The impact of spatial and temporal averages on prediction of water security using systems analysis:

towards understanding the true potential of WSUD

Peter Coombes and Michael Barry

Introduction

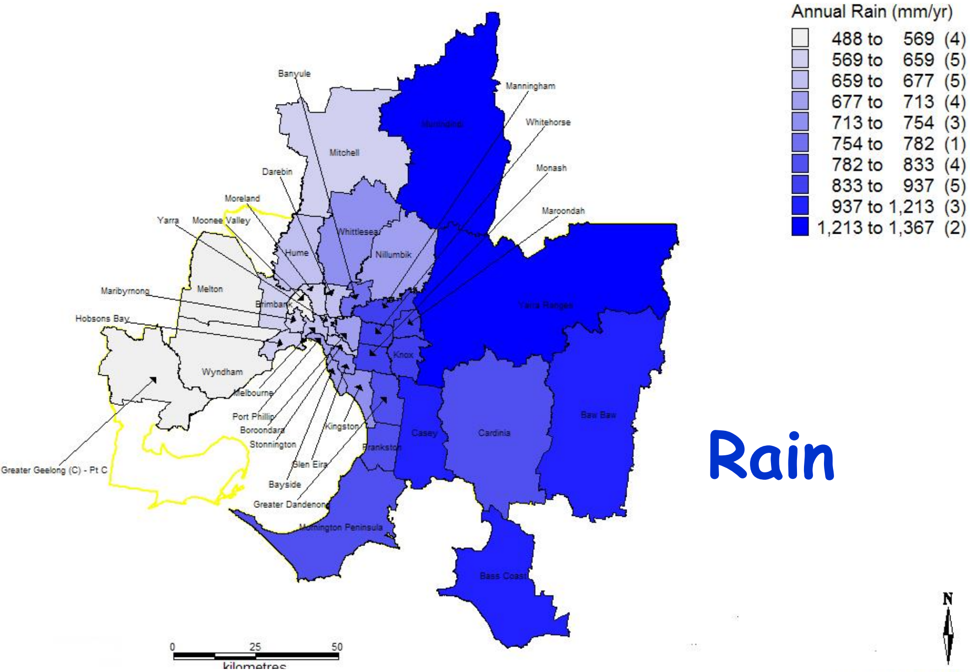
- Urban water security is challenged by a variable climate, climate change and population growth
- The current approach to water planning is:
  - A top down approach using global averages
  - Separate simulation of “supply” and “demand”
  - “yield analysis” based on centralised supply theory
- However a diverse range of strategies are required:
  - Multiple sources of water from within a city and from external sources
  - A range of innovative demand management strategies
- And a Metropolis includes strong spatial and temporal variation – cannot be described by averages

Introduction

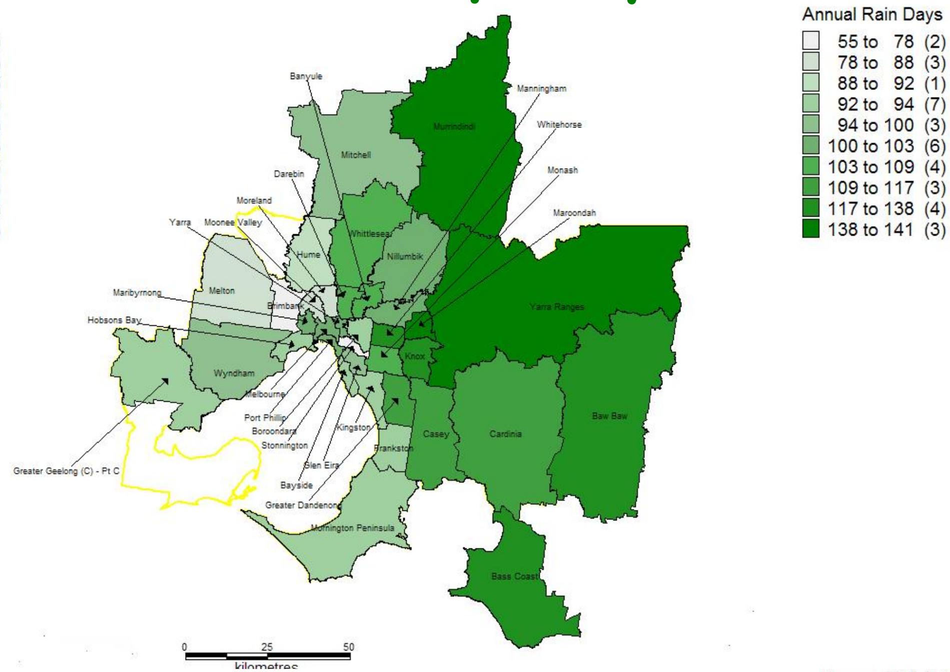
- Catchments within cities are more resilient than traditional water supply catchments
- WSUD approaches are spatially and temporally distributed throughout City
  - Strong links with urban development (infill and green field) and town planning processes
- This study developed spatially and temporally explicit systems models of Melbourne and Sydney:
  - Includes distributed (local) behaviours
    - Demographics, climate dependent water demands
    - Long sequences of daily input data from water supply catchments and climate
  - A bottom up process
- Does averaging the inputs change perceptions of water security?
- What impact does this have on understanding alternative local water supplies such as WSUD?

