Development of a Systems Approach to Integrated Catchment Management for ACT region

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Independent research and consulting

BMT WBM

Overview

- We have developed an integrated systems analysis of the ACT region.
  - Fully validated and calibrated
- Similar processes have resulted in strategic reforms in Sydney, Brisbane and Melbourne
  - SEQLD Healthy Waterways, SWC reform program and Living Victoria
  - Subject to extensive review and debate
- We applied these successful approaches and experience to the ACT
- **The Systems Framework approach allows understanding of impacts of solutions, strategies and policies at any scale**
  - What is the whole of catchment impact of a solution?

Objectives

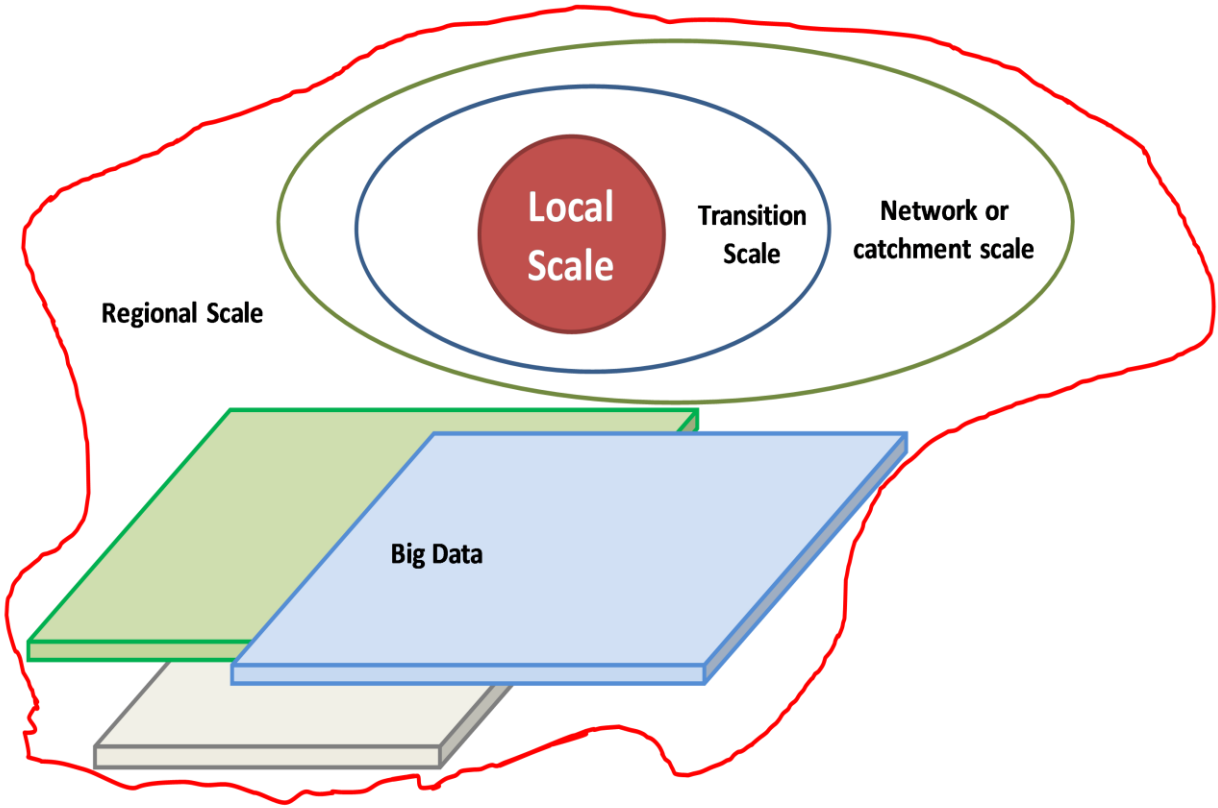
* Create a Systems Framework of the ACT region that combines
  * Analysis of water cycle, town planning, climate, economic and environmental issues
  * Operates at multiple linked scales
  * Demonstrates trade-offs throughout the region
  * Tests impacts of policy, strategy and solutions at any scale or location.
* Underpin the ACT government's submission to the Commonwealth government's Basin Priority Plan

Sustainable Loads Approach

- Use of pollutant concentrations insufficient to assess and manage environmental health
- The 'sustainable loads' approach has been adopted elsewhere and applied to the ACT in this study
- Involves dynamic links between hydrodynamic and water quality models
- South East Queensland (2005-06 and presently)
  - Develop and calibrate catchment hydrology and pollutant export models
  - Link to downstream 3D hydrodynamic and water quality models
  - Use linked model system to assess system as a whole
- Extended in the ACT by integrating a water systems model of the region

Systems Framework Approach

- Analysis from the "bottom up"
- Underpinned by "big data":
  - Population
  - Demographics
  - Climate
  - Water resources
- Combines water, planning, economic and environmental cycles



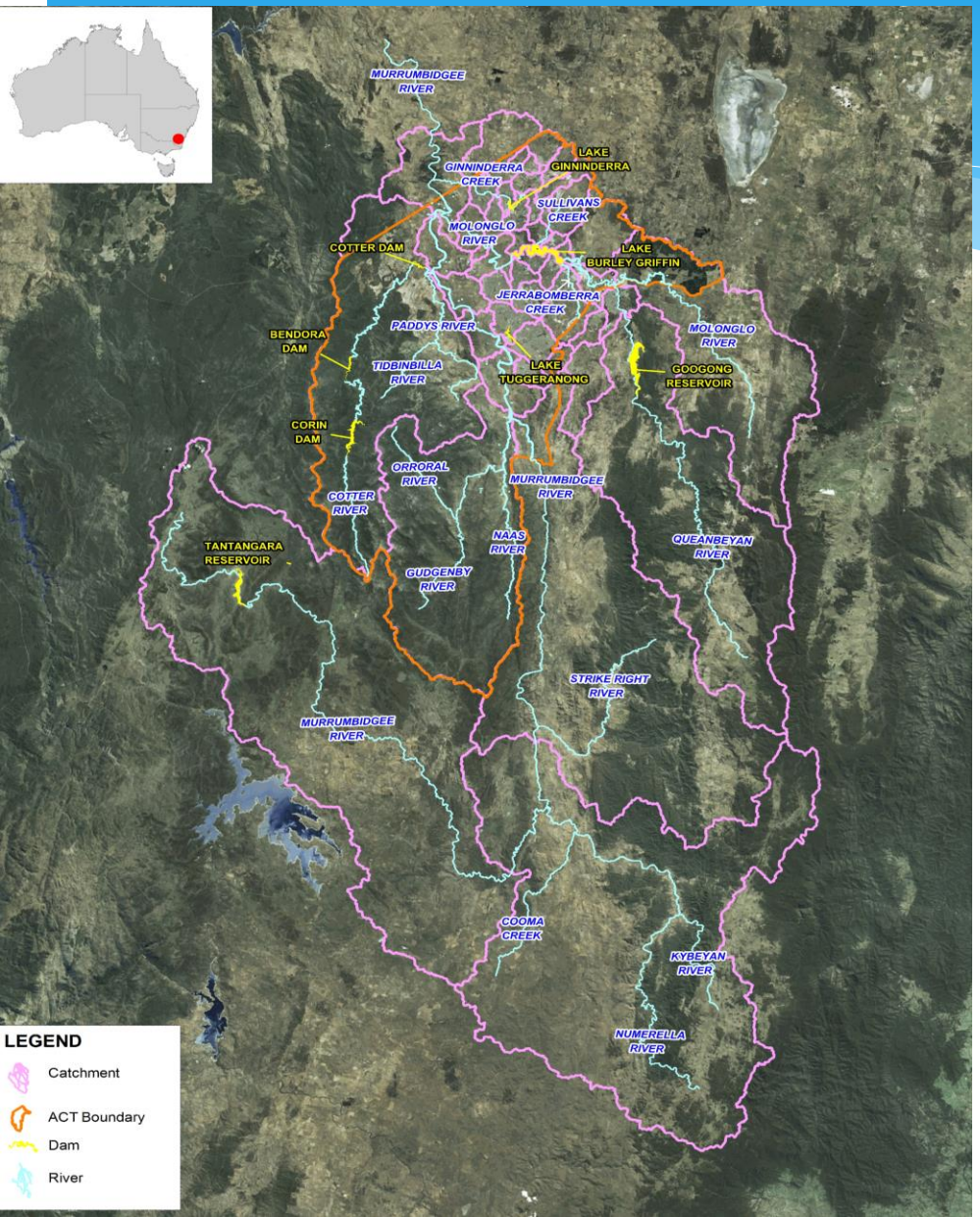
Context

* Parallel process of developing “top down” traditional lumped catchment hydrology and “bottom up” systems analysis (water cycle)
* Limited by delays in receiving data and urgency of Business Case
* Both approaches combined to meet deadlines
* Ongoing work on the Systems Framework for ACT

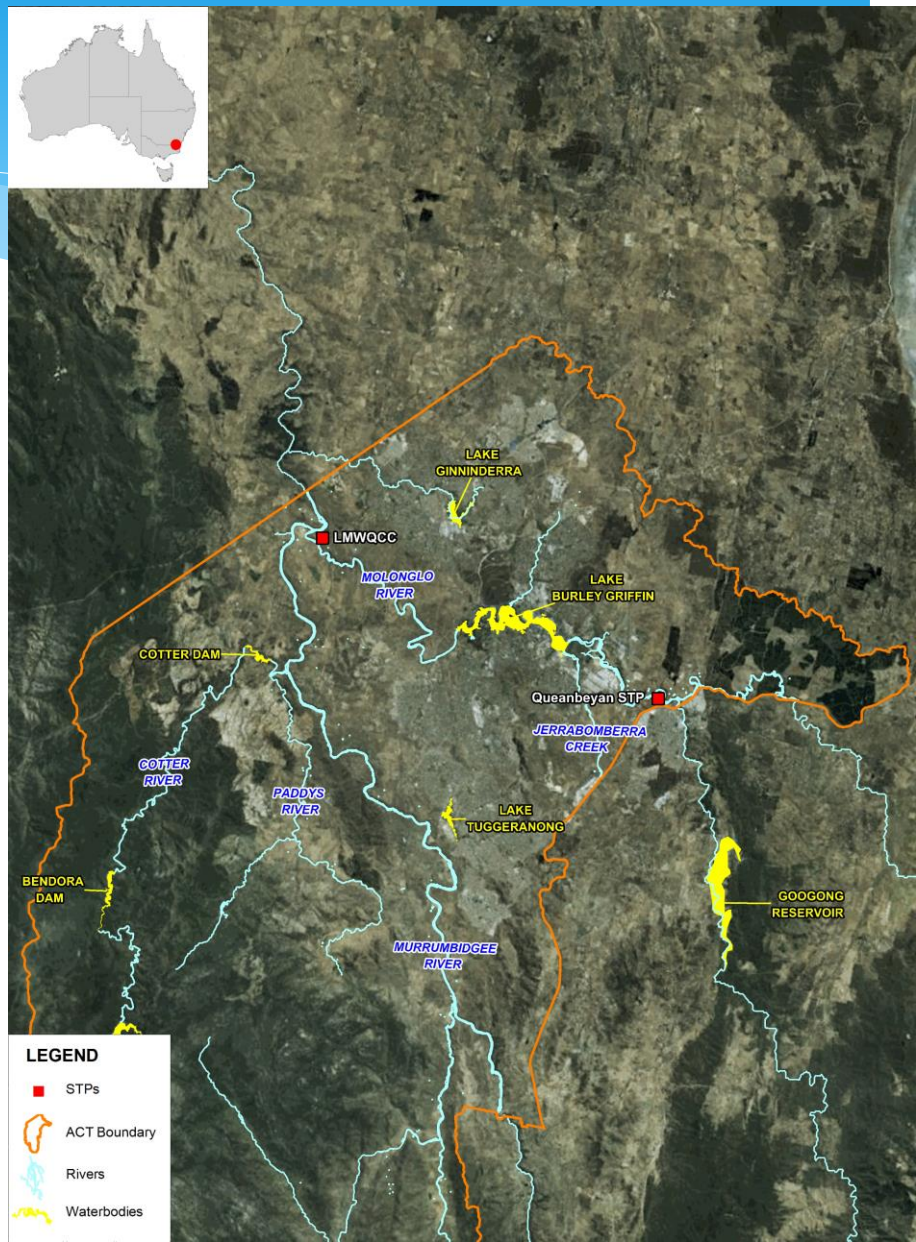
Methods

- Review and desktop analysis
- Selection of zones and input data
- Set up integrated catchment model: Source and Systems Framework
  - SIMHYD with EMC/DMC results for NSW (CRCCH)
- Calibration: Using observations from local gauges
- Validation: Using observations from local gauges
- Set up 3D analysis of the lakes
- Validation
- Analysis of performance of ACT Catchments and Lake Burley Griffin to 2050

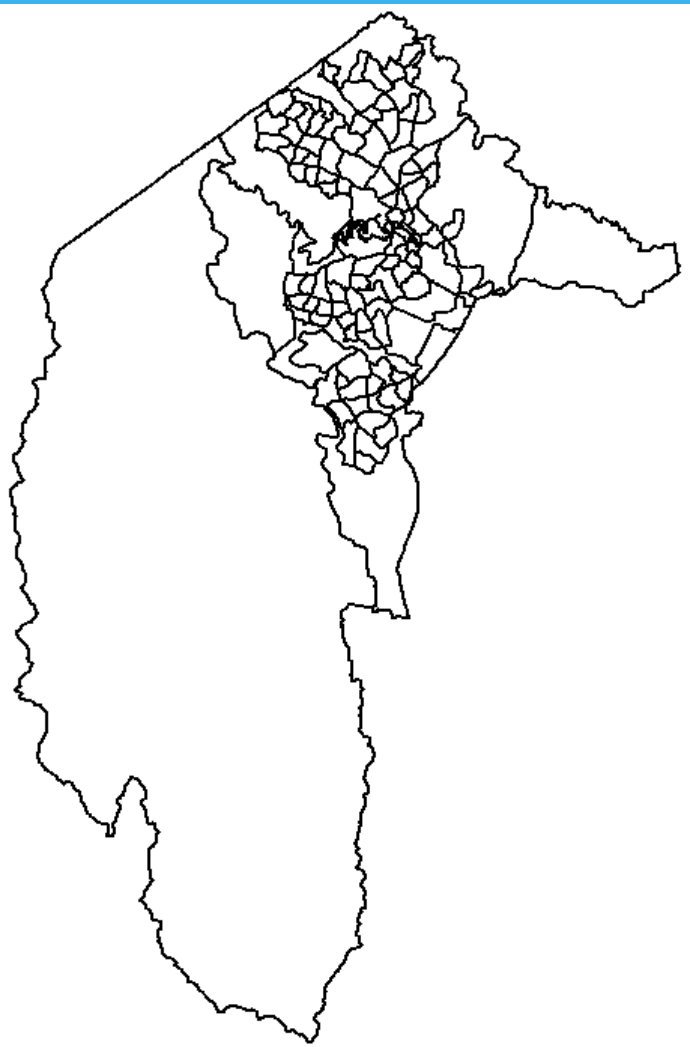
Definition of catchments, storages and waterways



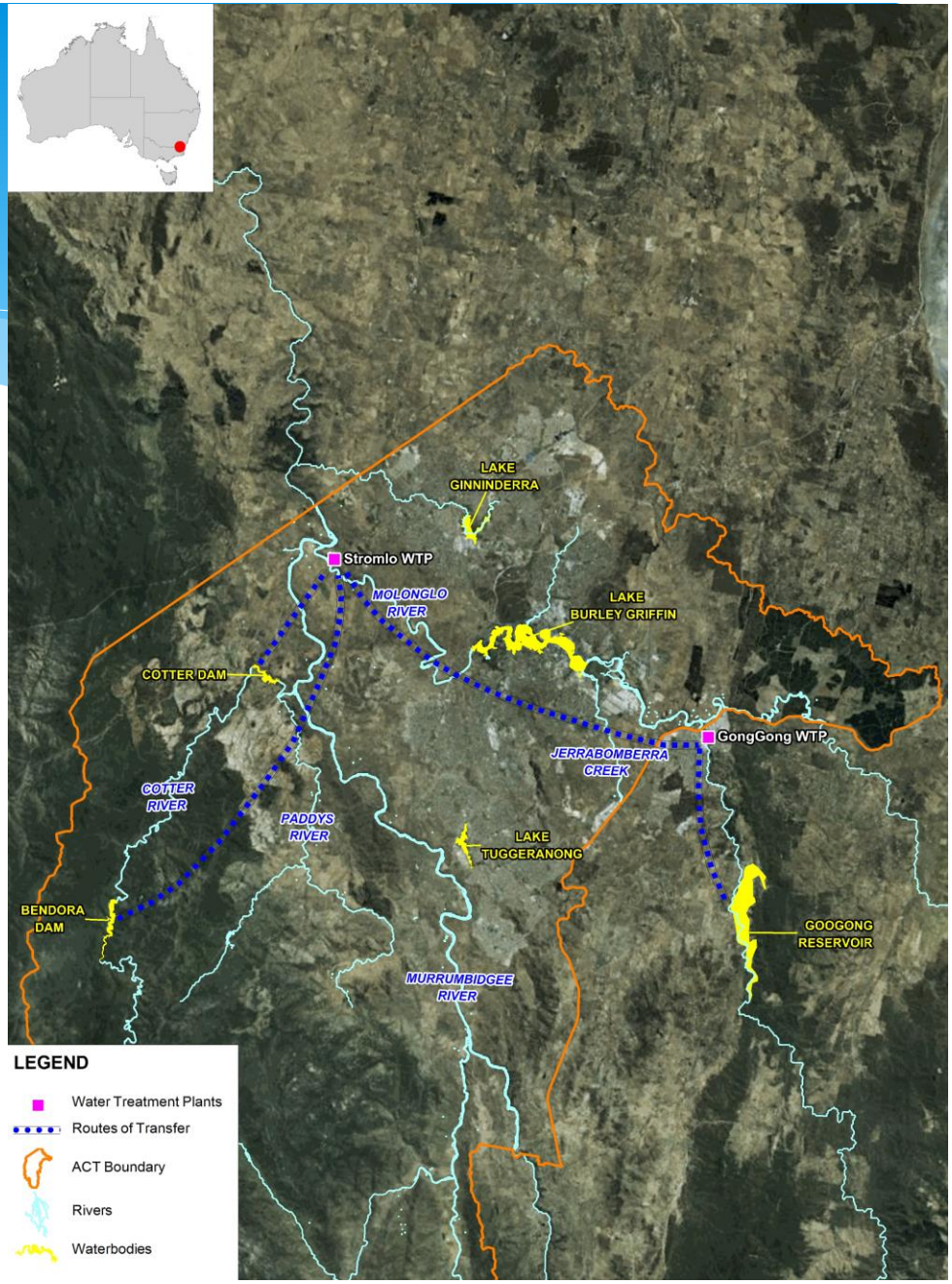
Wastewater treatment plants, storages and waterways



Selection of Zones

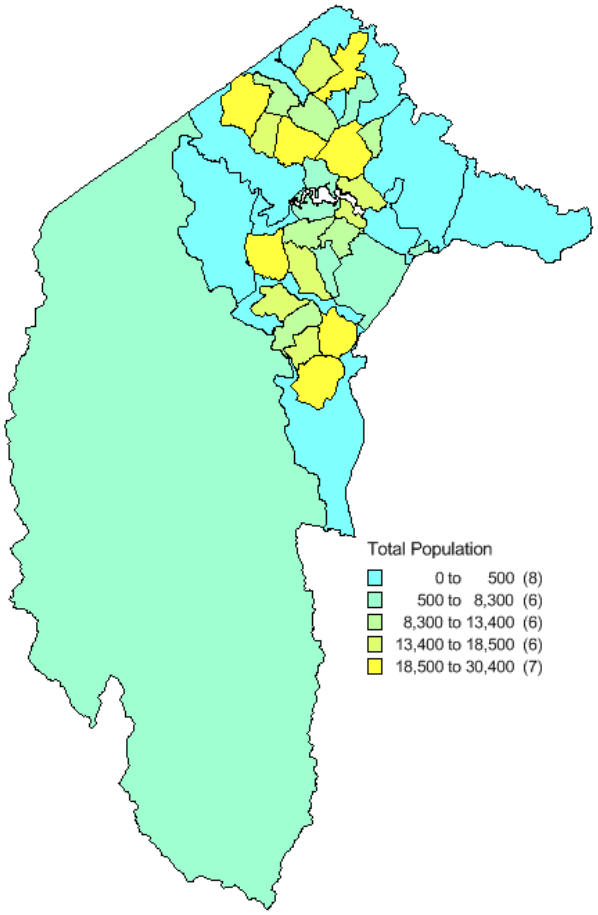


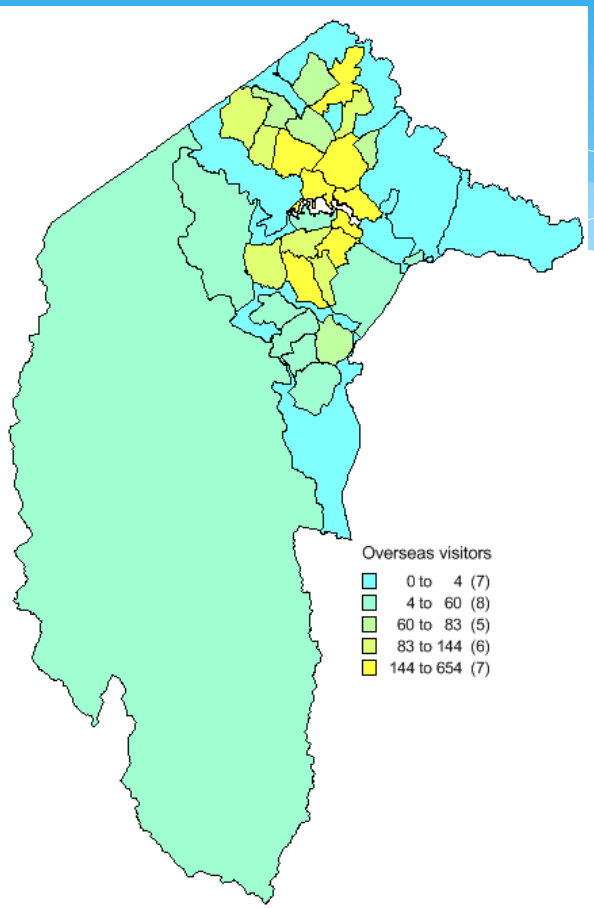
Statistical Local Area (SLA)

