Improving Understanding of Water Demand Drivers and the Implications for Medium and Long-term Forecasting

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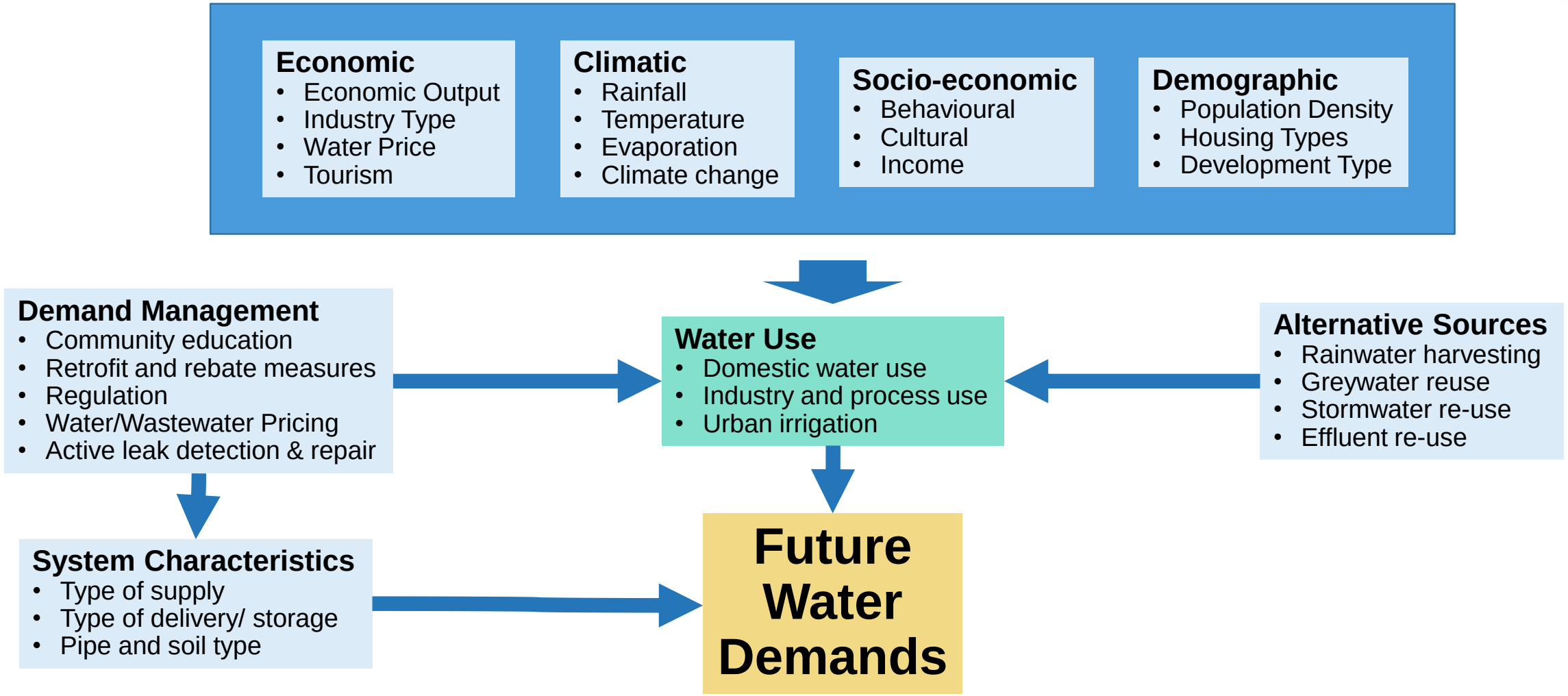
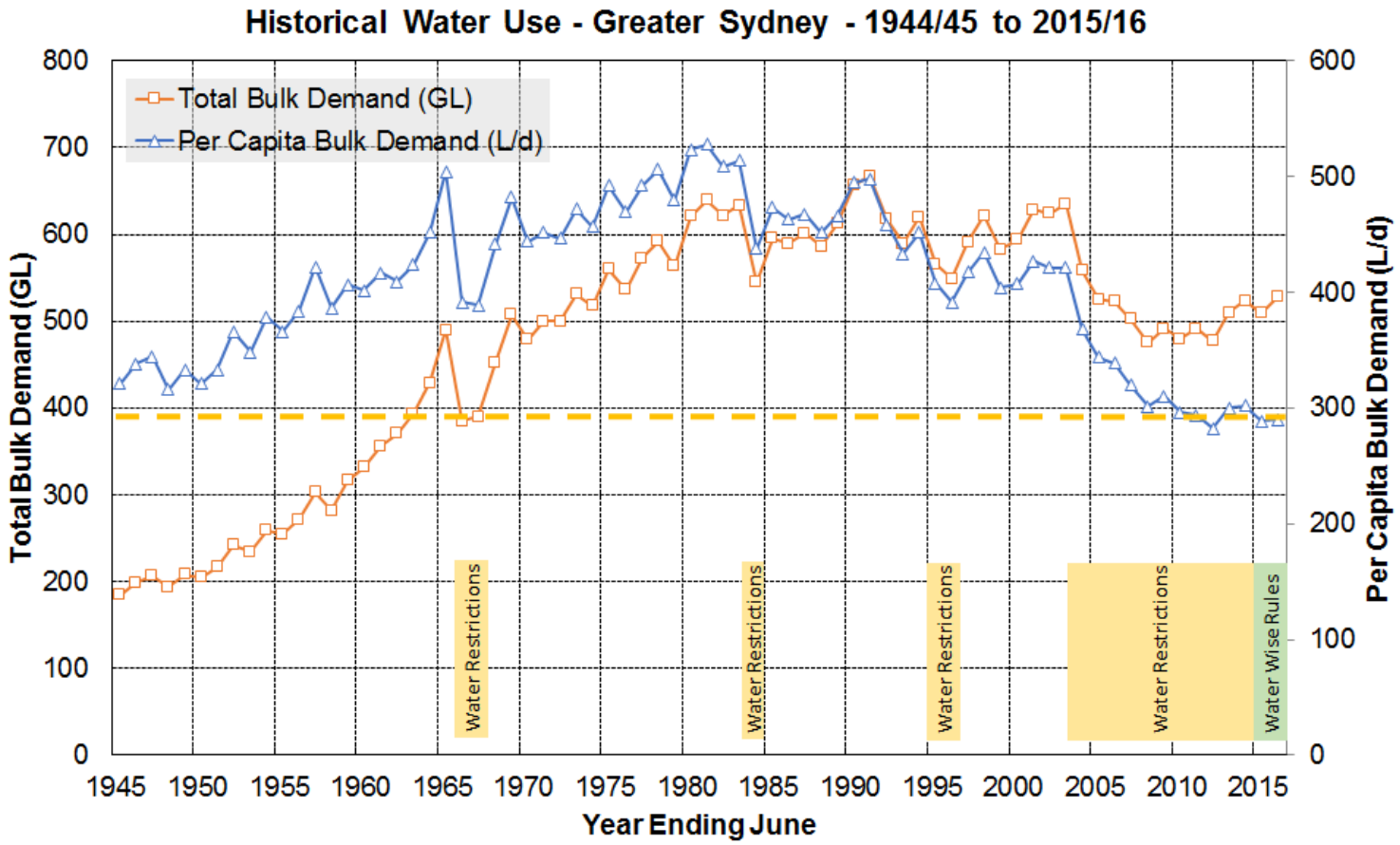
Introduction