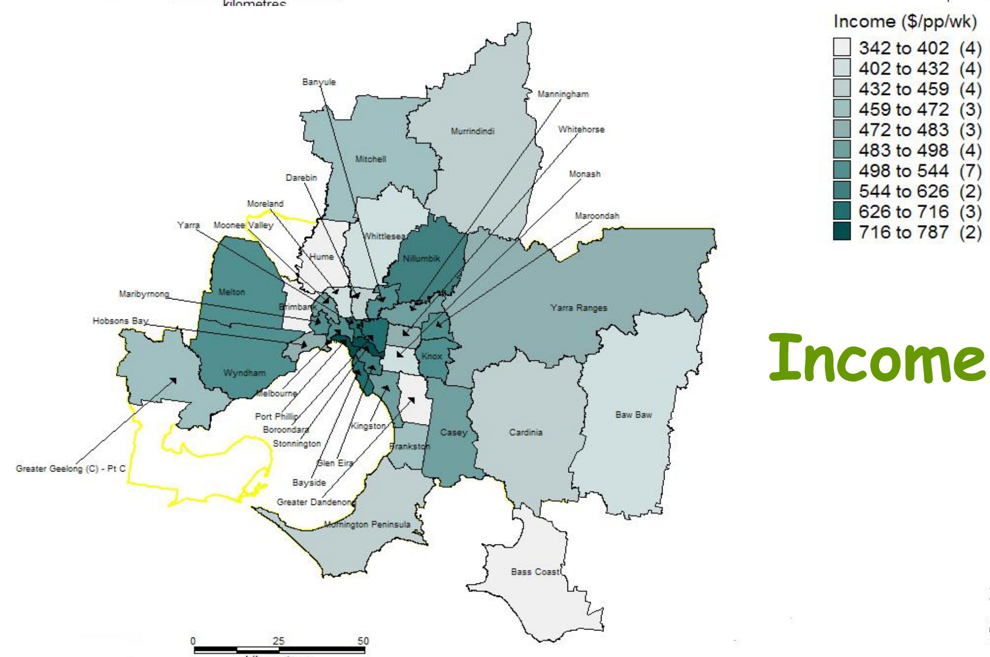
Melbourne variation

Frequency of rain

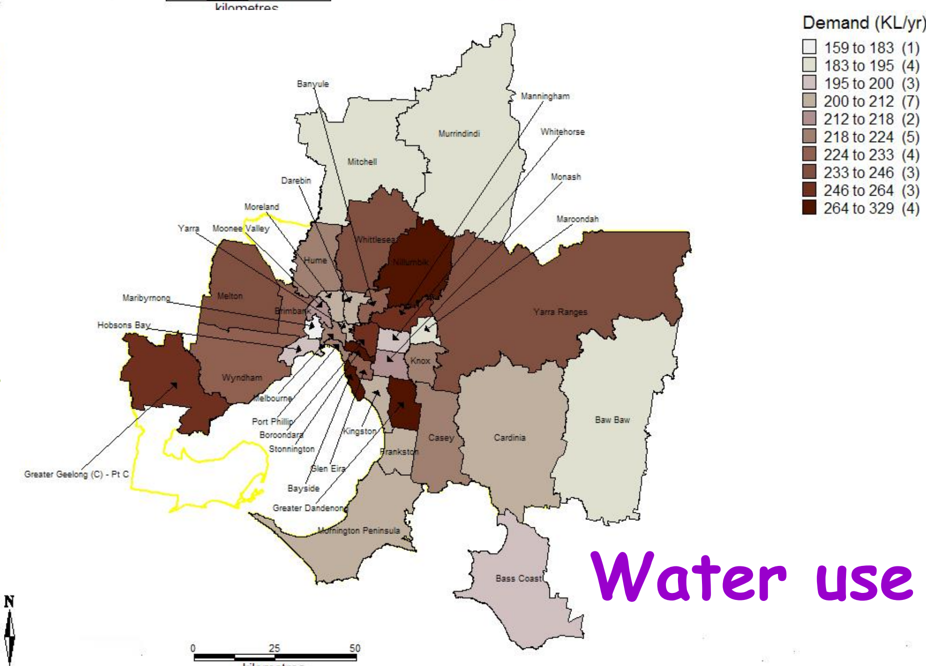


Rain





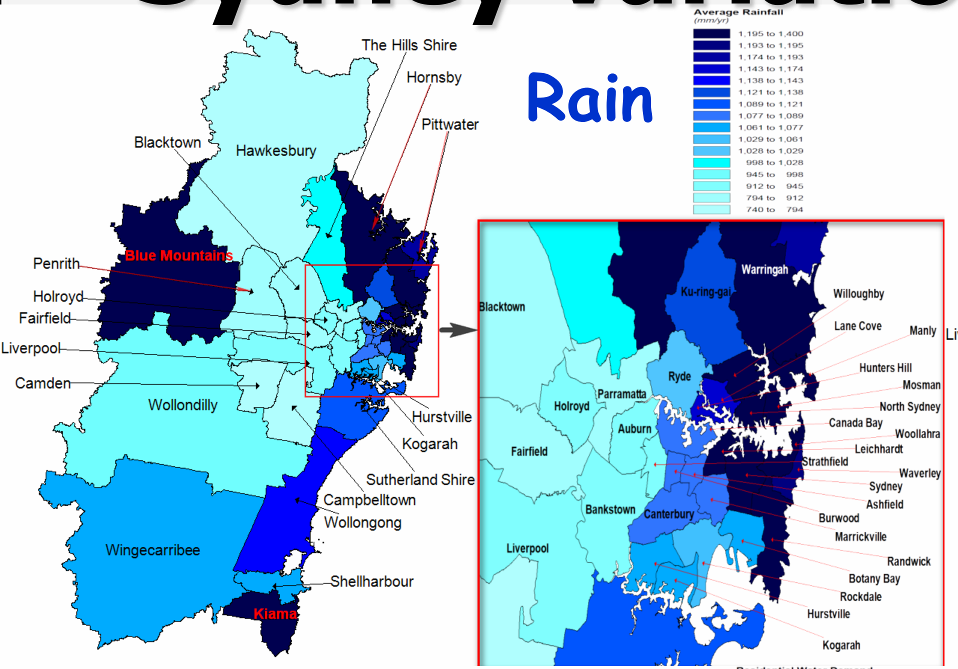
Income



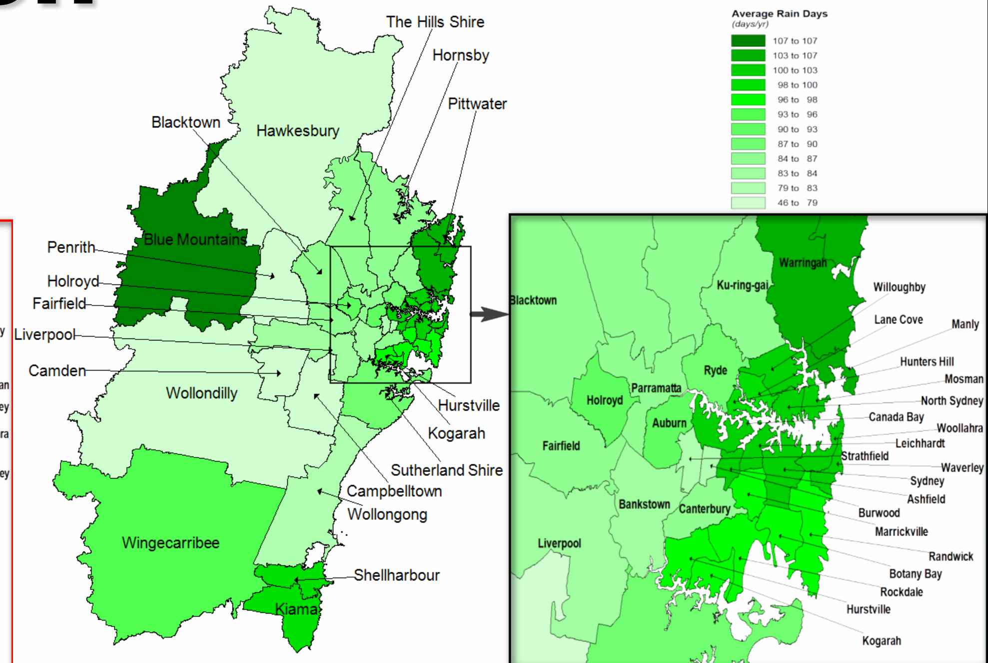
Water use

Sydney variation

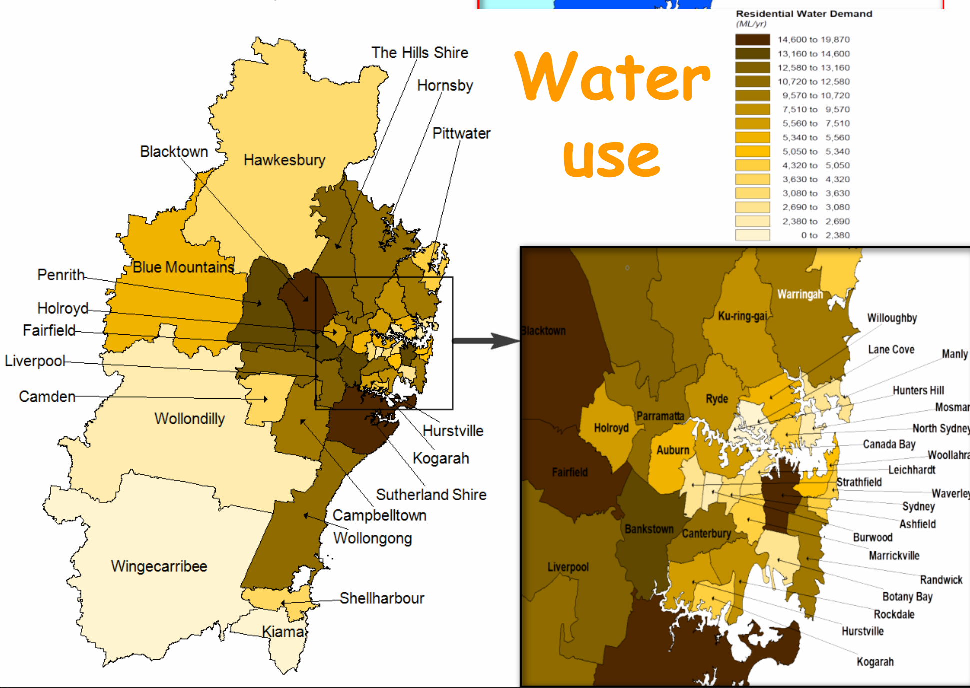
Rain



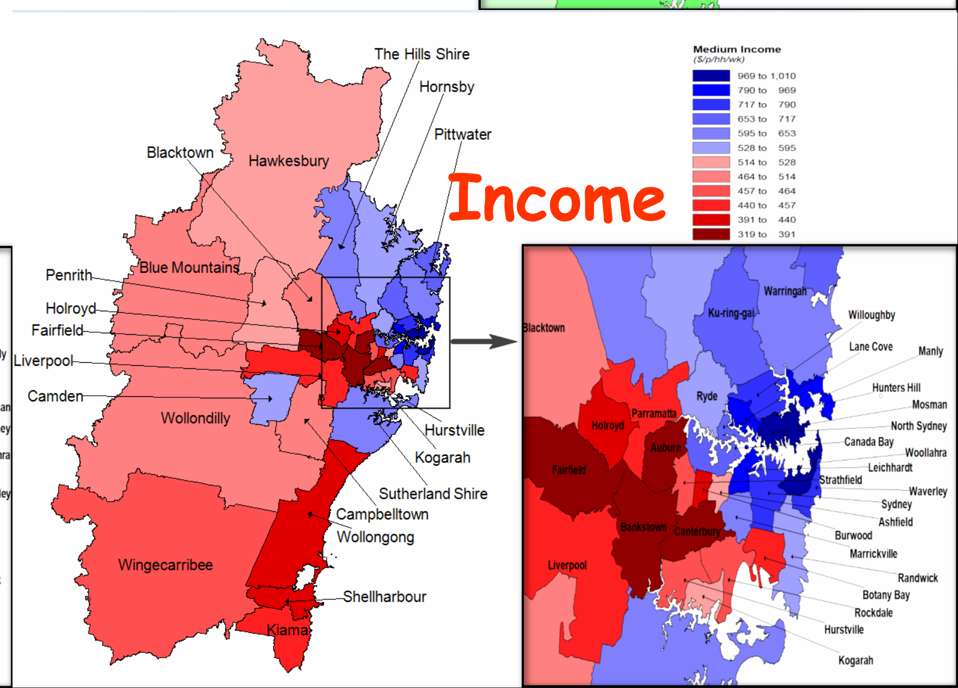
Frequency of rain



Water use



Income



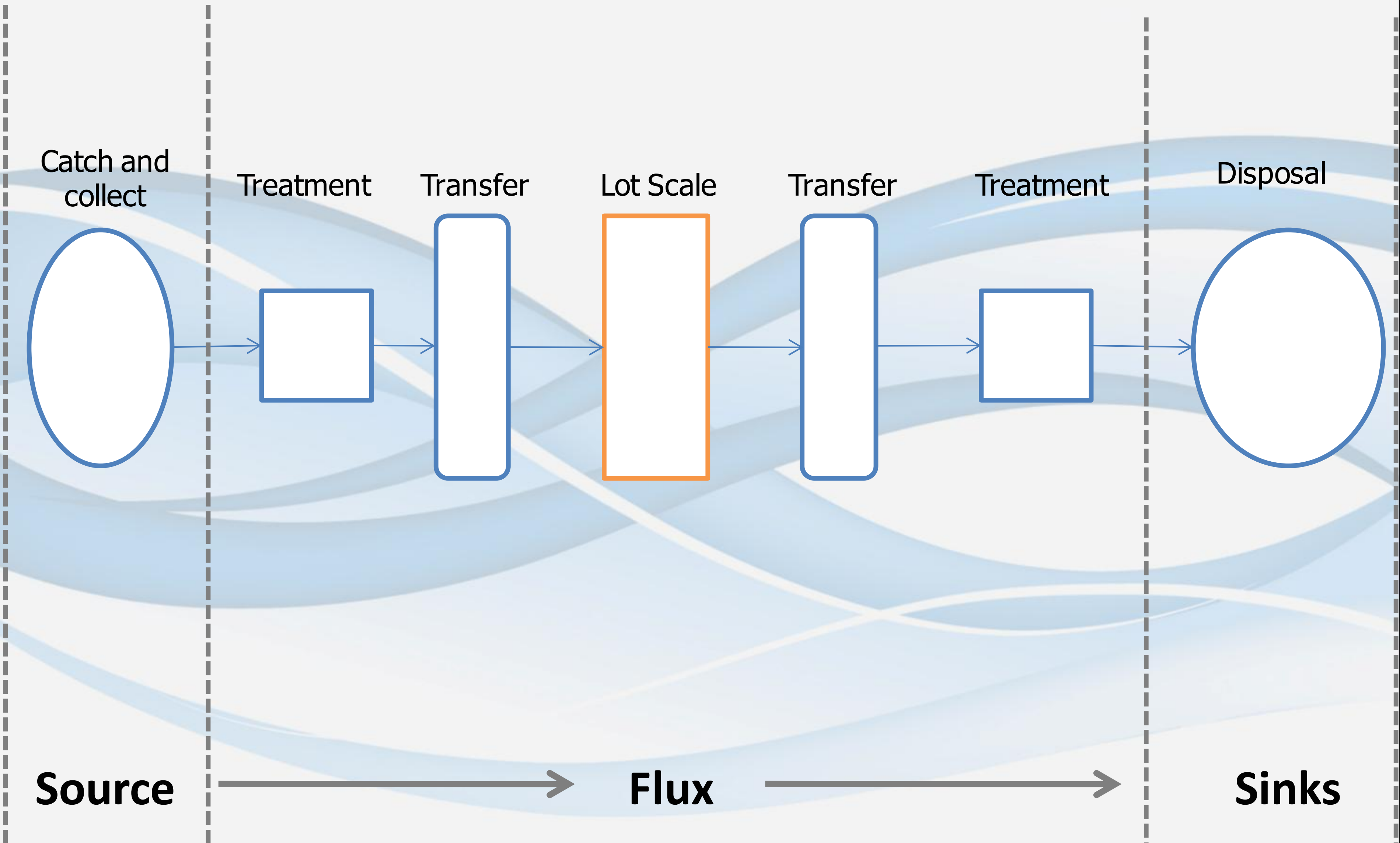
Methods

- Demographic data from the Australia Bureau of Statistics and State Government departments
- Climate data from the BOM and streamflow data from the SCA and MWC
- Water and sewage flows sourced from SWC and MWC + water retailers
- Local and cluster scale behavioural water demands and water balances simulated in the PURRS model at 6 minute time steps using long climate and demographic records – calibrated using water billing data from DSE and SWC.

Methods

- A scale transition framework compiles inputs from PURRS into Local Government areas (LGA) that was calibrated to observed data from water and sewage catchments
- The Wathnet model was used to collate and simulate all inputs across each city
  - Daily model of each system
- Then the spatial and temporal water demands were averaged and used in the simulations
- Water security was defined the annual probability of water restrictions
  - Acceptable security was less than 10% annual probability of water restrictions

Methods


Catch and collect
Treatment
Transfer
Lot Scale
Transfer
Treatment
Disposal
Source
Flux
Sinks