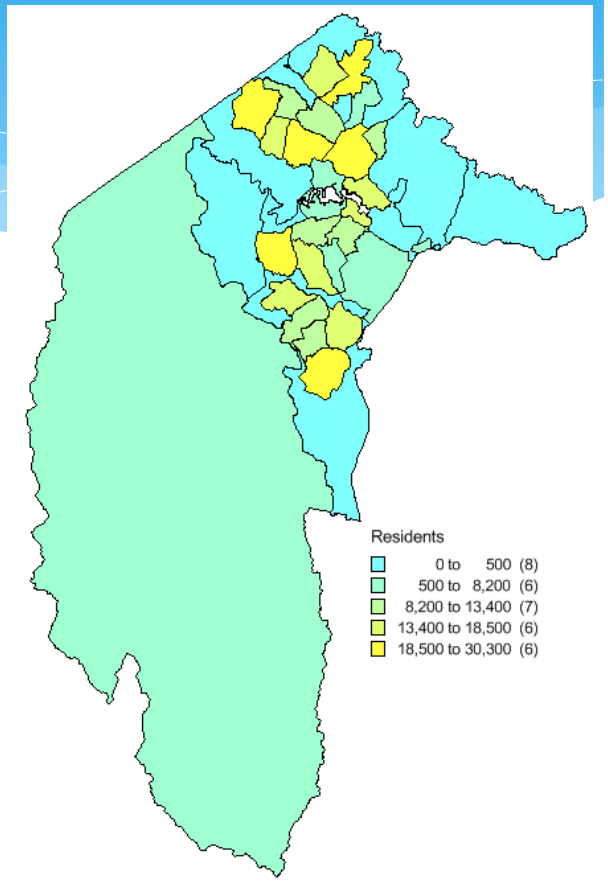


Water Resources

Selection of zones - Population

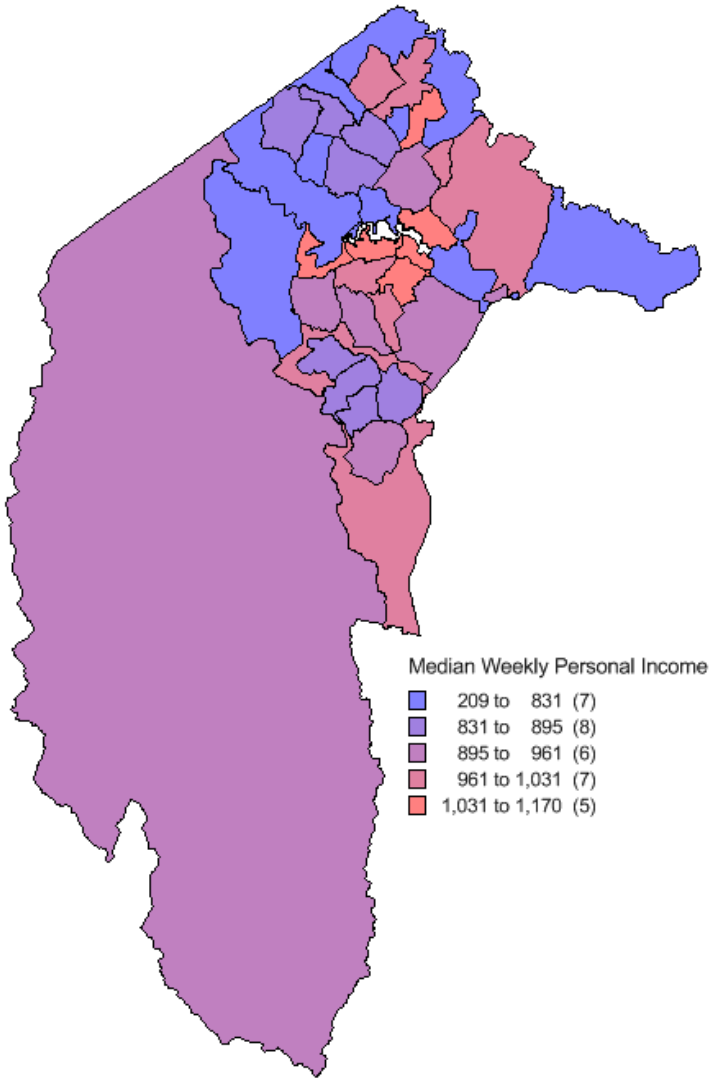


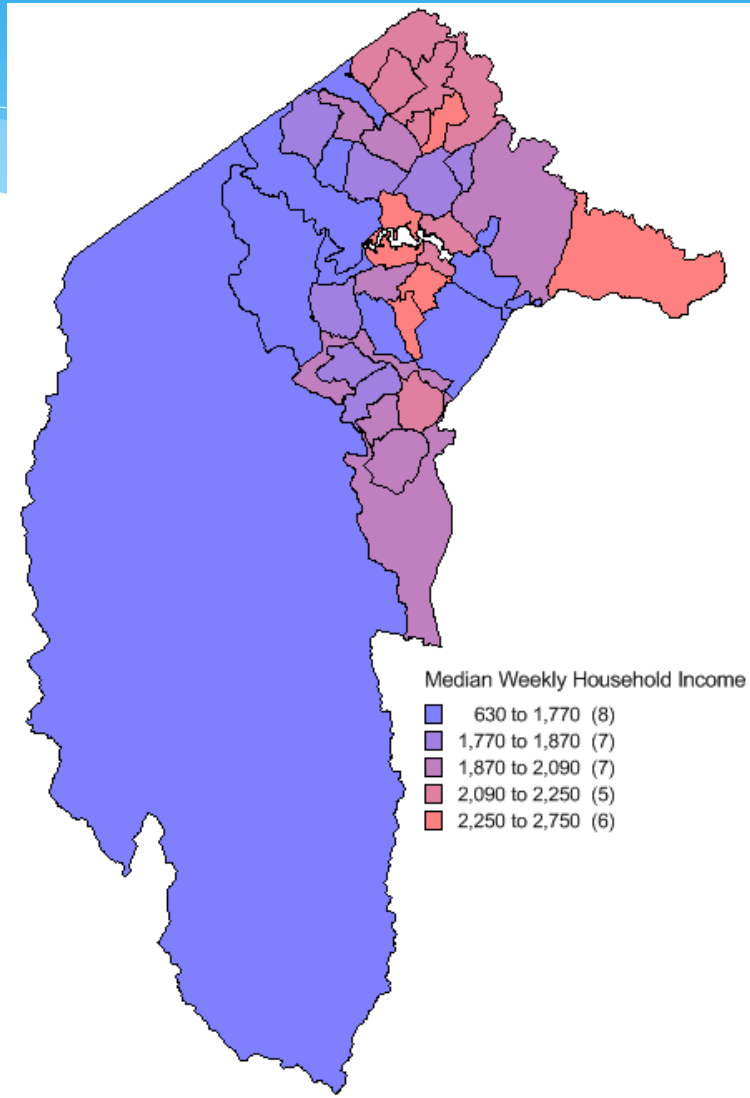




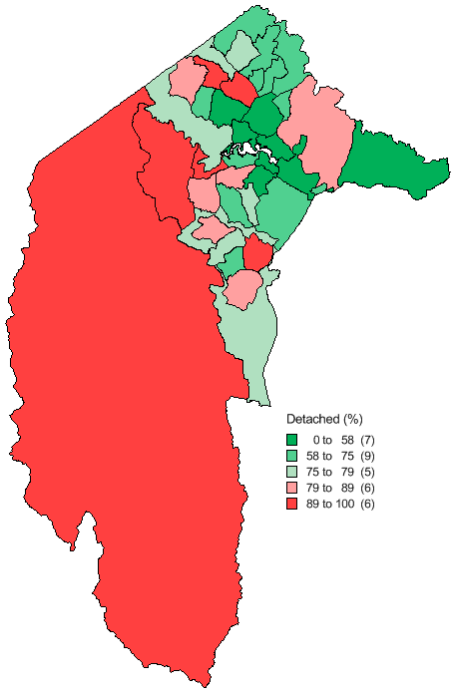
Based on 2011 Census Data

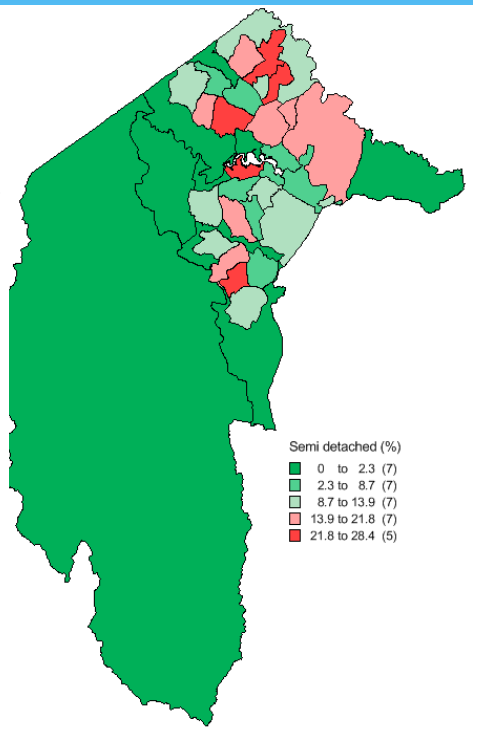
Selection of zones - Income

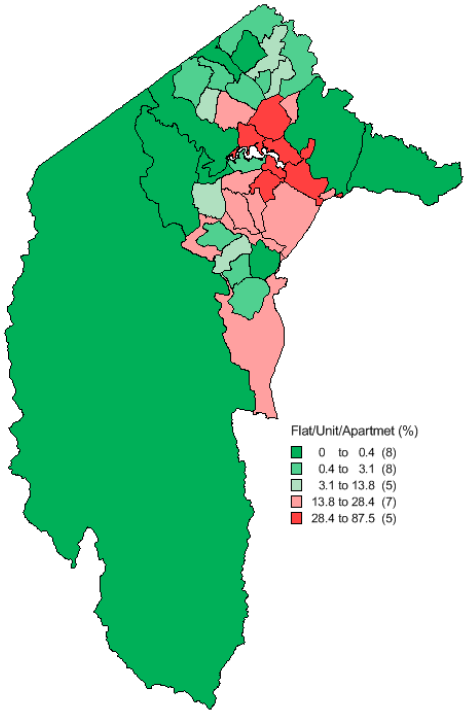


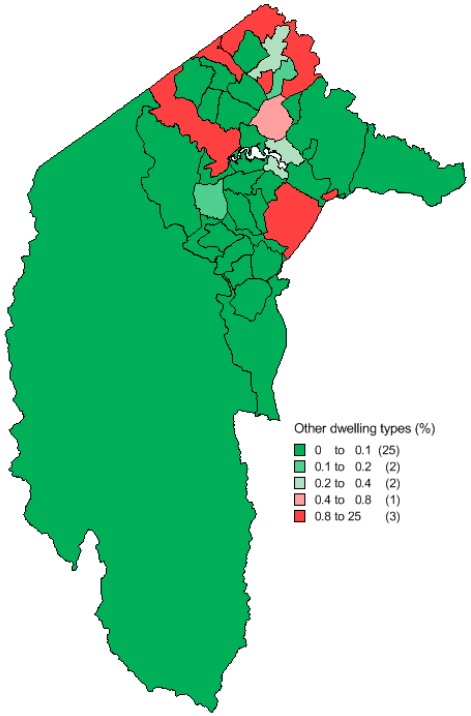


Selection of zones –Dwelling type

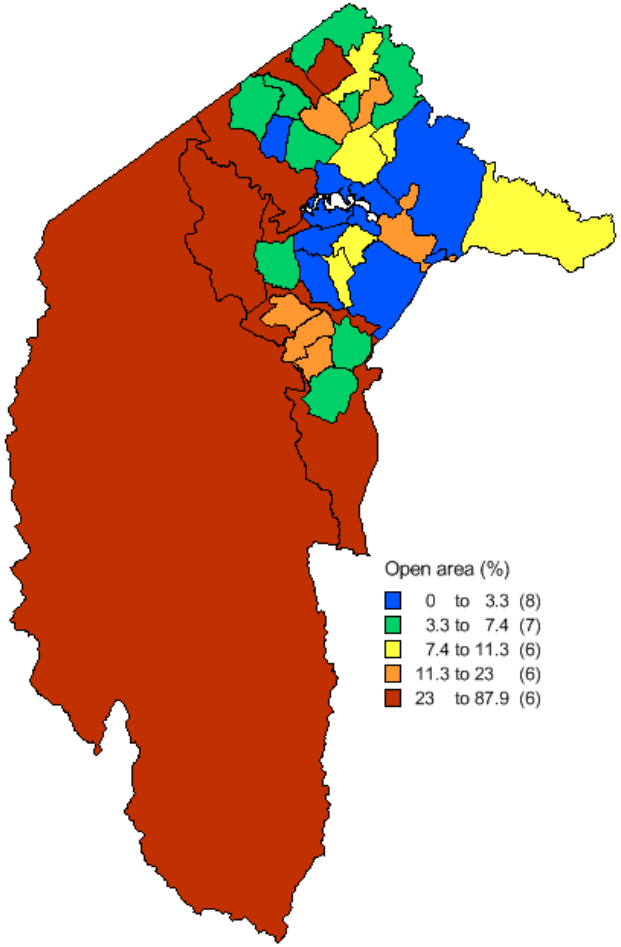


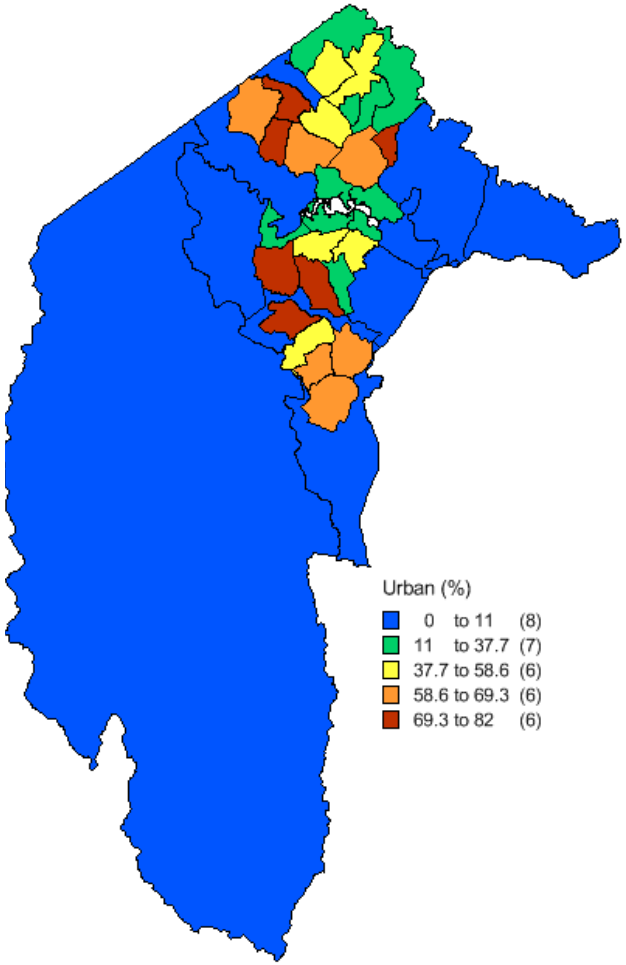


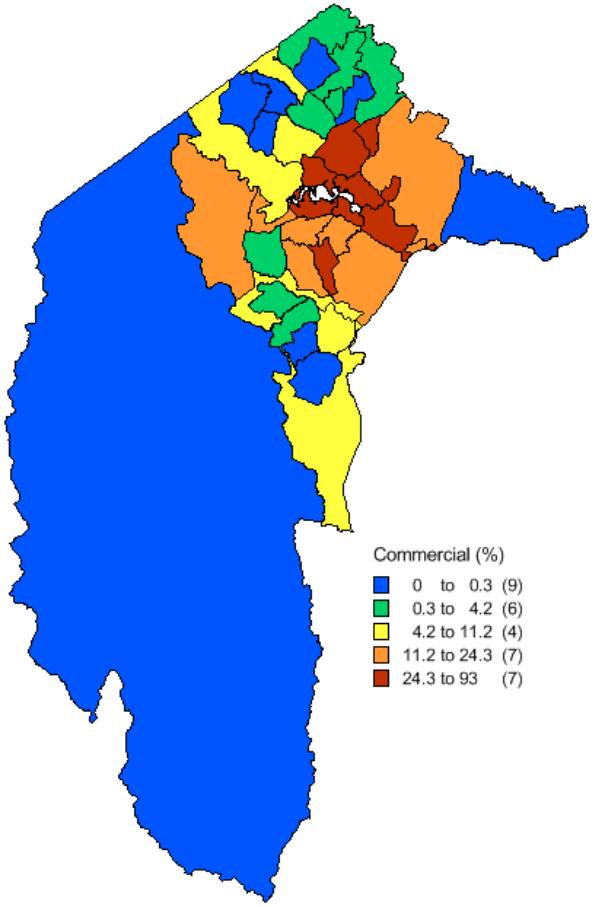




