Systems Analysis and Macroeconomic History Reveals Relative Progress Towards Water Sensitive Cities

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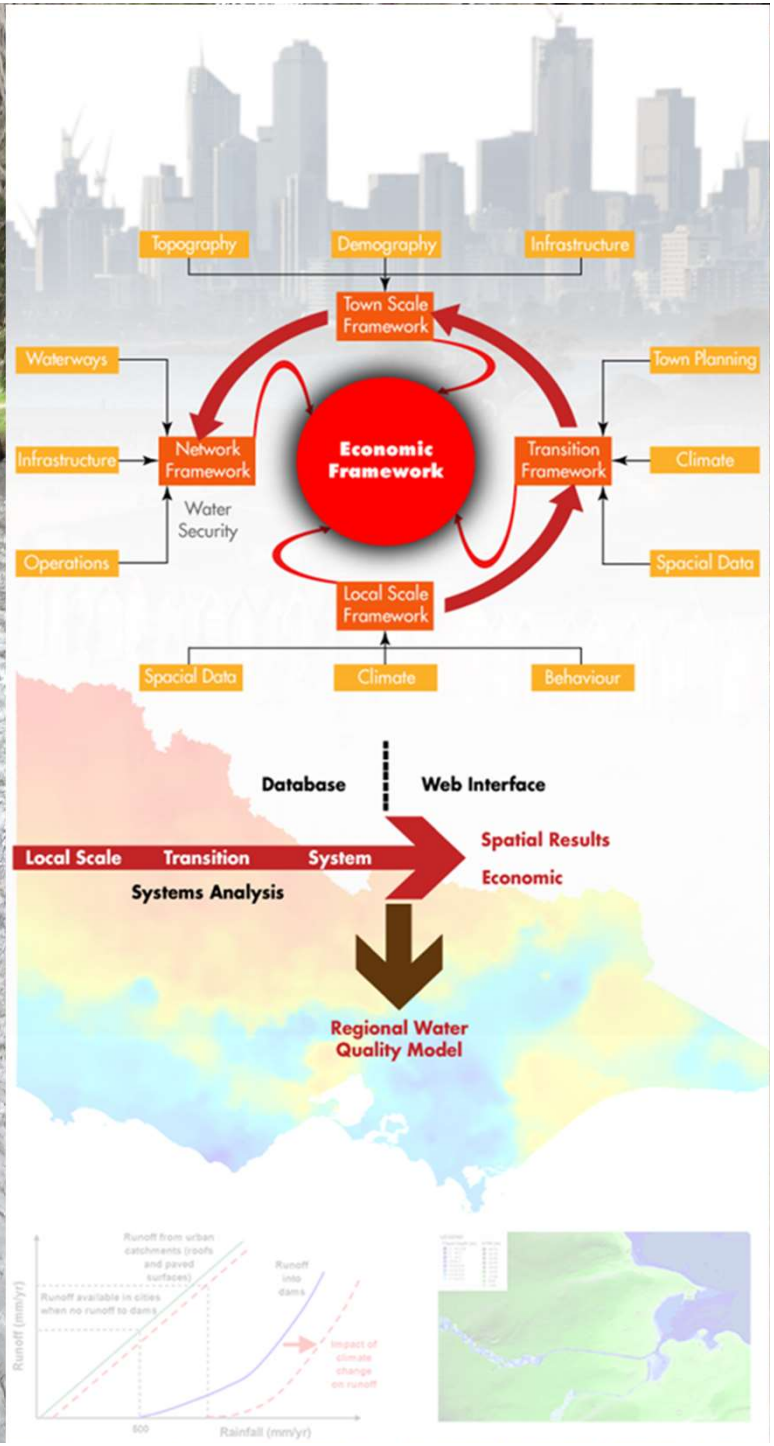
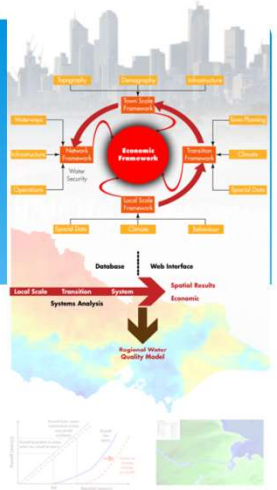


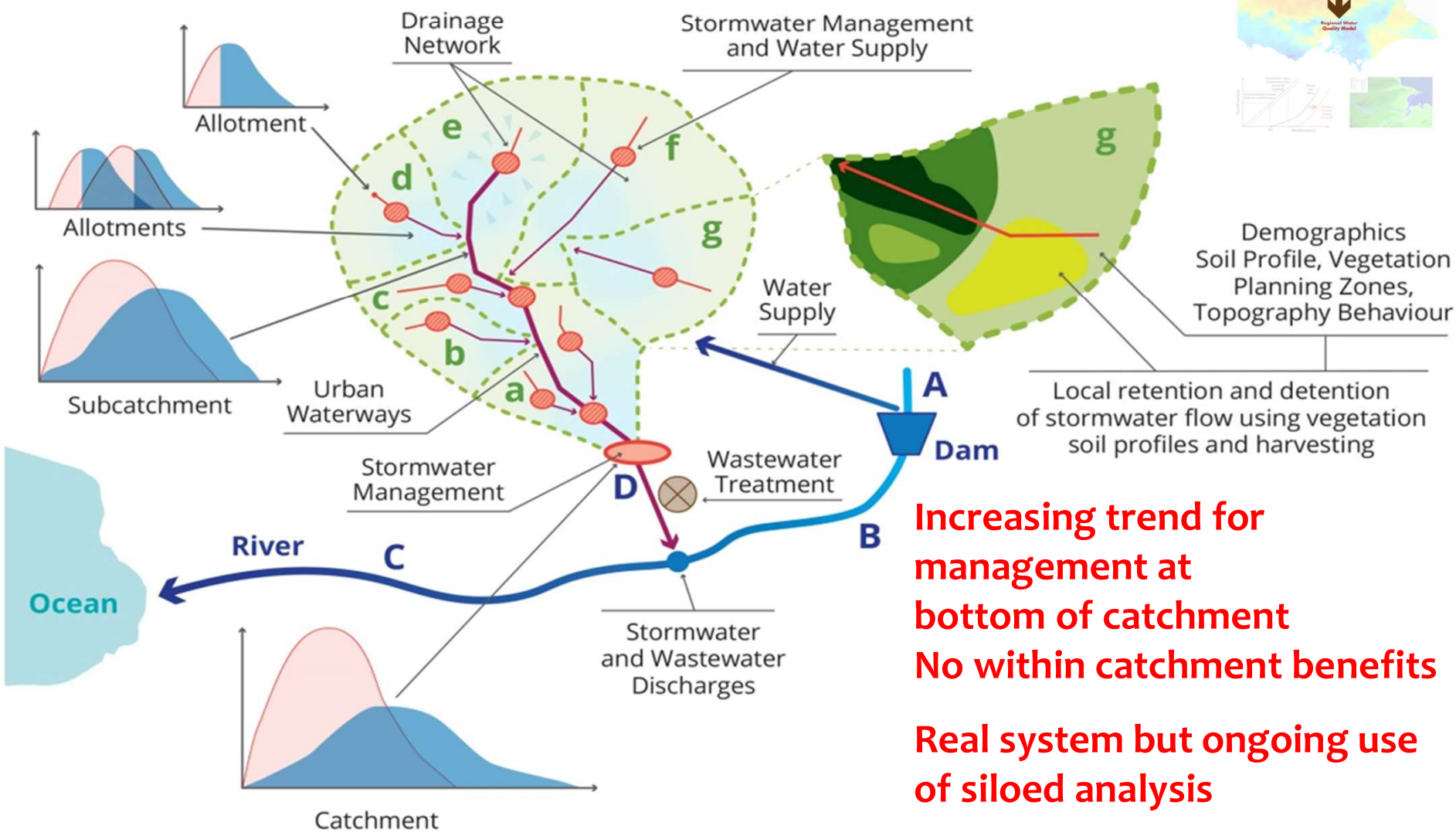
Changing definitions of "Water Sensitive"

* *Original definition of WSUD in 1994:*
  * *'a new approach to urban planning and design, based on the premise that traditional water supply, sewage disposal and drainage practices which rely upon conveyance and centralized treatment and discharge systems cannot be sustained in the long term'*

* Narrowing of definition over time to stormwater quality and centralised treatment – an add on to traditional approaches
  * Limited (at best) focus on volume or water balance
* Many different definitions IWM, WSC and so on
  * Diminishing solution space based on dominant interests