- Focus on water demands
  - Water demands MATTER!
  - Accurate forecasts have significant implications for forward planning - $$$$$$
  - What are the drivers?
- Analysis of existing customer database information can provide important information

Water Demand Drivers

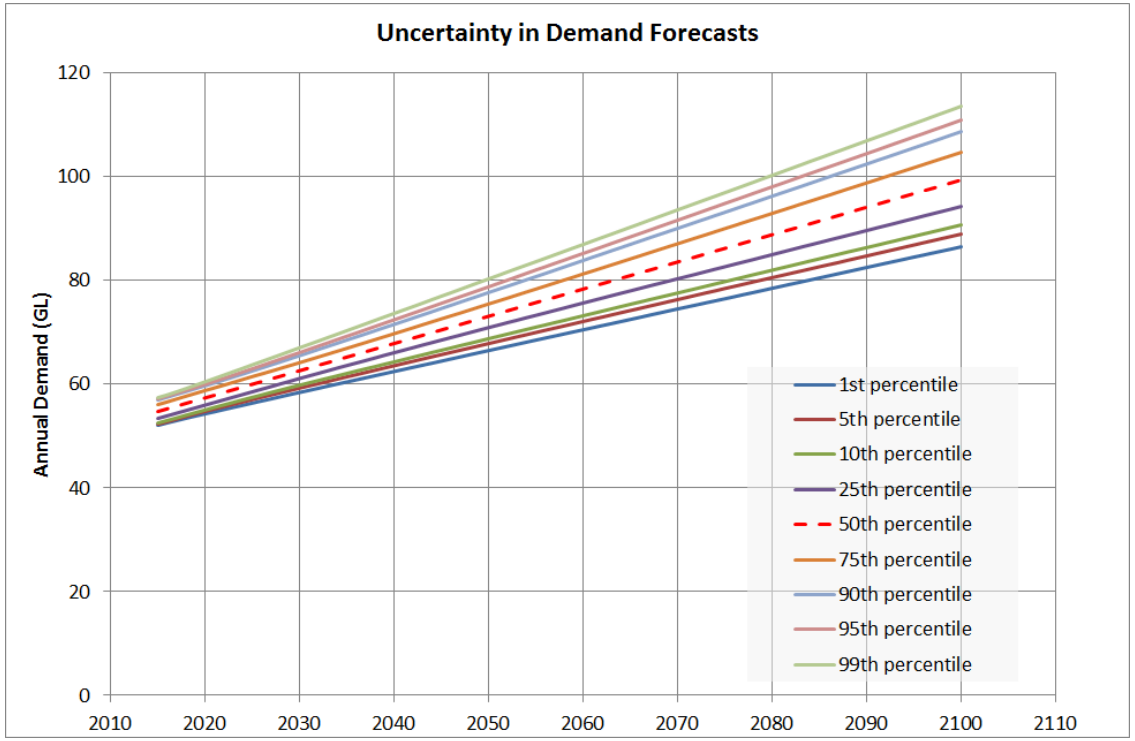


Water Demand History



Uncertainty in Demand Forecasts

- Starting per capita - ± 5%
- Ultimate per capita - ± 10%
- Population growth rate - ± 10%



Approach

- Residential customer database records
- By LGA, suburb or mesh block

Regression equations that predict variations in water demands on the basis of demographic and socio-economic factors