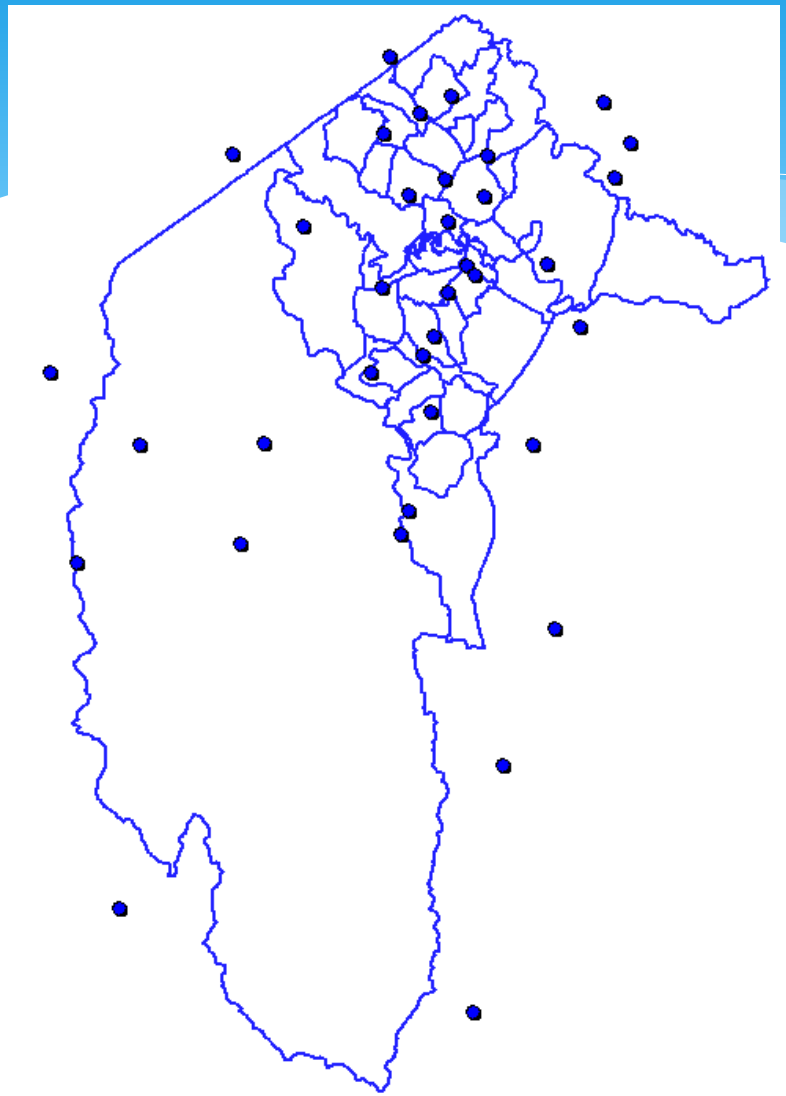
Selection of Zones - Land Use

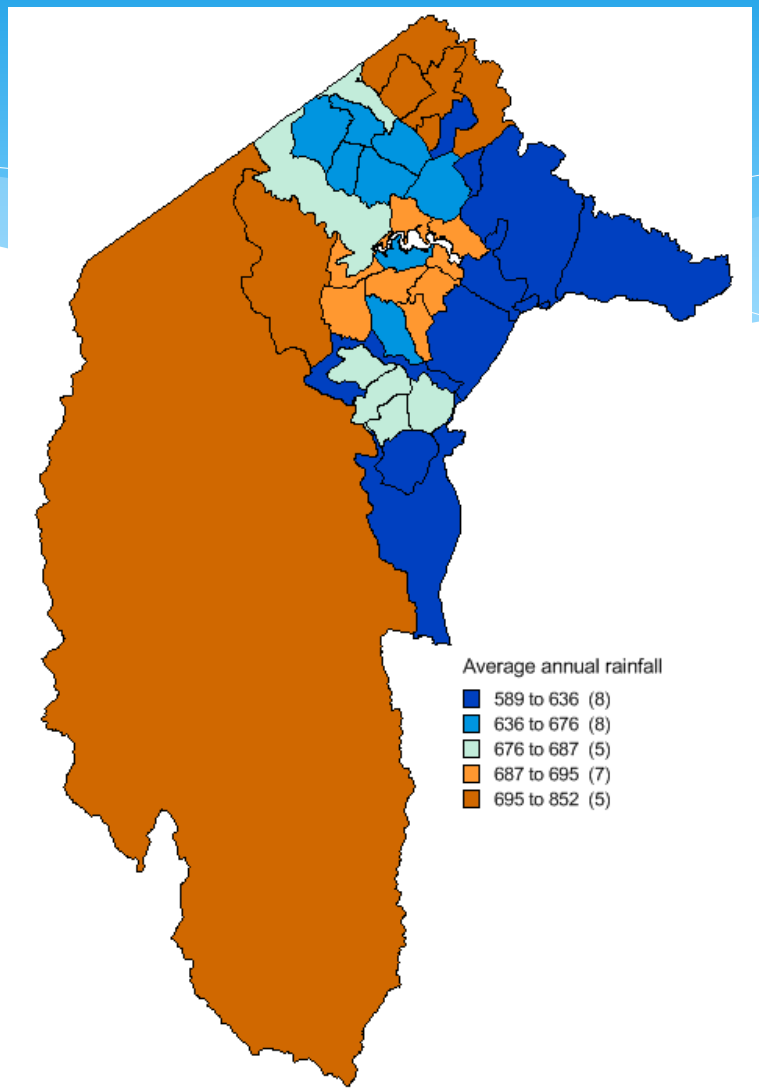






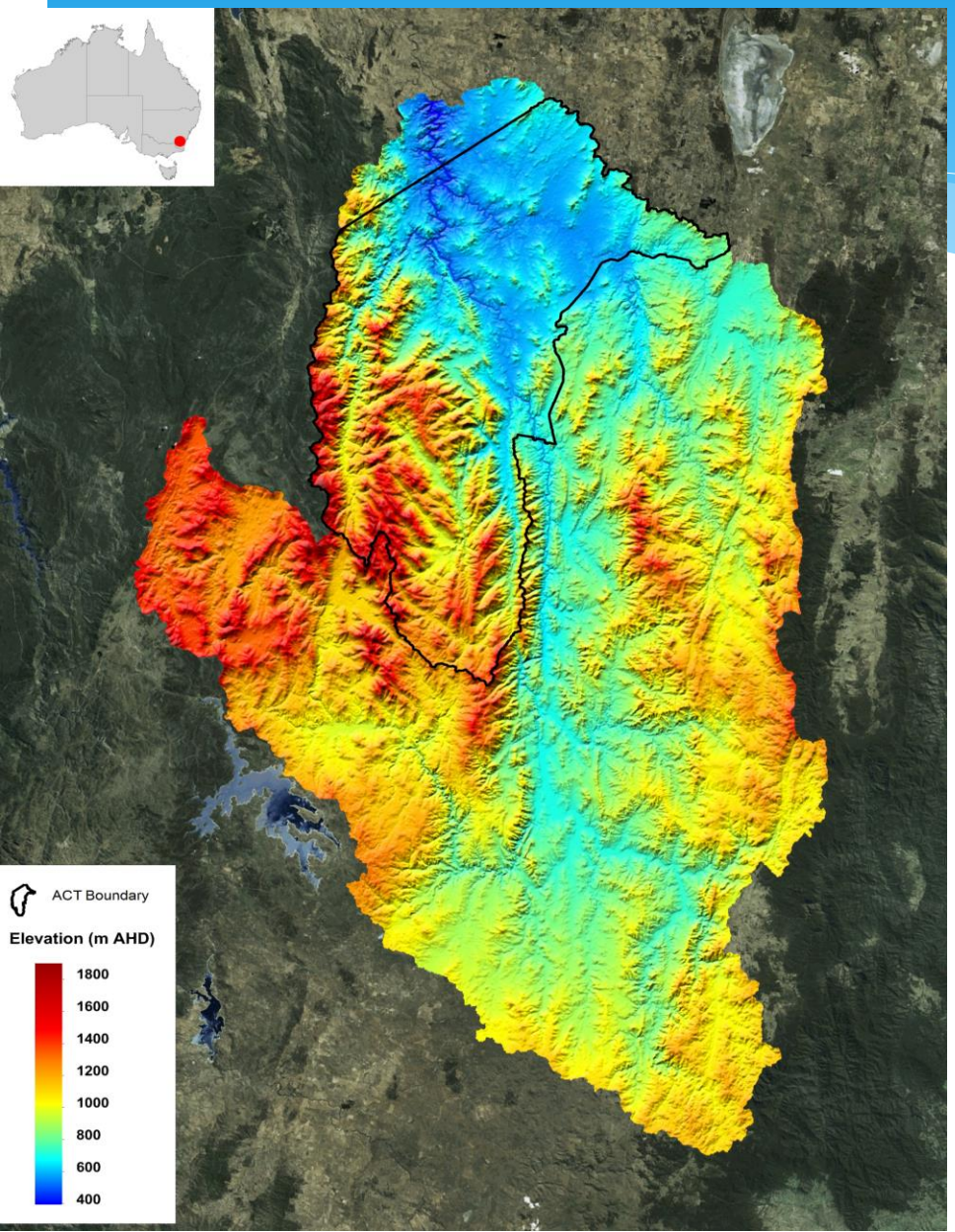
Selection of Zones: Climate



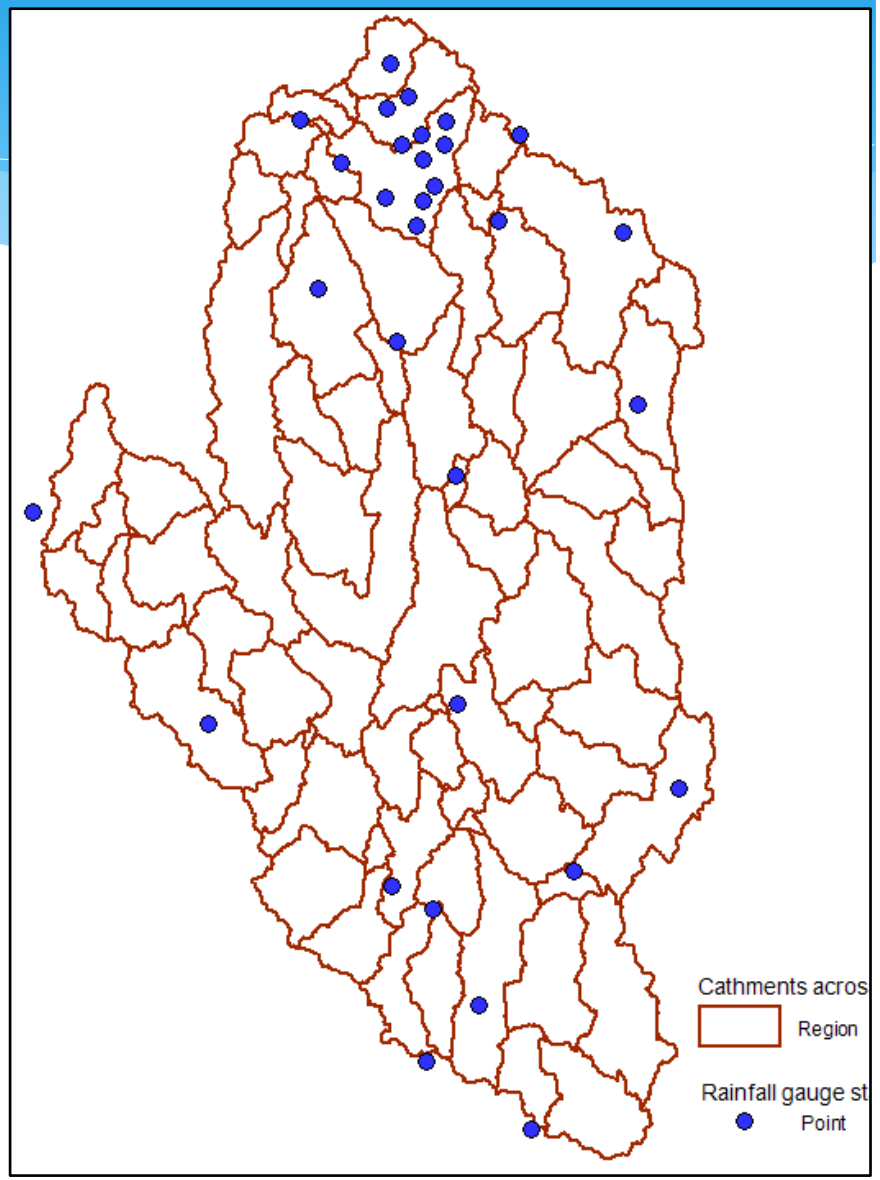


BoM stations in and around ACT

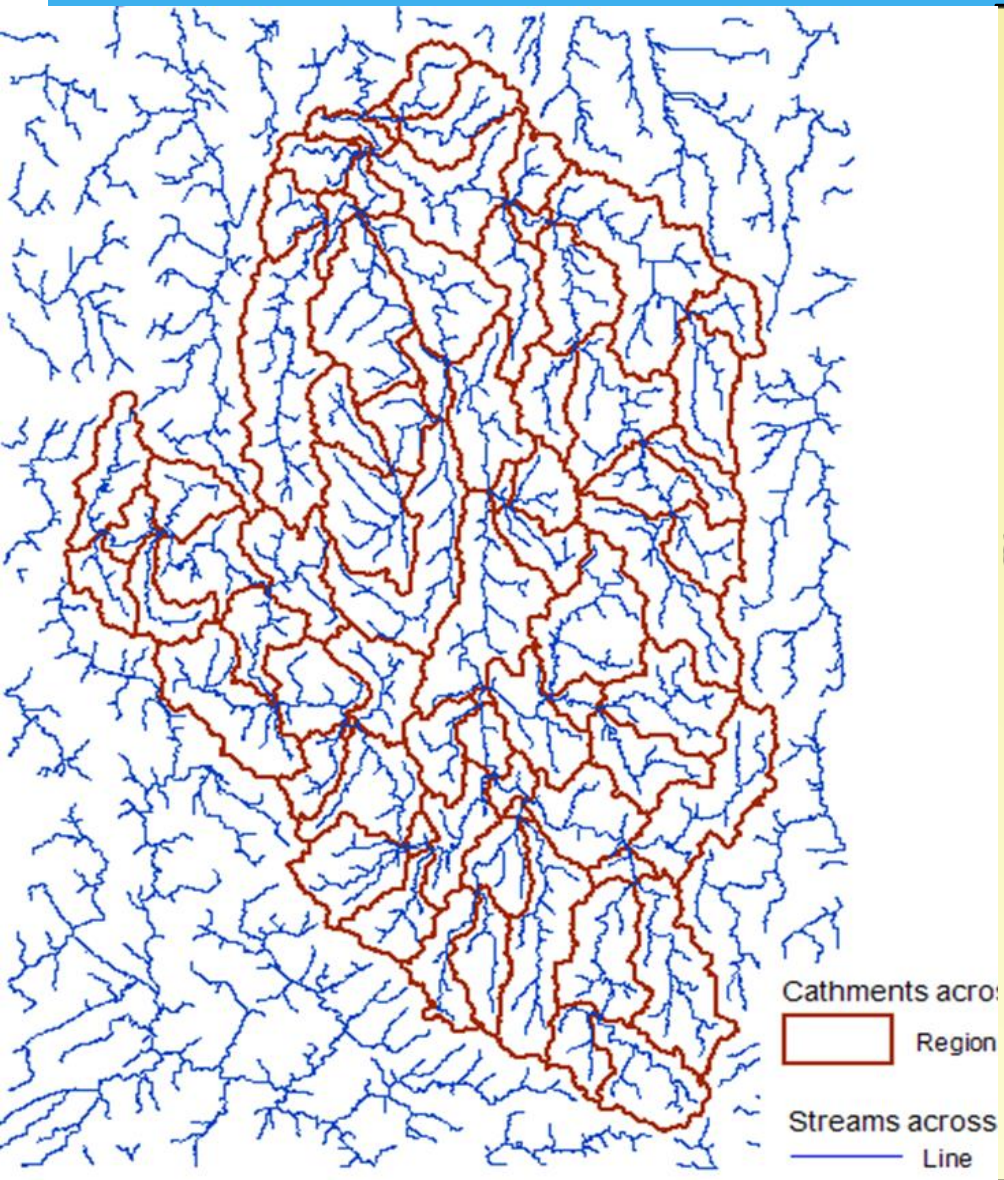
Topography



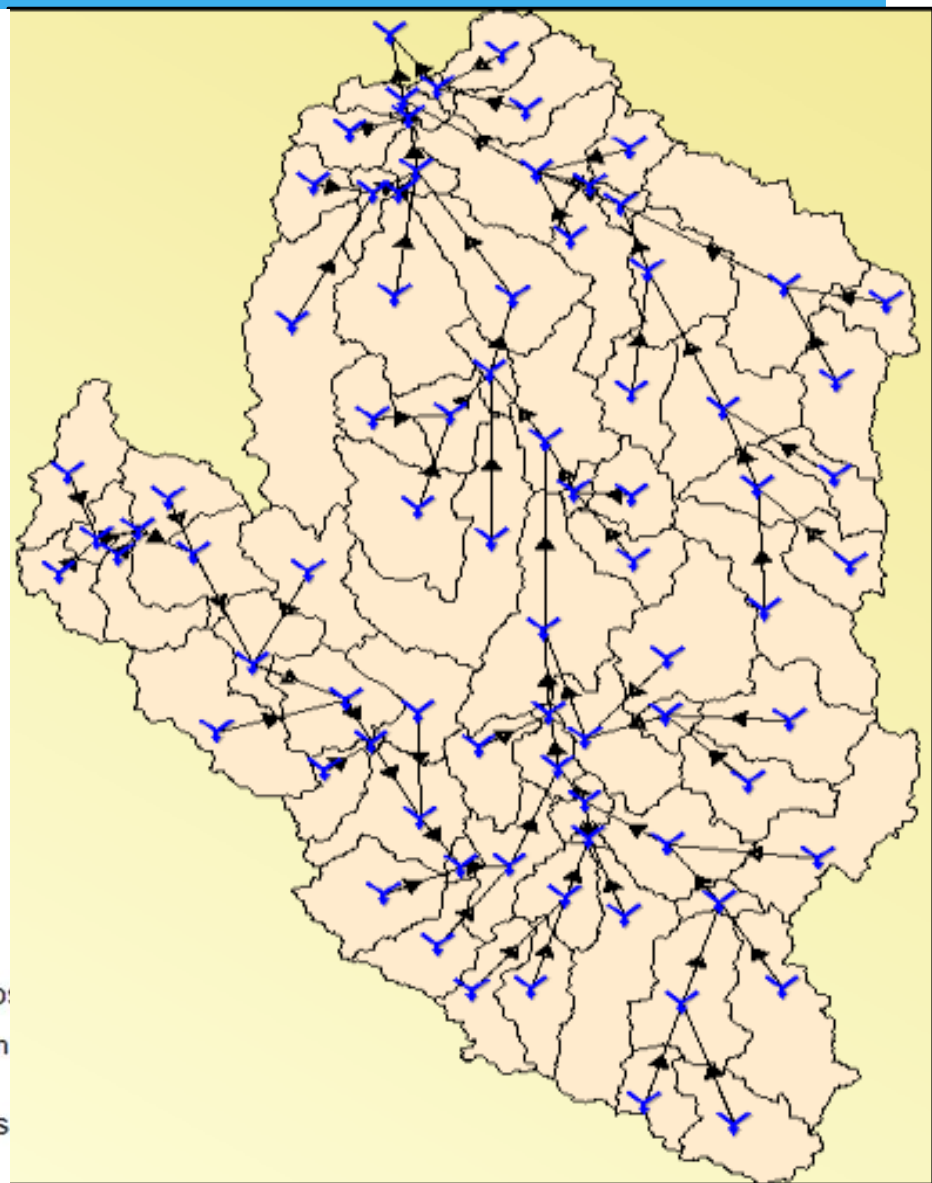
Rainfall gauges and sub-catchments



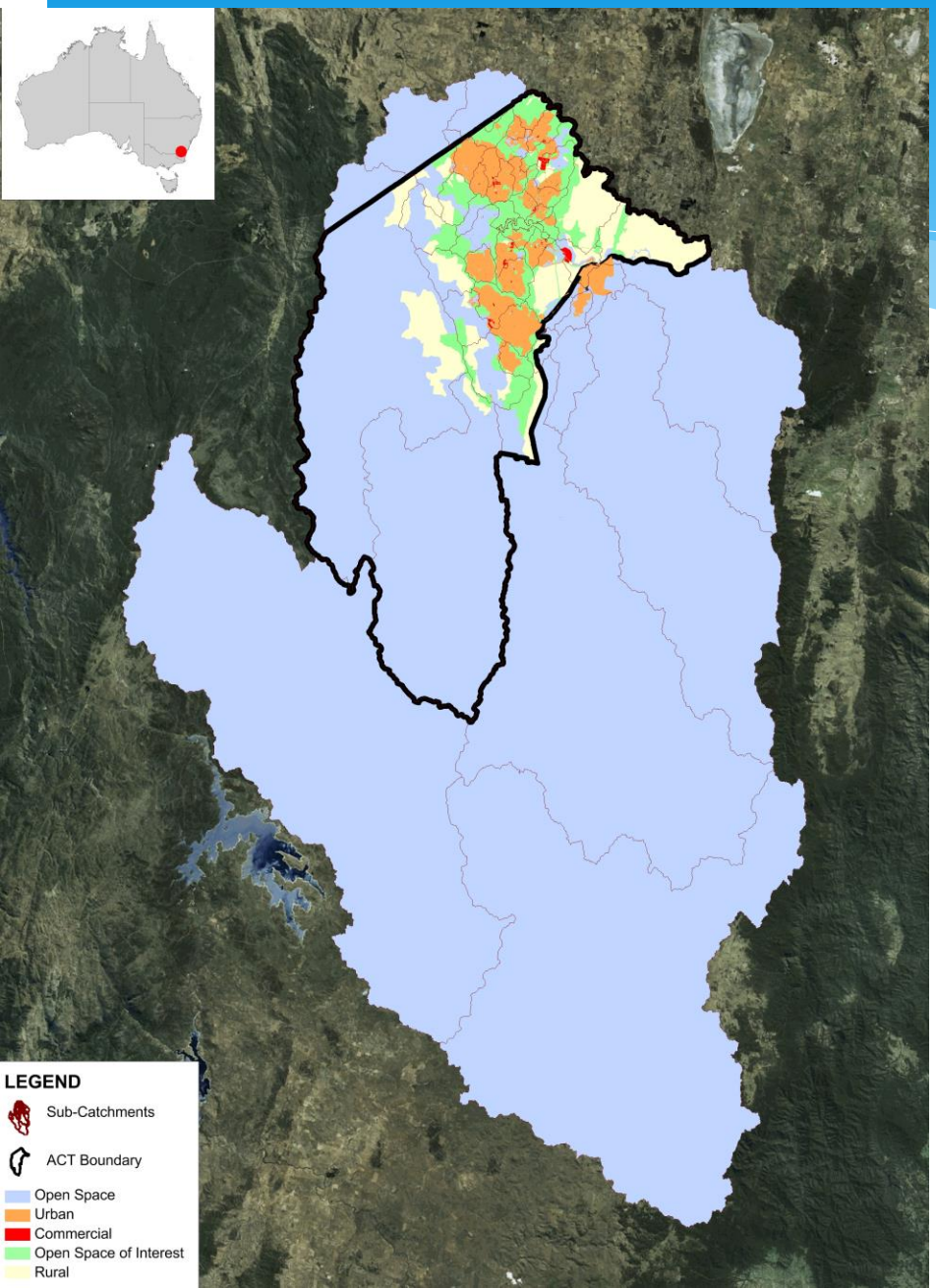
Waterways and catchments



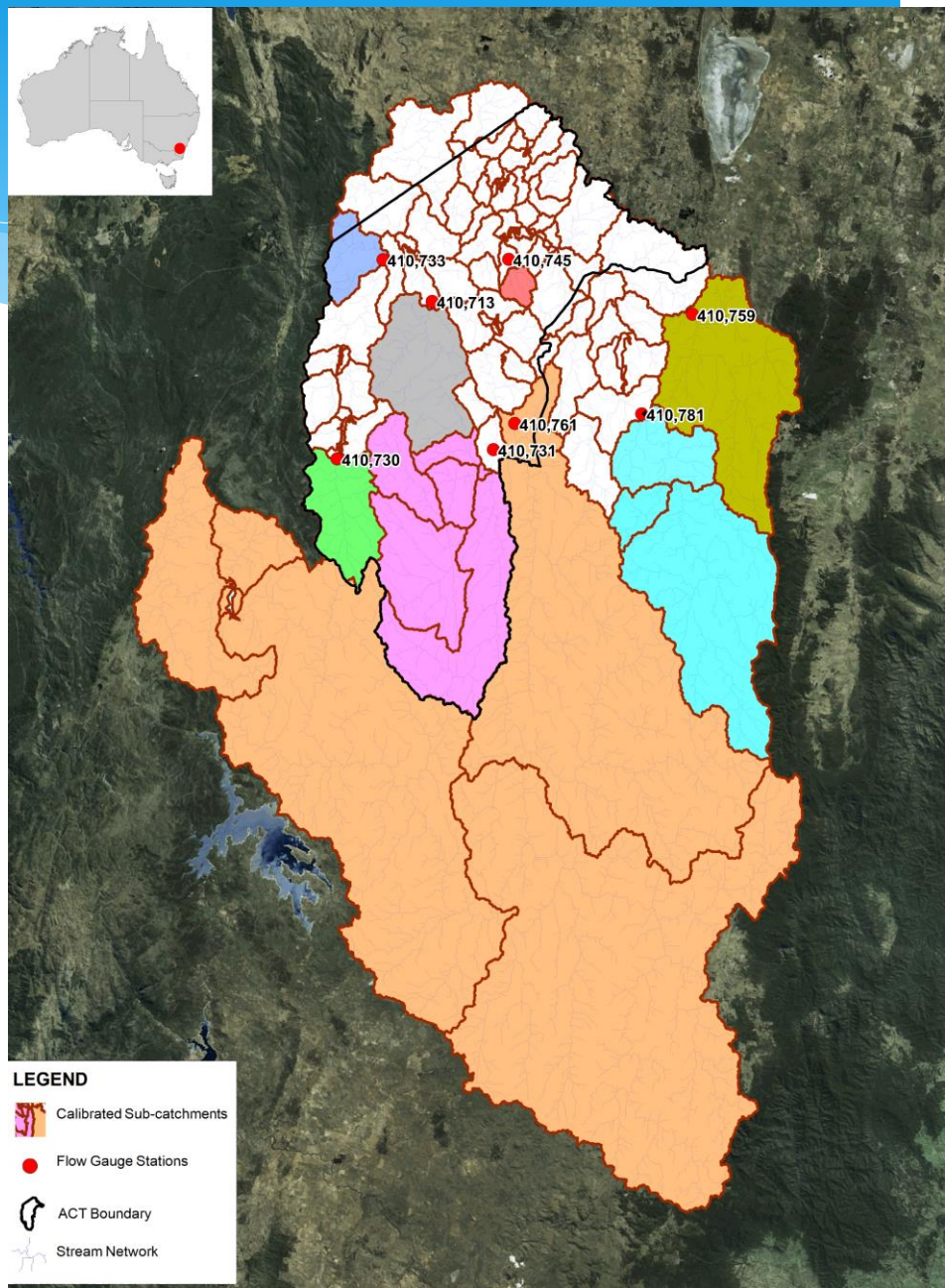
Nodes and links in model