Importance of management scale and cumulative impacts

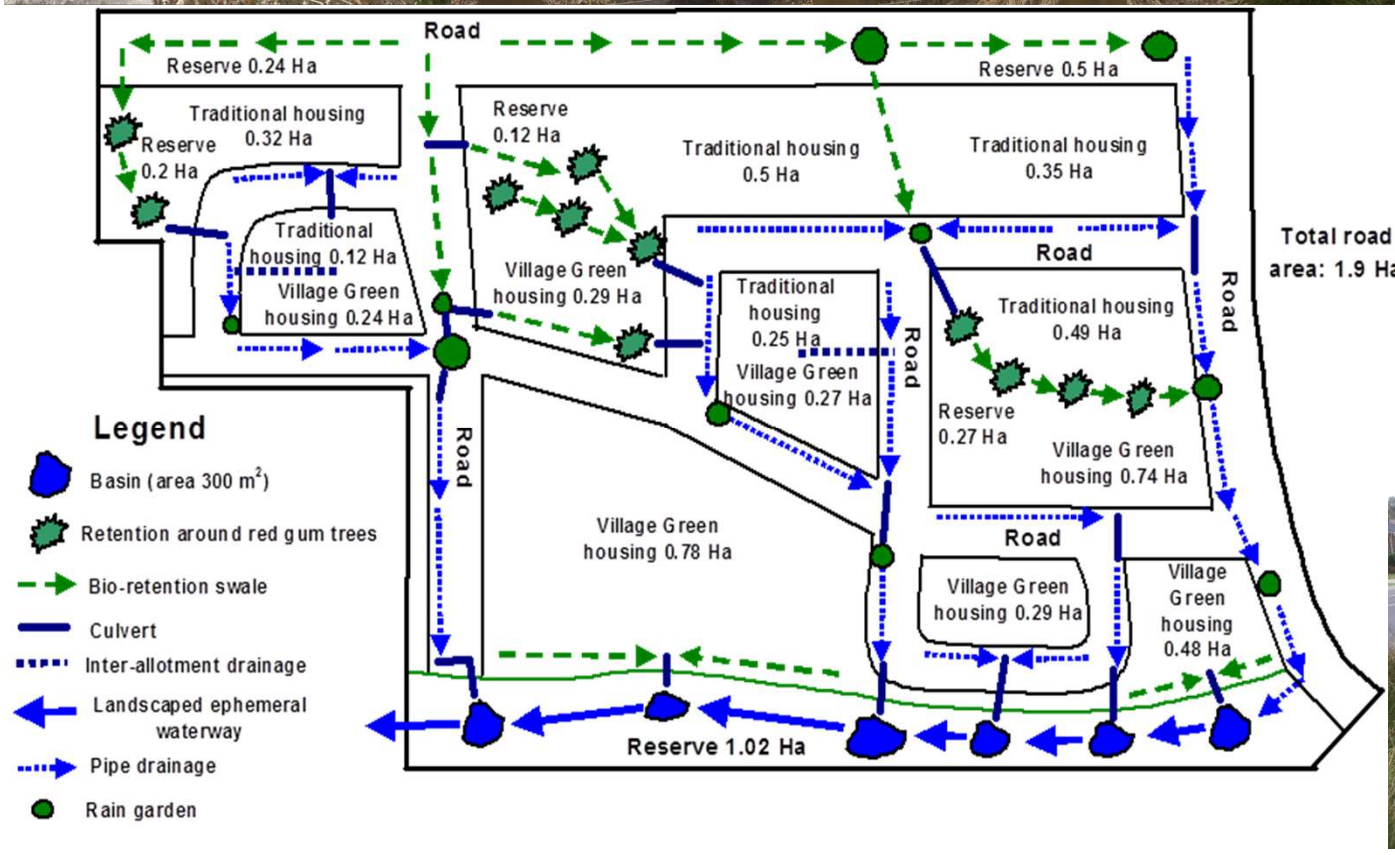




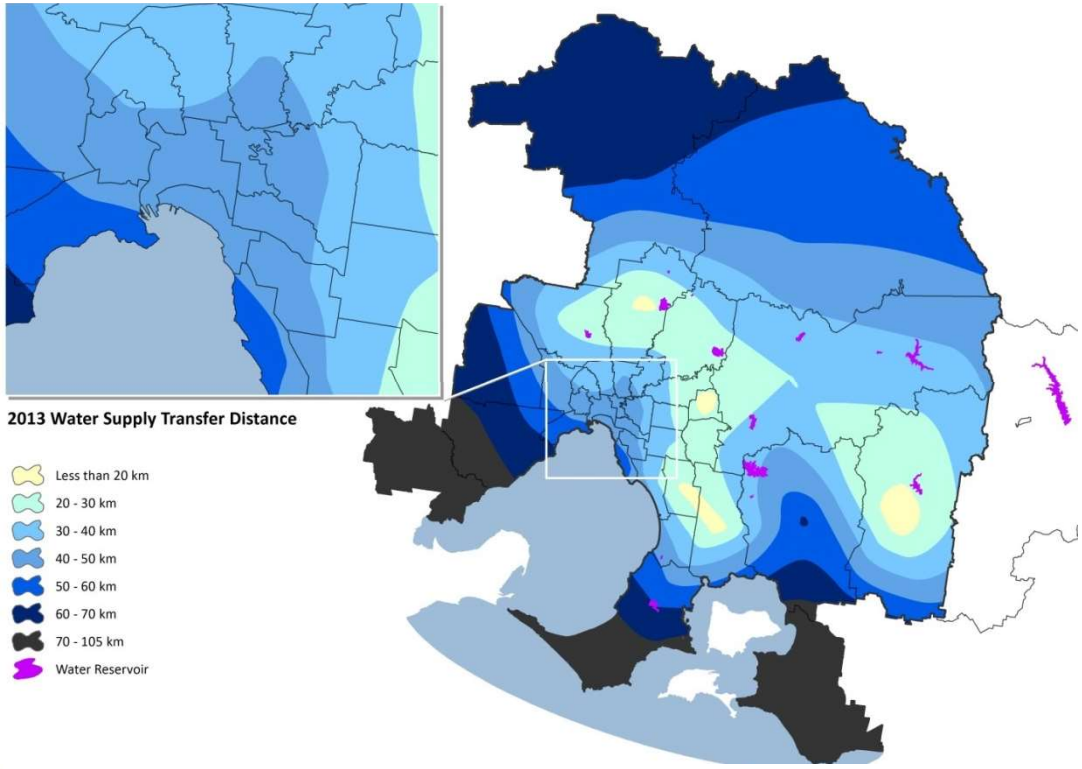
Increasing trend for management at bottom of catchment
No within catchment benefits

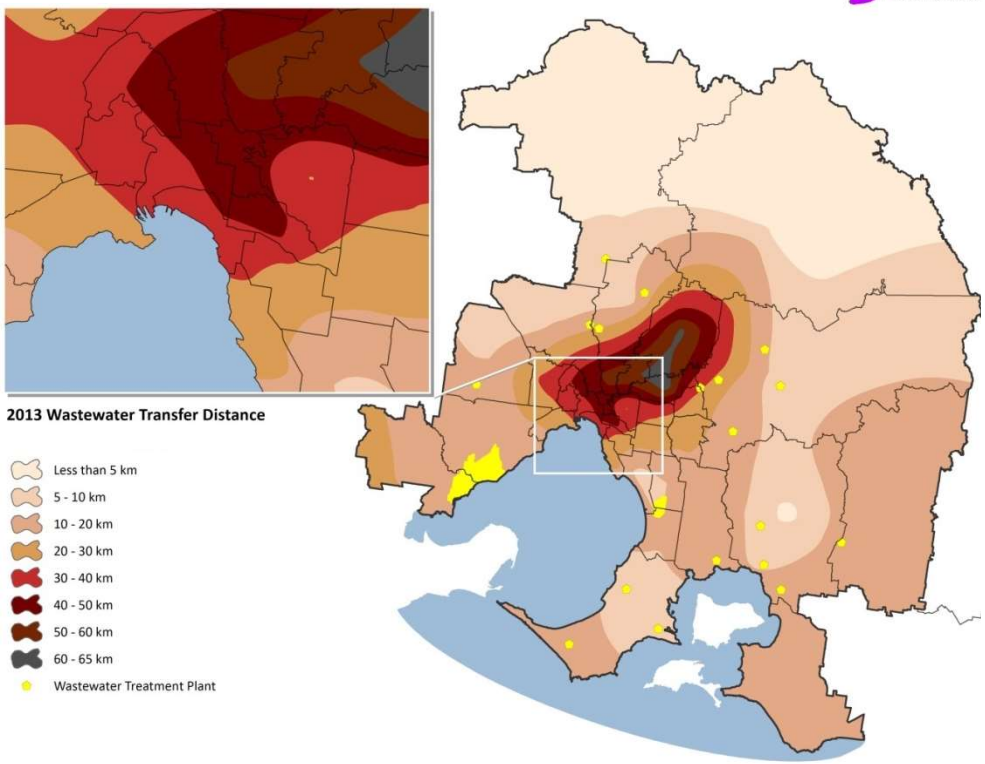
Real system but ongoing use of siloed analysis

