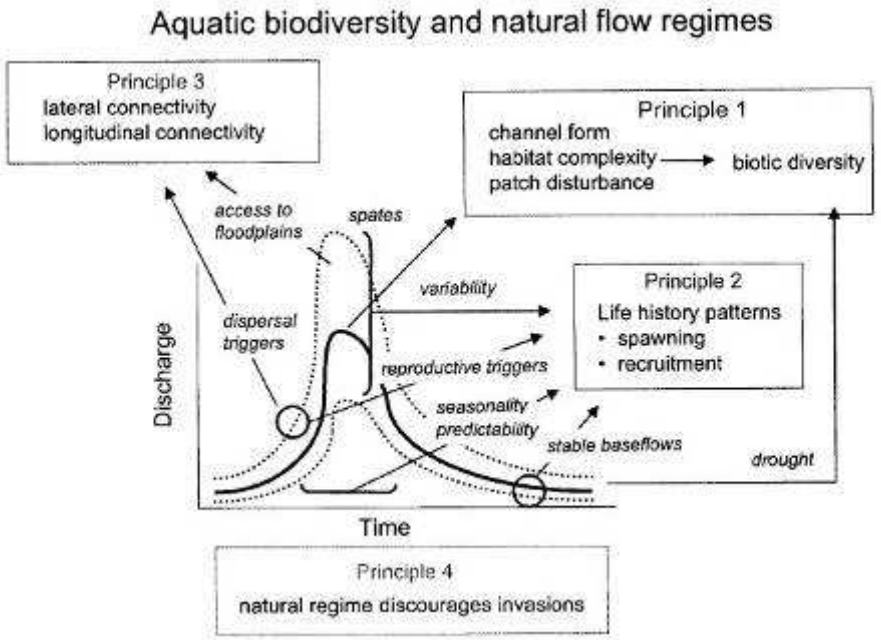
Environmental Water Requirements

- 2/3 Natural
- No more than 10% extraction (WFD)
- Shape of the hydrograph
  - Flood peaks
  - Critical durations
  - Max dry periods
  - Seasonality
- Conceptual models
- Expert opinion





Bunn and Arthington 2002

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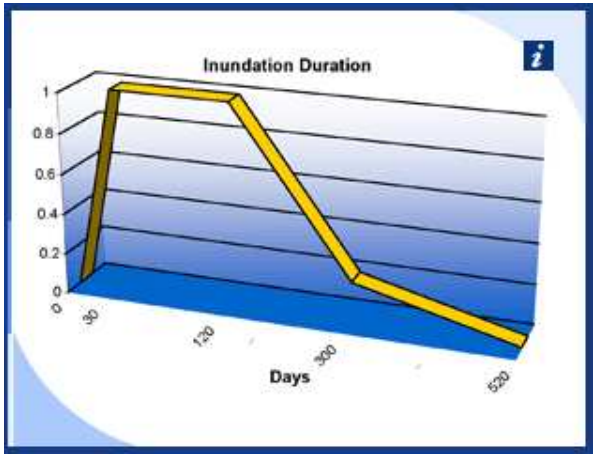
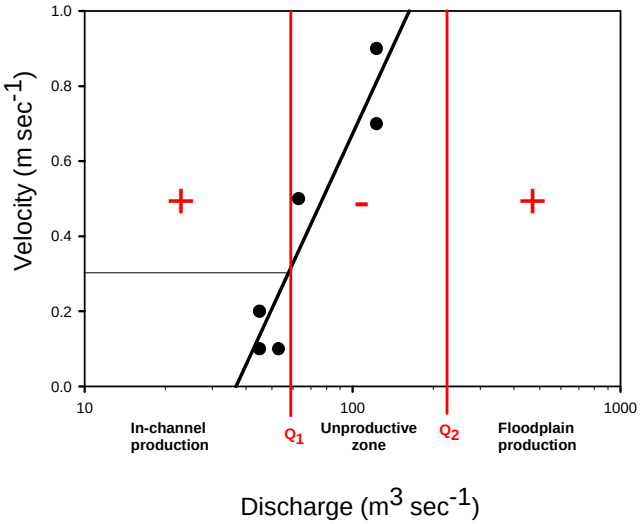
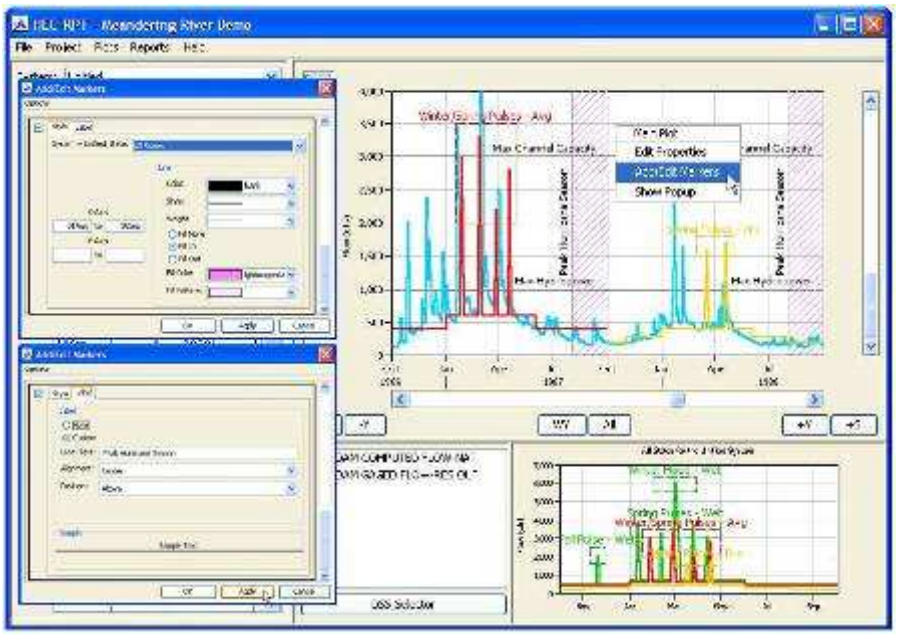
Environmental Water Requirements

- Building Block Method
- Response curves
- Thresholds
- Bayesian Networks
- Ecological Limits of Hydrological Alteration (ELOHA)