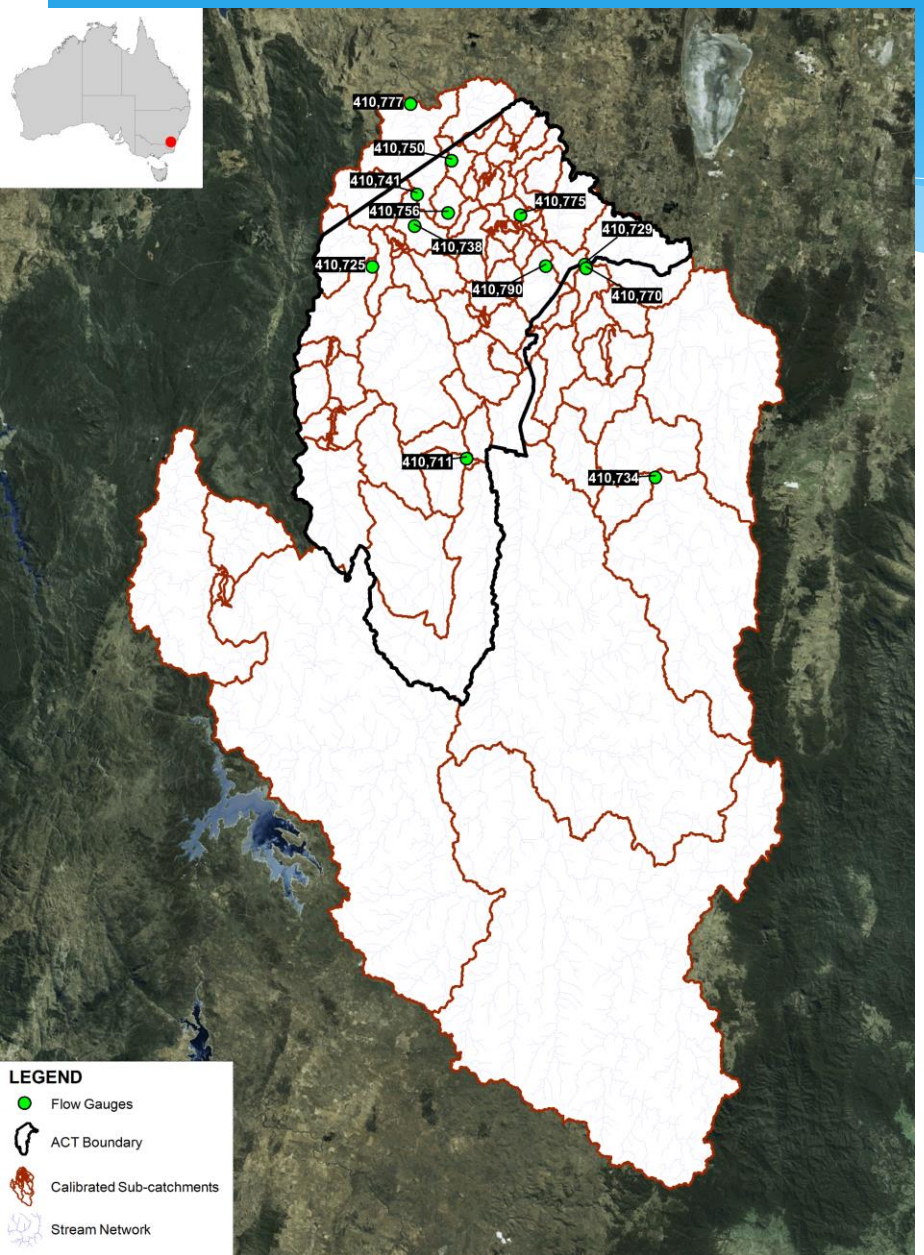
Land Uses



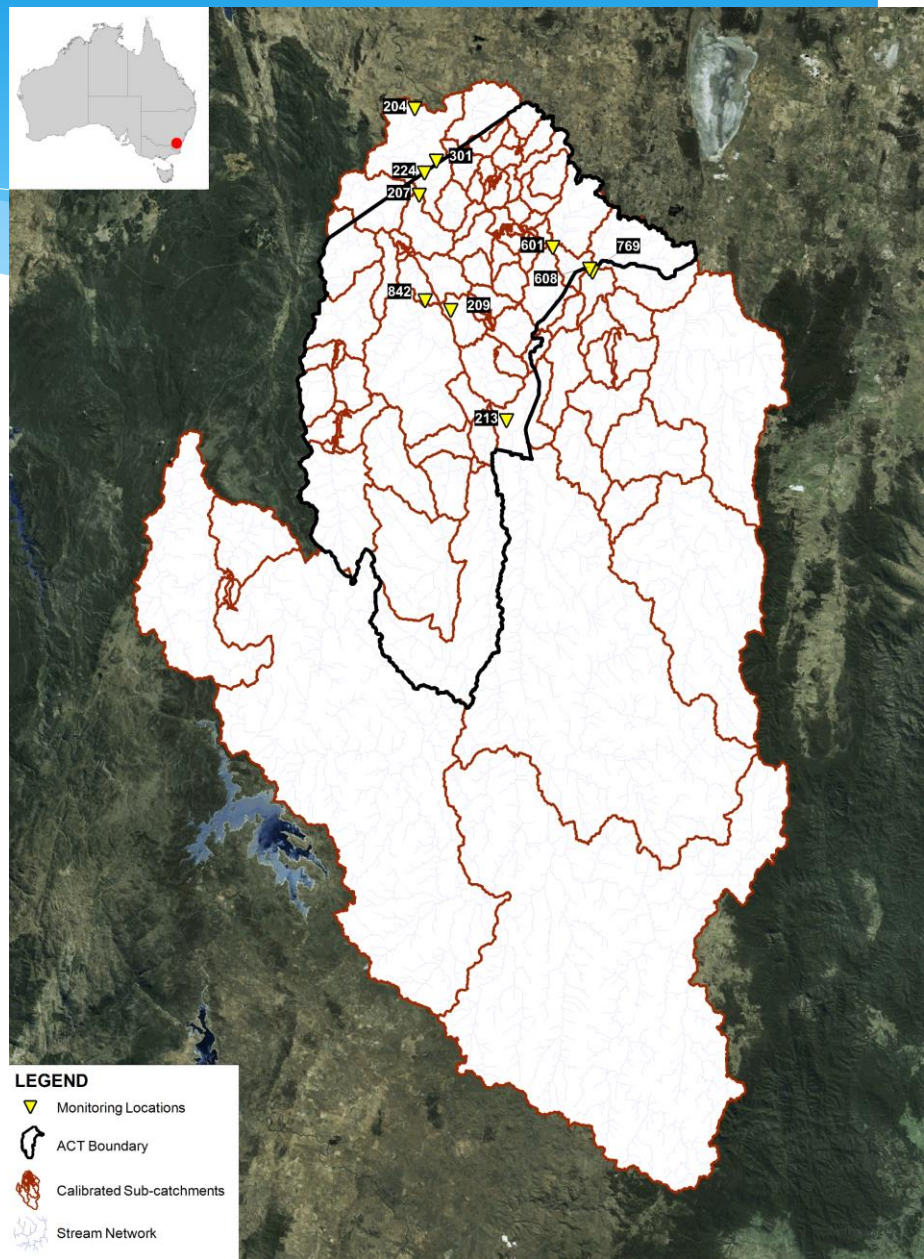
Catchments in calibration



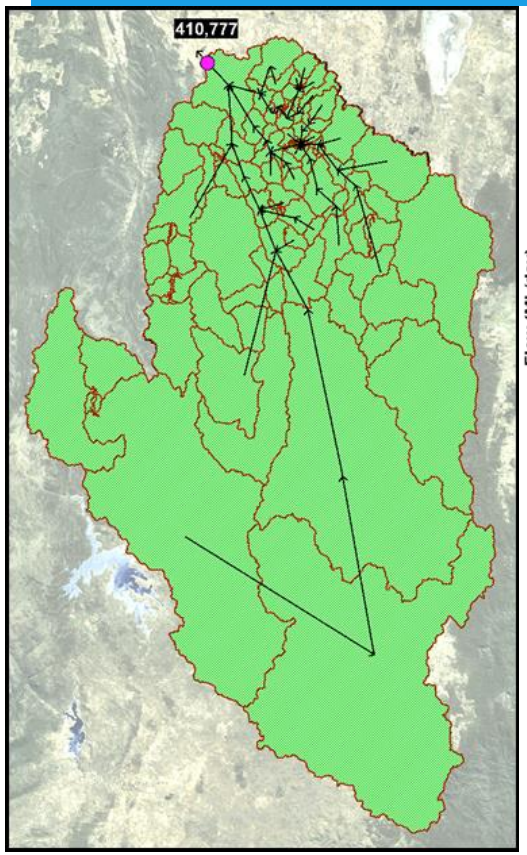
Validation Flow Gauges

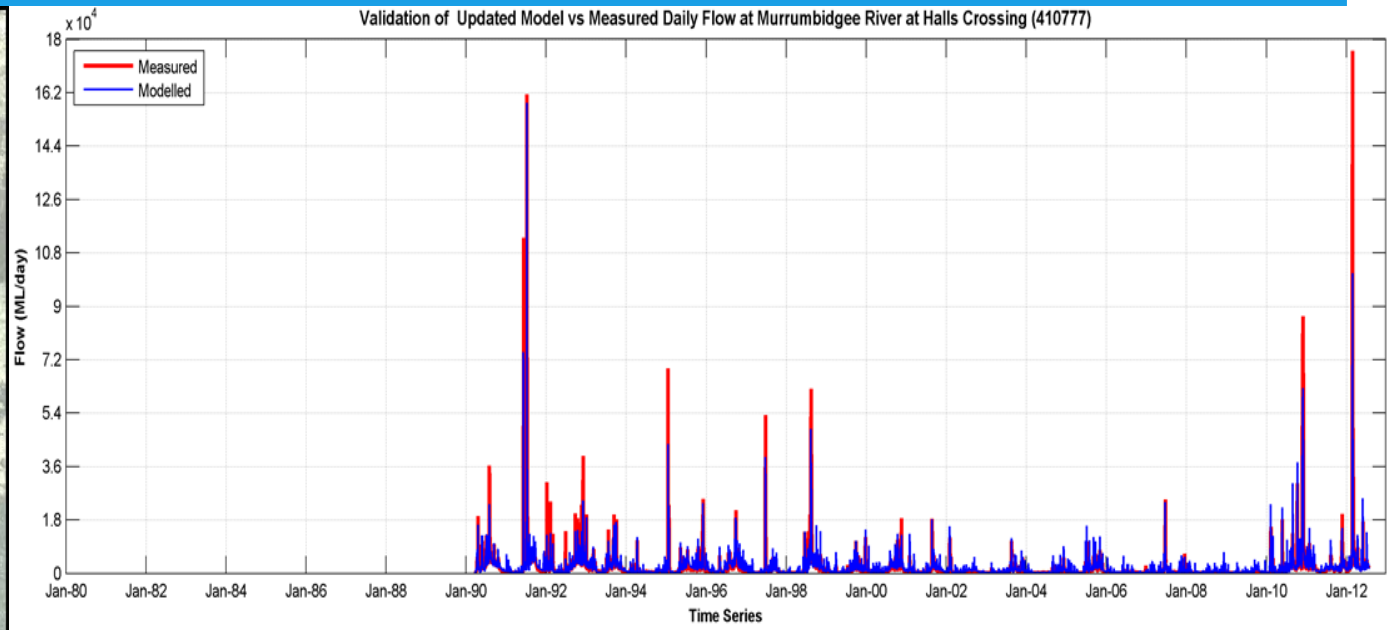


Validation Quality Gauges

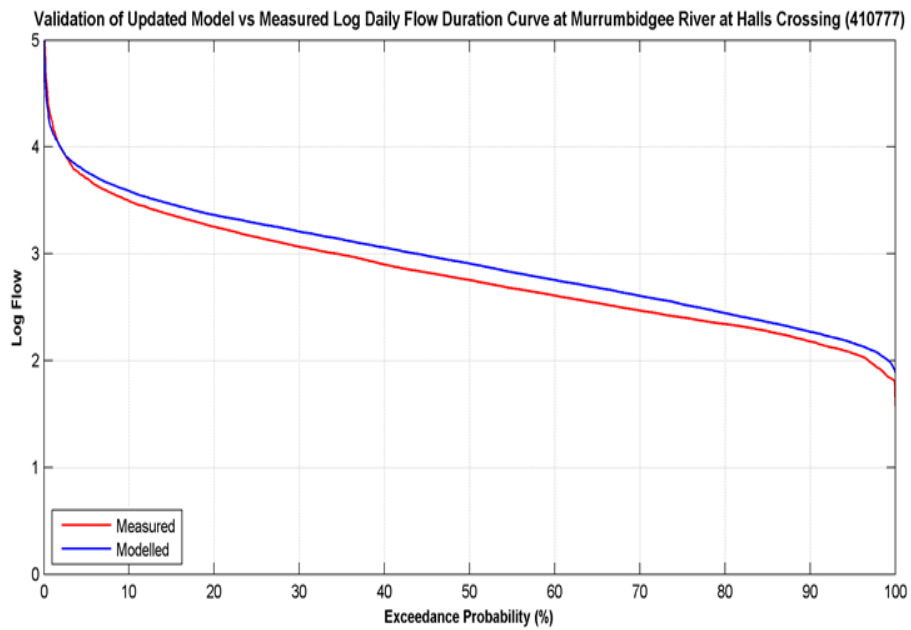


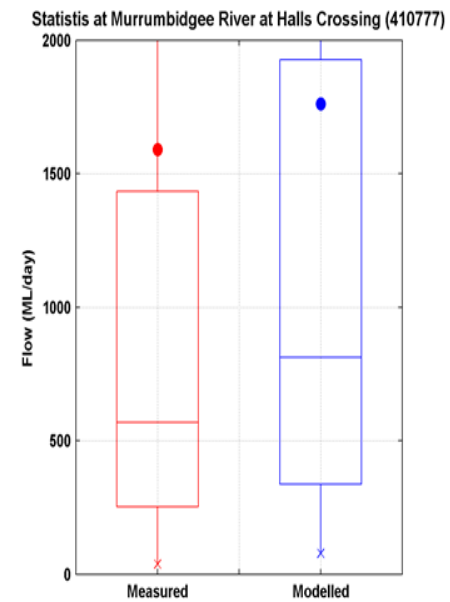
Flow Validation: Murrumbidgee River at Halls Crossing



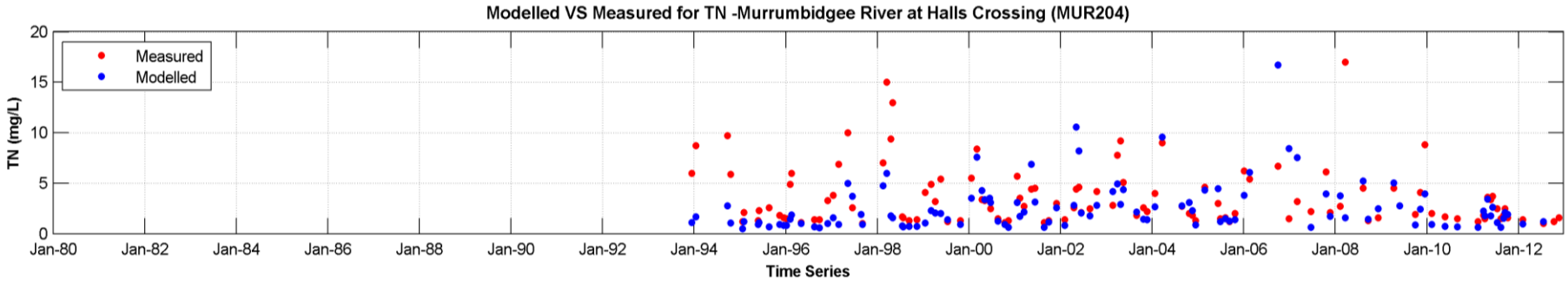


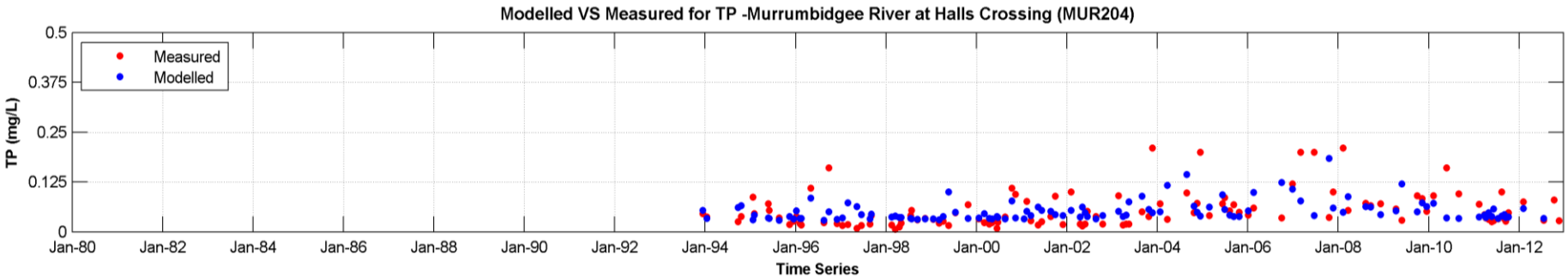
NSE Daily	CC Daily	Difference in Total Run-off
0.67	0.82	11 %