Renascence Rise – WSUD within catchment solution

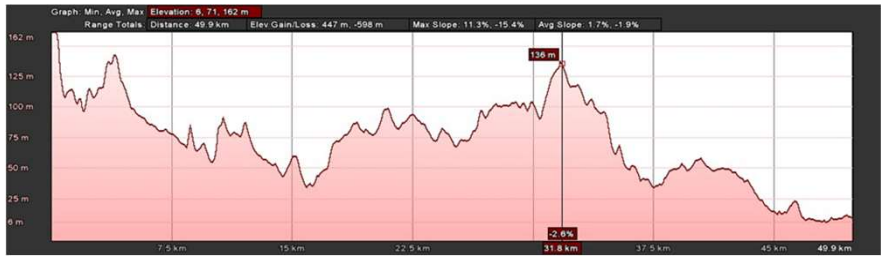


Cumulative transport issues: water & sewage





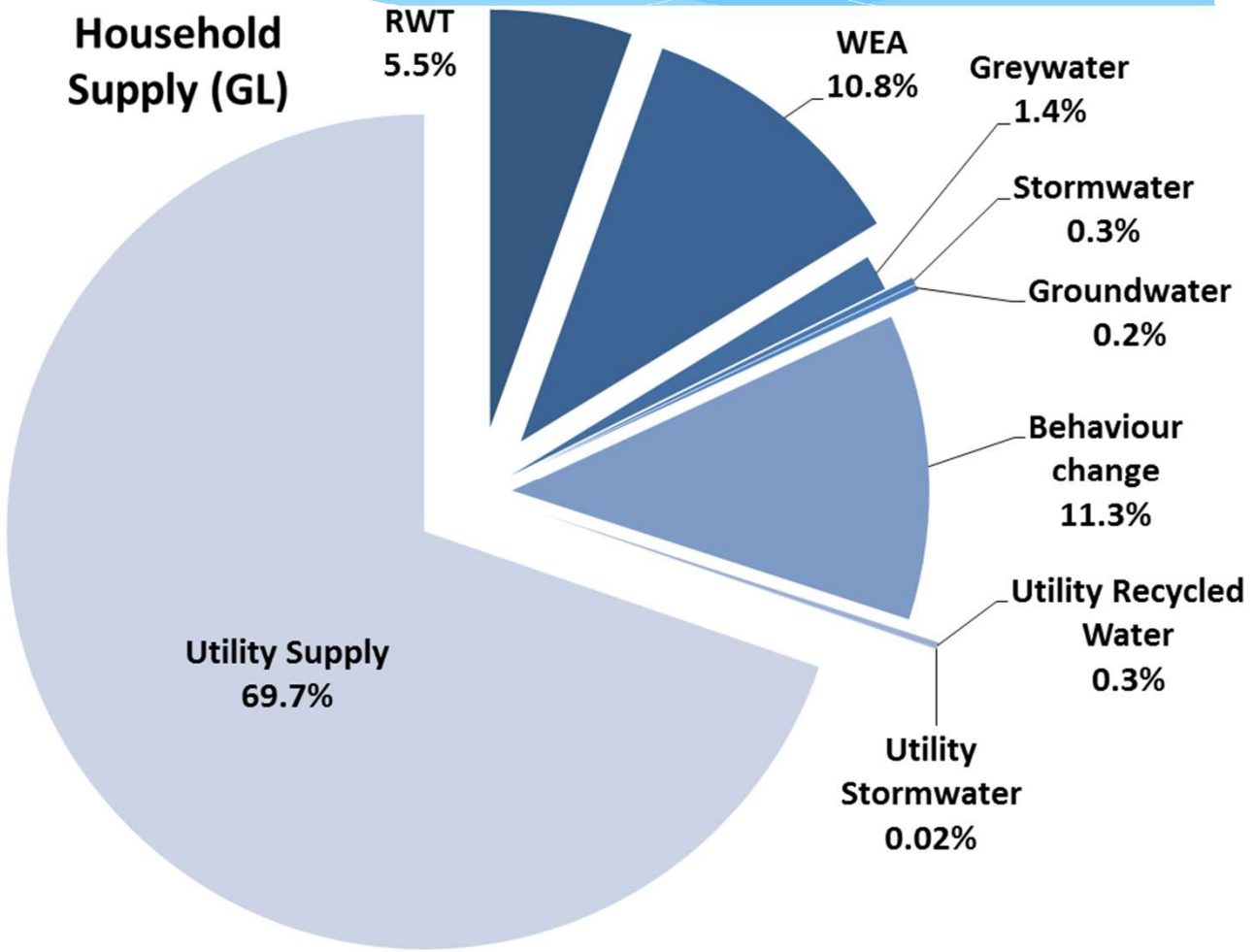
Water pathway



Sewerage pathway

Water balance of household supply for Greater Melbourne

* More than utility supply
* Utility water 69.7%
* Household interventions: 127 GL/annum
* Loss of this contribution equals another desalination plant



Greater Melbourne Stormwater

Status Quo (2016)

* Very low to moderate waterway condition
* Meta-analysis of water quality data shows patchy improvements and some substantial decline
* Senate Inquiry (2015)
  * Urban flooding and degradation of waterways is escalating

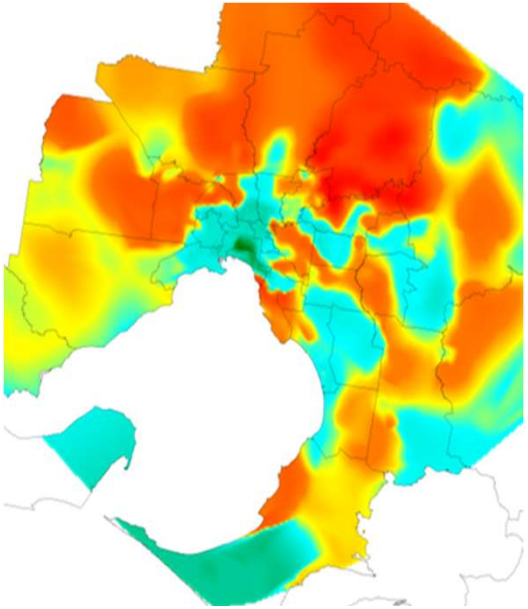
Local contributions (2016)

* 20 GL/annum decreased urban flows
* Reduced TSS: 3810 tonnes/yr
* Reduced TP: 8 tonnes/yr
* Reduce TN: 53 tonnes/yr

Evaluating historical benefits

* Used metadata from government agencies and utilities
* BOM, ABS, NWC, regulators, utilities, RBA, treasuries, manufacturing industry, BASIX
  * 2003 – 2017
  * Utilised spatially detailed raw data from ABS on water use, efficiency, rainwater harvesting
* Selected capital city regions with similar general characteristics
  * Desalination plants, different levels of support for water efficiency and rainwater harvesting
  * Adelaide, Melbourne, Perth, Southeast Queensland, Sydney regions
* Combined with detailed "bottom up" systems analysis to understand historical benefits
* Examined household welfare, economic efficiency, utility water operating costs and marginal costs

Greater Melbourne: Observed Water Use



Systems Framework Overview

Climate, environment, dwelling types, land uses, historical behaviour, costs

Local simulations

Basis of all modelling. Determines underpinning local water balances, environmental impacts and financial transactions

Population, dwelling numbers, antecentent dry days, season, rainfall, temperature, behaviour, infrastructure, planning zones

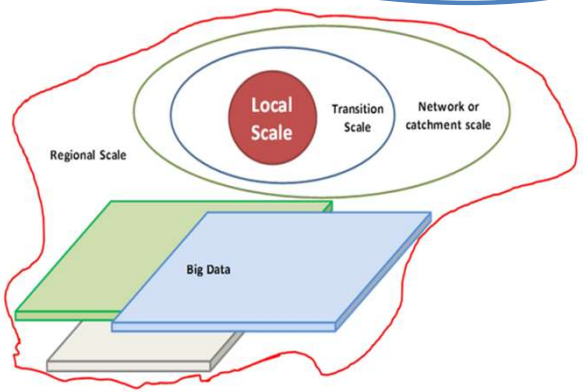
Transition processes

Translation of historical data and local simulation results for inputs to nodes in the stochastic systems model

Water, wastewater and stormwater networks, rivers, urban waterways, infrastructure, policy, regulations, operating rules.

Catchment behaviours

Simulates multiple replicates of system behaviours using results from earlier analysis in statistically significant manner

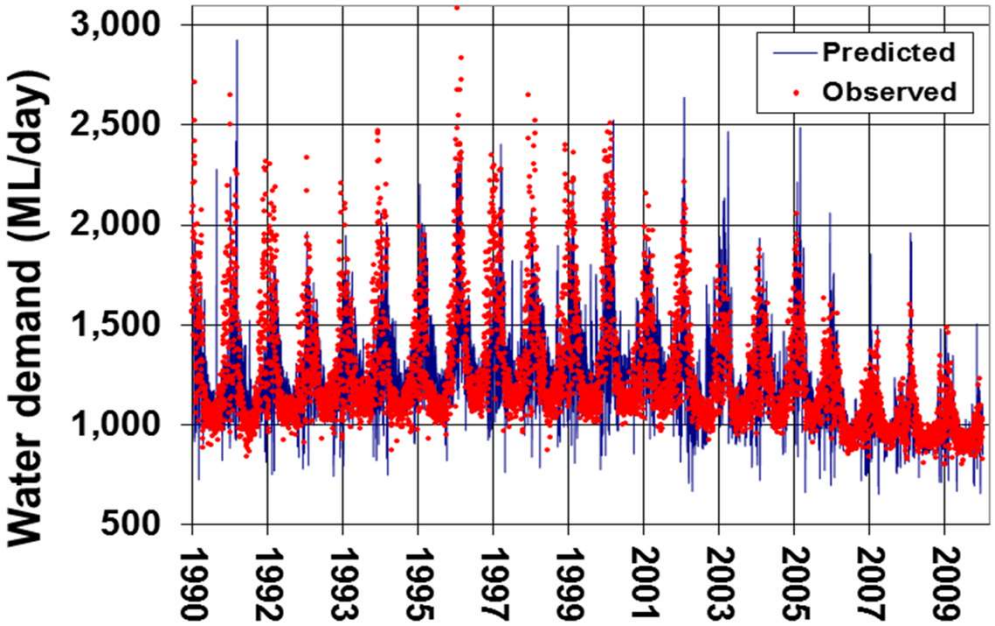


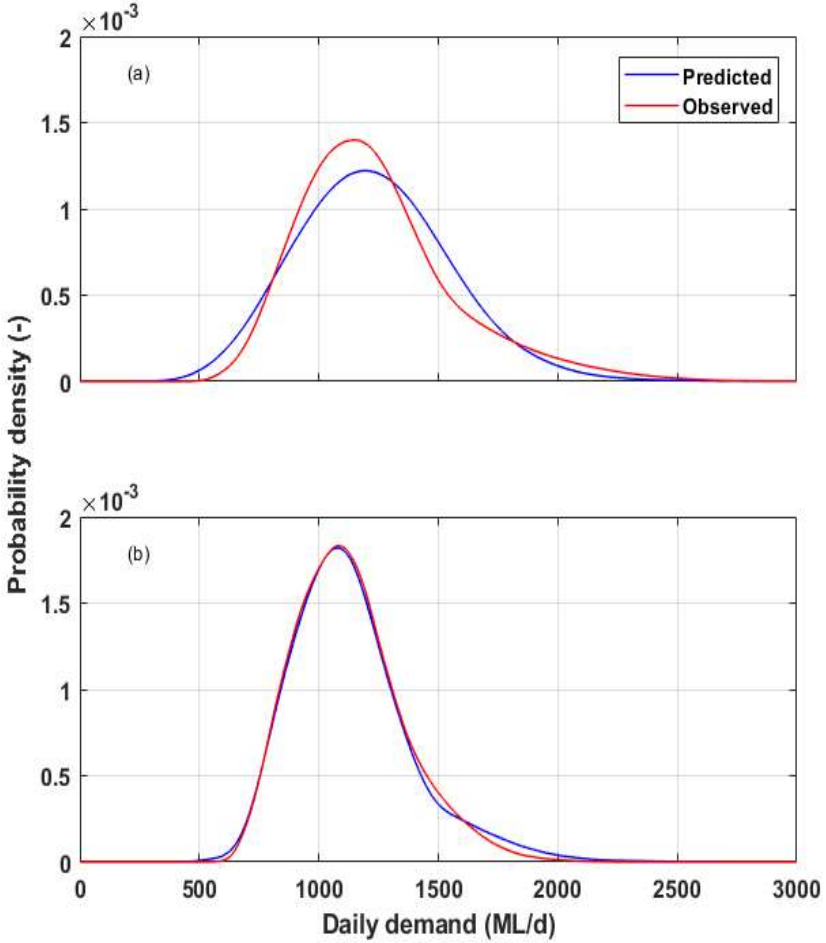
Water, wastewater and stormwater flows, water security, flood risks, waterway health, economics, greenhouse gas emissions