Methods

5 Sydney's footprint

4 Whole of Sydney

LGA Level

3 Catchments

2 Pressure reservoir scale

1 Lot scale

1 Source sewer generation (Lot scale)

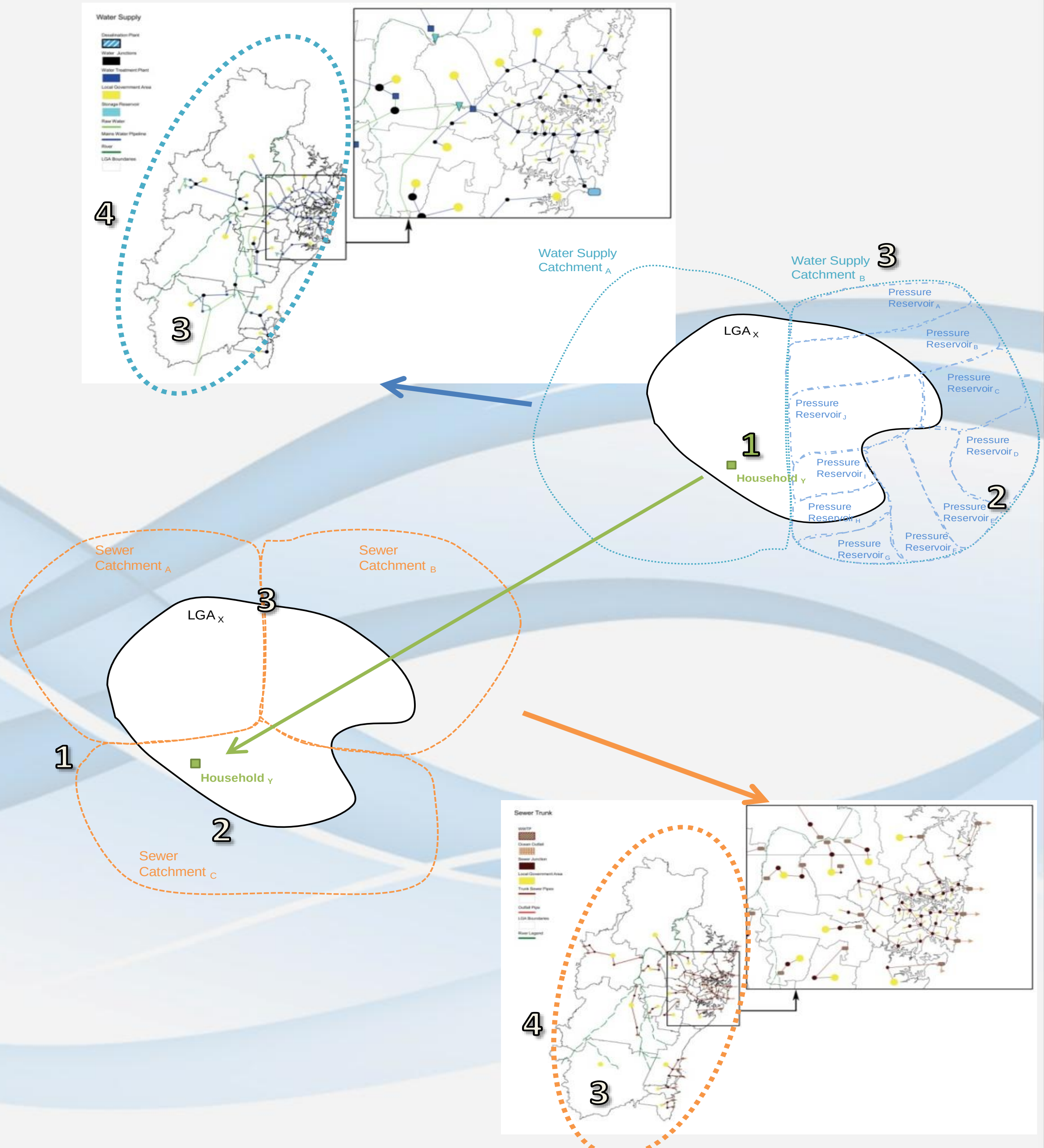
2 Sewer sub-catchment

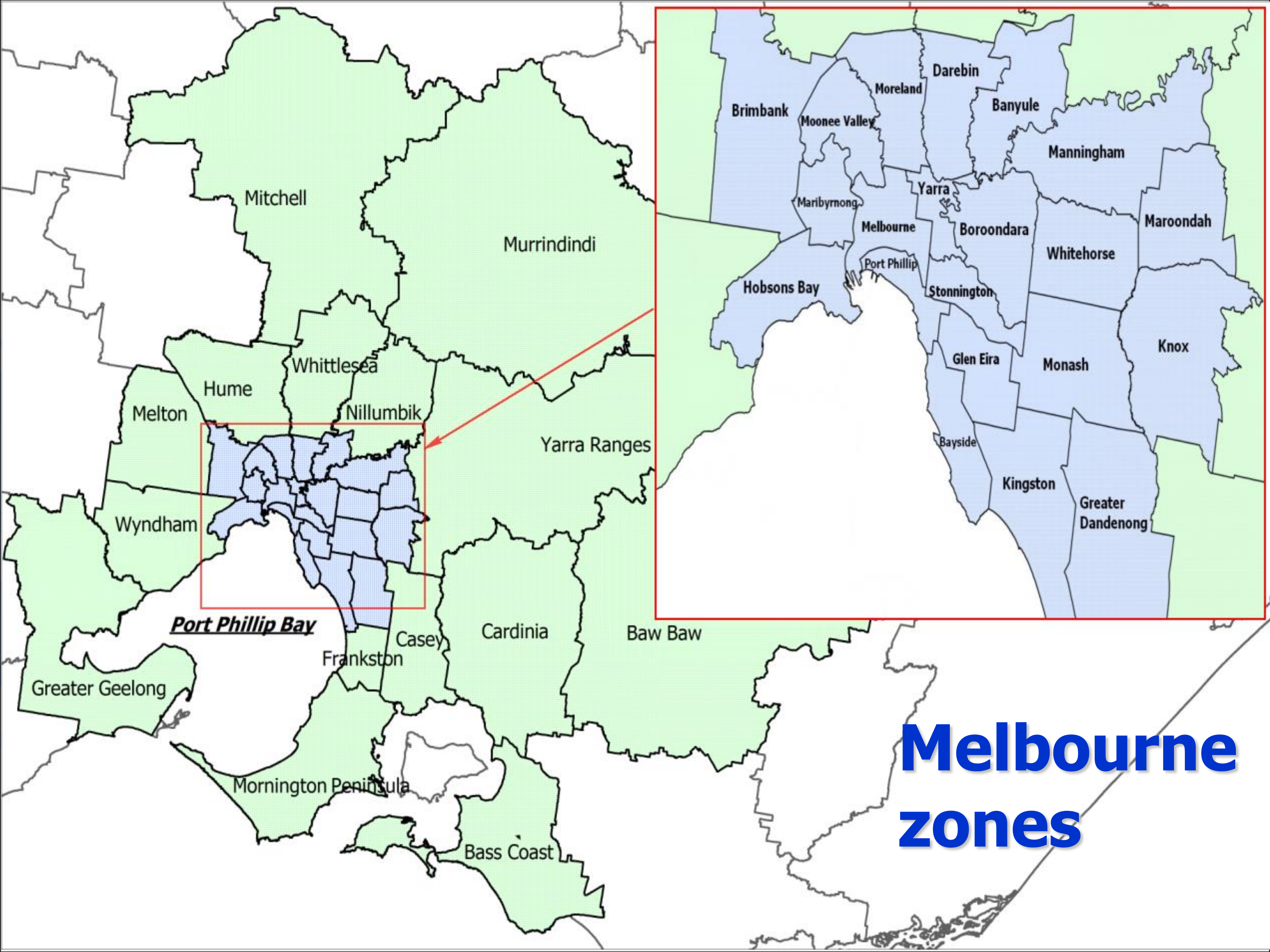
LGA Level

3 Trunk sewer and WWTP

4 Whole of Sydney

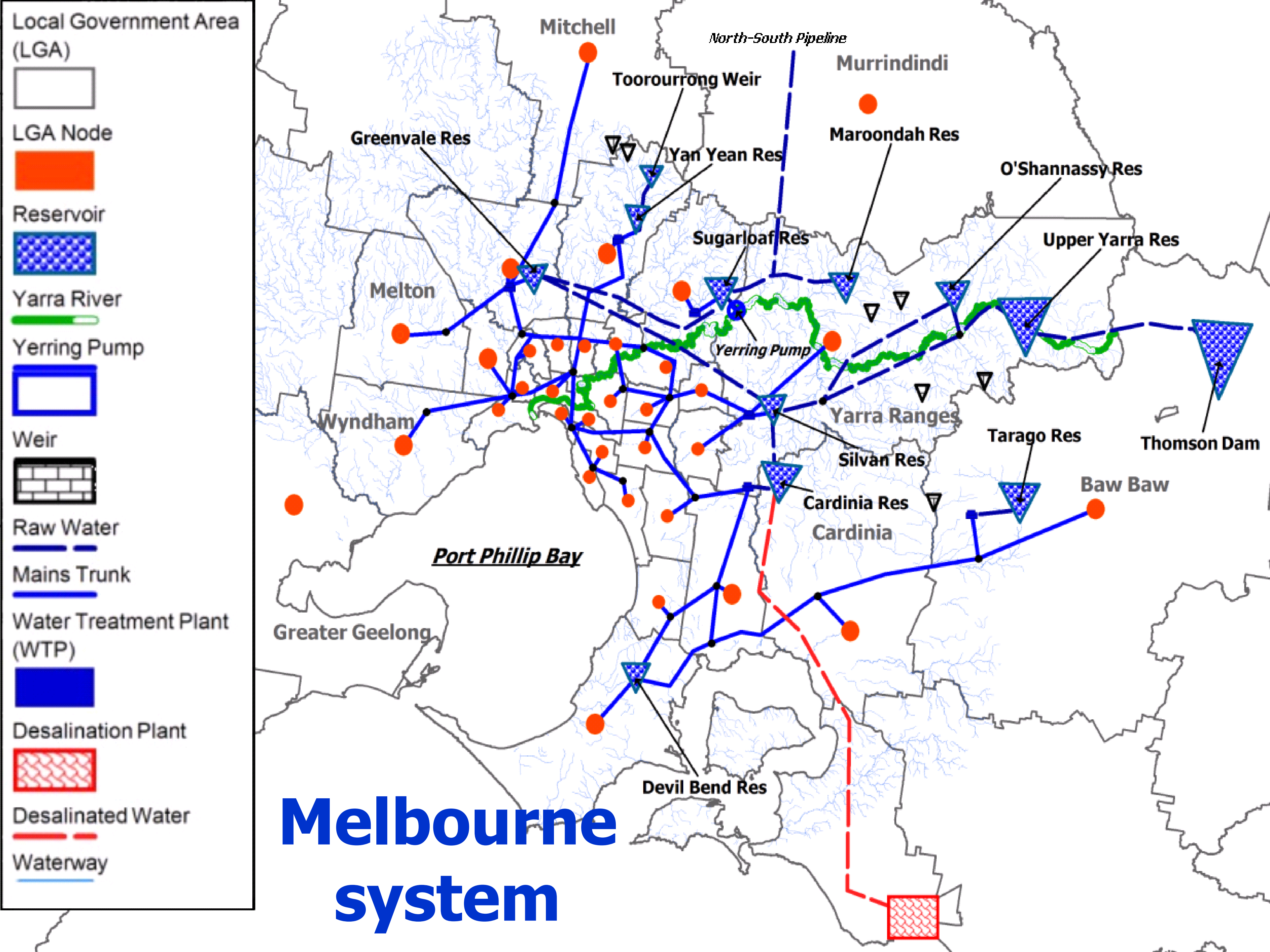
5 Sydney's footprint





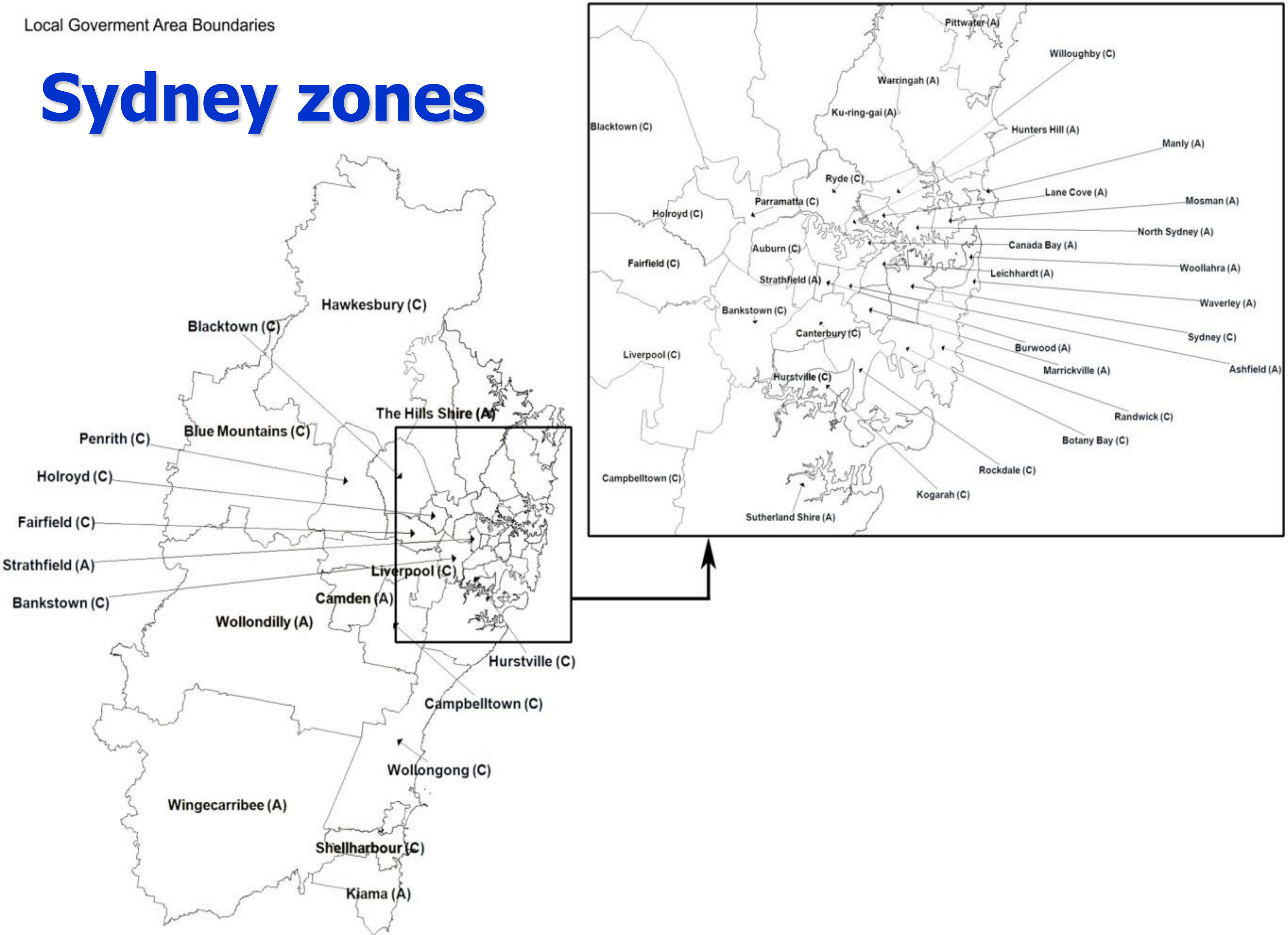
Melbourne zones

Melbourne system

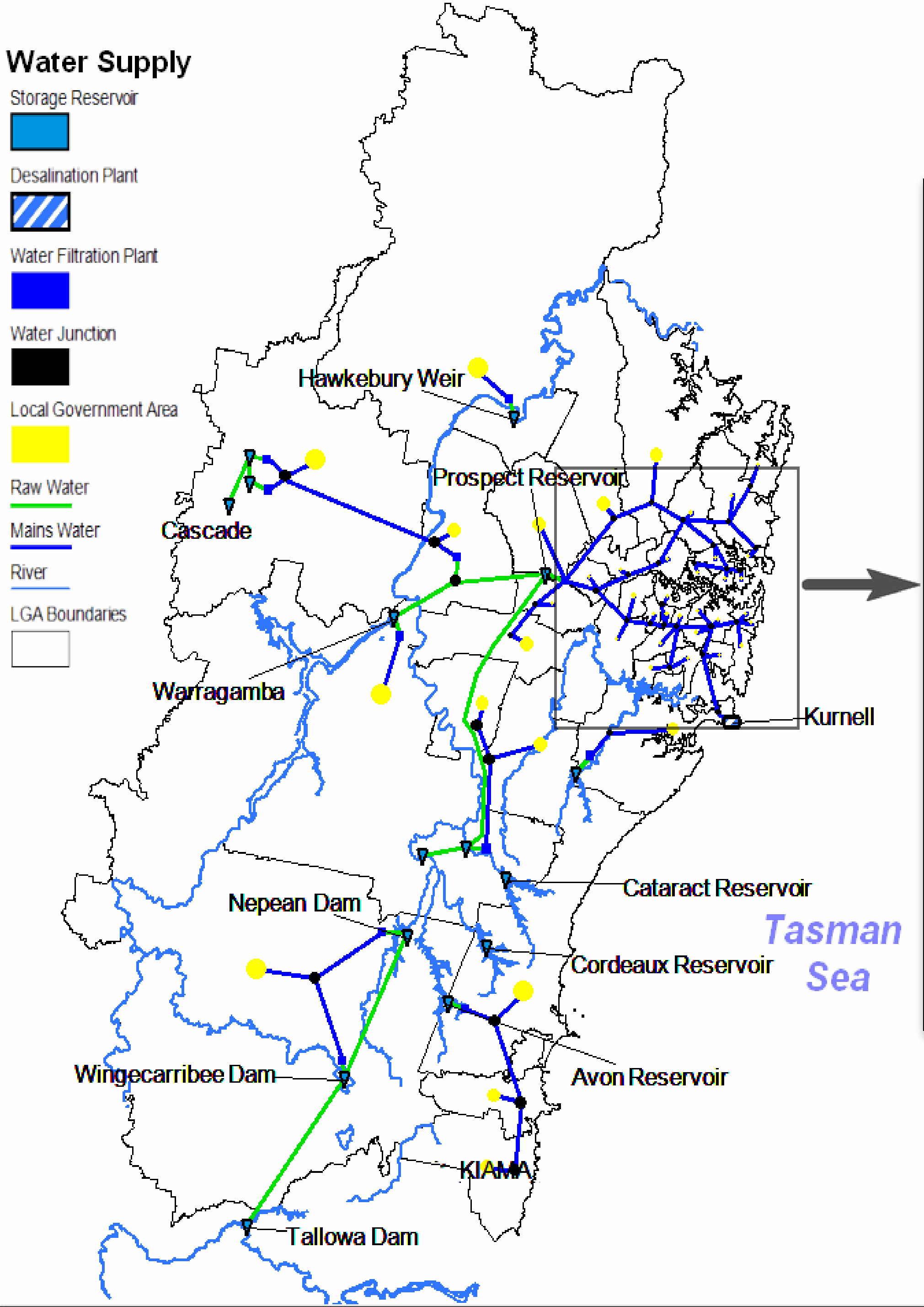