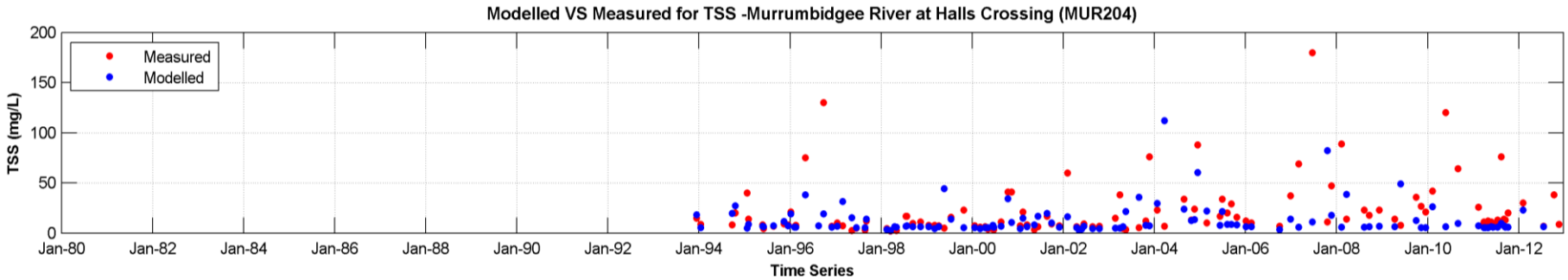


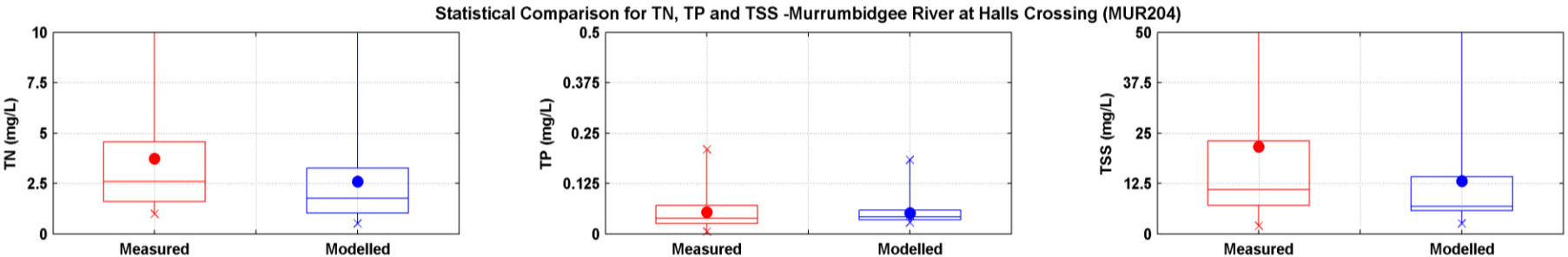


Quality Validation: Murrumbidgee River at Halls Crossing

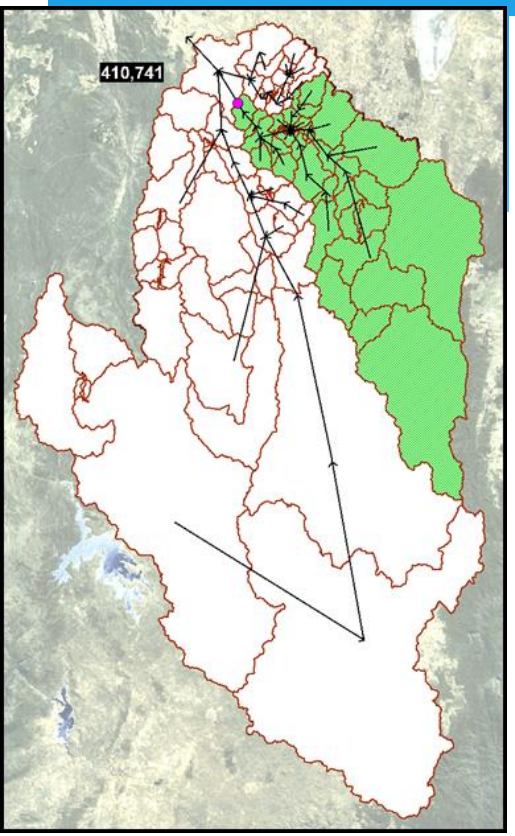


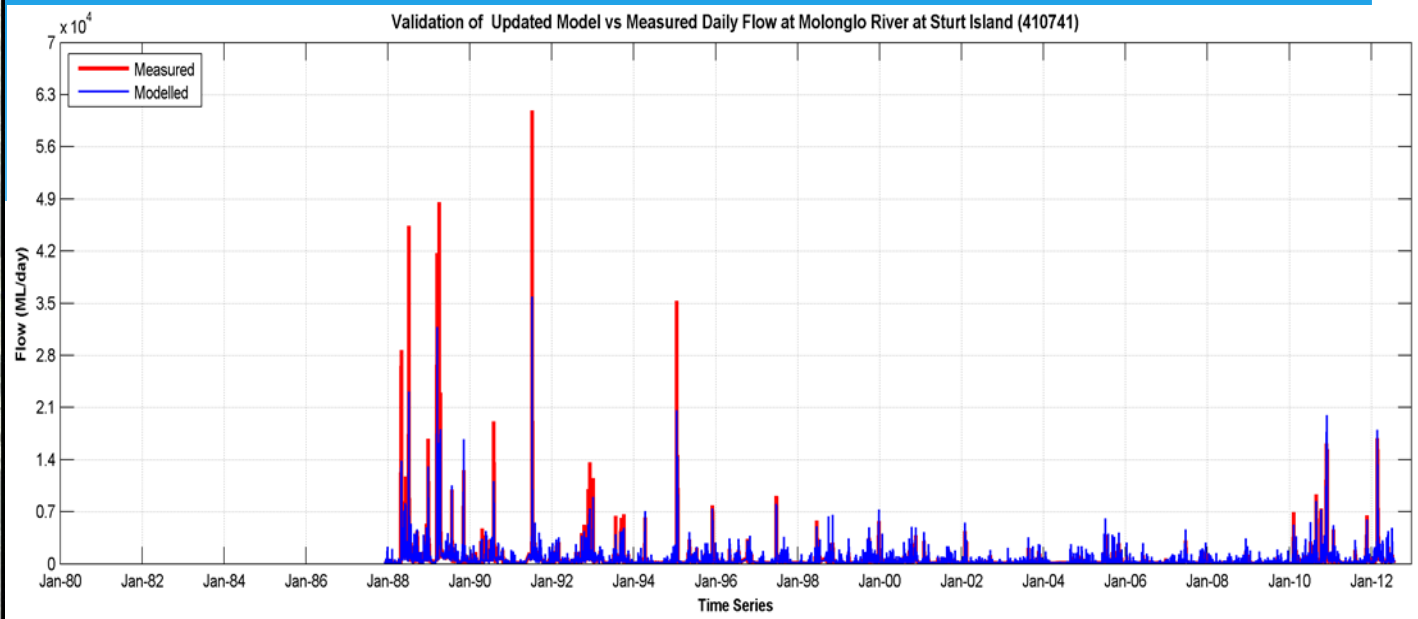




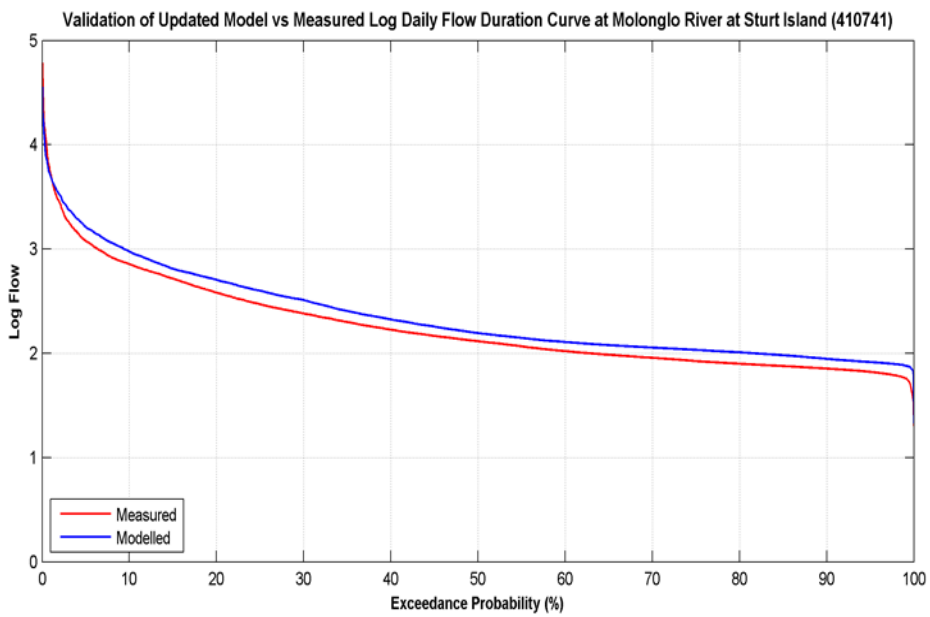


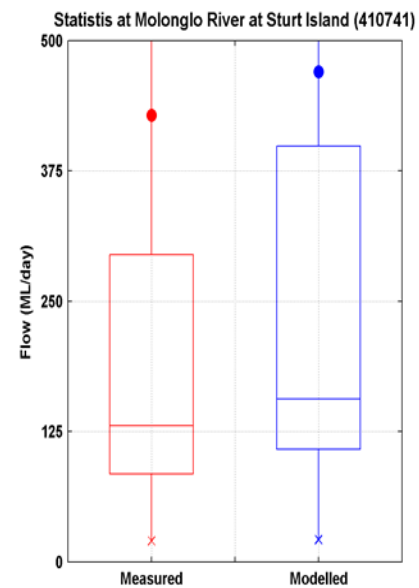
Flow Validation: Molonglo River at Sturts Island



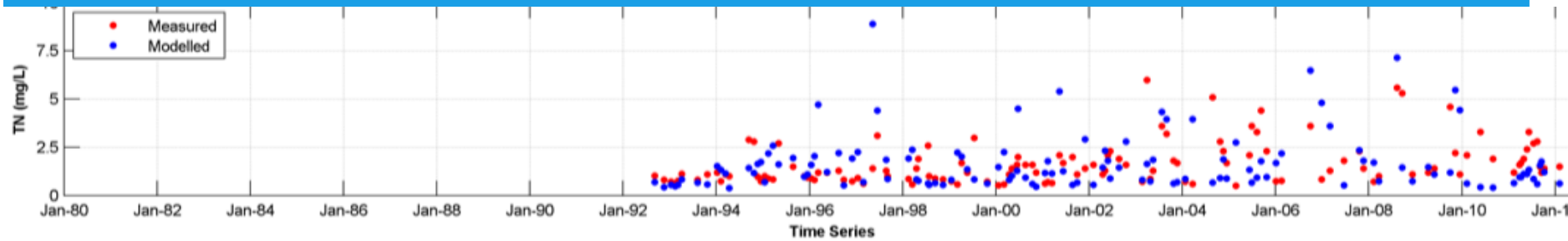


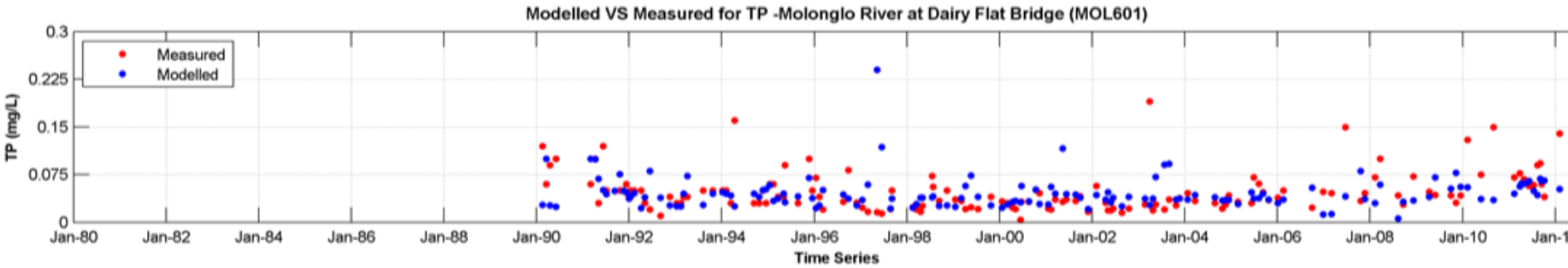
NSE Daily	CC Daily	Difference in Total Run-off
0.70	0.86	9.7 %