Verification Regional Water Demand

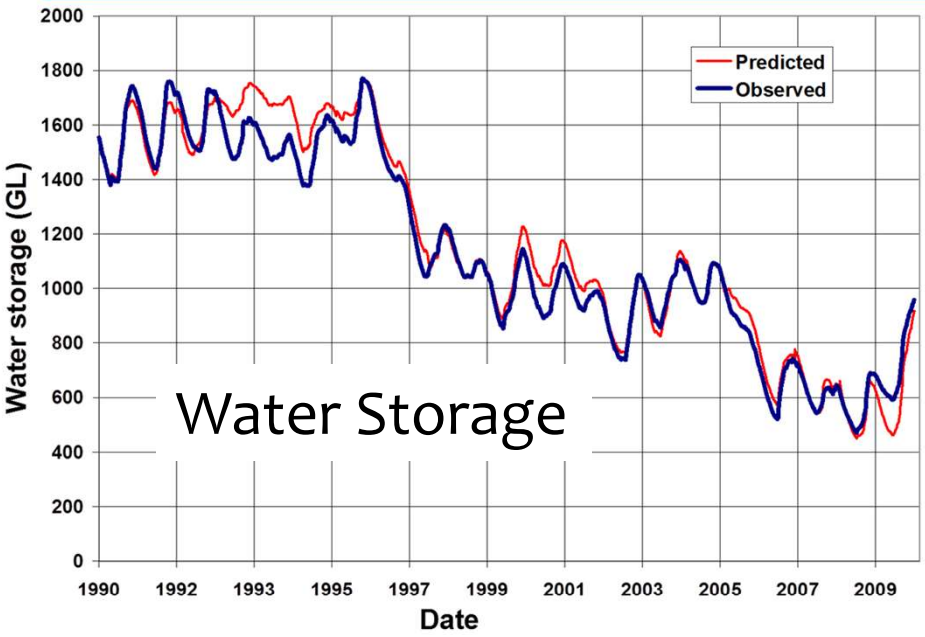
Melbourne distributions before and during drought (bottom)

Melbourne (1990 – 2010)