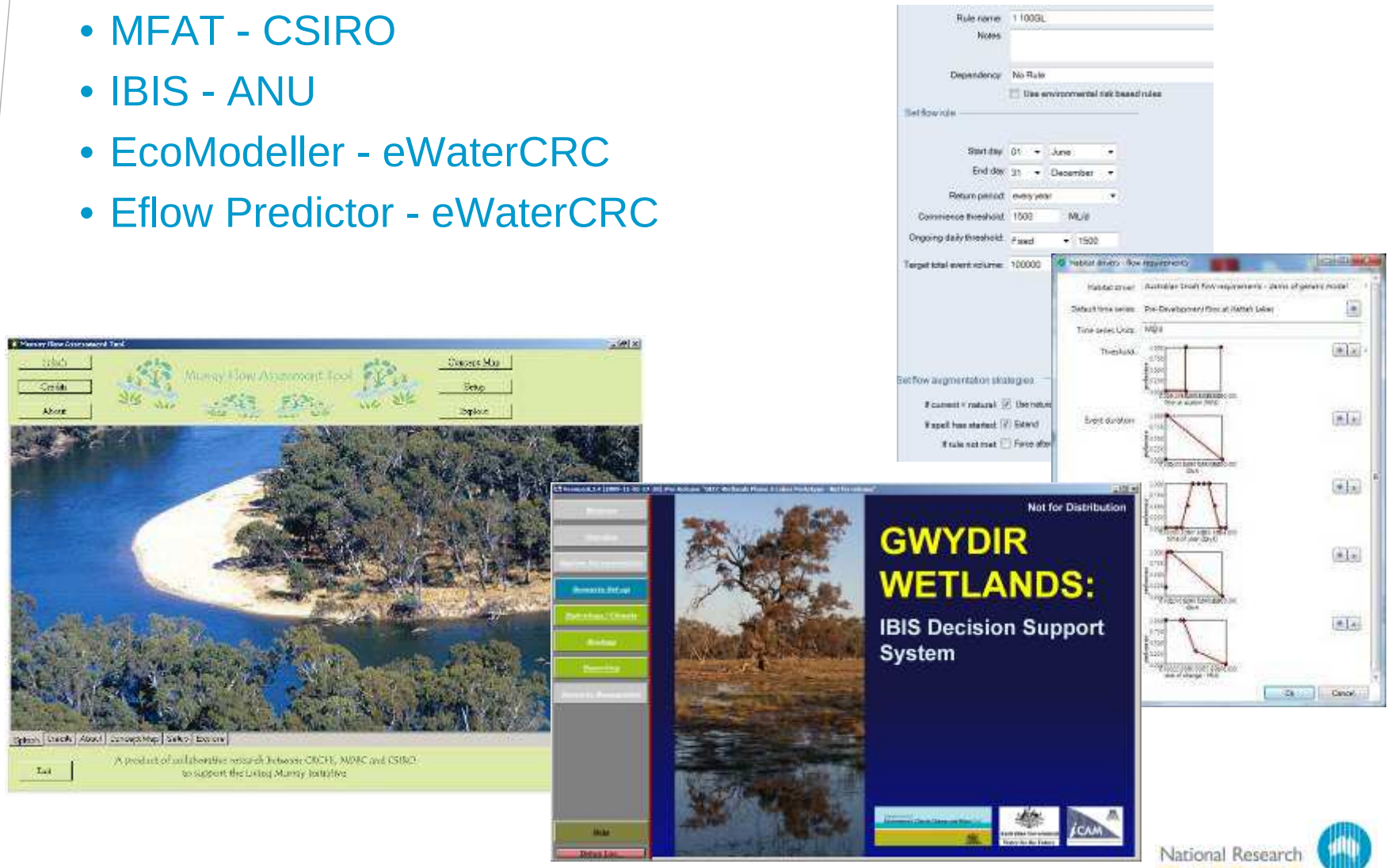






Decision Support Tools

- MFAT - CSIRO
- IBIS - ANU
- EcoModeller - eWaterCRC
- Eflow Predictor - eWaterCRC



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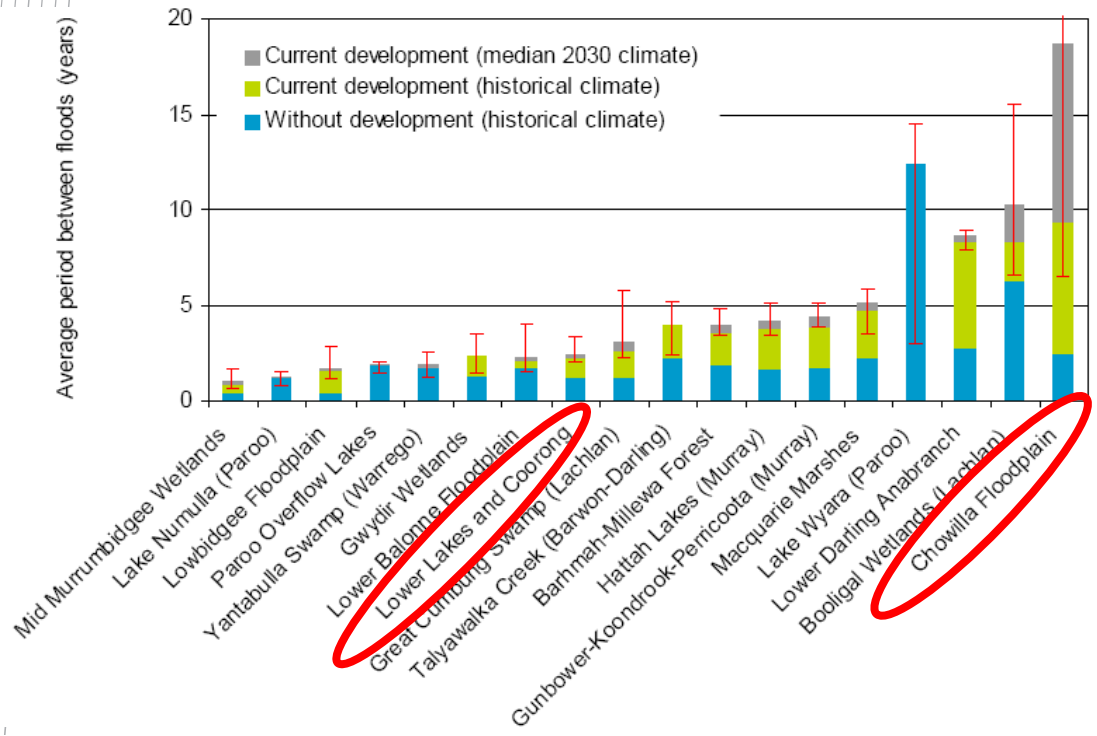
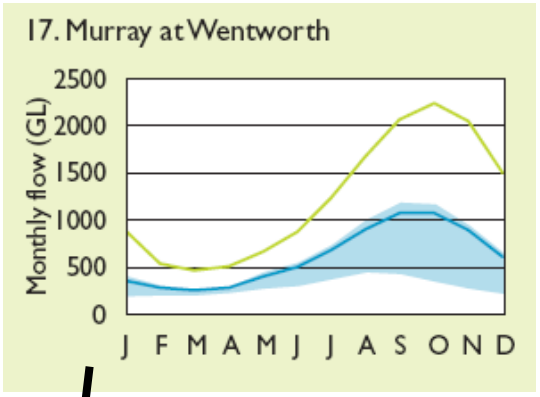
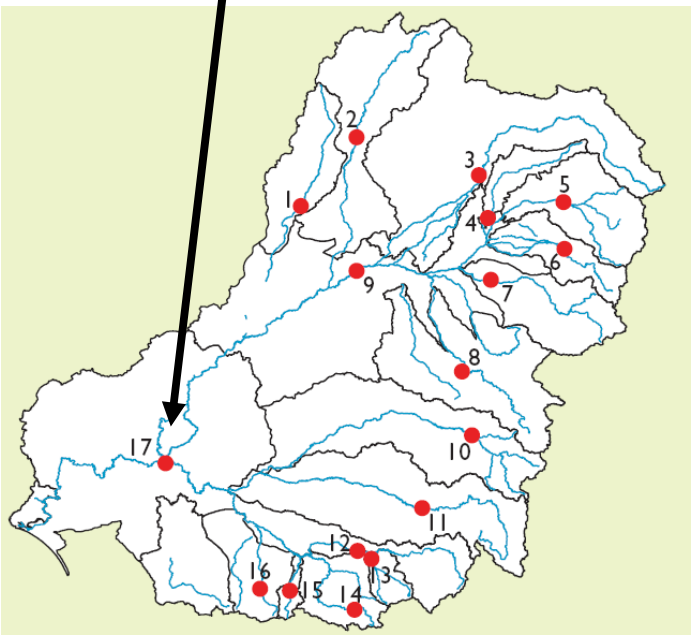
Murray-Darling Basin Sustainable Yields

- Captured flow rules from a number of sources
- Reported on meeting flow targets