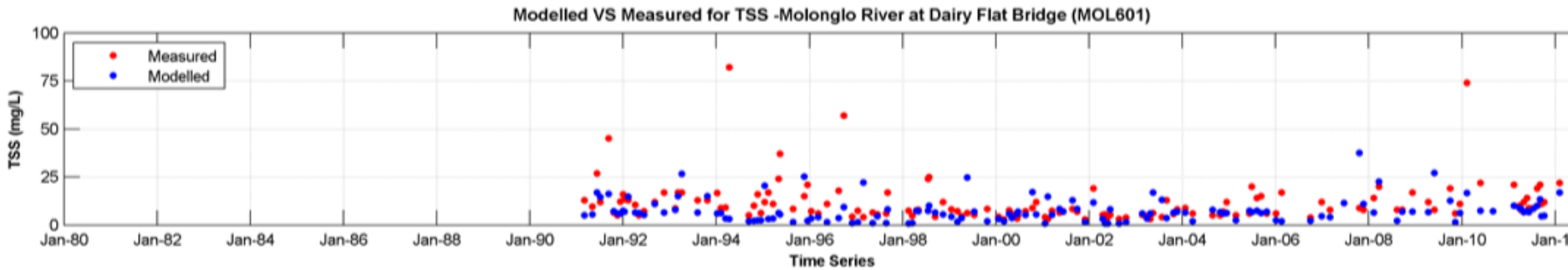


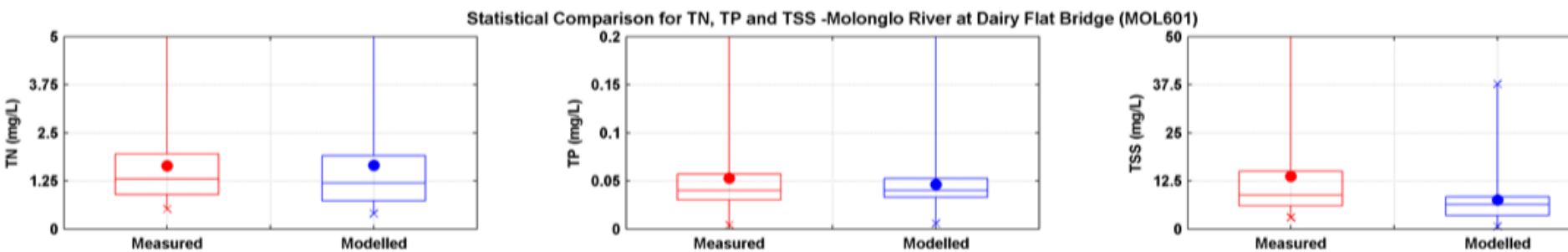


Quality Validation: Molonglo River at Dairy Flat Bridge

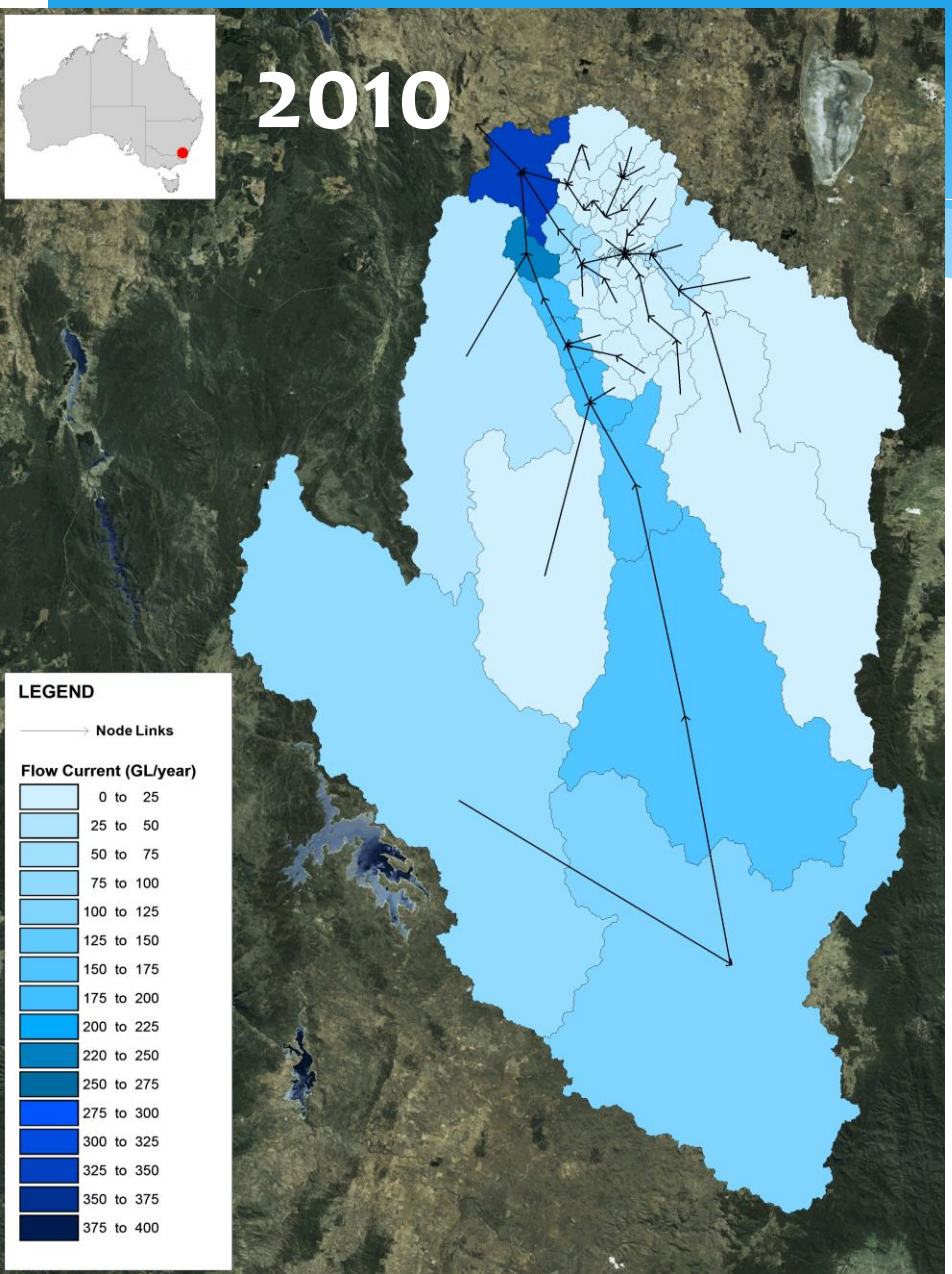


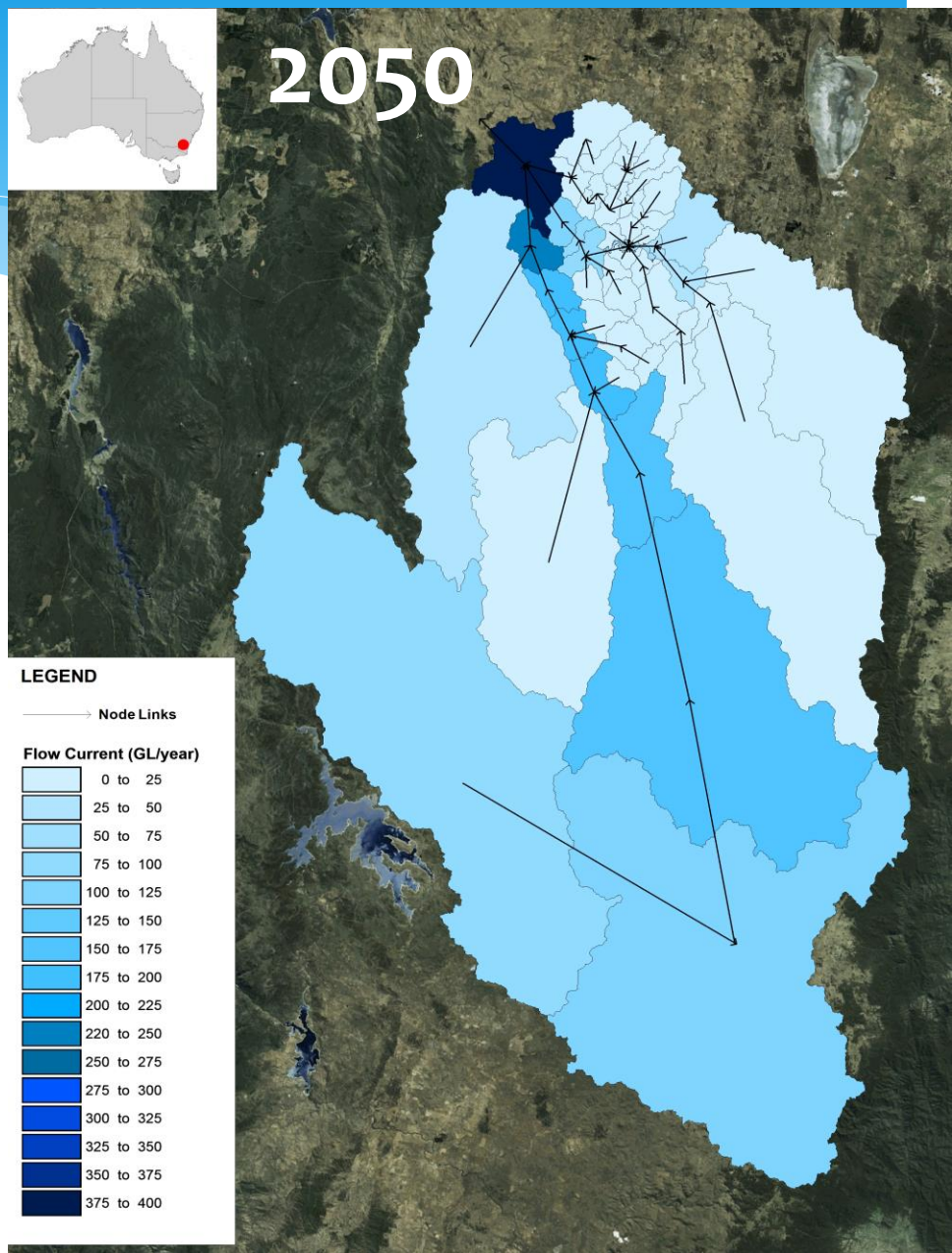




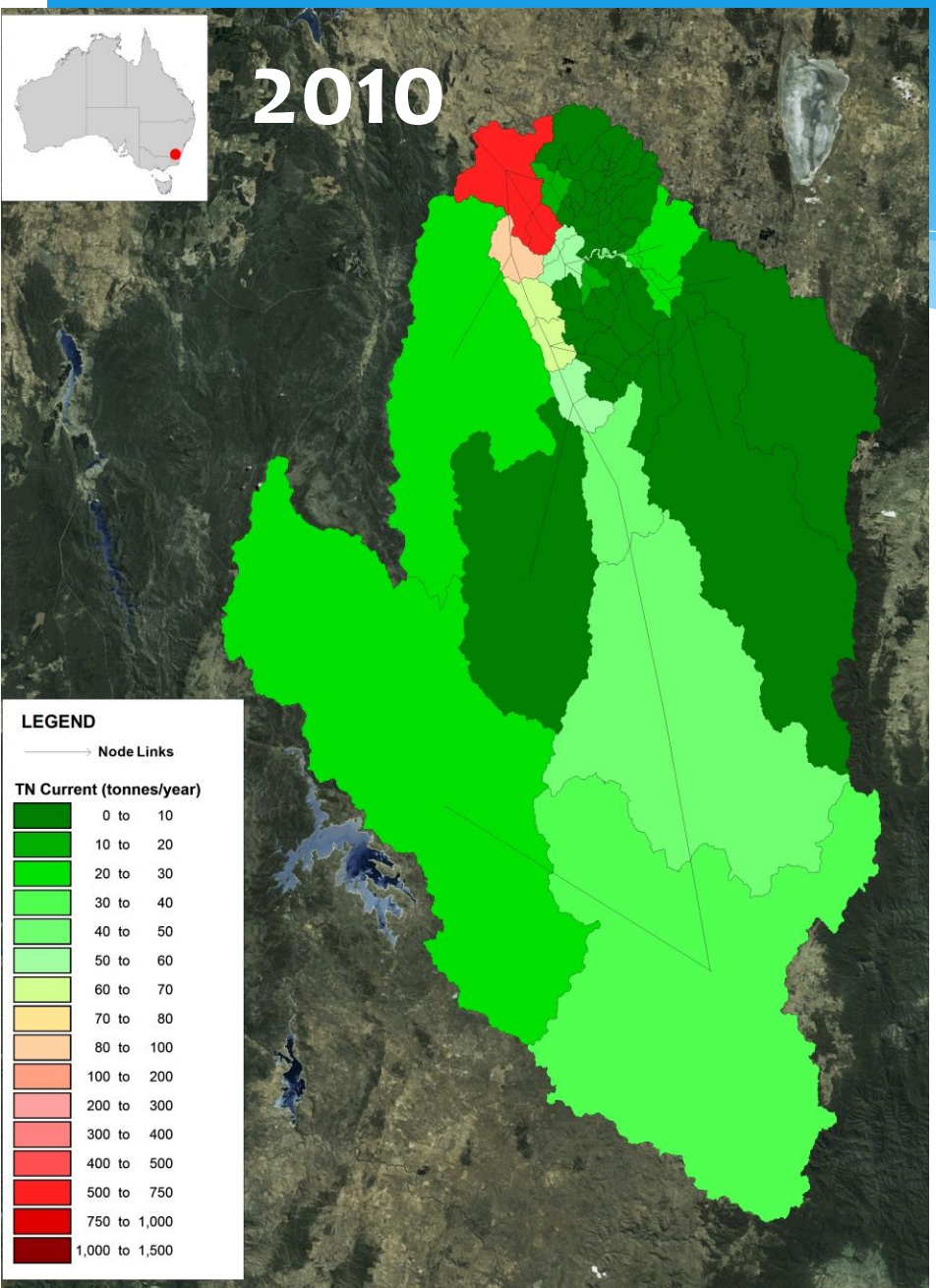


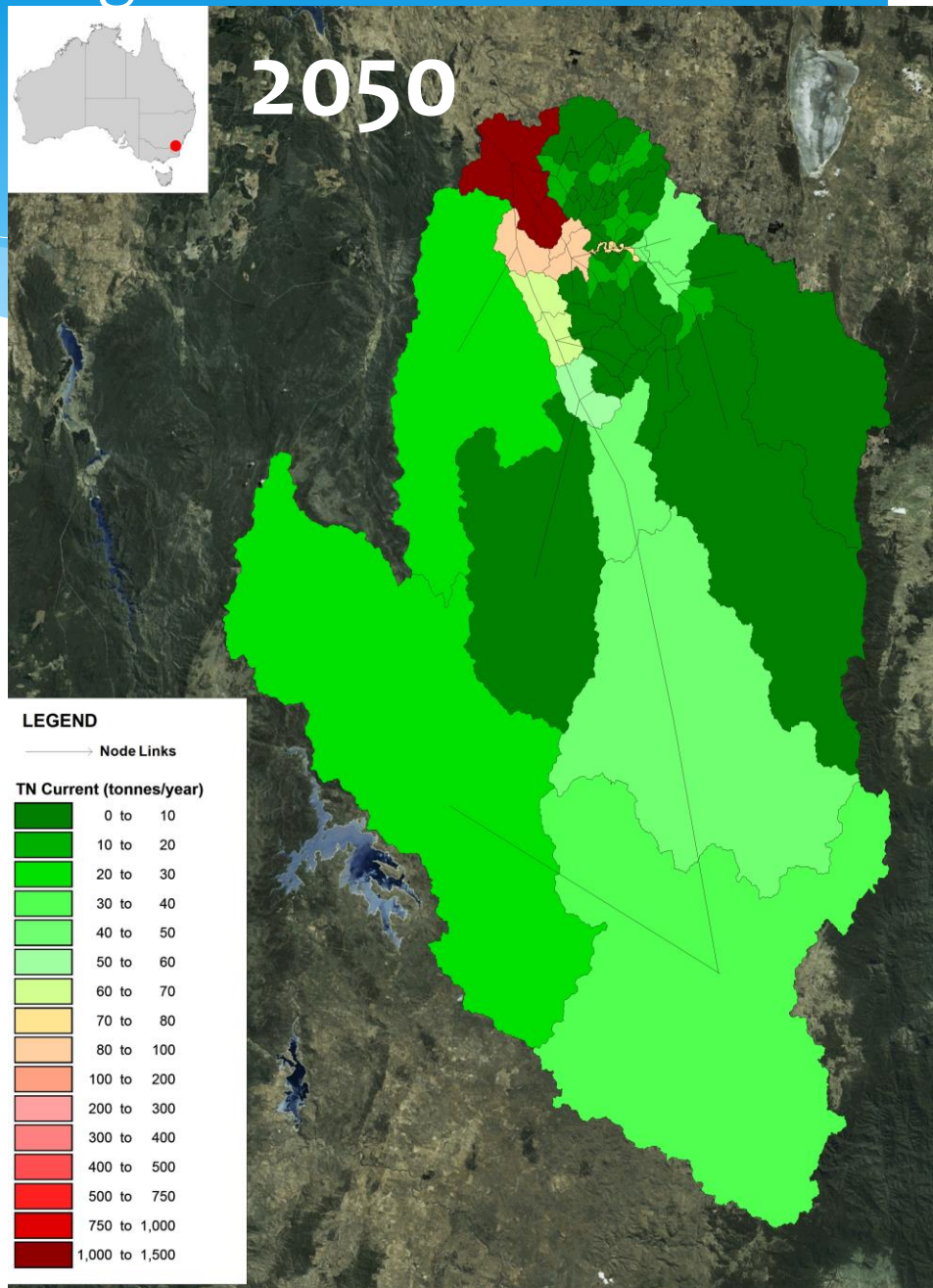
Cumulative Flow Volumes



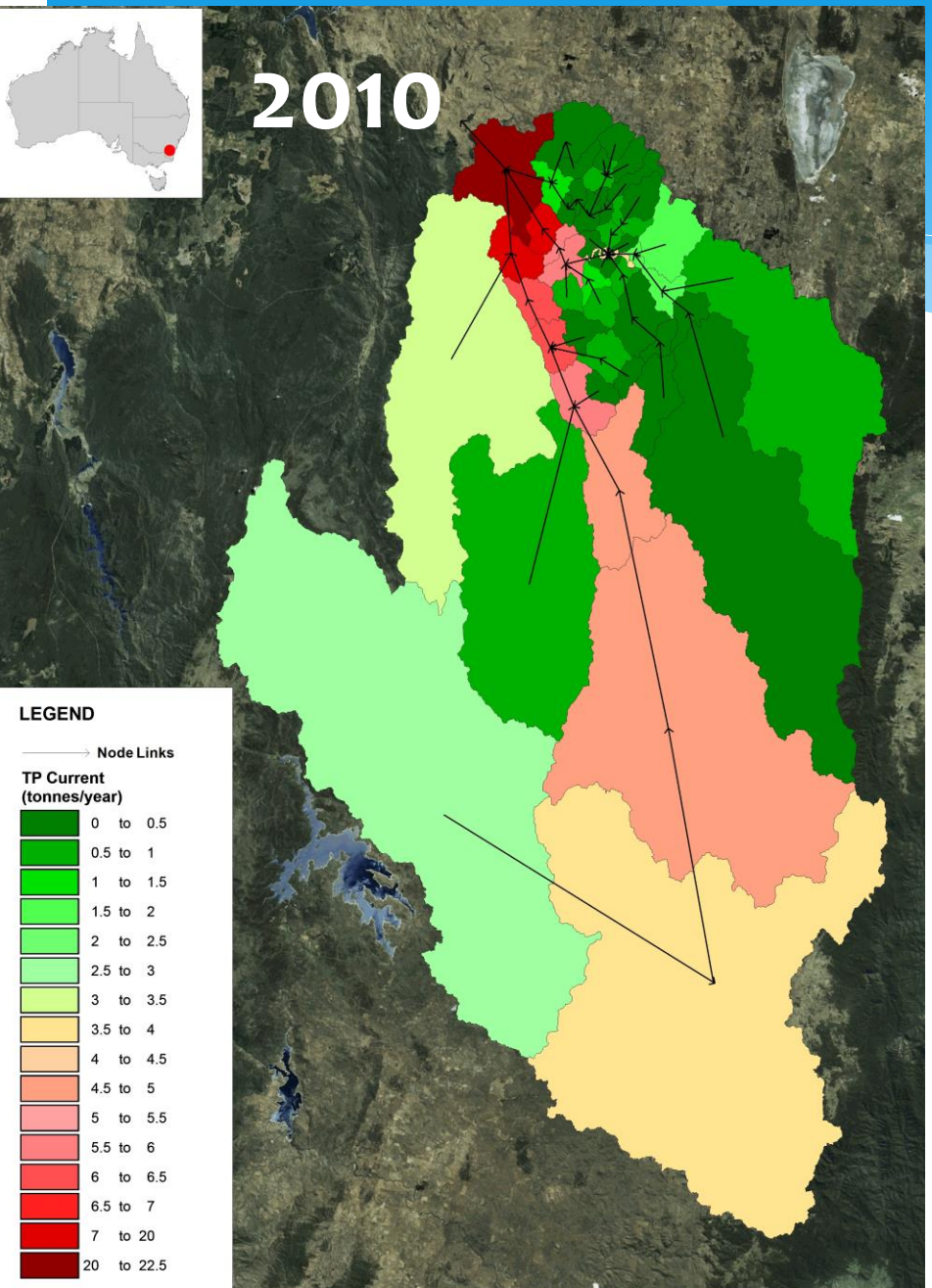


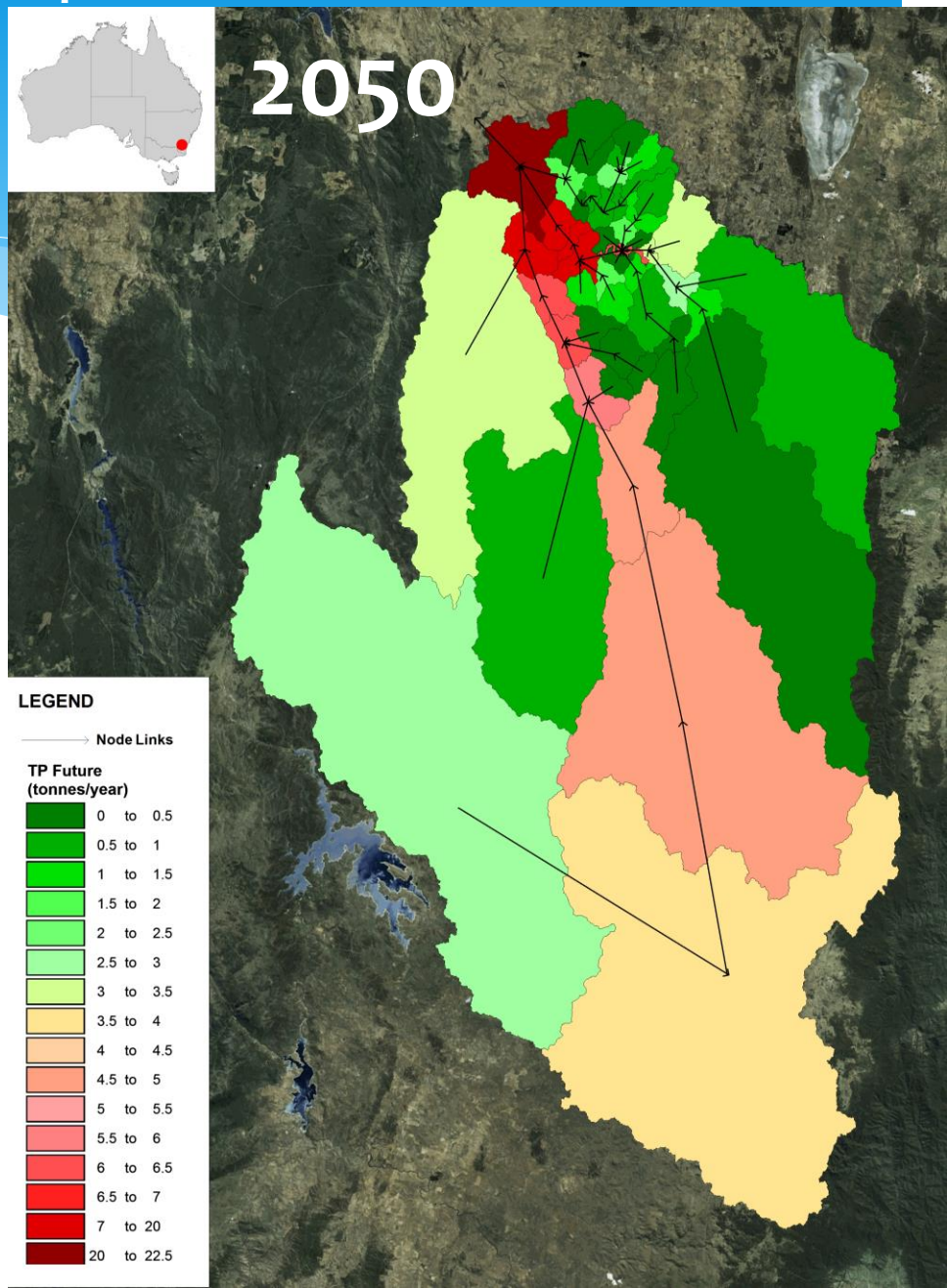
Cumulative Nitrogen Loads



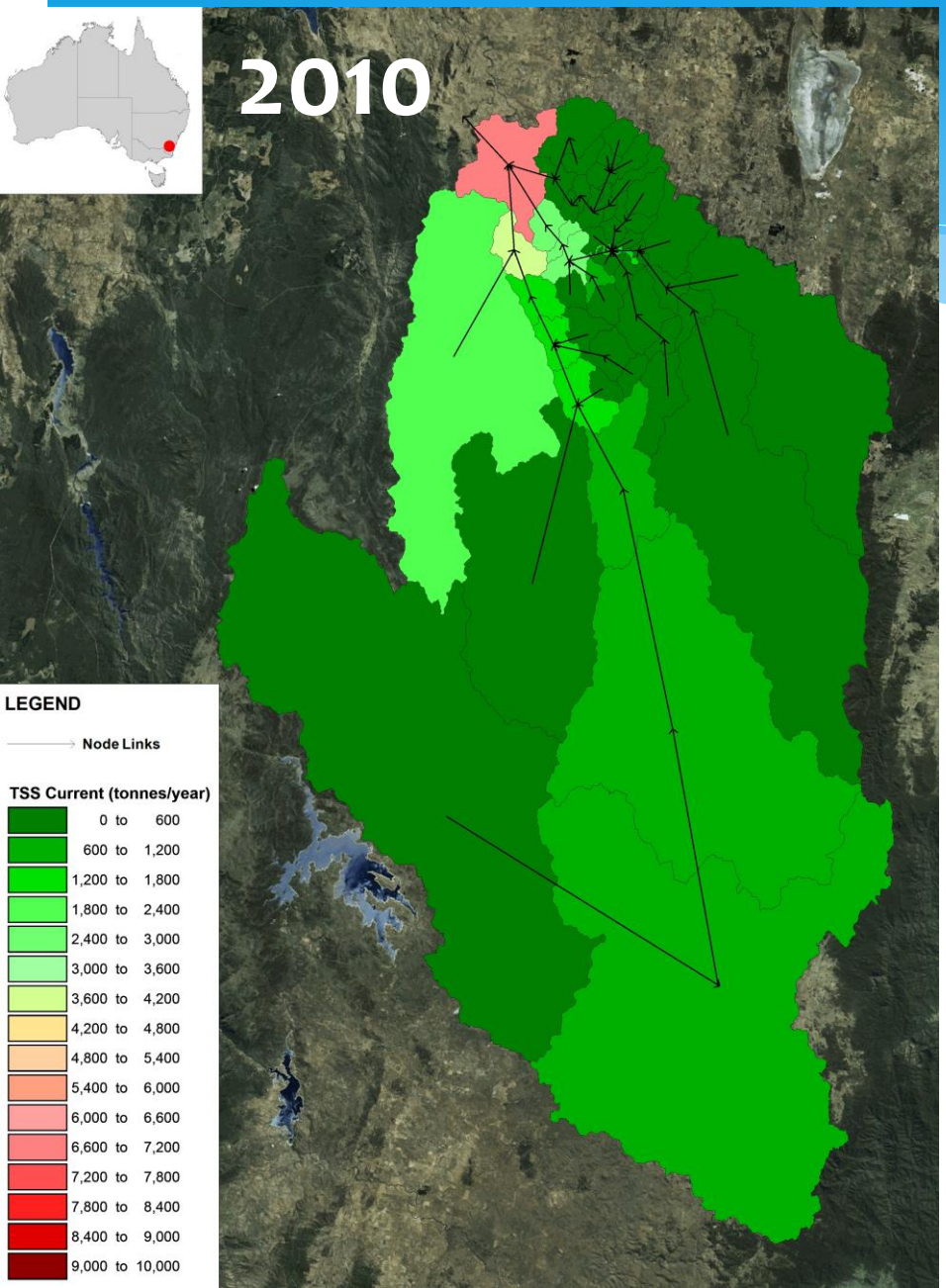


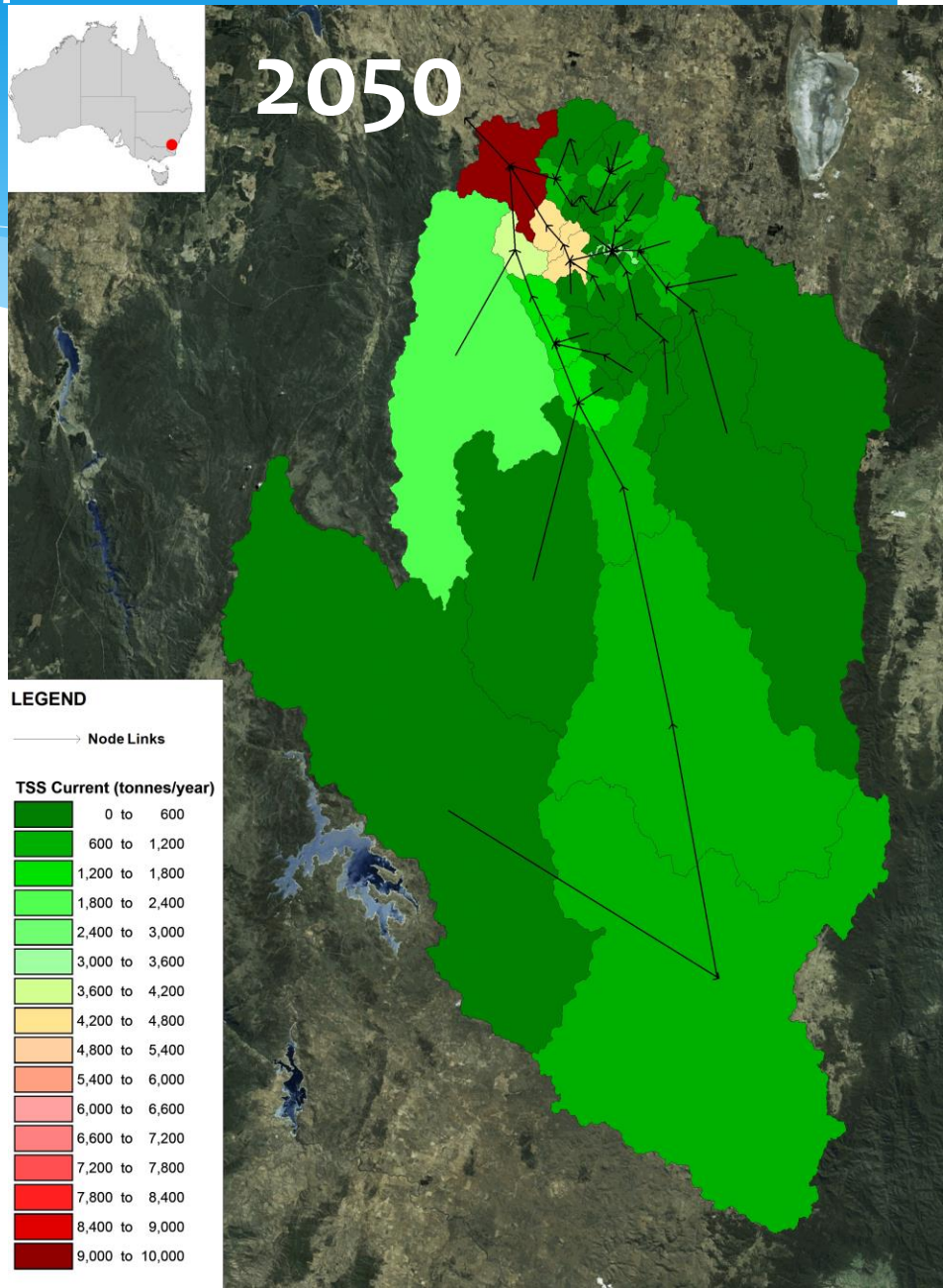
Cumulative Phosphorus Loads





Cumulative Total Suspended Solids Loads





Results

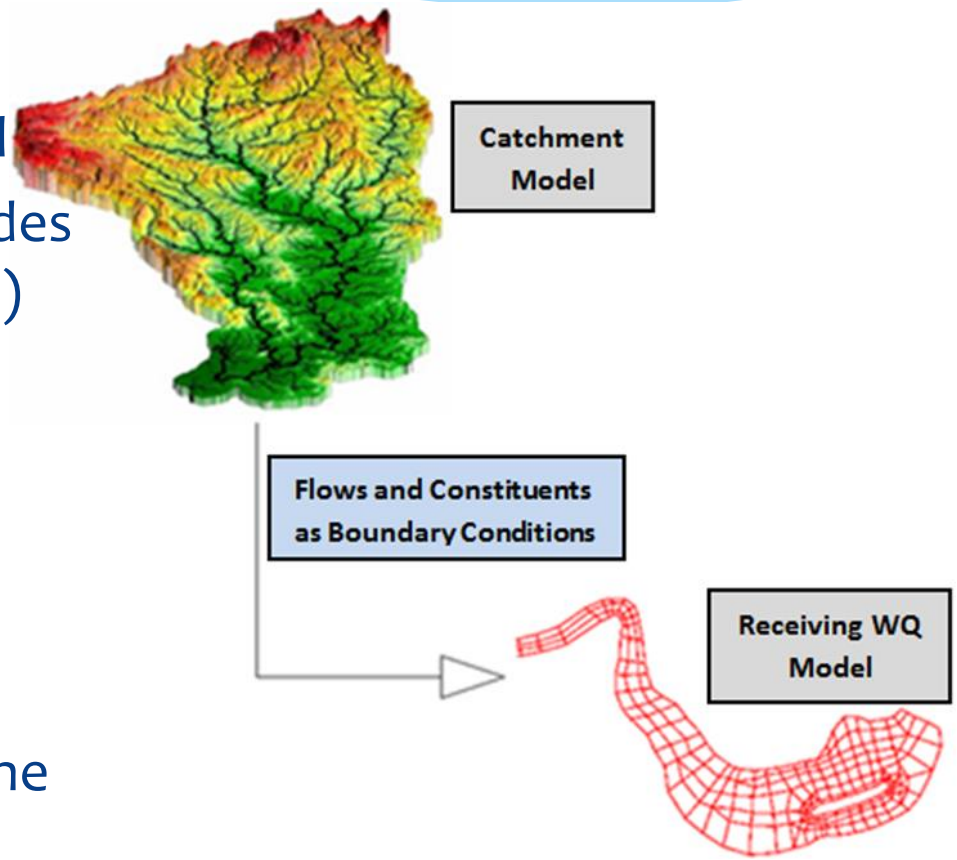
Cumulative Total Flow and Loads of Pollutants