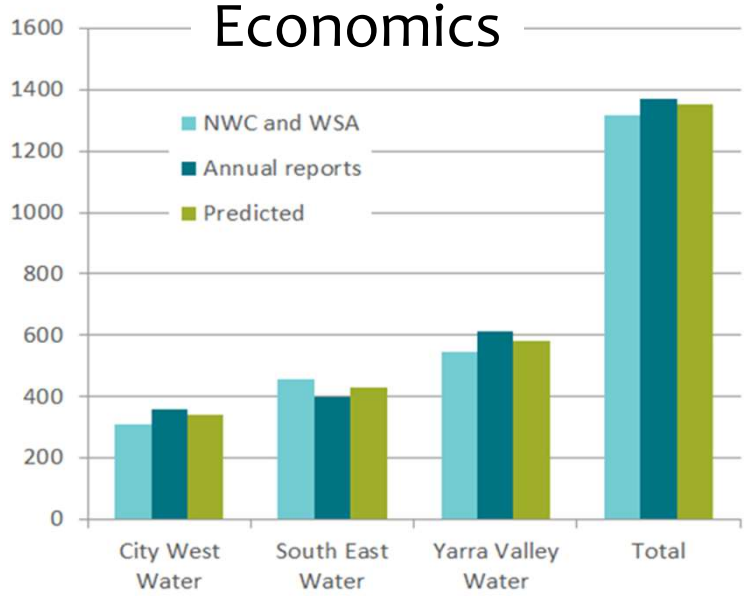


Verification

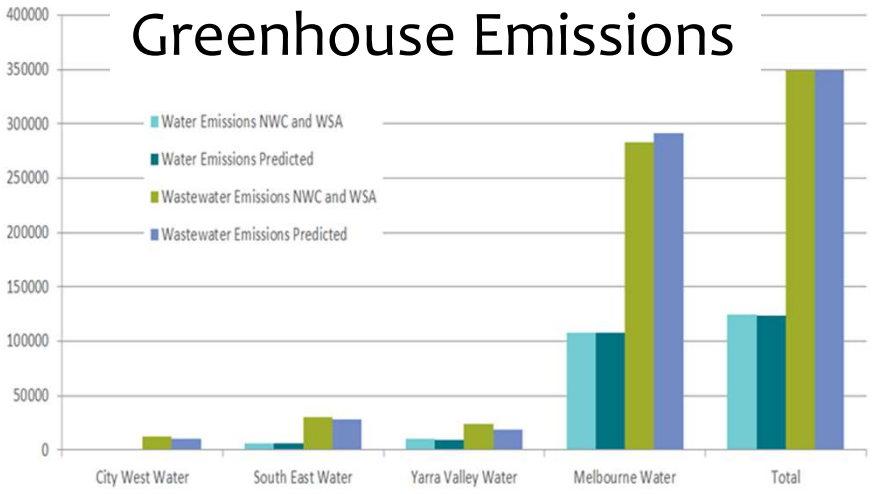


Water Storage

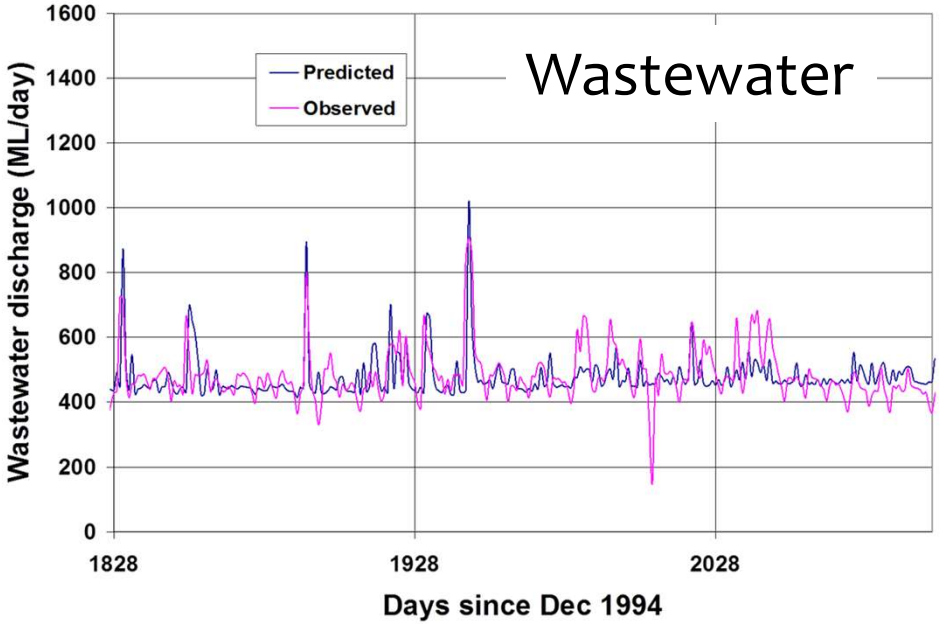
Economics



Greenhouse Emissions



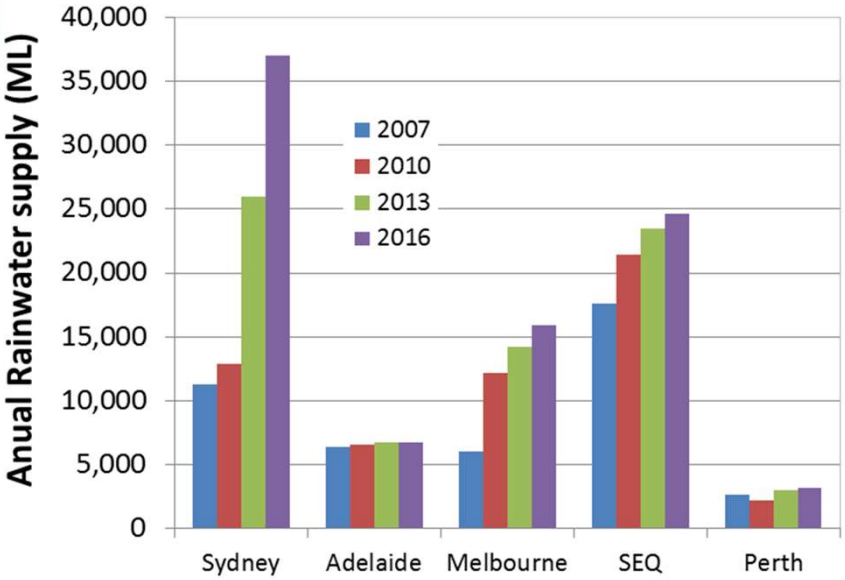
Wastewater



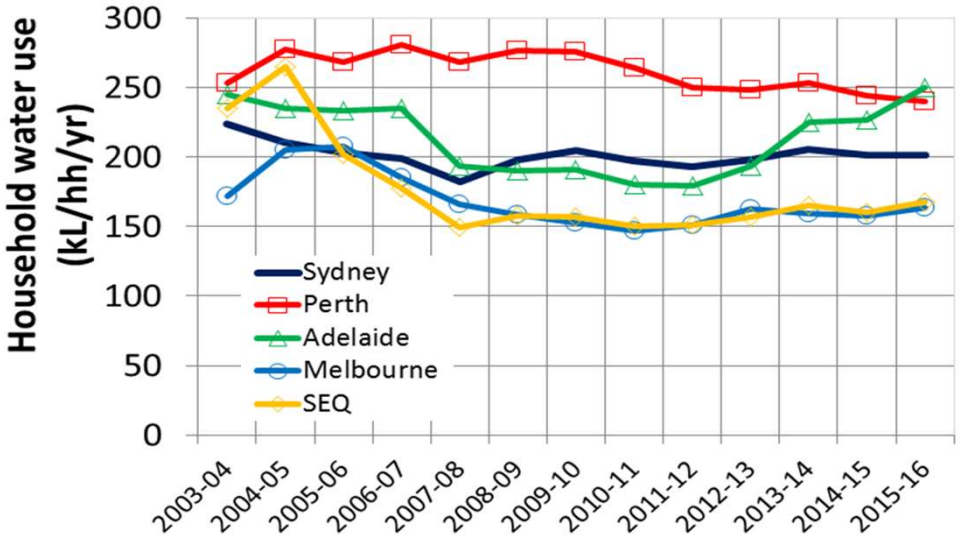
Historical savings

- Most regions reduced household use of utility water (SEQ: -28%, Adel: +2%) (A)
  - **Melb = -8%**
- Dwelling growth of 30% (SEQ) to 15% (Syd)
- All regions increased rainwater harvesting (B) and household water efficiency (C) since 2007
- Annual reductions in utility water use from 46.5 GL (Syd) to 3.3 GL (Adel)
  - **Melb = 33 GL**

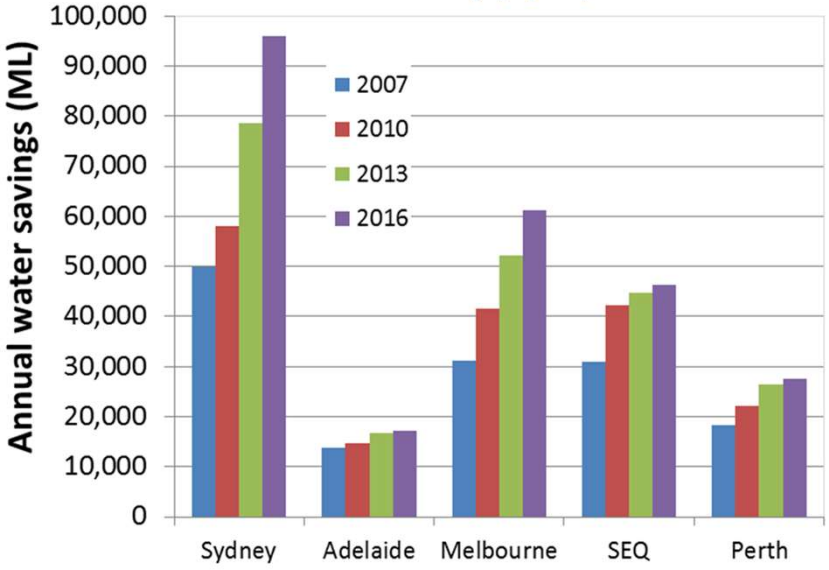
Rainwater harvesting (B)



Household water use (A)



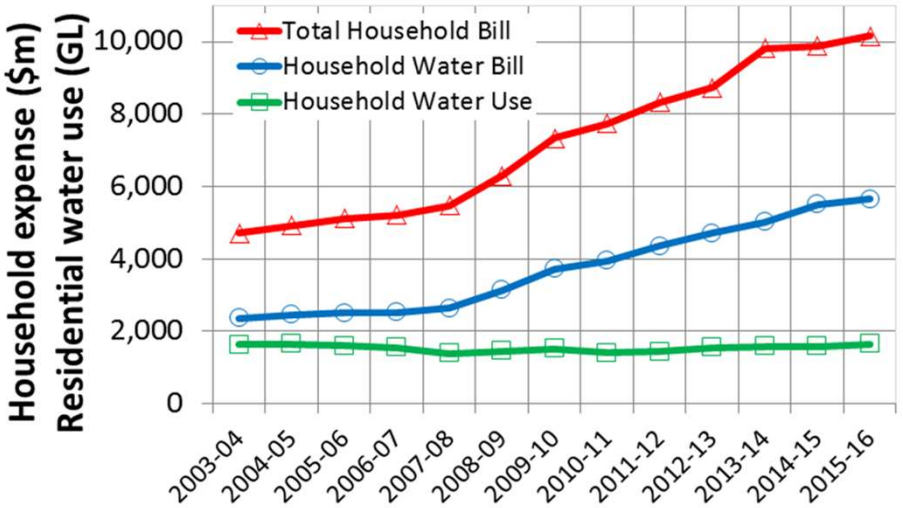
Water efficiency and rainwater harvesting (c)



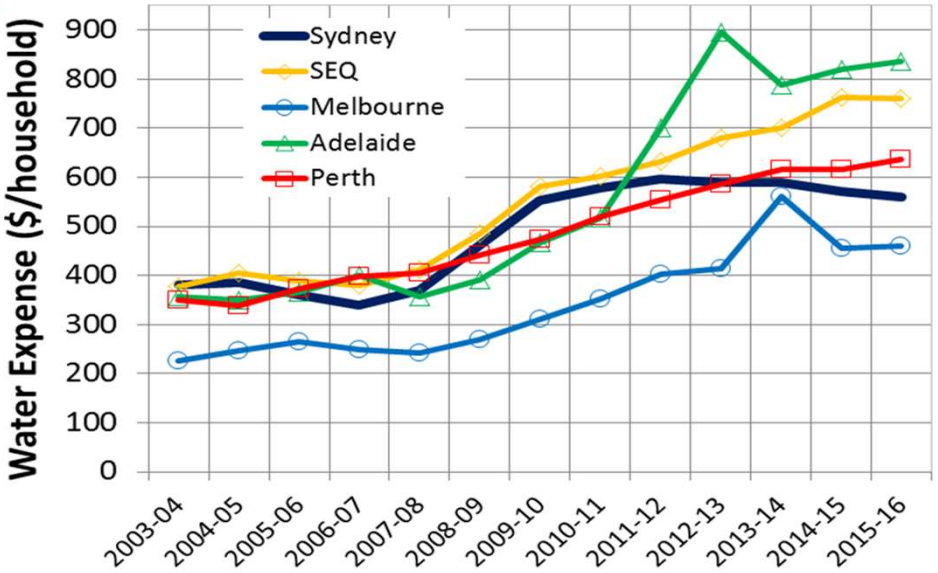
Historical economics

* Expenses for utility urban water and sewerage services increased by $6.7 b (95%) for all users and by $5.5 b (116%) for households (A).
* Real growth in household expenses for utility water services (B)
  * **Melb households 143%, customers 110%**
* Growth in utility water operating costs (C) - Lowest impact in Sydney due to highest water saving – downward pressure on utility water bills
  * **Melb utilities: 111% - 199%**

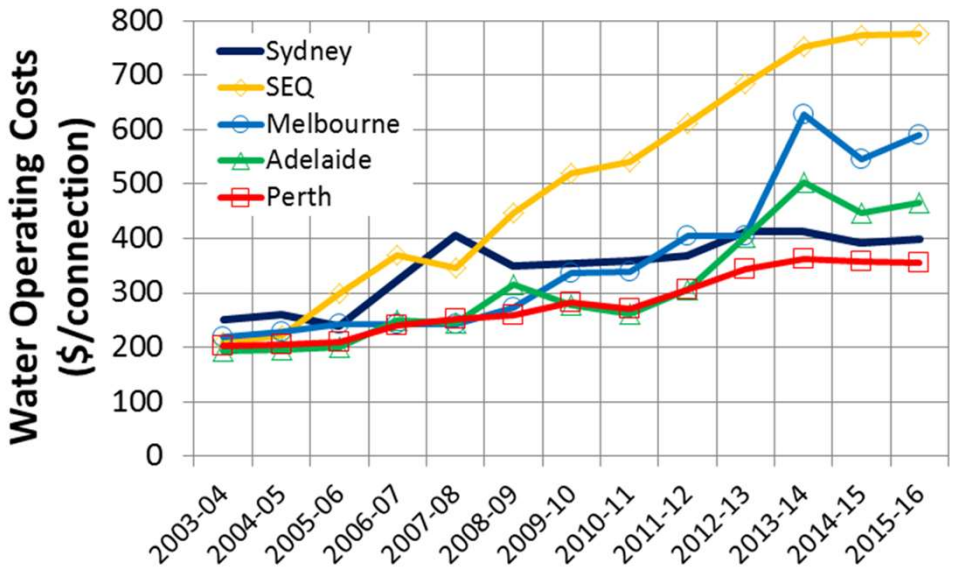
National urban water bills (A)



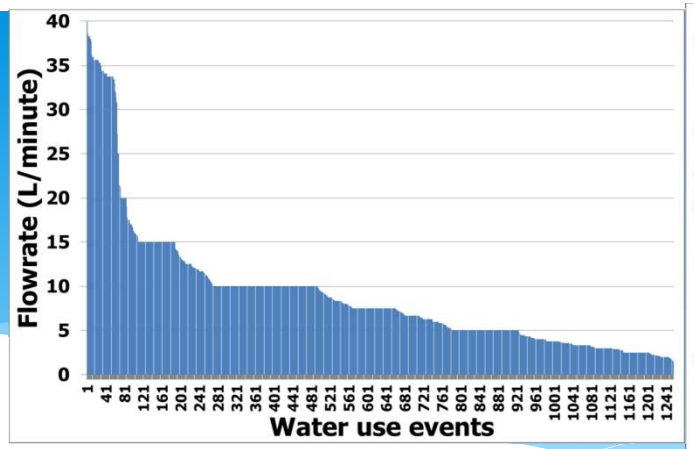
Household expense for utility water services (B)