Income elasticities of demands

Future changes in drivers

Potential changes in residential water demand

Regression equations

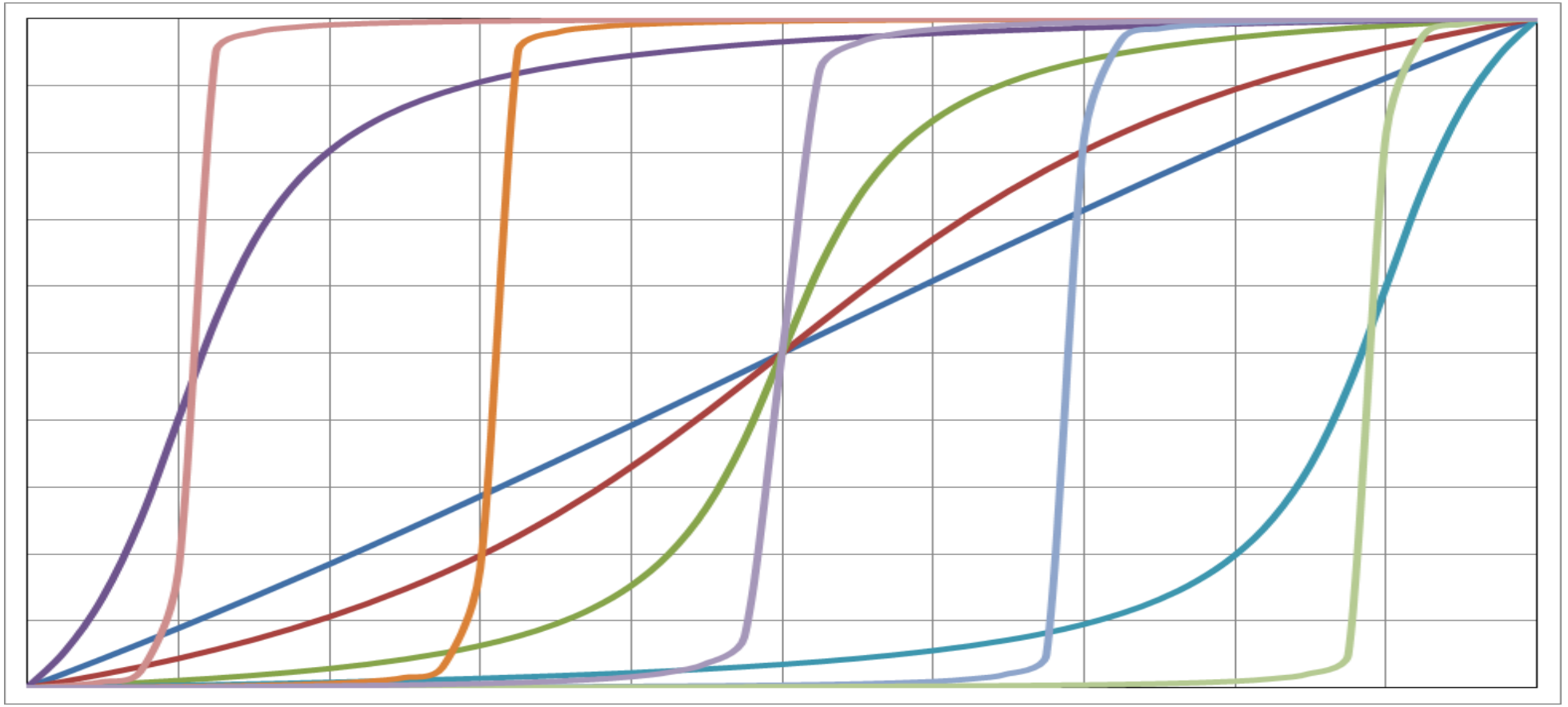
Multi-variable linear regression analysis with non-linear transformation of variables

$$C_i = \beta_0 + \beta_1 f_1(v_{1,i}) + \beta_2 f_2(v_{2,i}) + \ldots\ldots + \beta_n f_n(v_{n,i}) + \varepsilon_i$$

$f_n(v_{n,i}) = v_{n,i}$ If linear

$$f_n(v_{n,i}) = \tan^{-1}\left(\left(v_{n,i} - \frac{(v_{U,n} + v_{L,n})}{2}\right) \times \left(\frac{\pi}{v_{U,n} - v_{L,n}}\right)\right)$$ If non-linear

Typical Transformation Shapes



The Analysis

- Hunter Water service area – by census collector district (pre influence of BASIX)
- Residential unattached consumption per account (kL/yr)
- Drivers:
  - Average household size
  - Average household income
  - Soil permeability index
  - Average lot size
  - Distance from coastline
  - Average construction date