Quantity	Scenario		Change (%)
	Current (2010)	Future (2050)	
Total Flow (GL)	345	383	+ 11
Total Nitrogen (Tonnes)	721	1,125	+ 56
Total Phosphorus (Tonnes)	21	29	+ 8
Total Suspended Solids (Tonnes)	6,771	9,167	+ 35

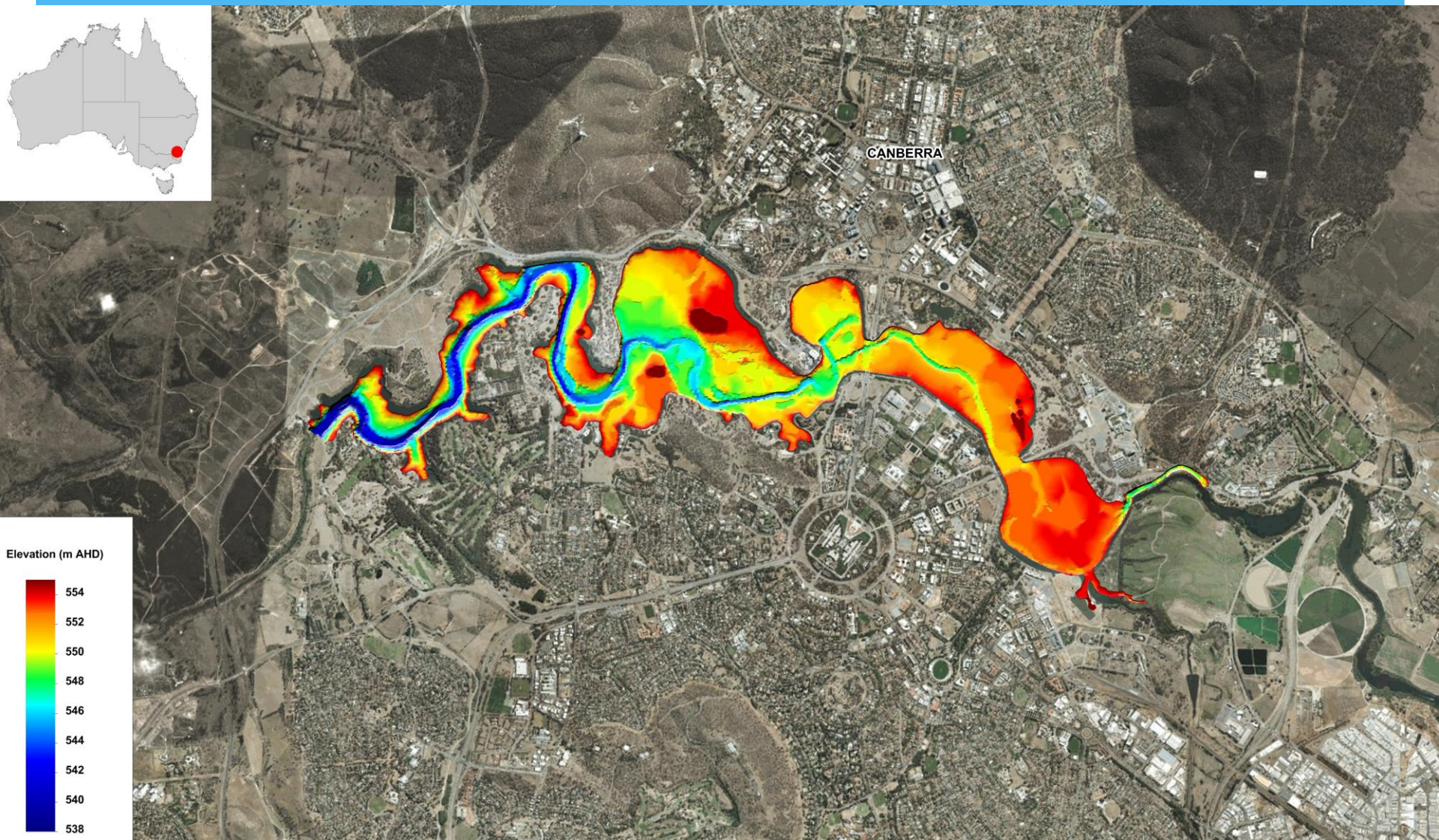
* Significant loads stored in Lake Burley Griffin

Simulation of Lake Burley Griffin

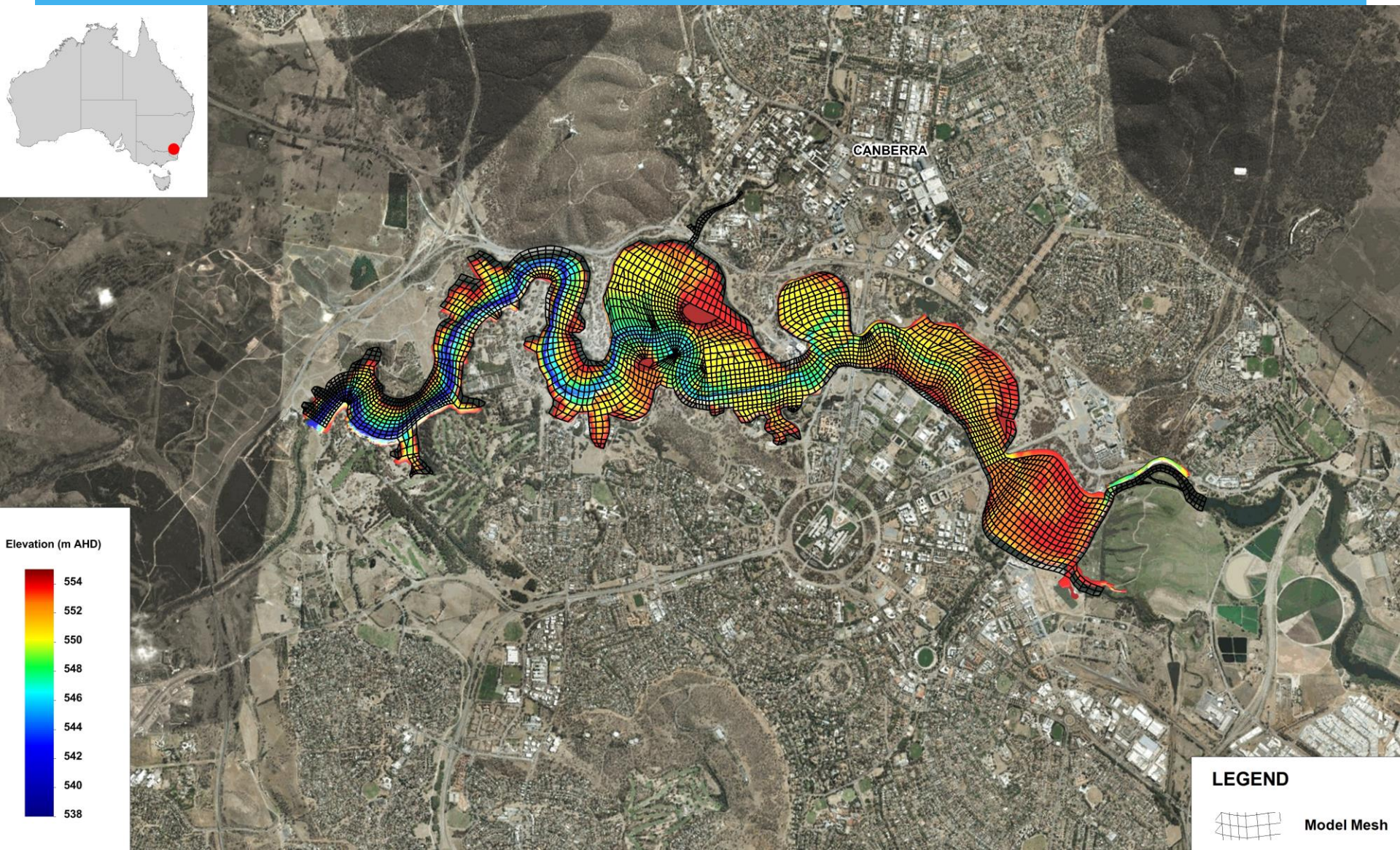
- Use TUFLOW FV (hydrodynamics) and Aquatic Eco-dynamics model (AED) (Hipsey UWA)
- TUFLOW FV is a finite volume model
  - Fully three dimensional and includes water temperature (stratification)
  - Flexible mesh (can match lake contours): 10 m – 50 m grids
  - Fully parallelised for speed
  - Adopted integrated systems approach – consider the whole
  - Same model as we are using on the Hawkesbury for SWC



Lake bathymetry

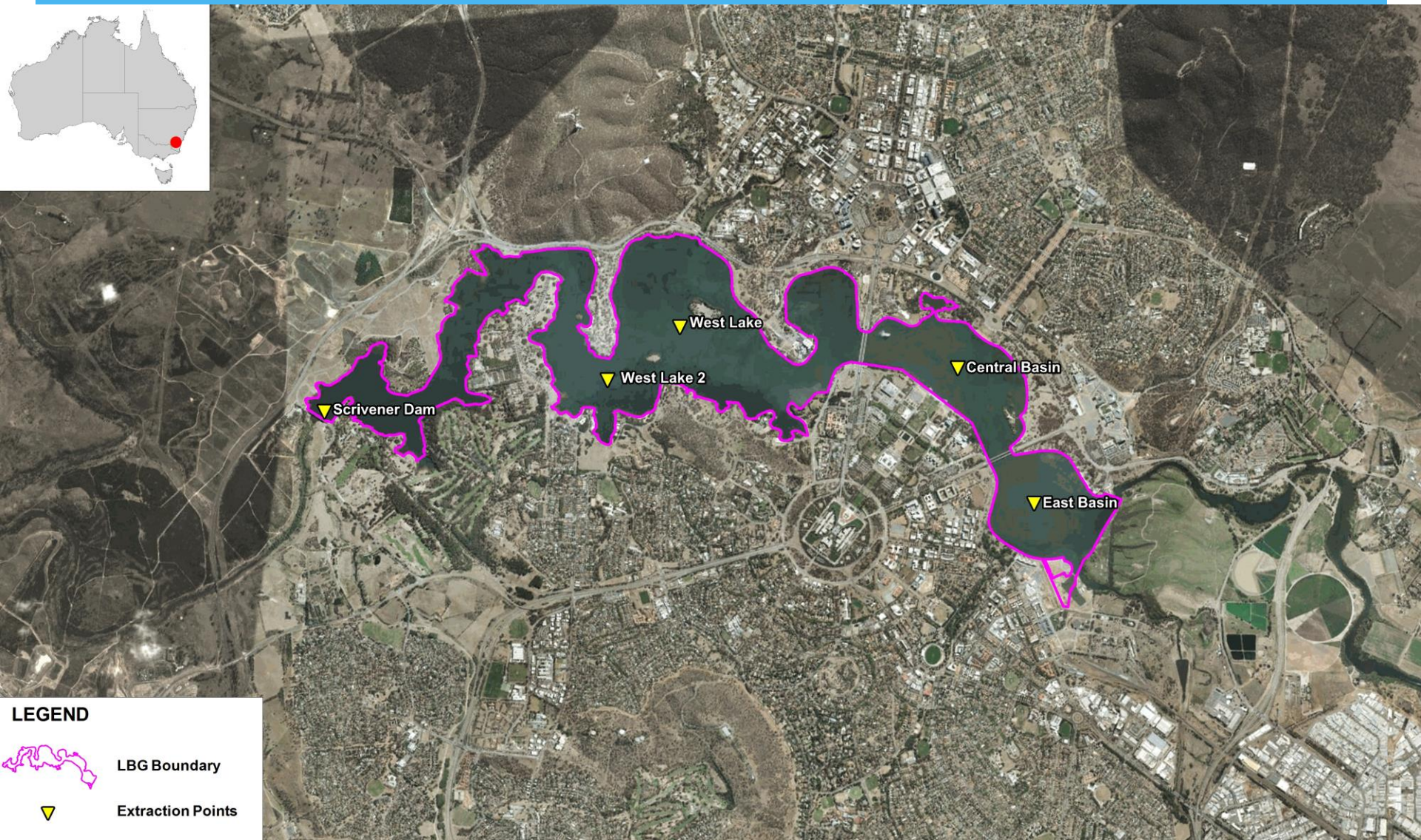


Model Mesh of Lake Burley Griffin

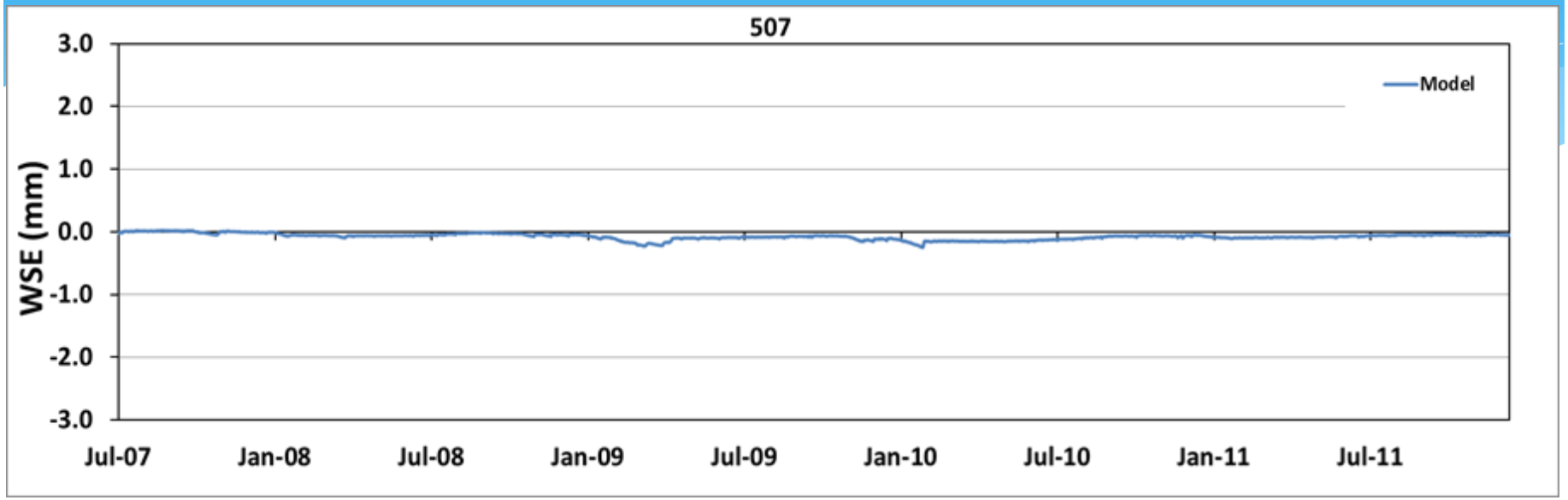


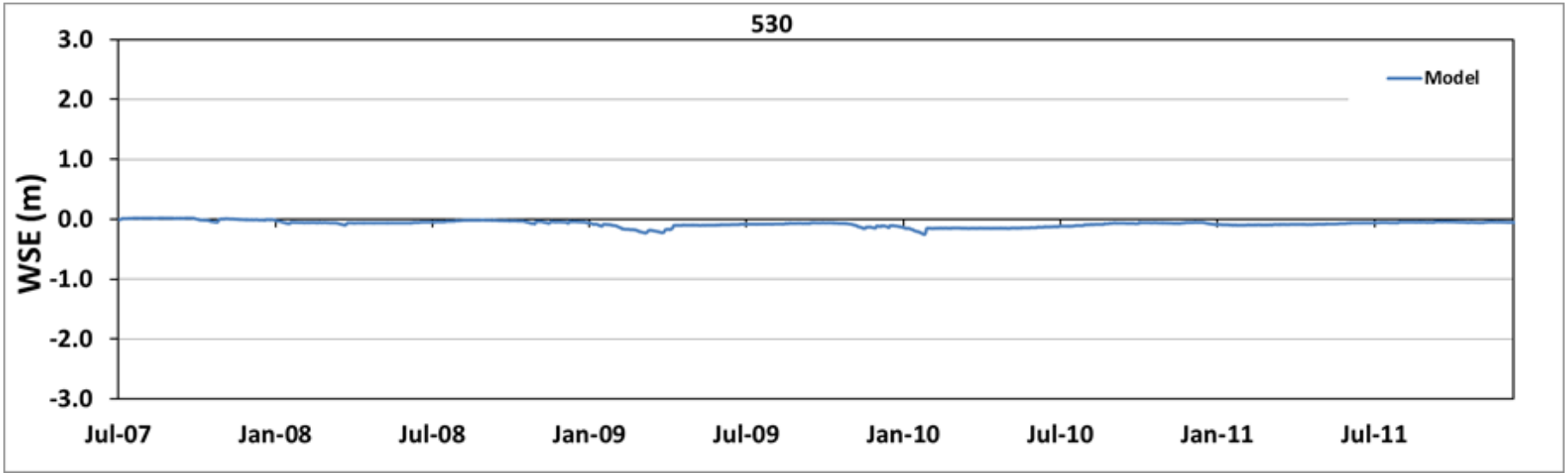
Lake Inflows

Lake Monitoring

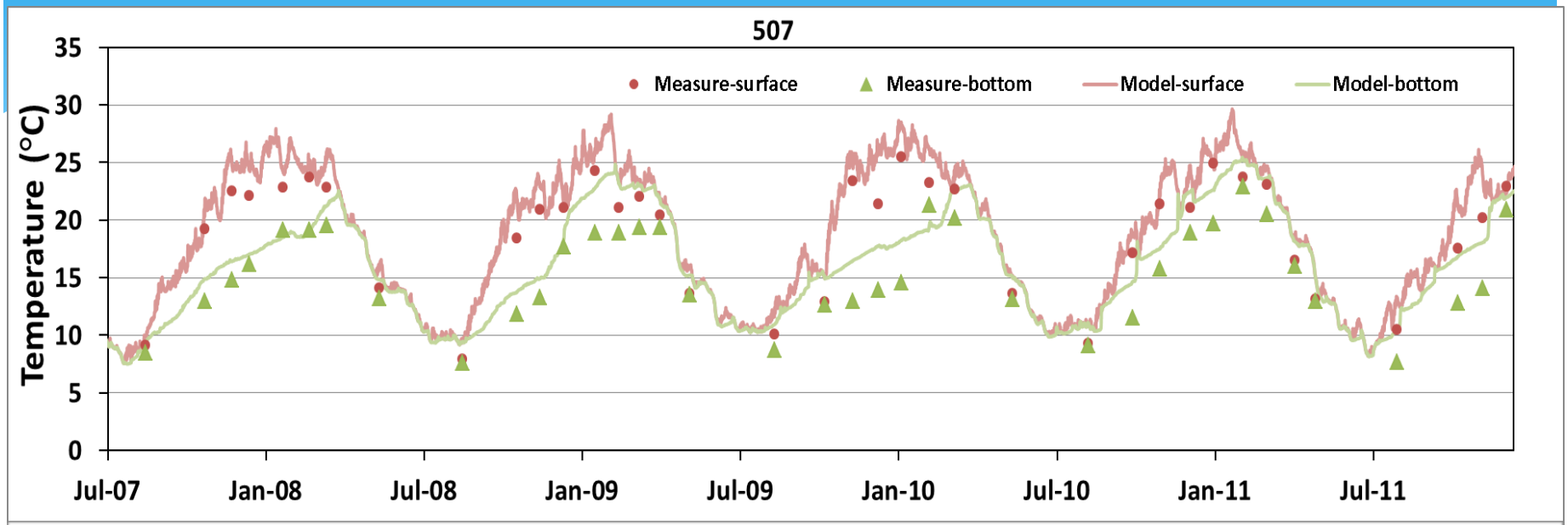


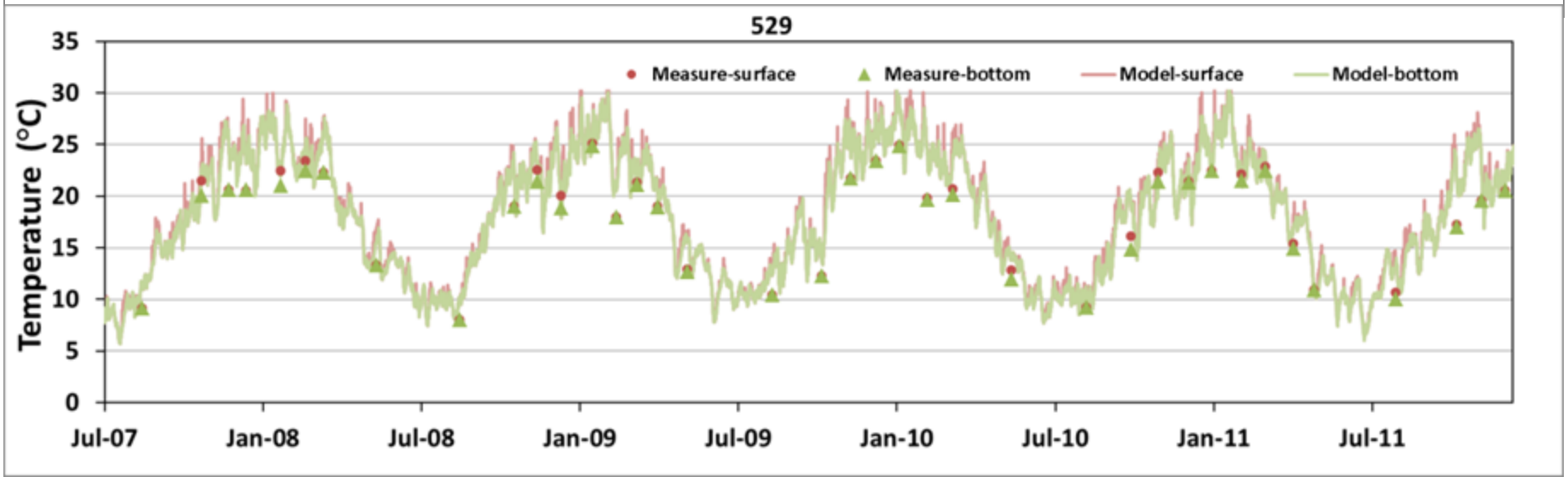
Validation: Lake water surface elevation