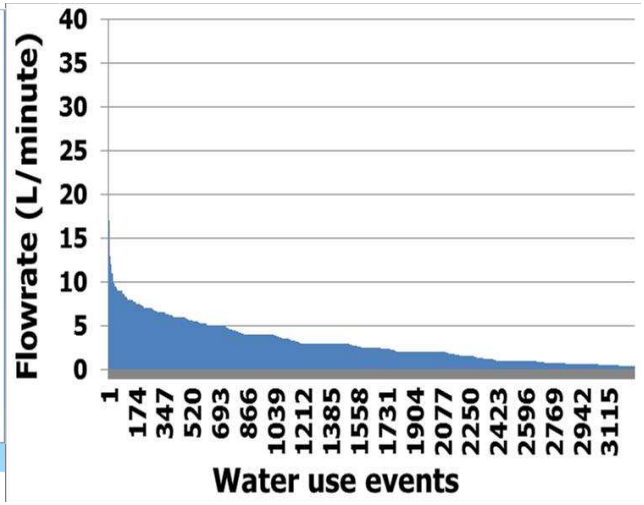


Utility water operating costs (C)



Household welfare

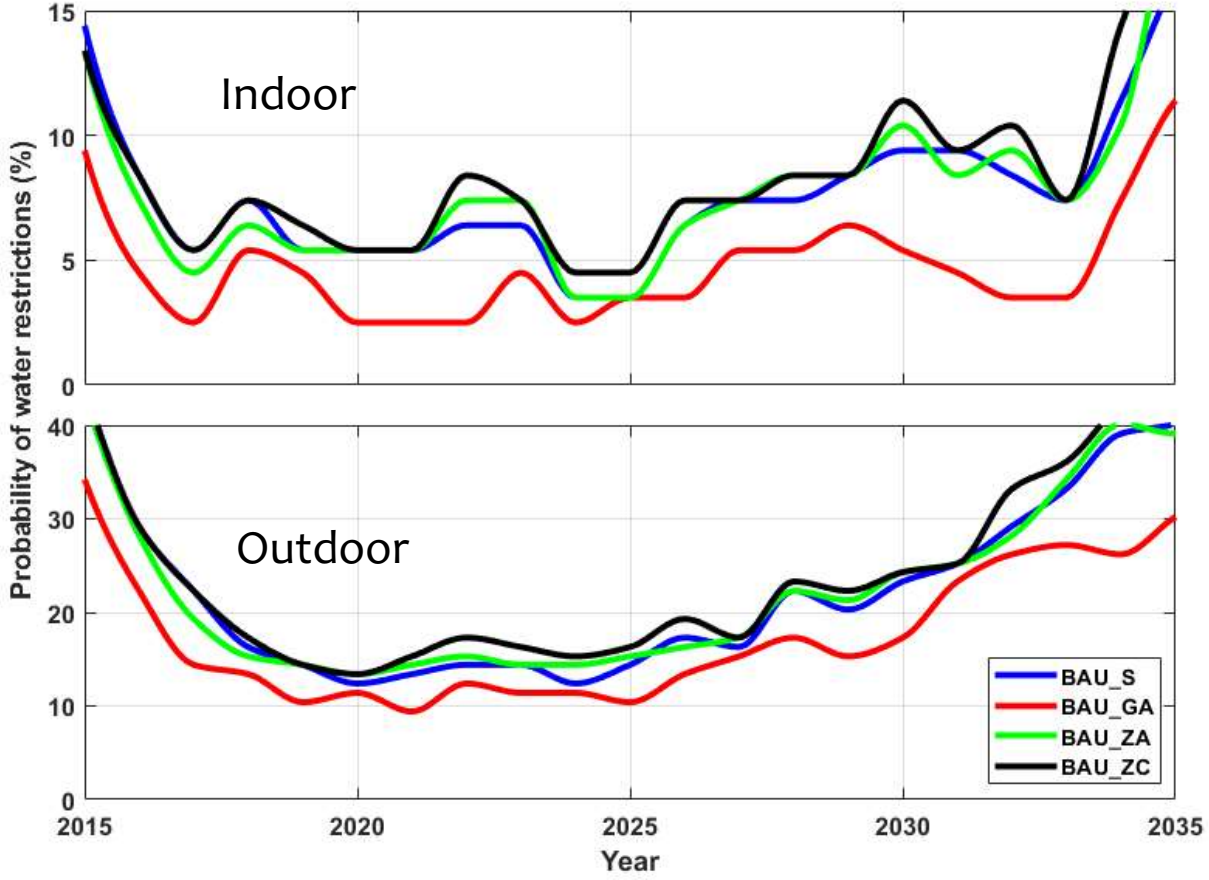




* Household expenses for utility water services the smallest proportion of available median income in Melbourne (1.18%) and largest proportion in Adelaide (2.52%)
  * Smallest change in Sydney (0.08%)
  * Largest change in Adelaide (1.04%)
* Low income houses (< $650/week)
  * Water expense greater than 2.3% for 17% of income for Sydney dwellings
  * Greater than 10.5% of income for 23% of Adelaide houses
  * 9.6% to 5.8% of income in SEQ, Perth and Melbourne
  * **Greater than 5.8% of available household income in 17% of Melbourne Households**
* ***Higher growth in household water savings has driven down utility water tariffs which decreases household expenses for all Sydney people – especially low income houses***

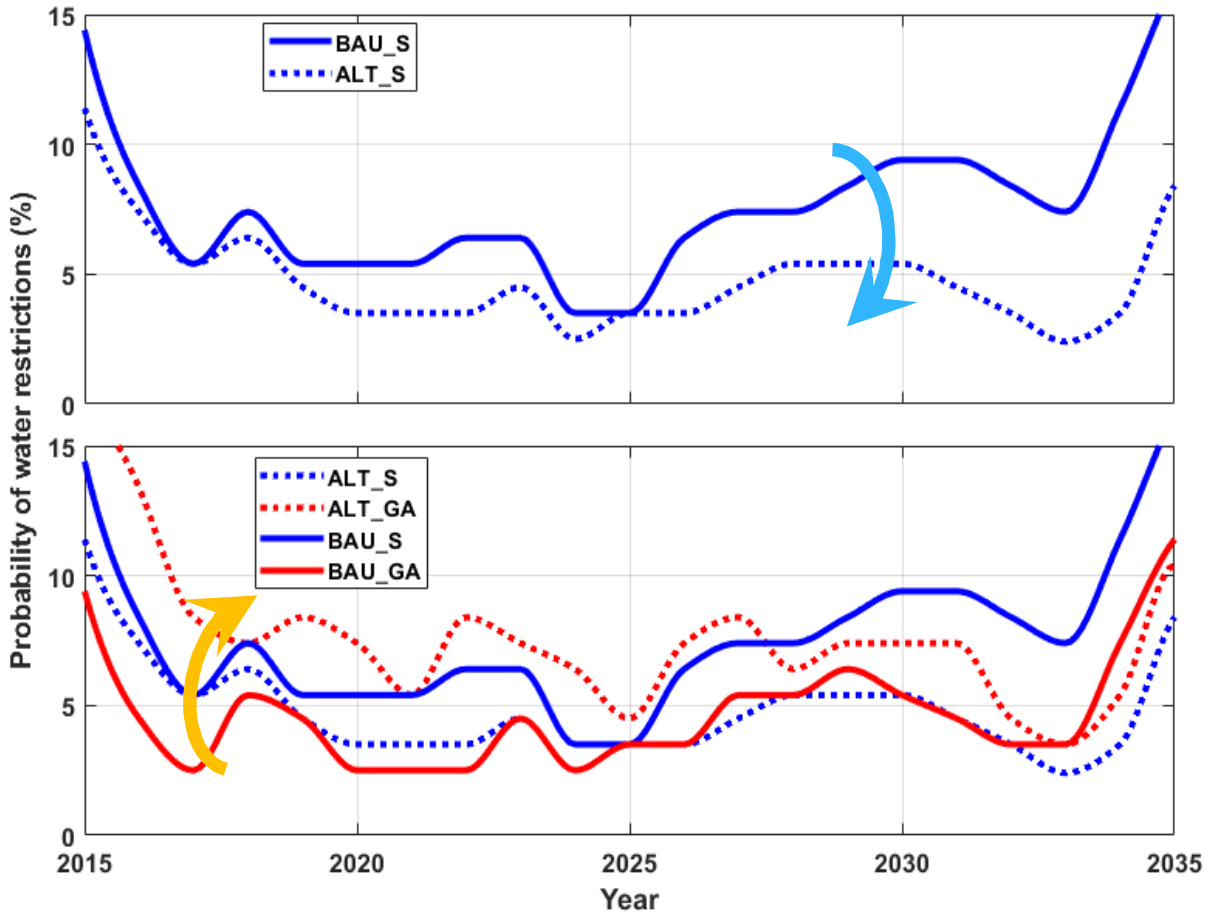
Water Security (impact of averages)

- Assessment of BAU:
  - Bottom up = BAU_S
  - Global avg = BAU_GA
  - Zone avg = BAU_ZA
  - Seasonal zone avg = BAU_ZC
- Different average inputs = variable understanding of security
- Traditional global average input over-estimates security