Spatial Complexity

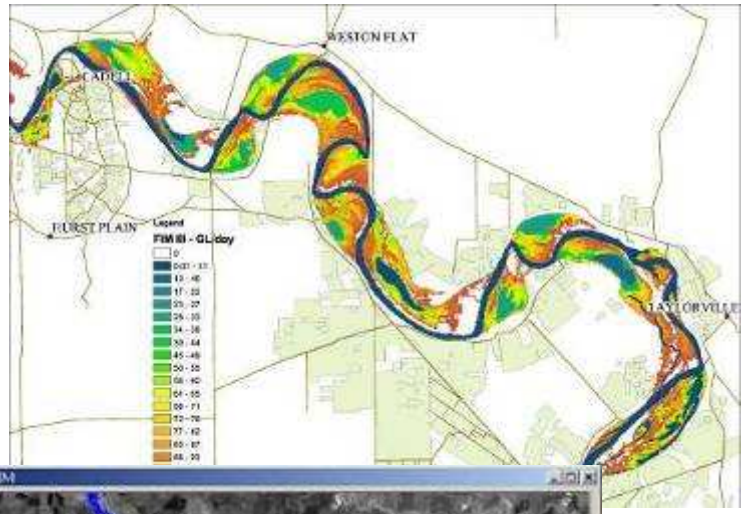
- Floodplain flows are highly variable
- Multiple different habitats on the floodplain with the same flow
- Flow main driver - multiple impacts such as salinity, land use, groundwater

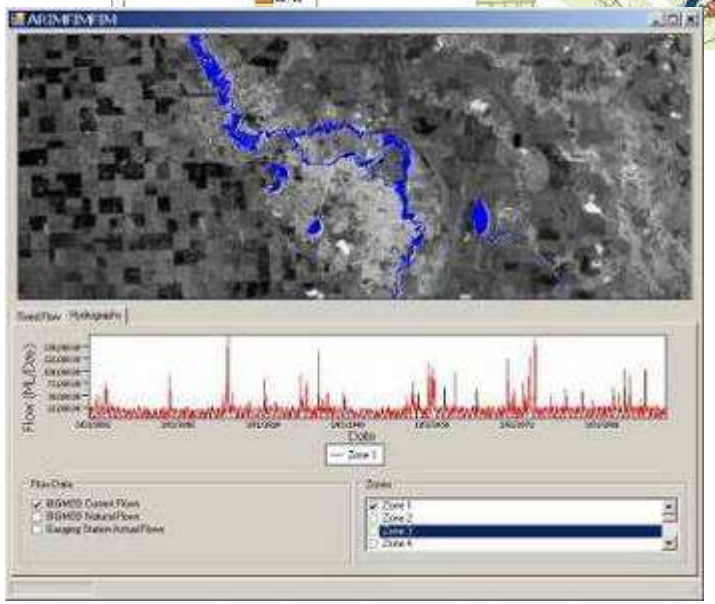
Spatial Complexity

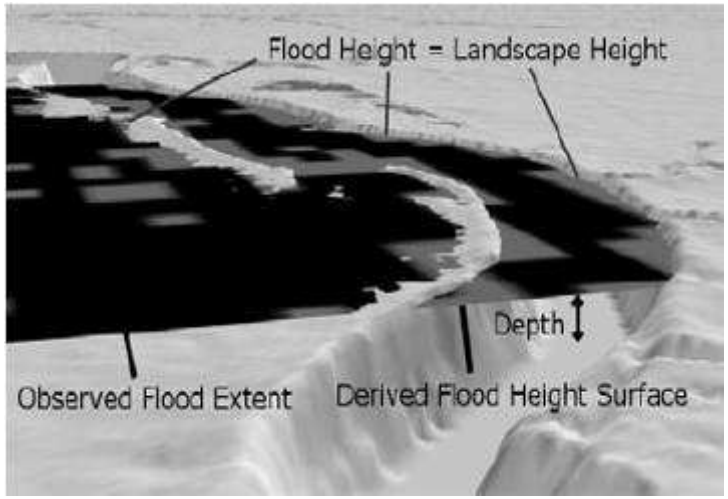
- Surface Water/Groundwater Interaction
- Dependent on soil type / recharge / aquifer connectivity / depth / salinity / flooding frequency

RiM-FIM

- Flood events (satellite imagery)
- Hydraulic models
- LiDAR interpolation
- Flood extent, depth and volume
- Wetland surface area/depth
- Wetting/drying cycles
- Assess changes in habitats







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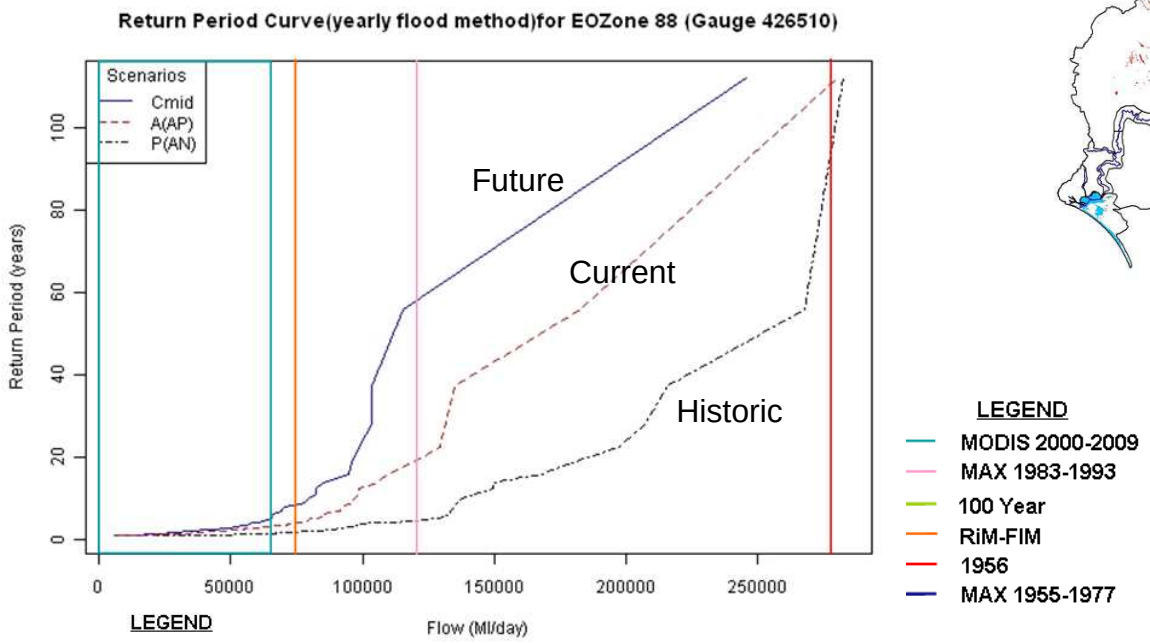
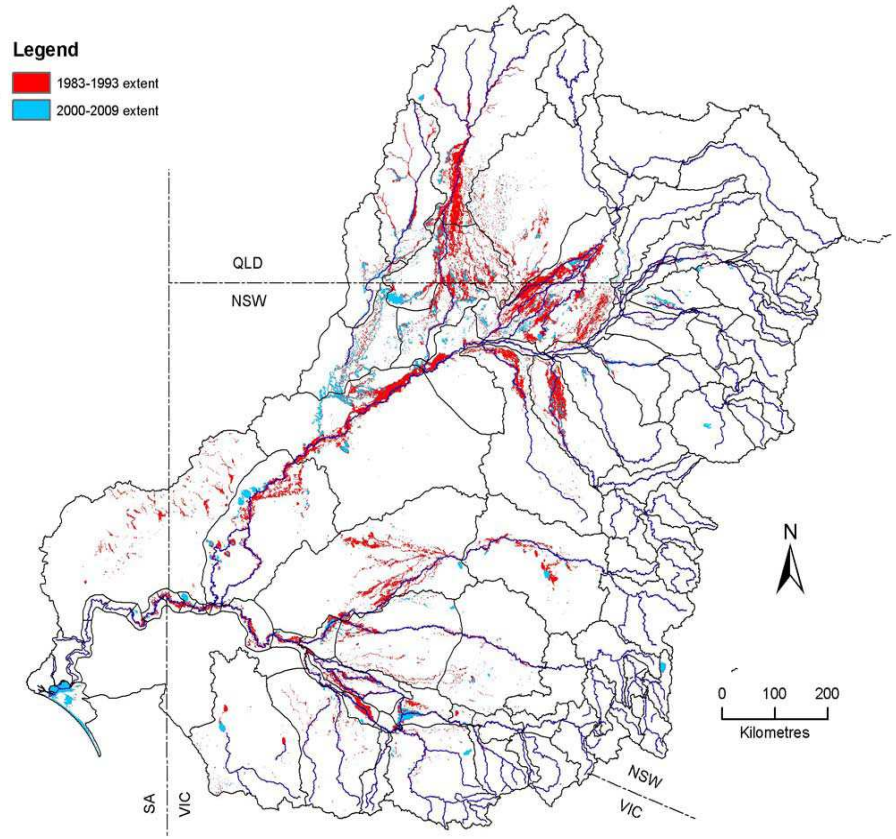
MDB-FIM