Results

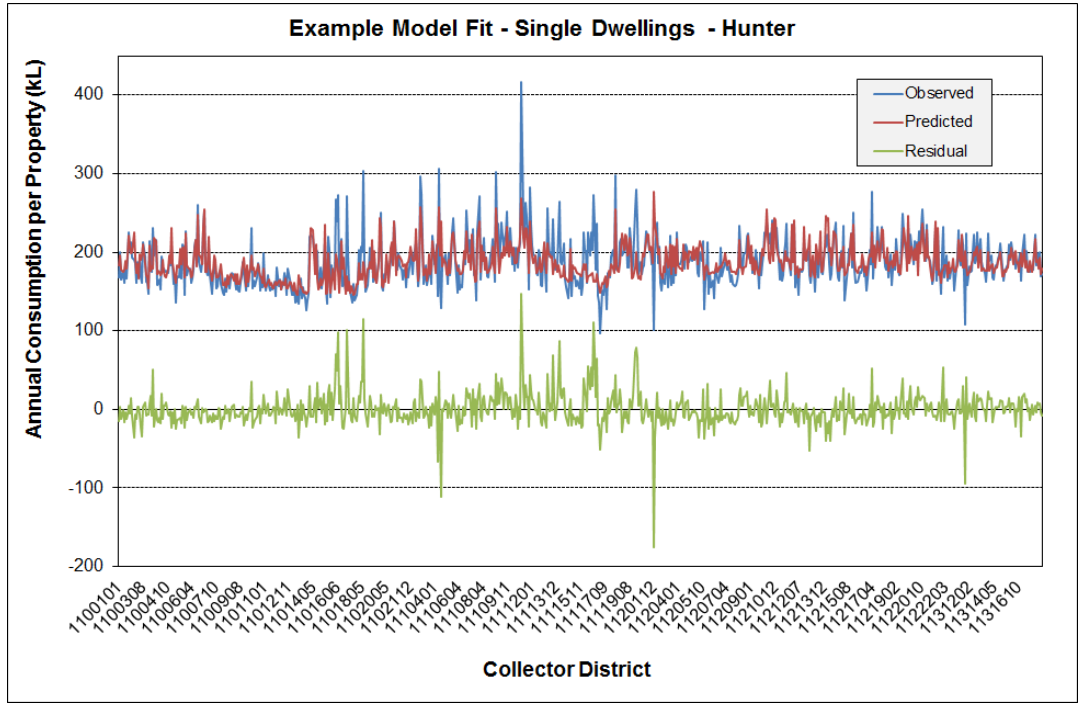
Regression Model Fit

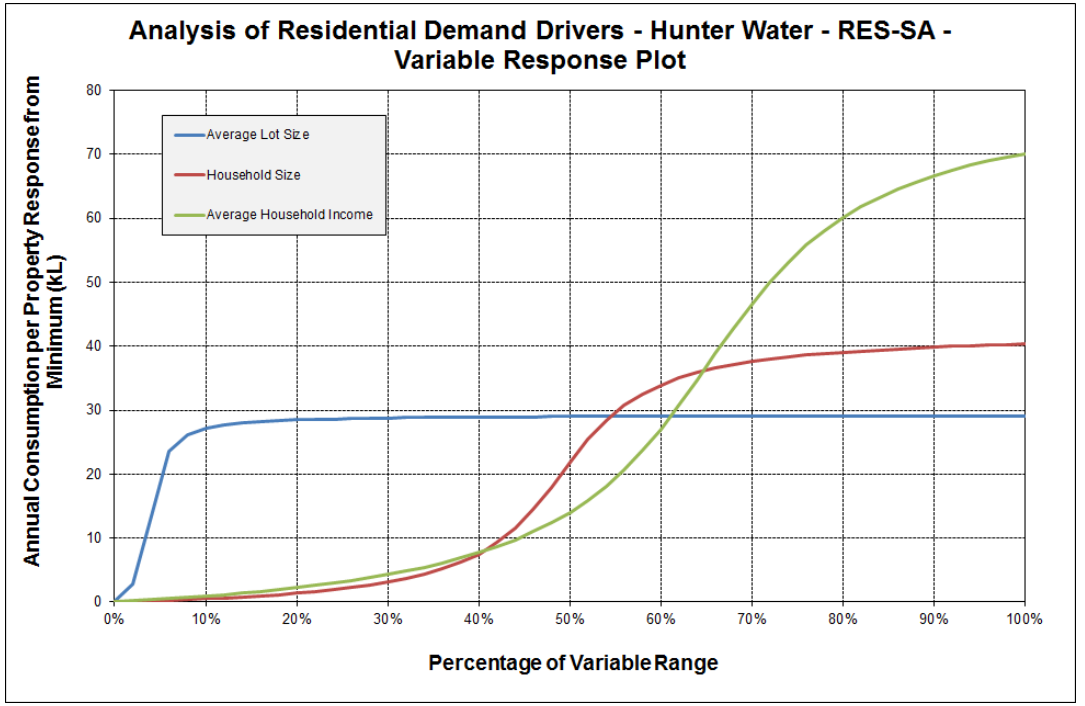
Parameter	Value
R-squared	0.4971
Standard Error of Y Estimate:	21.60
F Statistic:	252.41
Degrees of Freedom	766