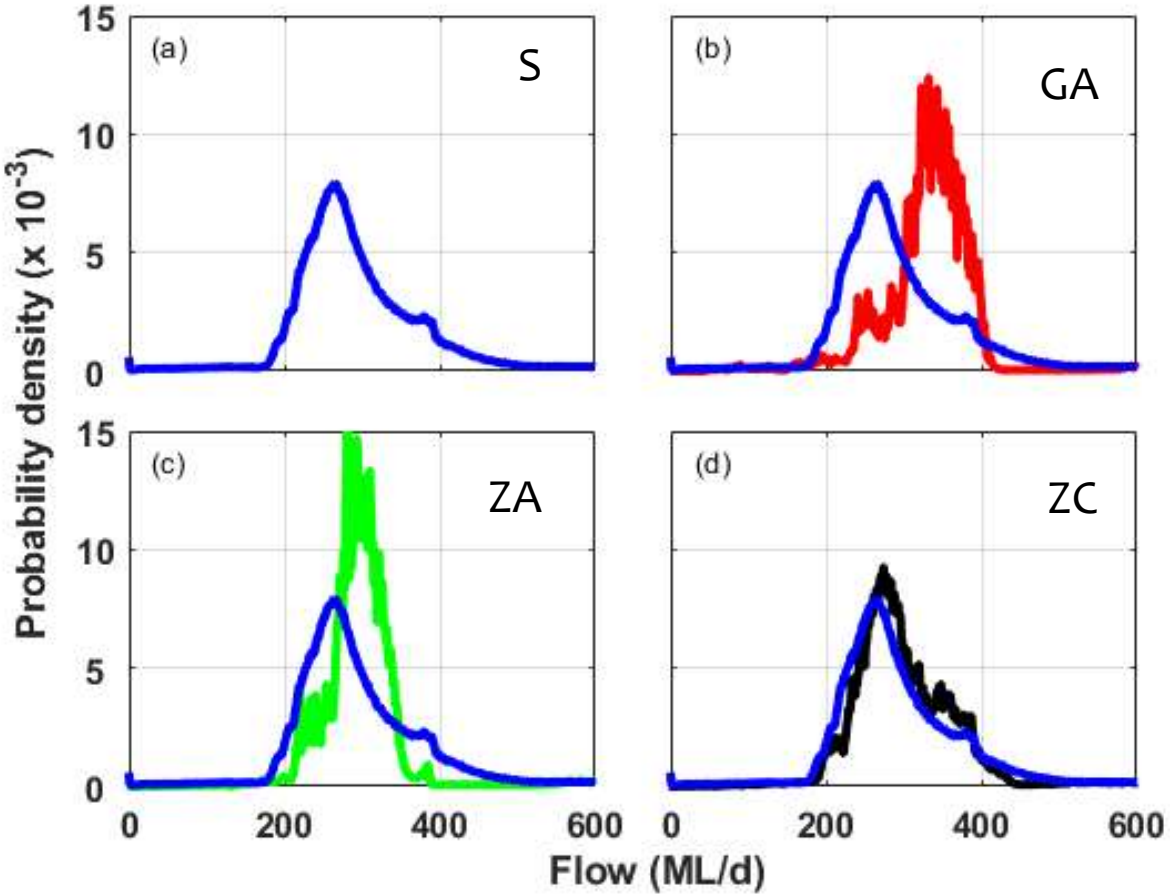
Water security and local solutions

- Building scale policy
  - BASIX drivers transferred to Melbourne
  - ALT_S
  - Improved water security
- Average inputs create an ***illusion*** of no or worse security benefit from distributed solution



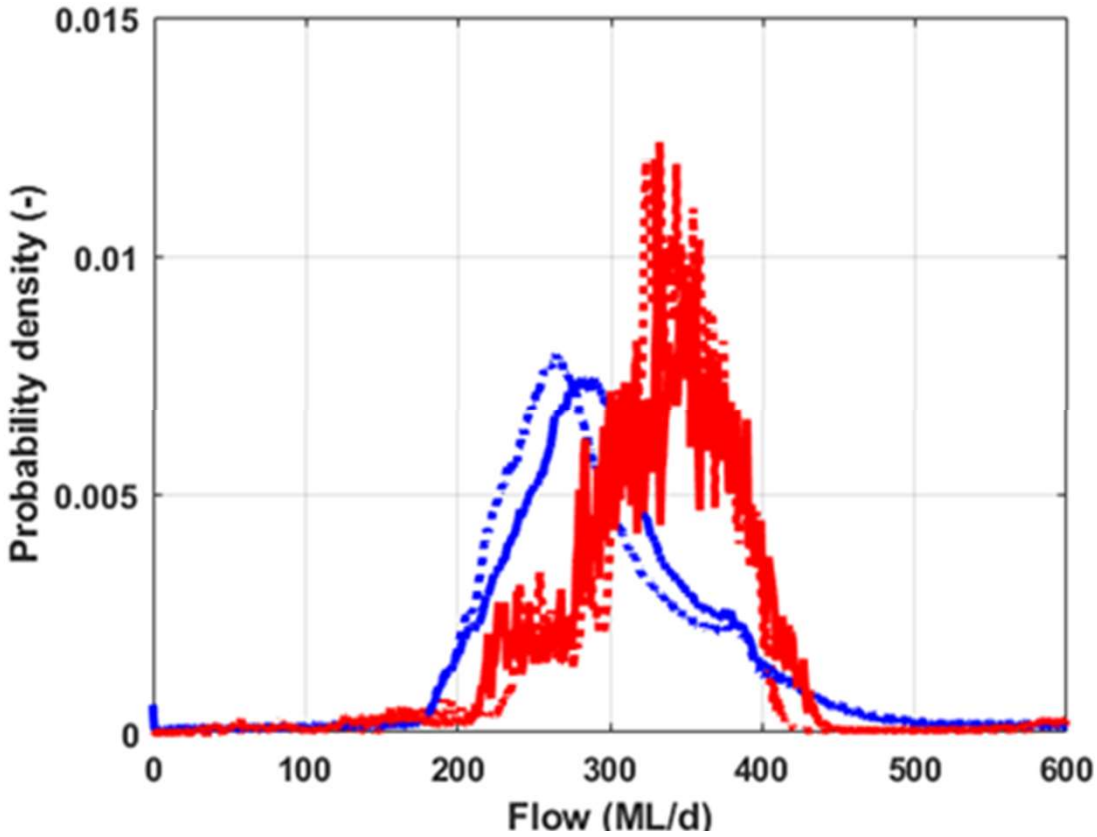
Water distribution infrastructure (impact of averages)

- Bottom up systems analysis (Blue) verses averages
- Traditional use of global average demands (Red) over-estimates magnitude and patterns of demands
- Use of zonal average demands (Green) improves results but still incorrect pattern and magnitude
- Zonal average with seasonal pattern (Black) improves results



Alternatives, averages and distribution infrastructure

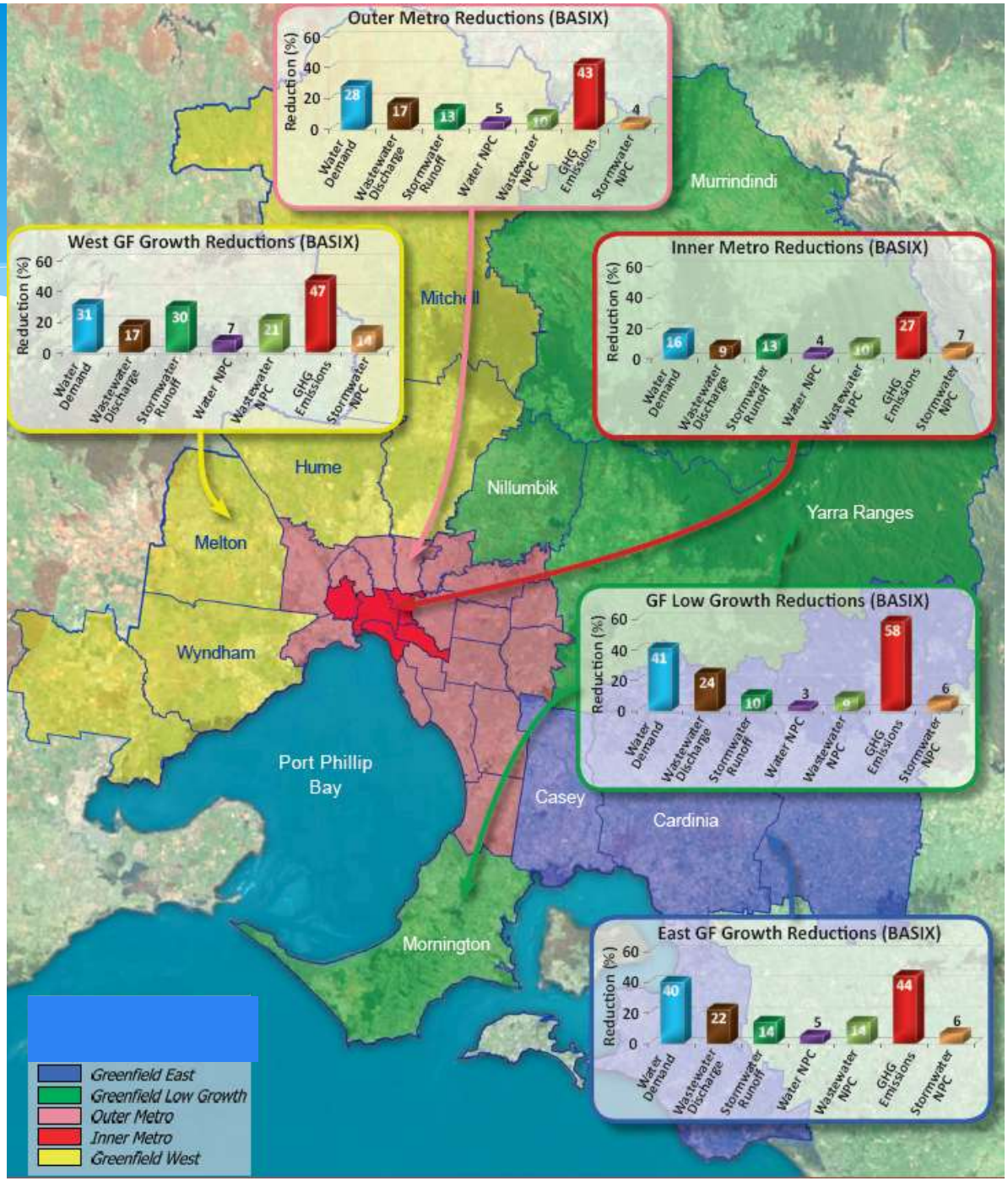
- Bottom up analysis showed reduced flows in infrastructure created by distributed solutions
- But global average inputs (red) show higher flows and no benefits from distributed solutions