- Based on flood mapping from existing datasets and remote sensing
- Eco-hydrological classification
- Return period curves for each of the 93 sub-catchments





Shows areas in red and blue that were flooded between 1983 and 1993 and areas in blue that were flooded in the last 9 years. Only 25% of the 6 million hectares of active floodplain in the Basin (1 in 10 ARI) was inundated in the last nine years.

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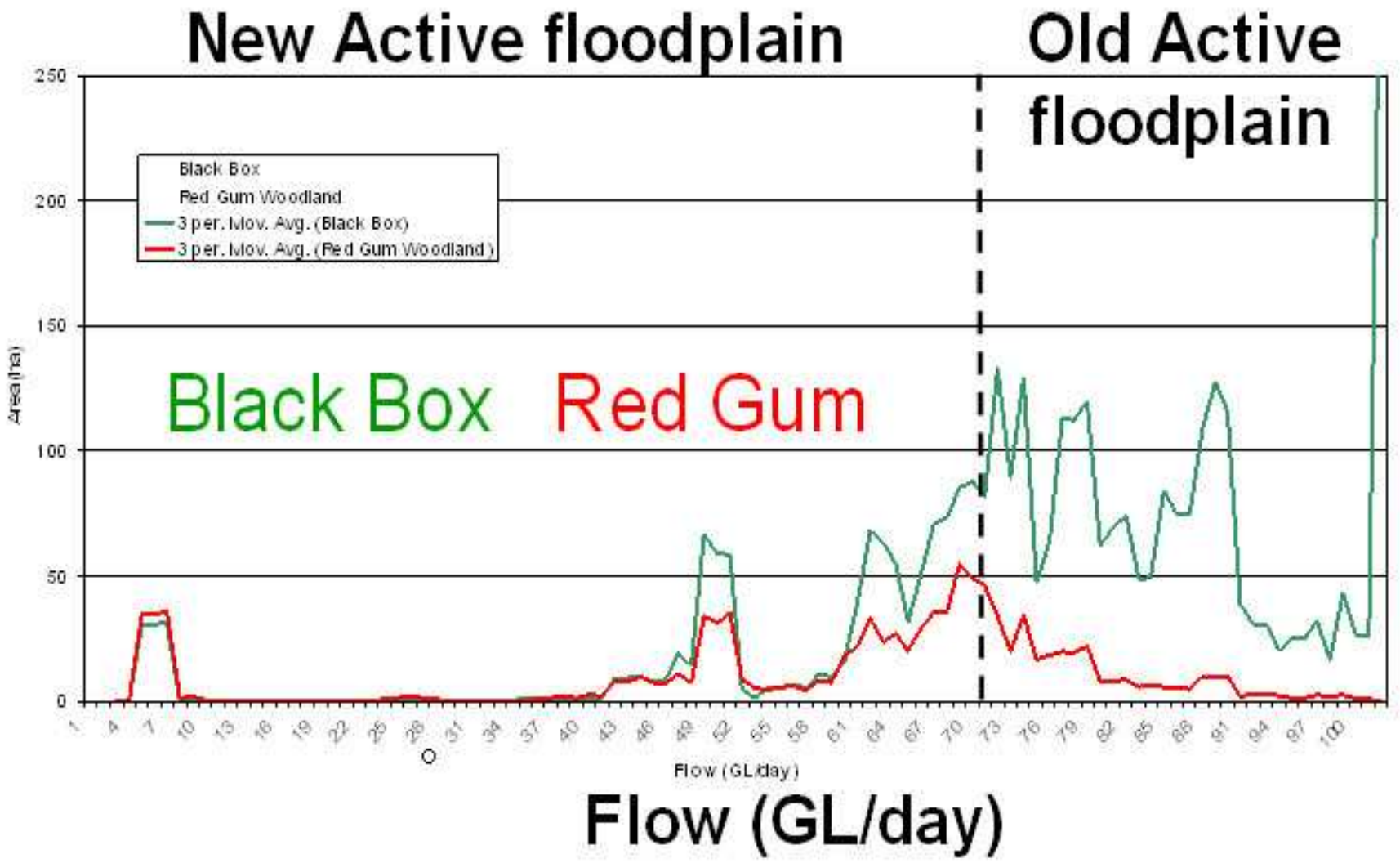
Active Floodplain



The Question

How much water does the environment need?

We could use an expert panel or a flow ecology model

How much environment do you want

Ecosystem Objectives

- What are we trying to achieve?
- Can we really put the environment first?
- Do not compromise key assets
- What is our objective with less water than natural?

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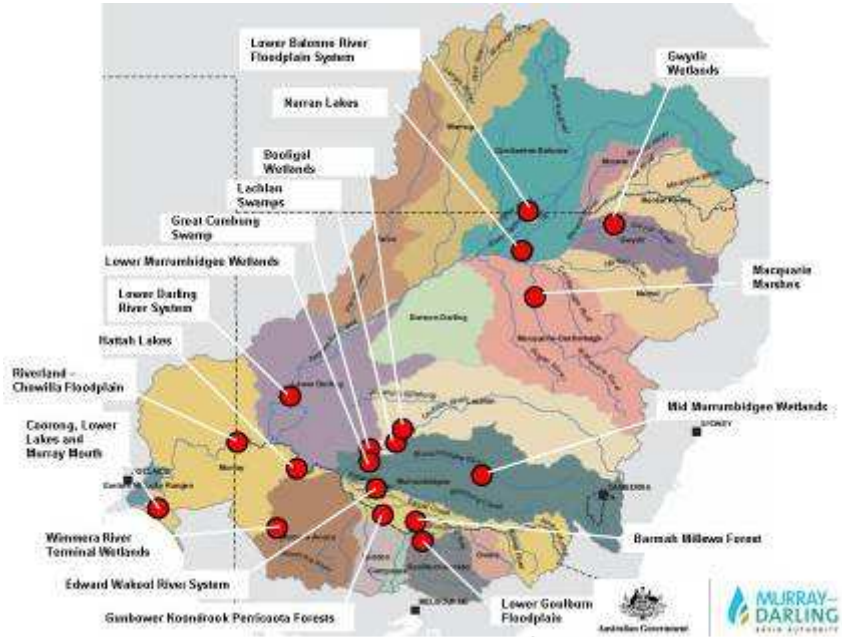
Basin Plan