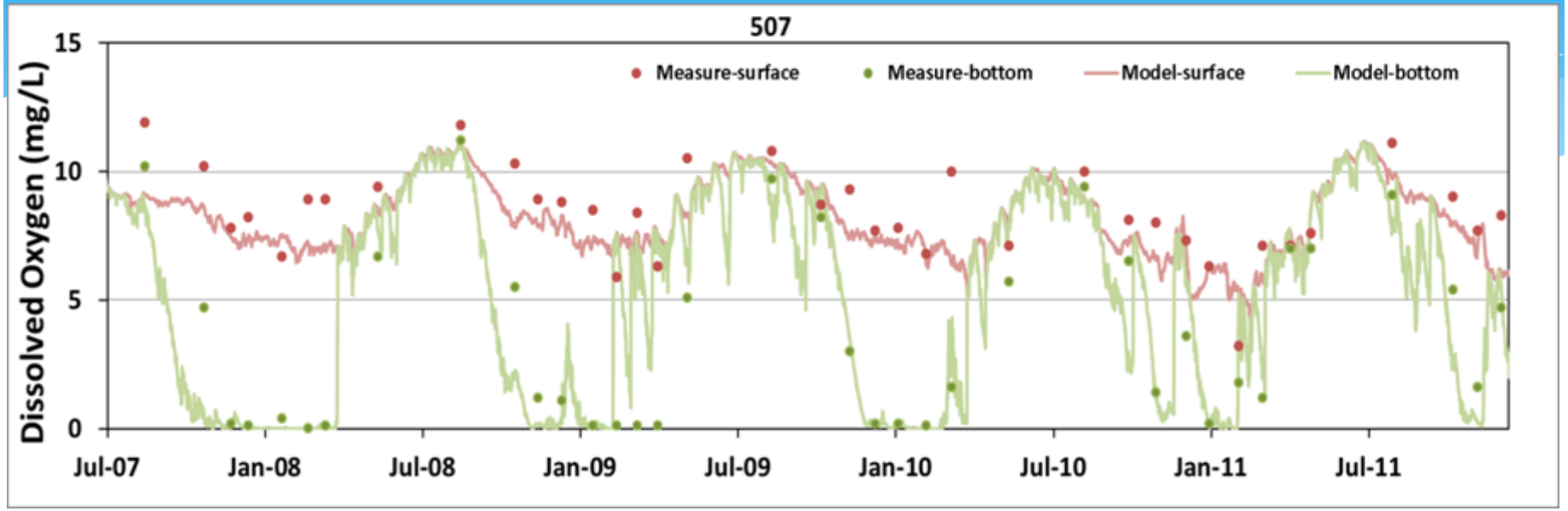


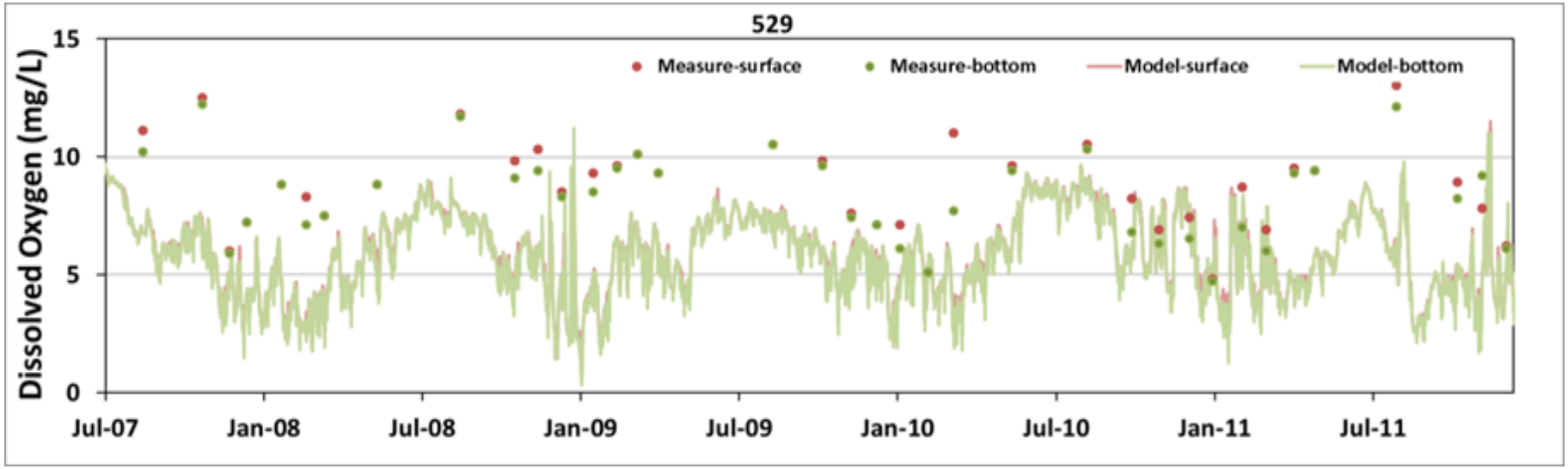
Validation: Water Temperature





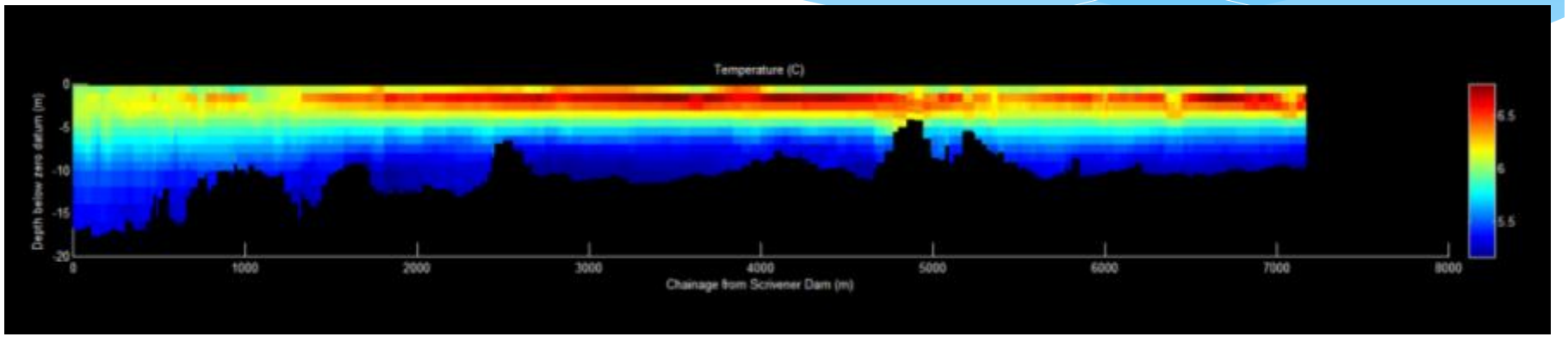
Validation: Dissolved Oxygen



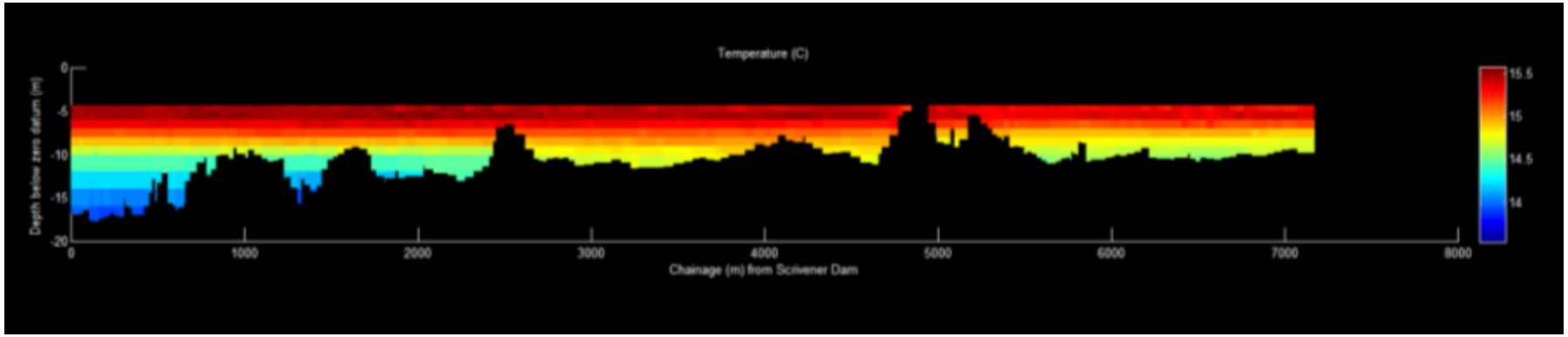


Thermal Stratification

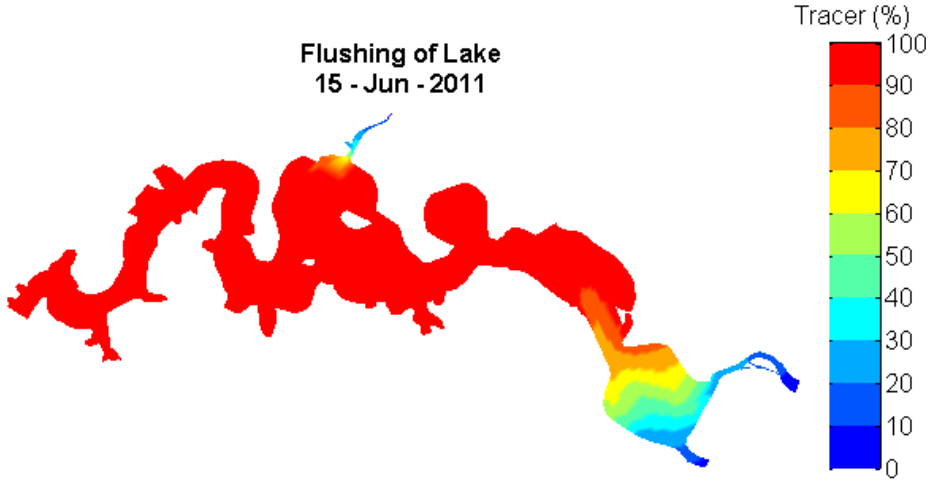
- **Spring**

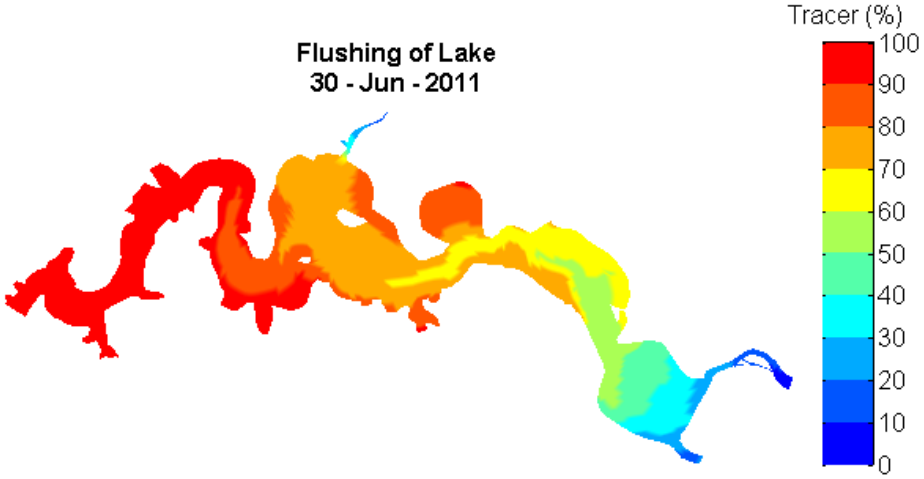


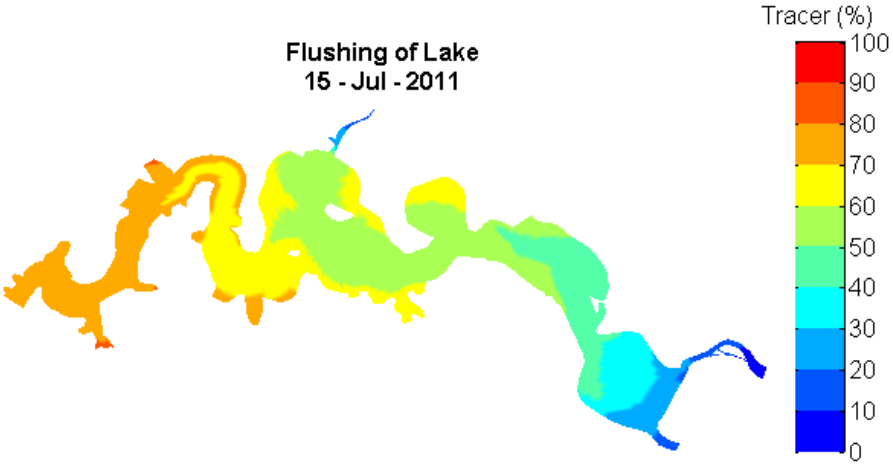
- **Summer**

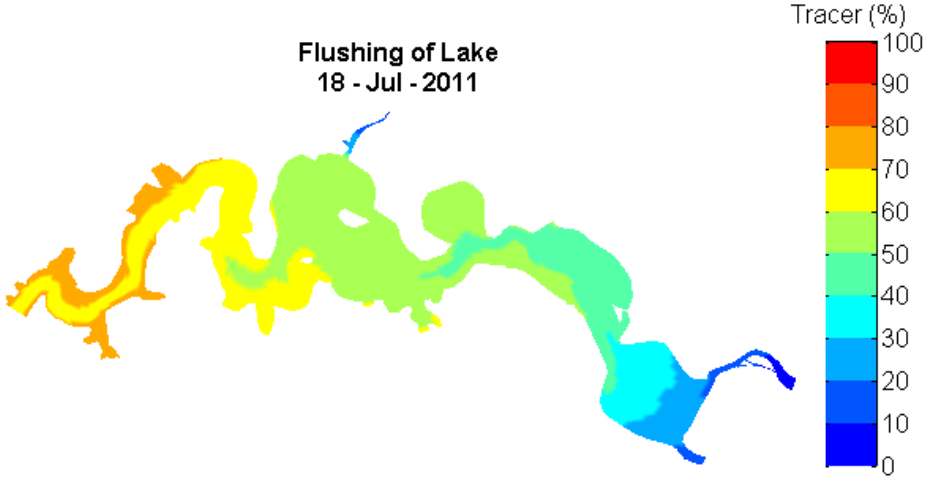


Lake flushing characteristics



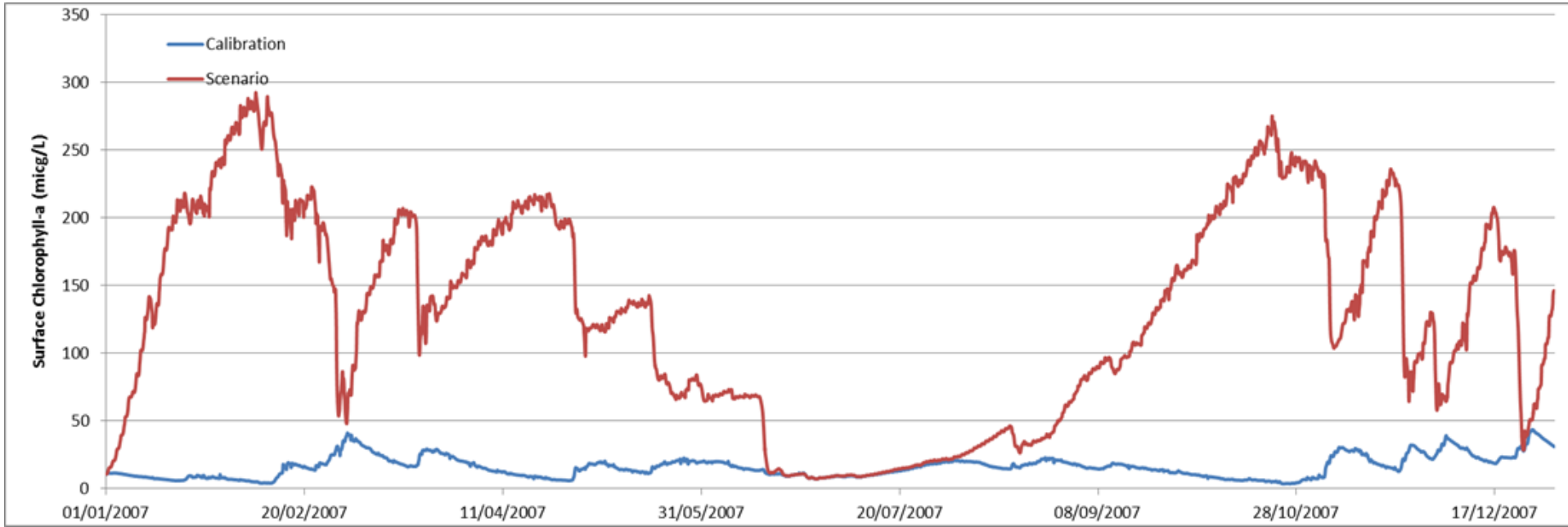






Example scenario: risk of algae growth

* Demonstrates linkages between catchment choices and nutrient cycling in Lake Burley Griffin
* Increased sediment delivery to lake from unmitigated urban growth
* Risk of algal growth is amplified in response to nutrient inputs



Observations

- Wastewater treatment plants (WWTP) contribute significantly to pollutant loads of nutrients discharging from the ACT.
- Stormwater nutrient and sediment loads from urban areas impact on key water bodies
- Results from the integrated systems analysis reveal the accumulation of pollution loads throughout catchments.
  - This challenge is heightened by the further accumulation of contaminants in Lake Burley Griffin and other storages.
- Zones subject to higher urbanisation generate significantly greater loads of pollutants into stormwater catchments.
  - These pollutant loads will ultimately accumulate in the ponds and lakes throughout the ACT area.

Observations

- An increase in the pollutant loads in response to the projected population growth for 2030 and 2050 was observed.
- Both increases in discharges from WWTPs and increases in urbanisation contribute to the greater pollutant loads that are correlated with population growth.
- Population growth increases total pollutant concentrations entering Lake Burley Griffin and exiting the ACT.
- Sediment loads are derived from both urban and non-urban land use areas
  - Non-urban land uses dominate sediment export from the ACT

Conclusion

Developed a Systems Framework for analysis of trade-offs across multiple disciplines and scales for policy, strategy and solutions in the ACT.

What is the impact of a stormwater solution for a development on the entire ACT and Murray-Darling Basin?

Our international research programme continues to work on this Systems Problem