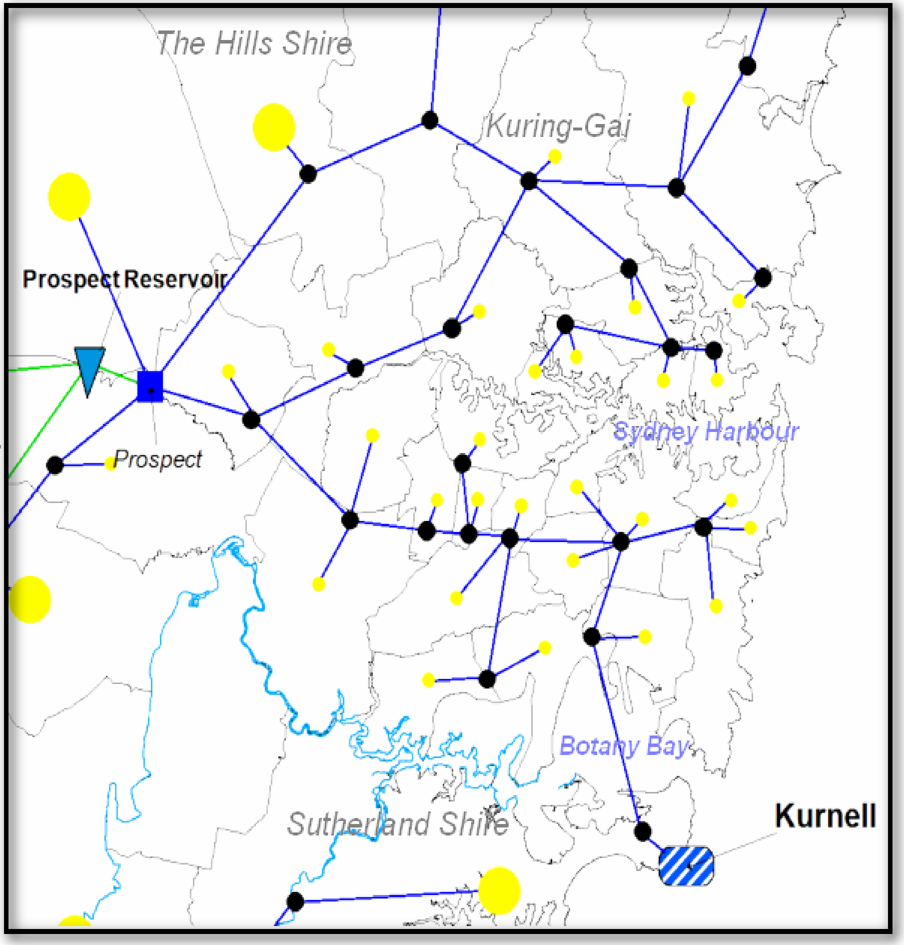
Local Goverment Area Boundaries

Sydney zones

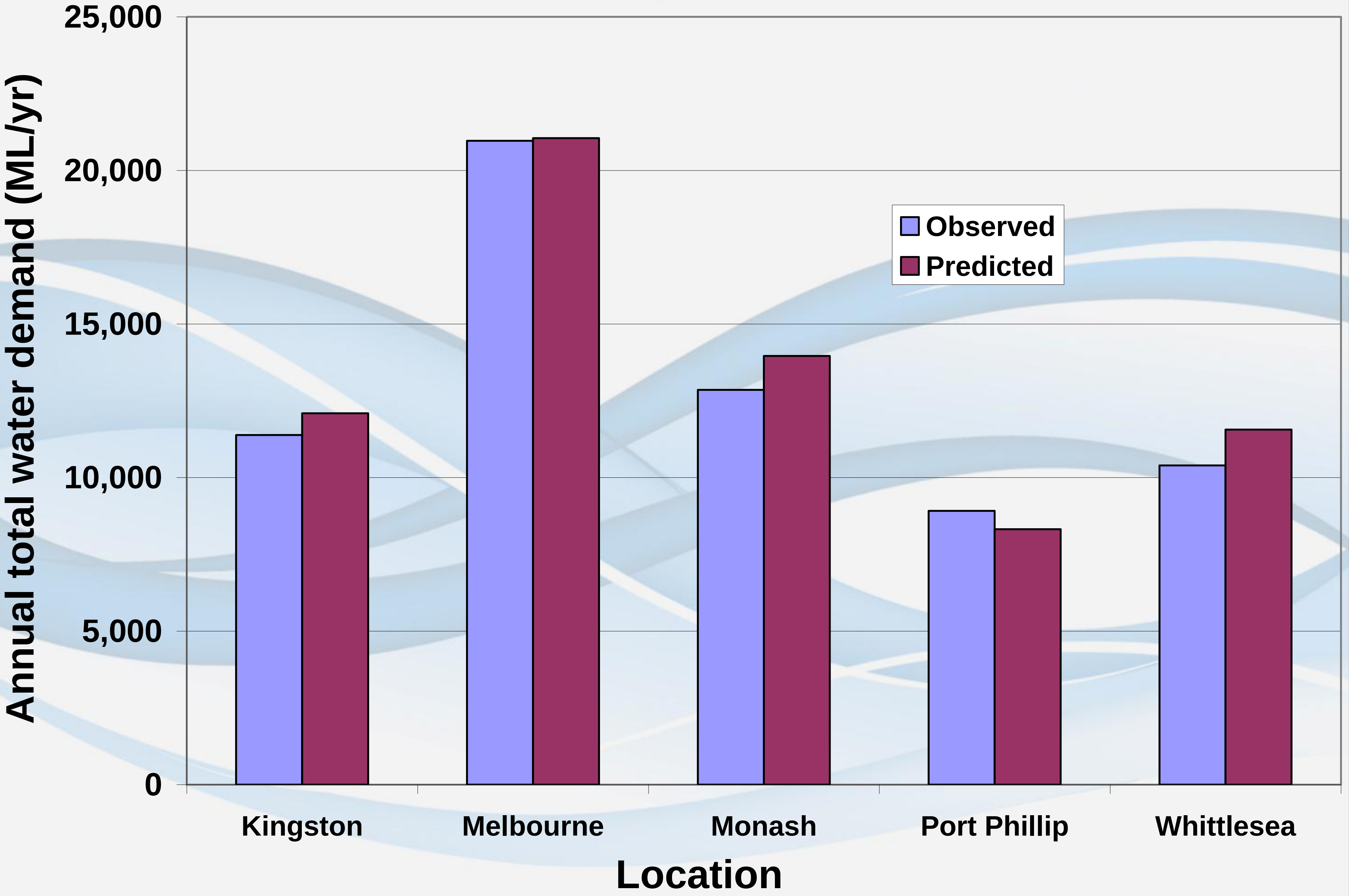


Sydney System

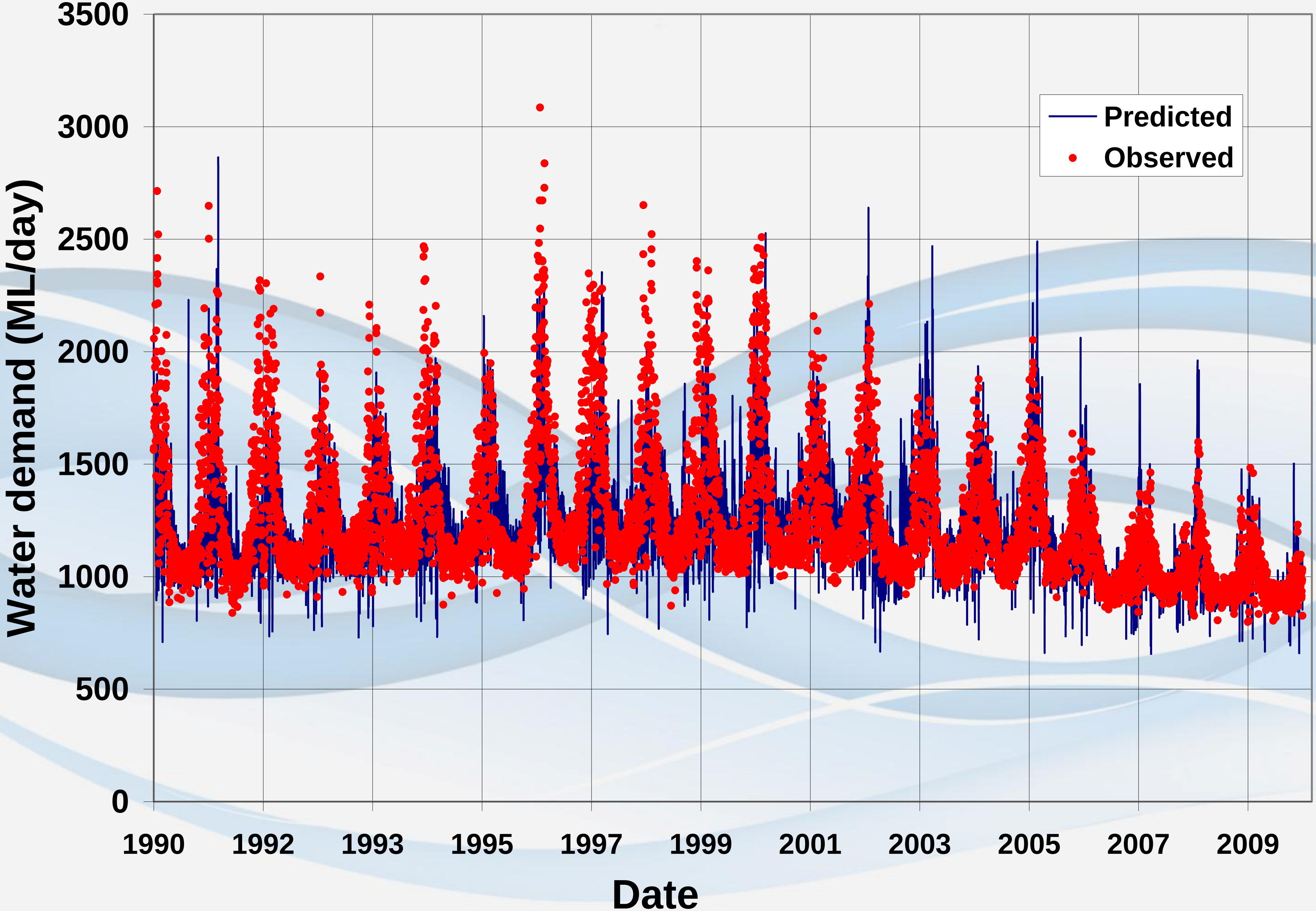




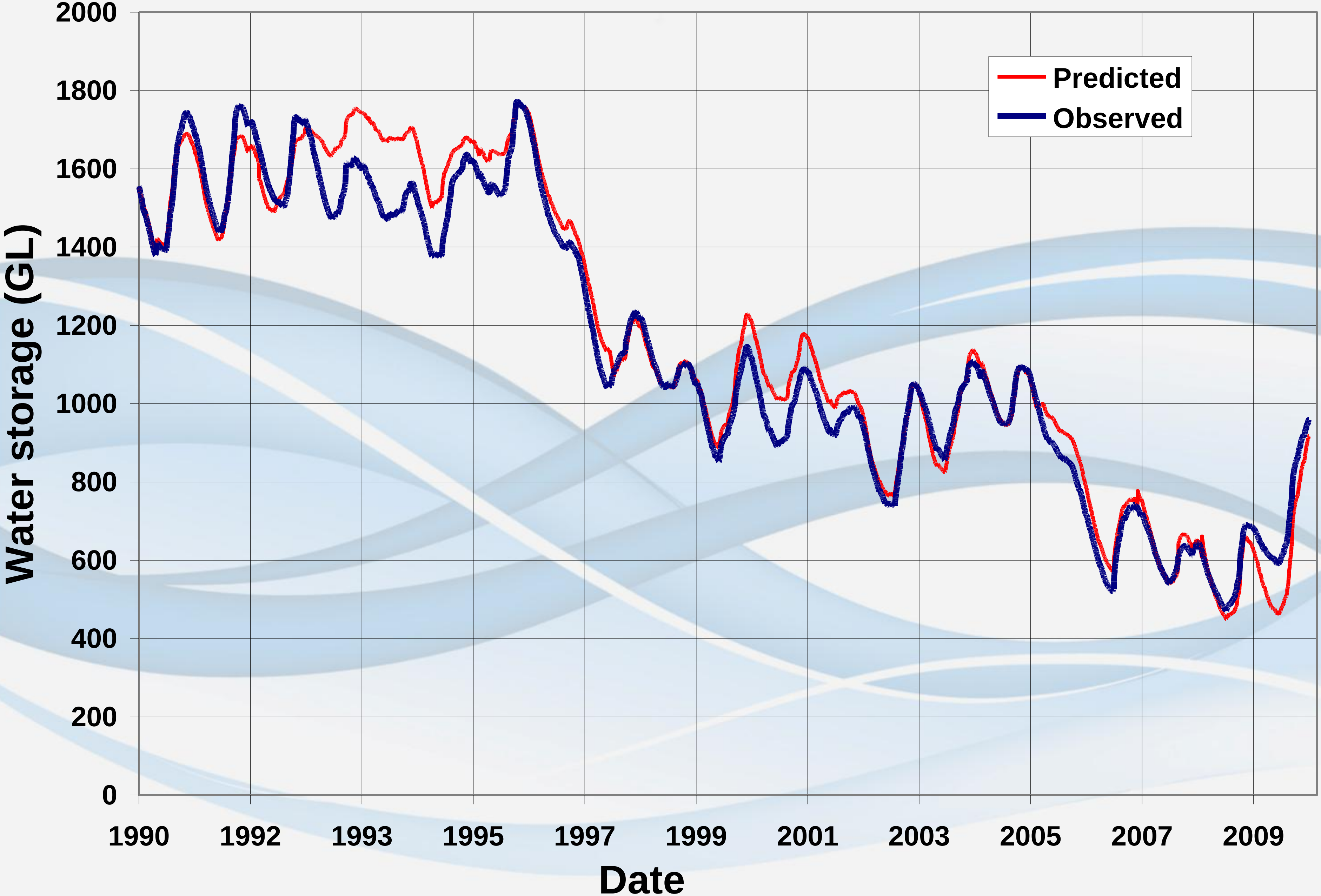
Melbourne lot scale demands



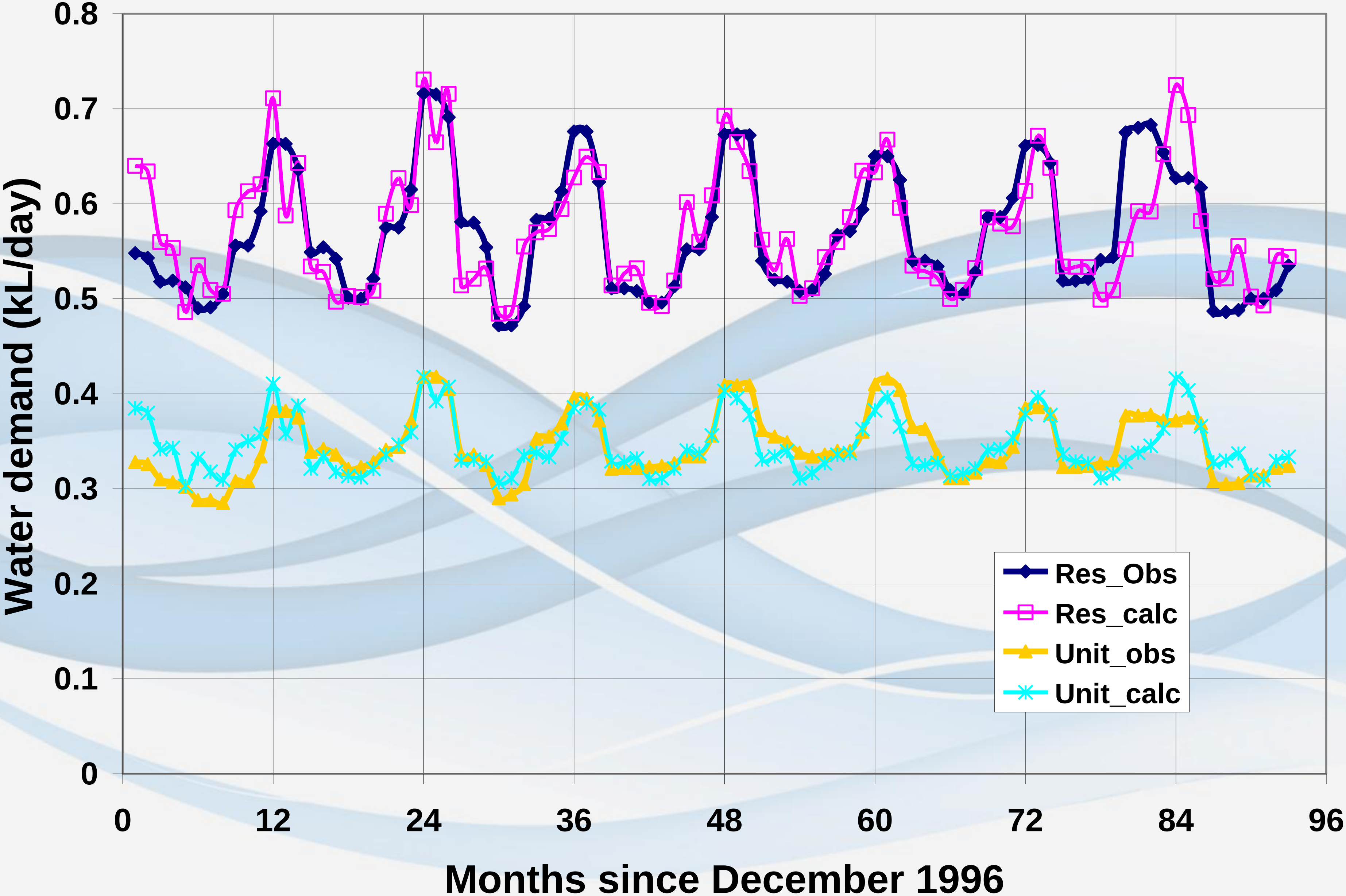
Melbourne Water Demands



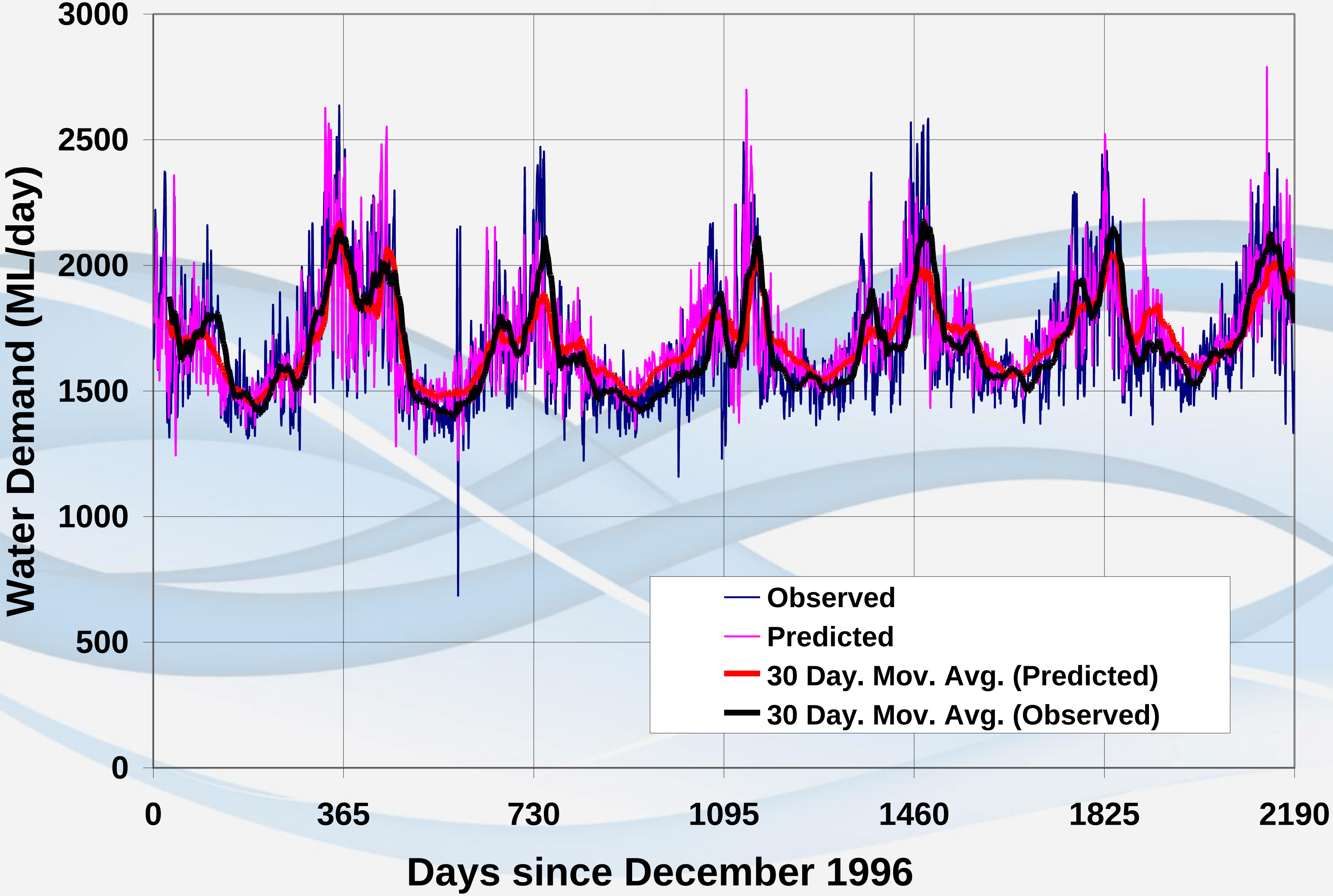
Melbourne Water Storages



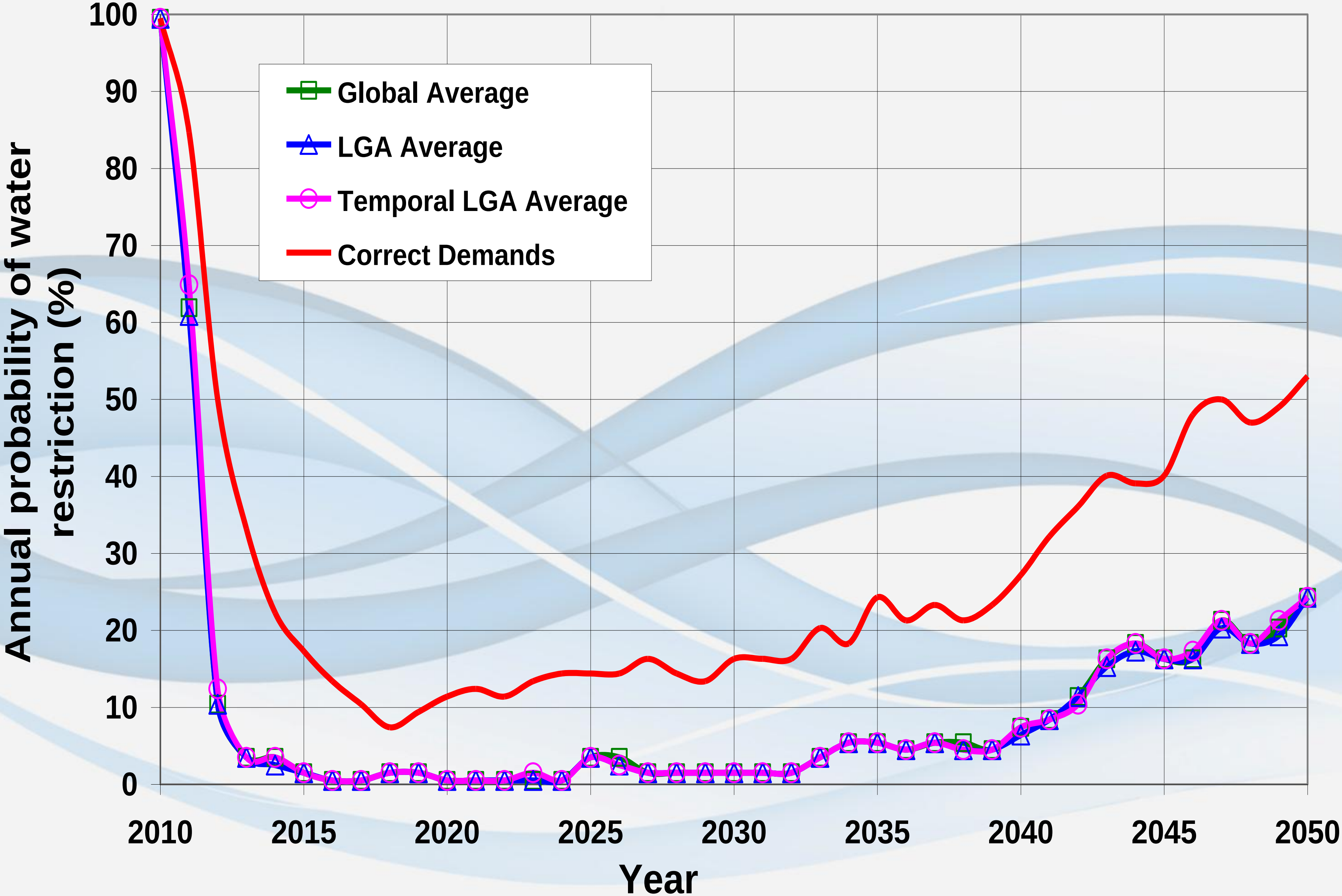
Sydney lot scale demands: Hornsby