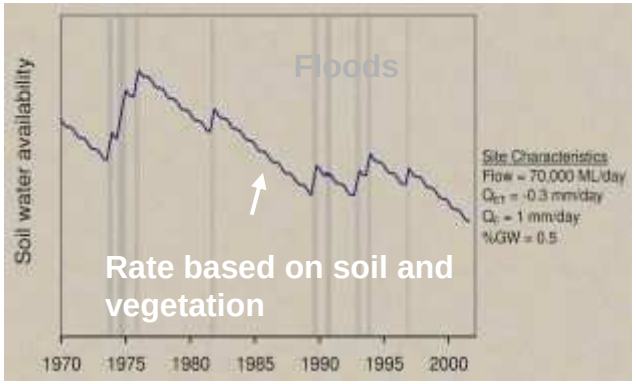
Indicator assets - **Ramsar listed**	Restore to the condition at the time of listing (Section 21(1) of the Water Act and Section 334 of the EPBC Act)
Indicator assets – **not Ramsar listed**	Maintain the current extent of the asset, and restore its long term condition to a sustainable level.
Ecosystem functions	Use flow metrics as a surrogate for the performance of the functions. Restore those flow metrics to a sustainable level.

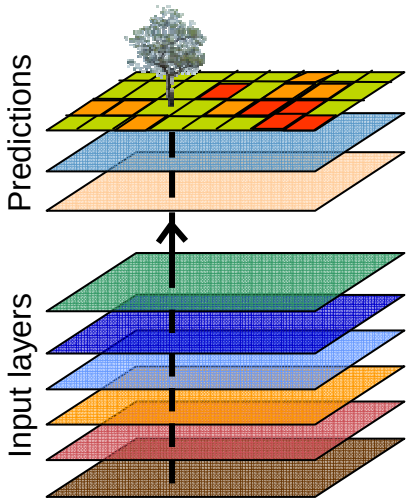
- eFlow Predictor
- RiM-FIM
- Hydraulic models for Murray Icons NSW inundation and IBIS
- **WINDS at Chowilla**
- **Coorong State Model**



WINDS Model

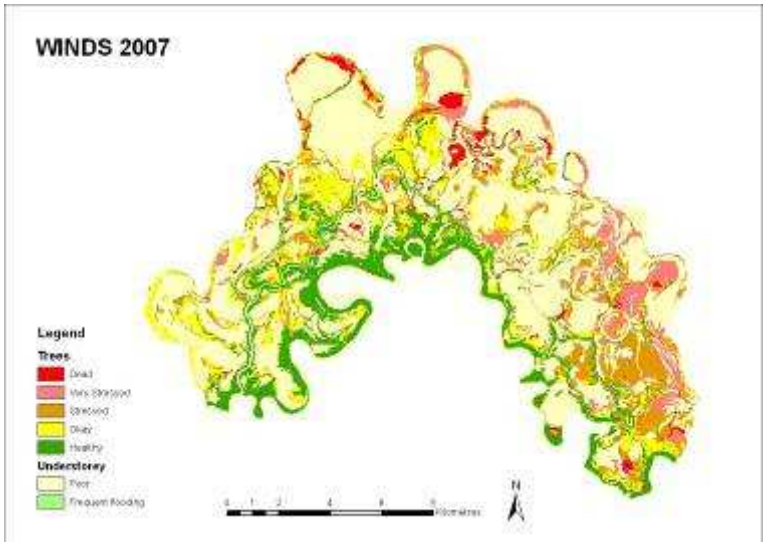
- Floodplain scale
- 30m grid GIS
- Models salt accumulation over time
- Indicator of vegetation tree health
- Determine water requirements
- Assess tree health under various scenarios (gw / flows / pumping / new regulator)





Vegetation tree health
Water availability
Soil salinity

Vegetation type
Flooding and rainfall
Water source
Soil type
Groundwater depth
Groundwater salinity



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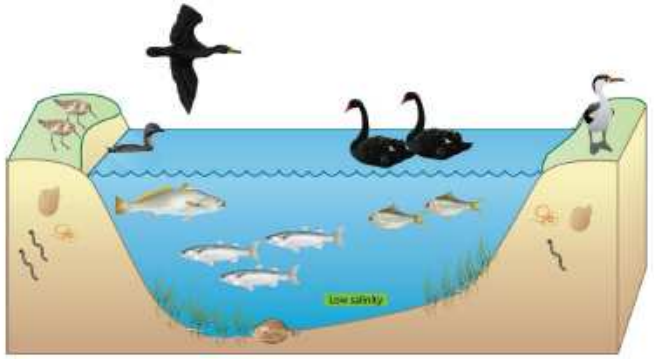
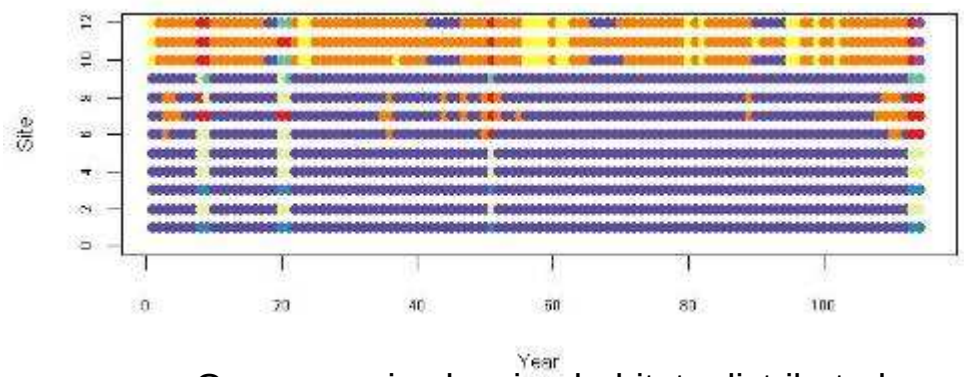
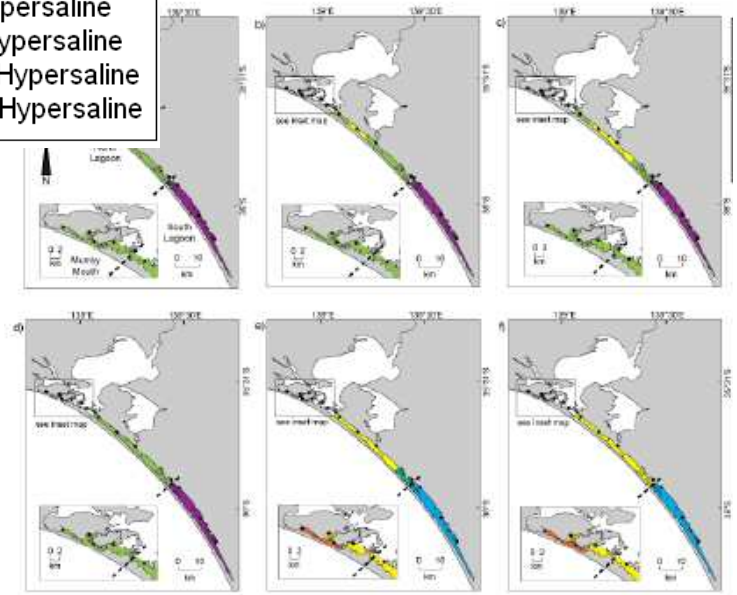
Credit: CLLAMMecology