Statistical Significance of Variables

Variable	Coefficient	T-statistic
Intercept	208.74	75.40
Household size	10.34	7.82
Real average household income	14.17	10.26
Average lot size	27.24	10.66
Soil permeability index	Not statistically significant	Not statistically significant
Distance from Coastline	Not statistically significant	Not statistically significant
Average construction date	Not statistically significant	Not statistically significant
Average age of residents	Not statistically significant	Not statistically significant

Demand Drivers - Residential





Key Interests in Results

- All things being equal:
  - Newer development implies more efficient fixtures and appliances, smaller lot sizes
  - Not statistically significant as a driver !!??
- Other results consistent with results in other cities

Results in Other Cities

Service Area	Year of Analysis	Income	Household Size	Lot Size	Soil Type	Age of Residents	Water Pressure	Lot Elevation	Micro climate
Sydney	1992	√	√	√					
Canberra	2010	√		√			√	√	
Christchurch	2005	√	√	√	√				
Brisbane	2004	√	√	√		√			√
Melbourne	2000	√	√	√					
Hunter	2009	√	√	√					

Income Elasticities of Demand

$$\varepsilon = \frac{dq}{dp} \times \frac{p(i)}{q(i)}$$

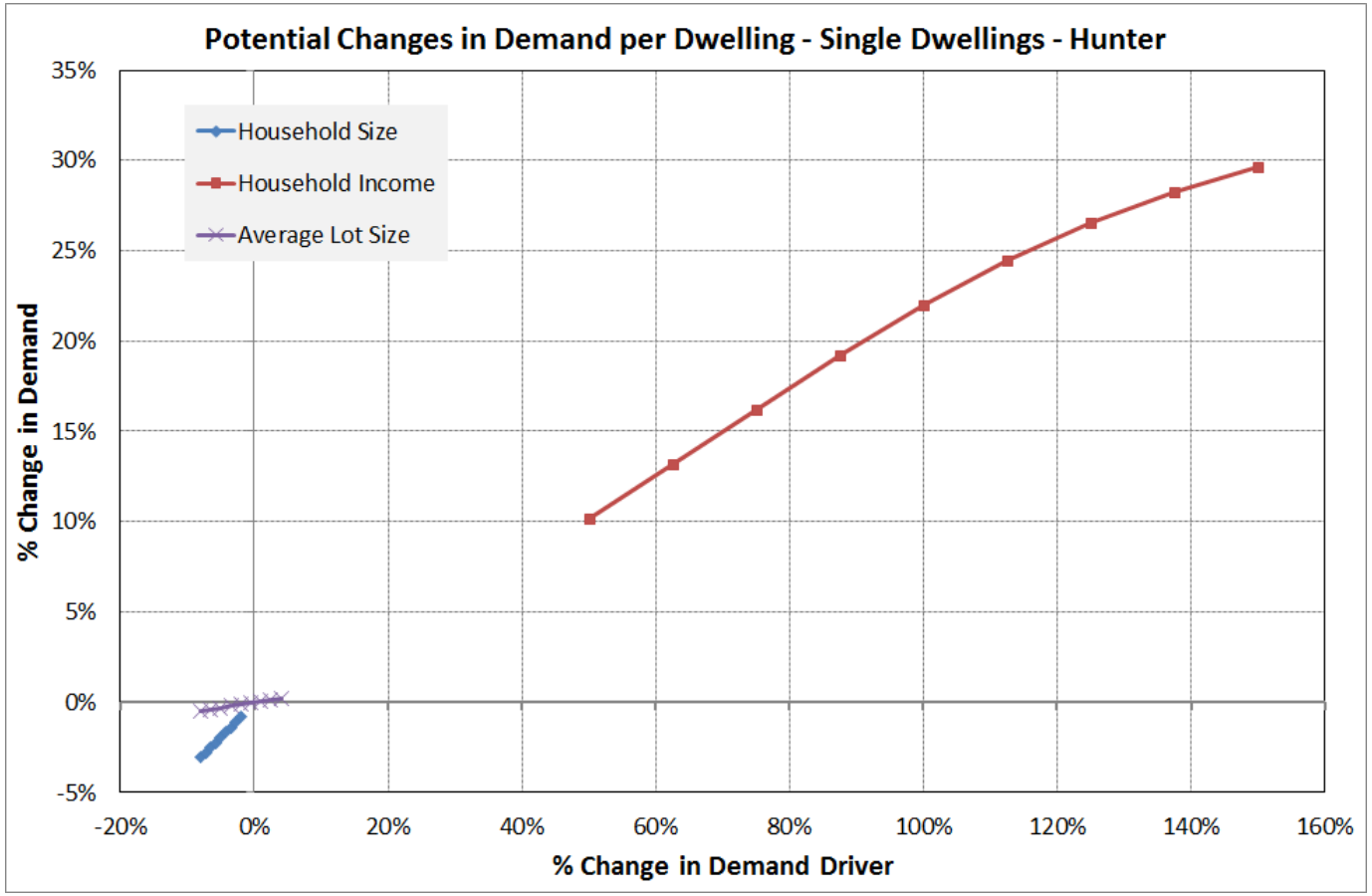
$$\varepsilon = \frac{ln(p_2/p_1)}{ln(q_2/q_1)}$$ Differentiating

$$\varepsilon = \frac{(p_2/p_1 - 1)}{(q_2/q_1 - 1)}$$ Over small ranges

Future Scenarios

Driver	Discussion	Assumed Driver Range
Household size	Falling household sizes have been a general trend for some time in throughout Australia.	-8% to -2%