Targets & potential

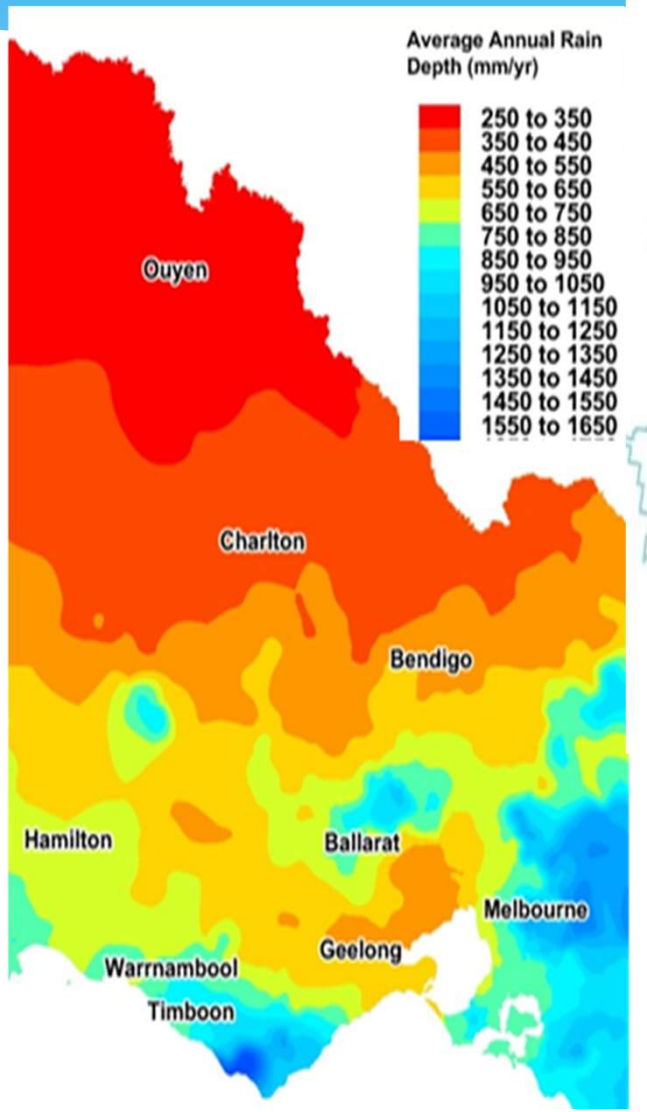
Local targets (weighted avg)

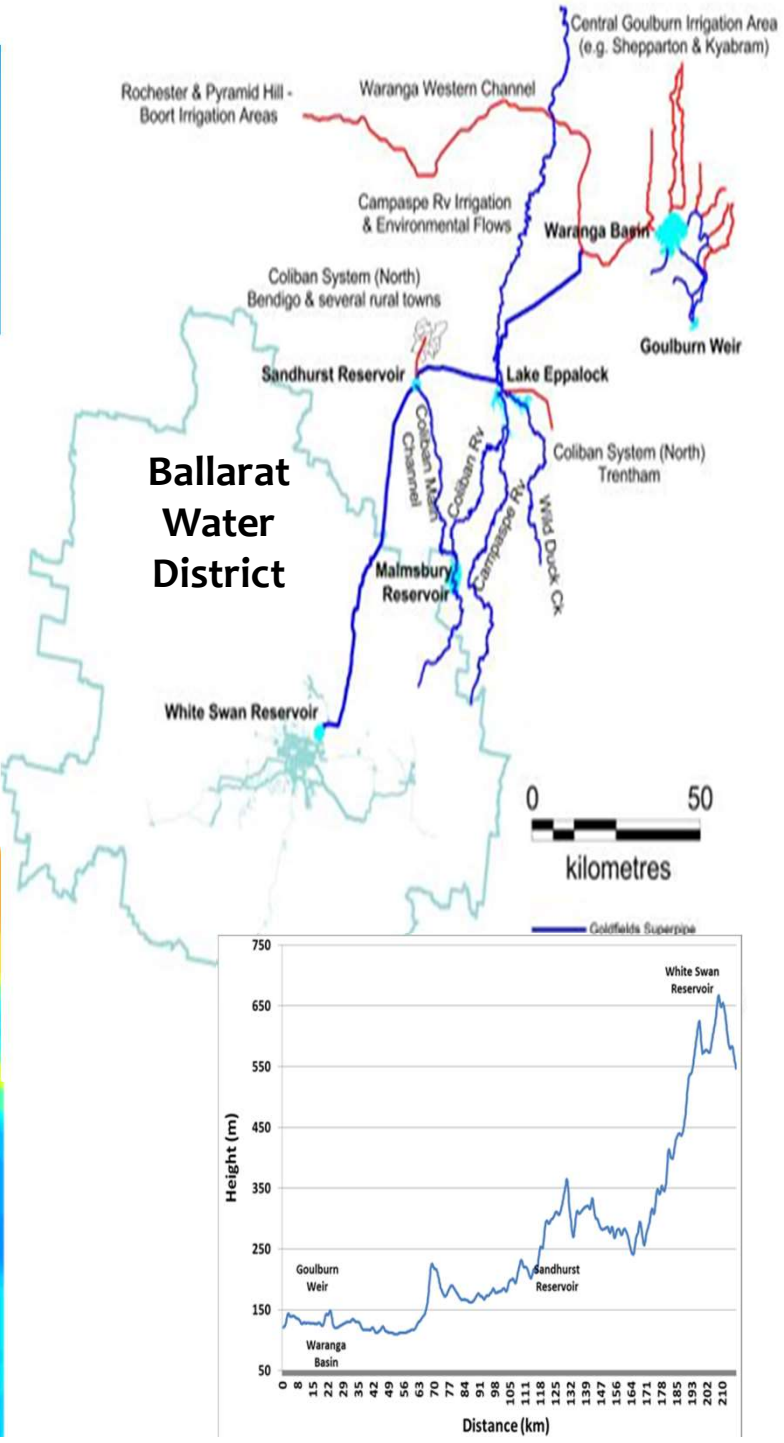
Zone	RW	WEA	SW
WEST GF	20%	33%	26%
East GF	27%	32%	21%
GF Low	25%	31%	23%
Outer Metro	25%	30%	23%
Inner Metro	23%	28%	22%



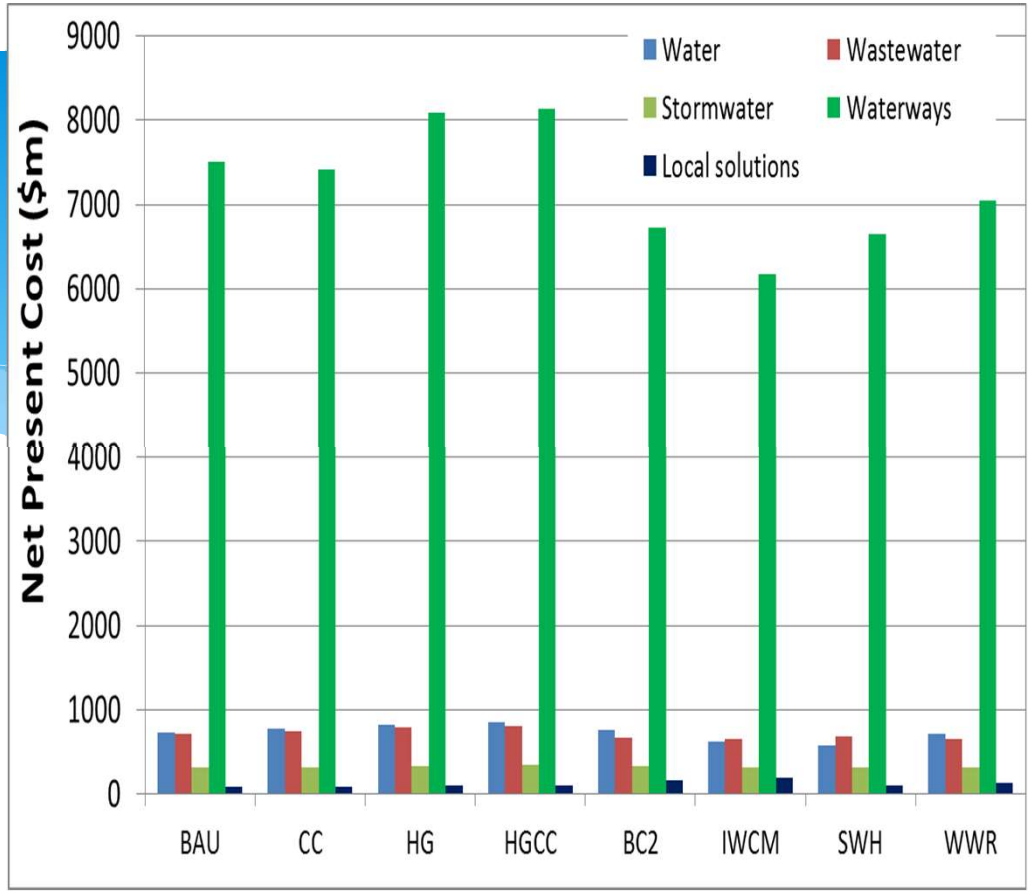
Ballarat

- Ballarat Water district is linked, across different climates to multiple river systems
- Moorabool, Yarrowee, London, Campaspe and Goulburn Rivers





Results



* Impacts on waterways (pollution), water supply and wastewater management dominate costs
  - Climate change
    - increases water demands and flooding, decreases streamflow and stormwater runoff
    - Increases costs of water and wastewater services and local solutions

* High growth scenario increases all costs & impacts – worsens climate change impact
* All mitigation options increase local costs to reduce water, wastewater and waterways costs

Insights

* The stormwater and water cycle challenge is escalating
  * Urban flooding and waterway degradation is increasing
* Definition of water sensitive continues to narrow (captured)
* Separate siloed and centralised average analysis continues
  * Creates illusion of diminished opportunity for alternative solutions at multiple scales
  * An illusion that only centralised solutions provide benefits
* Declining diversity of contributions and solutions
* However, relative to population, institutional and climate challenges, there has been progress to more water sensitive cities