Coorong Ecosystem State Model

- Define biotic assemblages
- Link hydrology and salinity to distribution
- Use models to predict changes to hydrology and salinity
- Predict future distribution of biota



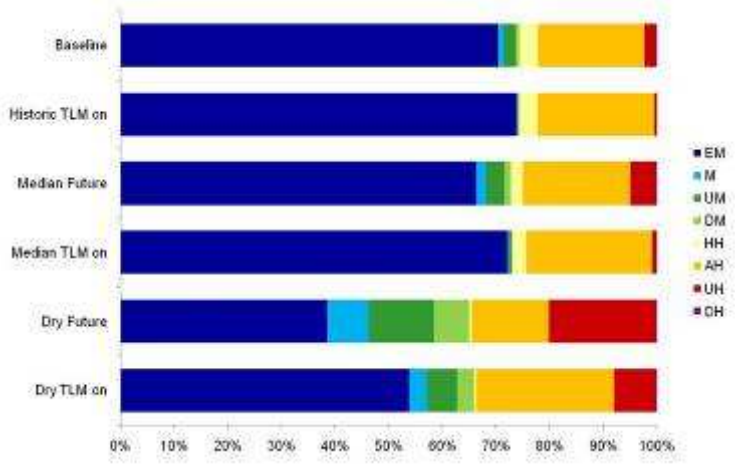


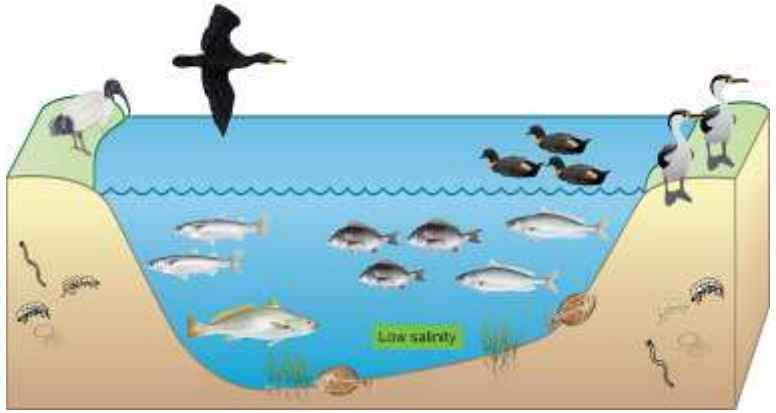


One scenario showing habitats distributed along the Coorong over time

Applications

- Assist in setting environmental water requirements for Coorong
  - What are the relevant thresholds?
  - How much water is enough?
- Assess the impact of flow delivery and timing on the ecology of the Coorong
  - How should water be delivered?
- Assess ecological response to Basin Plan scenarios
  - How do proposed changes compare to current conditions & without development?





Credit: Flinders University

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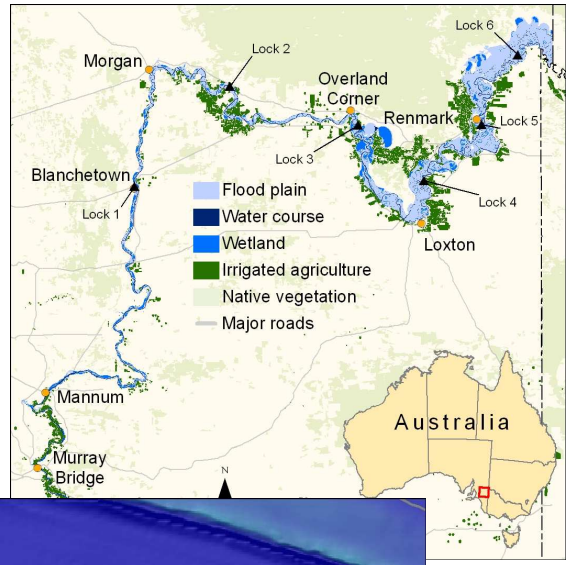
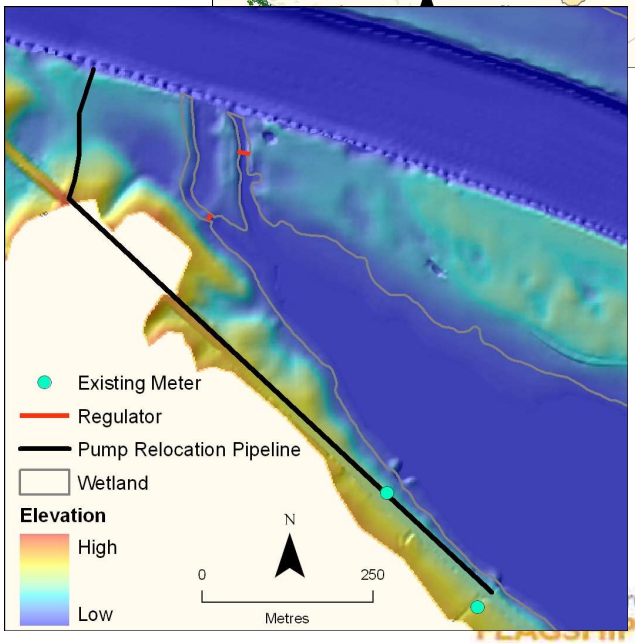
Environmental Water Management

- Manage the complexity of water demands
- Highly complex spatial and temporal environment
  - Habitats
  - Connectivity
  - Seasonality
  - Primary and secondary responses
  - Time delays
  - Resilience
- Environmental Objectives
  - Biodiversity
  - Resilience
  - Low flow conditions
- Large investments in Environmental Water
- Infrastructure and flows