Real average household income	From 1996 to 2006 real household incomes grew at a rate of approximately 1.5% p.a. in both the Hunter and Sydney regions.	50% to 150%
Average lot size	Over the next 50 years we have a 70% increase in population growth and this new population is in dwellings with lot sizes of +10% or -20% of current lot sizes.	-8% to +4%
Soil permeability index	The average soil permeability index across the CD's is 7.05. If 75% of new development occurs in the inland areas of the supply area with typical indices or between 7 and 8 (7.5 on average)	+1% to +2%
Distance from Coastline	If 75% of future single dwelling development occurs at a distance 50% greater than the current average distance from the coastline, and there is a 100% increase in population, then there will be an approximately 20% increase in distance from the coastline.	+15% to +25%

Changes – existing customer base



More Recent Demand Drivers

- ↓ More water efficient fixtures and appliances
- ↓ Water recycling
- ↓ New housing codes (BASIX)
- ↓ Falling heavy industrial use
- ↓ Higher residential housing densities
- ↓ Rising real water prices
- ↓ Behavioural changes
- ↓ Emphasis on system leakage
- ↑ Increased tourism

Conclusions

- Demand drivers can be better understood using accessible data
- Provides guidance on future challenges
- Influences identified will influence over medium to long term – minimal impact over regulatory periods
- Be cautious about forecasting falling per capita demands until you have the full suite of drivers

Thanks!

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