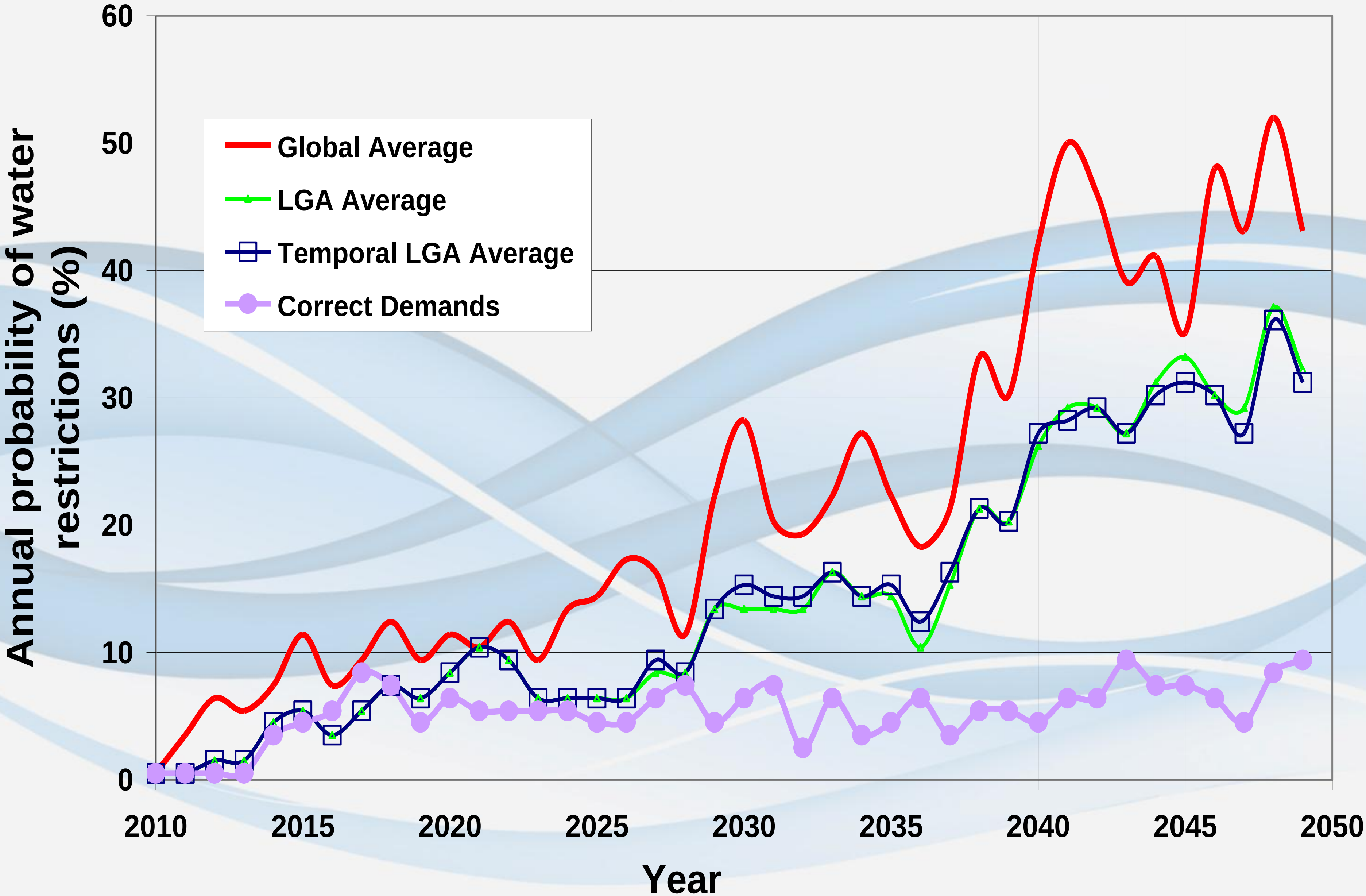
Sydney water demands



Results: Melbourne security



Results: Sydney security



Concluding observations

- Use of average water demands to replace spatial and temporal variation generates:
  - Dramatic reduction in certainty about system behaviour
  - Incorrect understanding of the behaviour of the system
- Use of averages cannot capture the substantial temporal and spatial variation of a city
  - Climate, demographics, urban form and socio-economics
- The use of global averages for simulation of regional water systems is unlikely to describe the spatial and temporal contribution of WSUD approaches that generate water resources or reductions in water demands within a metropolis.

Concluding observations

- The likely characteristics of WSUD policies include time based adoption of measures in response to planning policies and urban development, retention of water within urban landscapes and water supplies from within cities:
  - This process cannot be described using current methods
- It is likely that generalisations about climate and streamflow inputs embodied in current practice introduce further uncertainty about system behaviours.
  - This is the subject of ongoing collaborative research.

Acknowledgement

- The contribution of Mark Colegate to this investigation, and
- support of the Victoria government and Sydney Water
- are gratefully acknowledged by the authors.