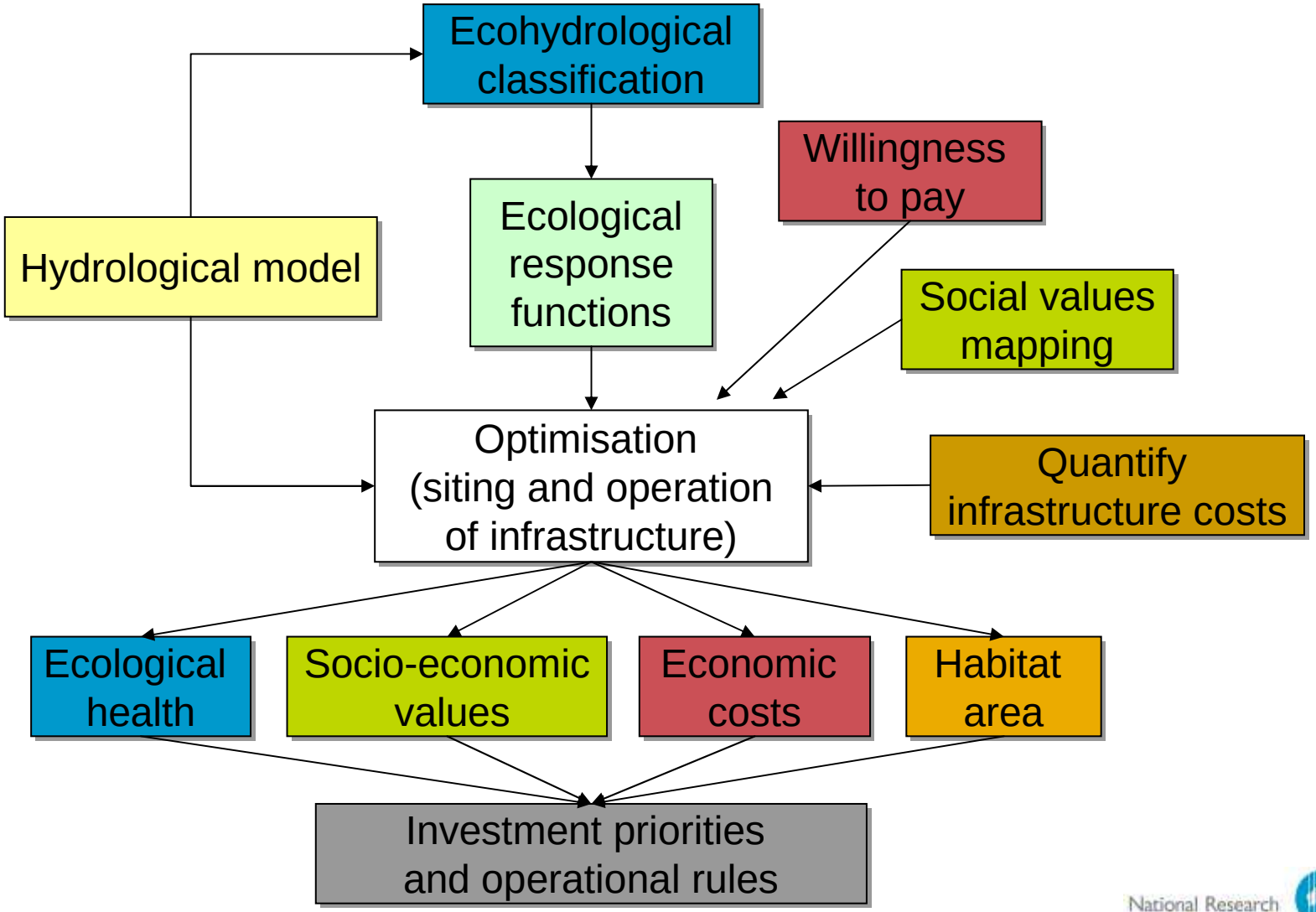
Murray Futures

- Multi-Criteria Optimisation of how SA can best invest in infrastructure:
  - To improve environmental health of floodplains and wetlands
  - To improve the security of irrigation water
  - To produce water savings
- In recognition that:
  - Infrastructure will need to operate in conjunction with flow management
  - Infrastructure investments and management influence socio-economic and ecological values





Murray Futures



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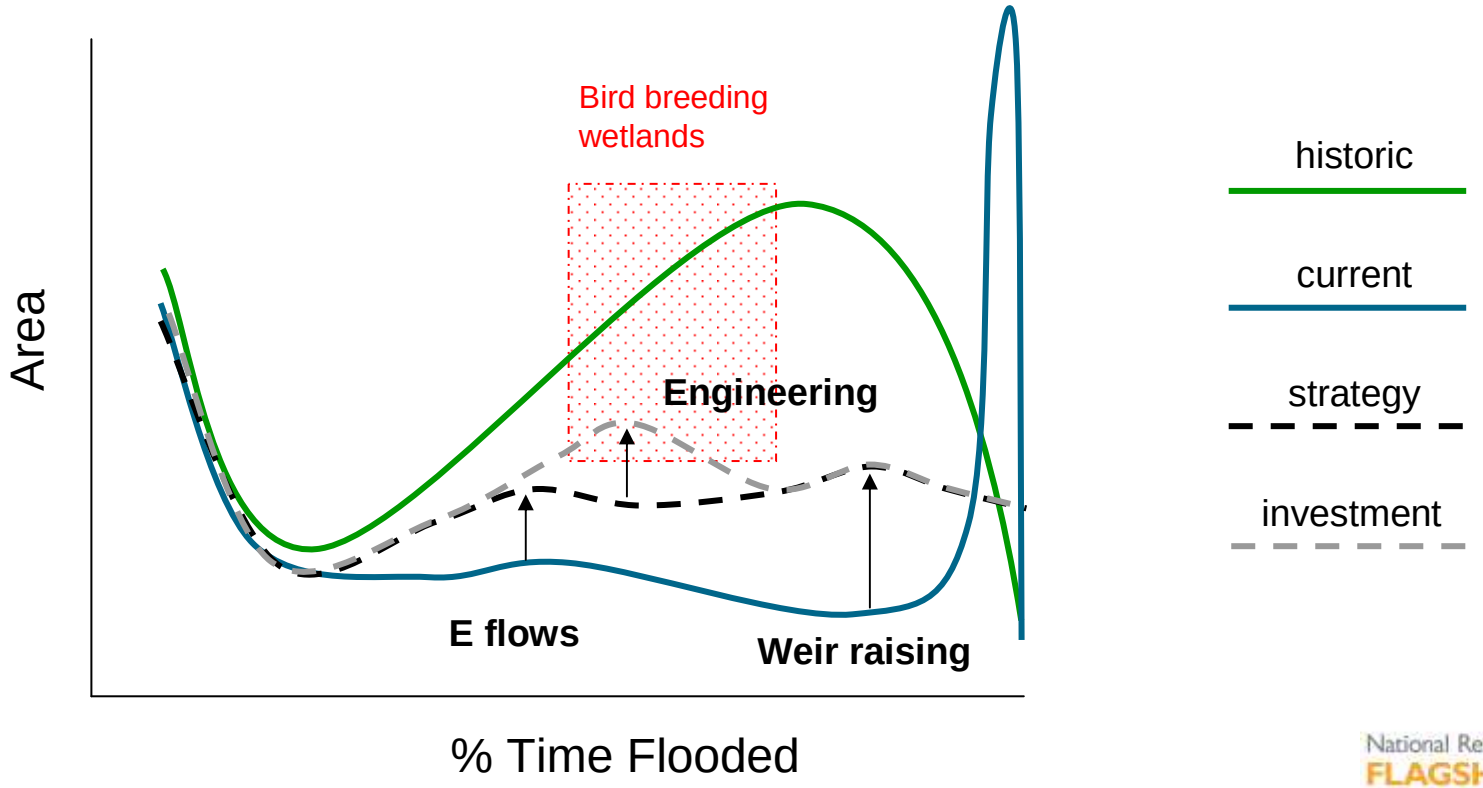
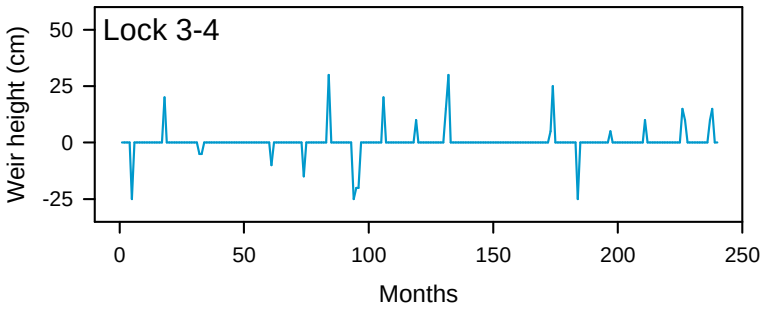
Ecosystem Response

1. Response curves for ecosystem health
2. Landscape approach
   - Natural hydrological diversity and biodiversity
   - Not necessarily in the same location

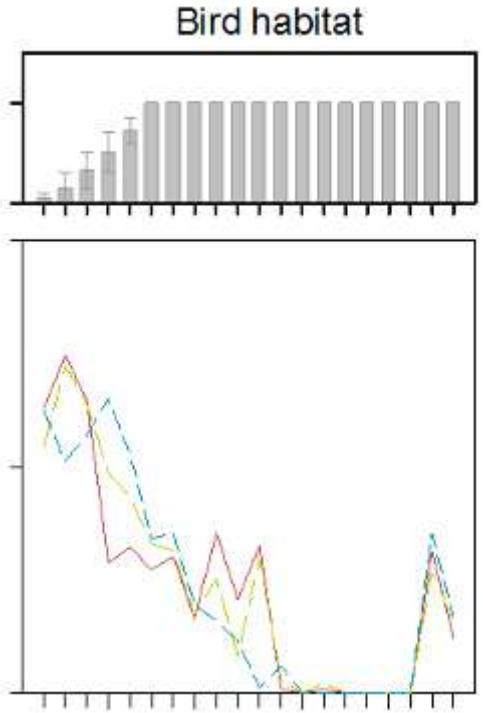


Murray Futures

- Extremely complex problem – decisions over space and time
- Considers ecological, hydrological, social, and economic aspects
- Meta-heuristics can find good solutions
- Model identifies cost-effective and robust investments for riverine conservation
- Optimal locations and operations



Blue = natural
Red = current
Green = model



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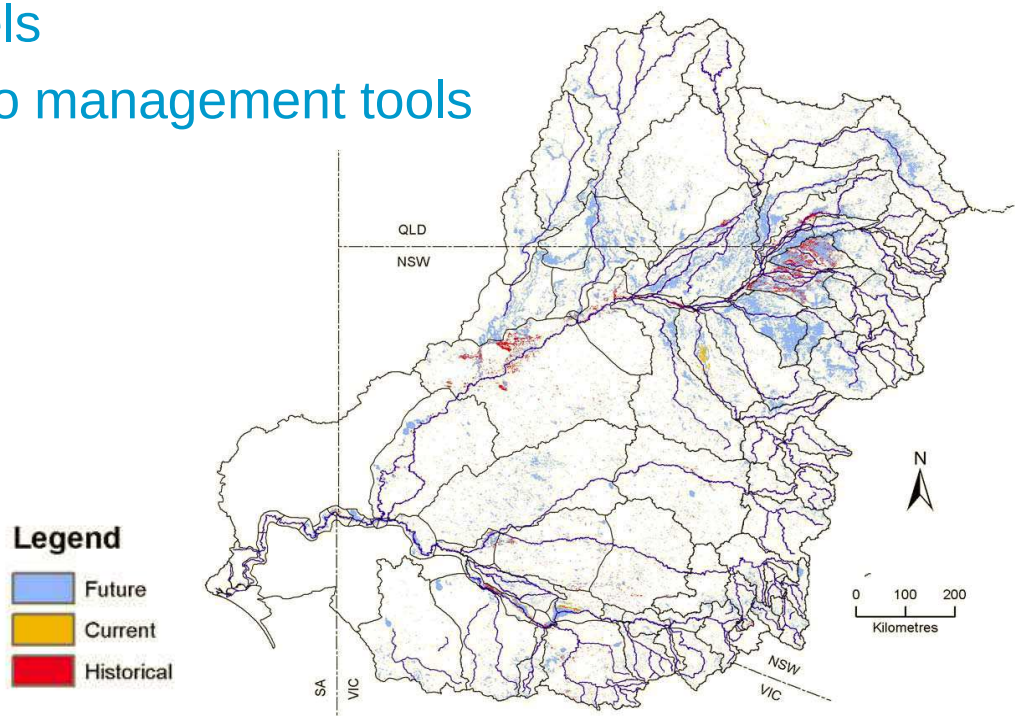
Conclusion

- Science to understand ecosystem responses
- Promote monitoring for adaptive management and model population
- Link socio/economic/ecosystem modelling
- Link to hydrological models
- Incorporate objectives into management tools
- Multiple scenarios
  - Climate change
  - Management



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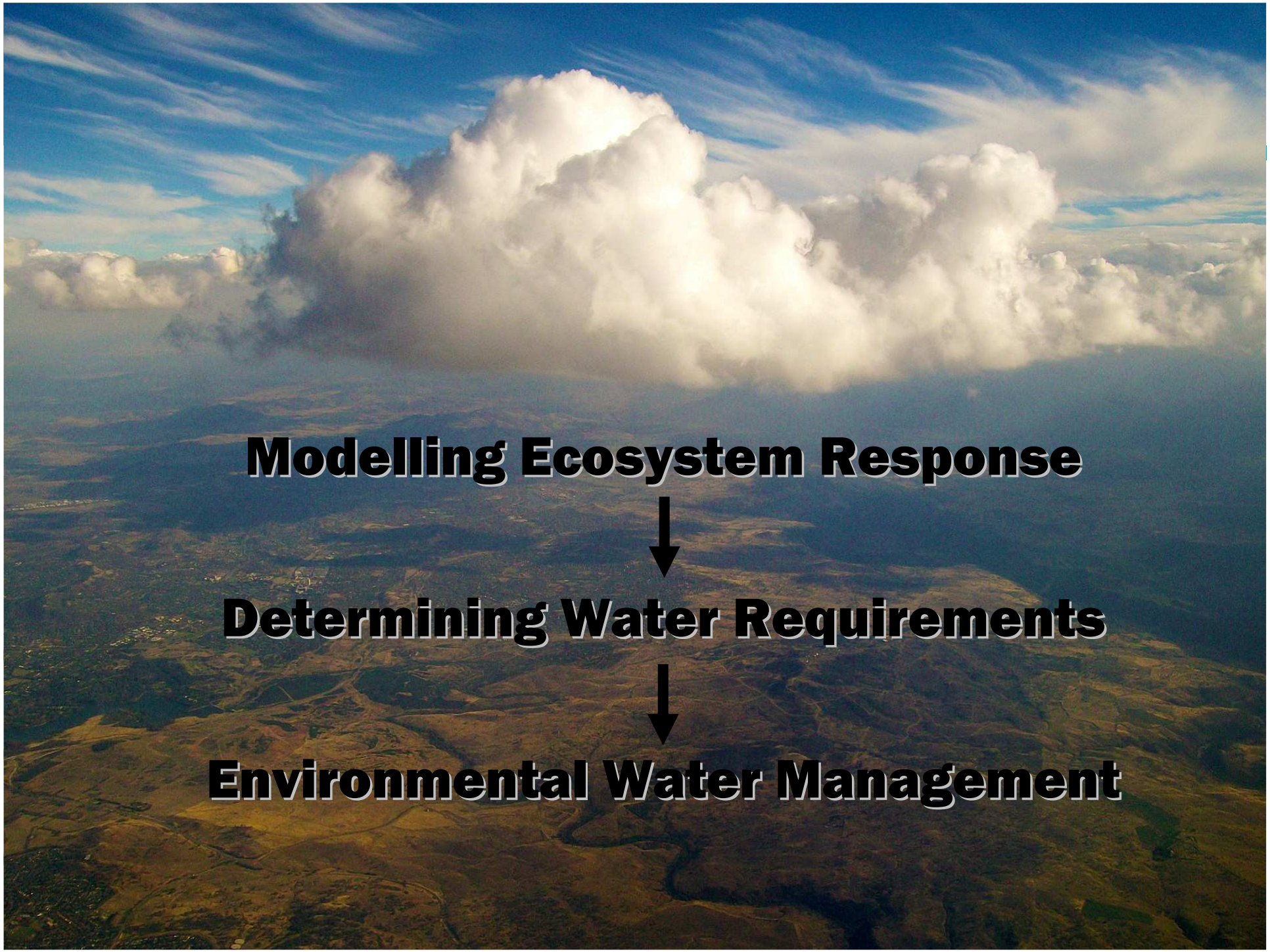
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Water for a Healthy Country
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Ian Overton – Stream Leader
Phone: +61 8 8303 8710
Email: ian.overton@csiro.au

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