

Conservation and Gallons per Capita per Day: Some Unresolved Issues

Kurt A. Schwabe

Professor of Environmental Economics and Policy

School of Public Policy

University of California – Riverside

Adjunct Fellow, Water Policy Center, Public Policy Institute of California

Adjunct Professor, Center for Food and Resources, University of Adelaide

Gallons/capita/day (GPCD)

- MWD (1990): 208 gpcd
- MWD (2013): 175 gpcd

Urban GPCD elsewhere...

Israel: 84
Spain: 76
Australia: 80 to 130

Value of a Statistical Life (VSL):

- U.S. \$3.5 million
- Australia \$2.1 million
- Japan \$8.2 million

Other measures? (Miller 2000)

- Disability-adjusted life Years (DALY)
- Quality-adjusted life years (QALY)

Development Index-GDPC

- U.S. \$57K
- Australia \$49K
- Spain \$36K

Other measures?

- HDI
- Ln(GDPC)

Outline

- Gallons Per Capita Per Day (GPCD) – a single confusing measure without a context
- Other single measures that need context
 - Impact factors (for academic journal quality)
 - Publication rates (to measure performance)
 - Income per capita (to measure well-being)
- GPCD and Conservation achievements in California during the Drought (Public Water Agencies)
- GPCD -- the role of water use sector (California Water Service Agencies)
- Example of Relationship between Conservation, Recycling and Imports
- Summary

Unpacking GPCD

Three often reported measures for a particular location, l , and time, t :

1. GPCD_p (w/ leakages/non-revenue). If use total water produced:

$$\frac{\text{total water produced}_{l,t}}{\text{population}_{l,t}} = \frac{\text{total water sales}_{l,t} + \text{leakages}_{l,t}}{\text{population}_{l,t}} \quad (1)$$

2. GPCD_s (w/o leakages). If use aggregate sales to individual sectors, s :

$$\frac{\text{total water sales}_{l,t}}{\text{population}_{l,t}} = \frac{\sum_s \text{total water sales}_{s,l,t}}{\text{population}_{l,t}} \quad (2)$$

- *Sectors s include residential (single- and multi-family), commercial, industrial, and governmental*

3. R-GPCD. If use sales to residential customers, r , alone:

$$\frac{\text{total residential sales}_{l,t}}{\text{population}_{l,t}} = \frac{\sum_r \text{total water sales}_{r,l,t}}{\text{population}_{l,t}} \quad (3)$$

- *Residential sectors r include single-(SFR) and multi-(MFR) family units*

Unpacking GPCD

General issues with not recognizing differences between three:

1. $GPCD_p > GPCD_s > R-GPCD$
 - *Comparisons of “efficiency of water use” not that informative*

2. $GPCD_p$ less responsive to prices and mandates confronting individual sectors
 - *Becomes more significant the larger the system loss is or the larger the nonrevenue water sector is*
 - *May require individual sectors to conserve more than state-mandate if not accounted for*

3. $R-GPCD_{\text{single-family residential}} > R-GPCD_{\text{multi-family residential}}$
 - *Although individual pricing and metering likely more effective with R-GPCD and thus may reduce that difference*

Unpacking GPCD

Consider $GPCD_s \dots$

$$GPCD_s = \frac{\sum_s \text{total water sales}_{s,l,t}}{\text{population}_{l,t}} =$$

$$= \frac{\text{residential sales} + \text{commerical sales} + \text{industrial sales} + \text{govenmental sales}}{\text{population}}$$

Note: when you sum across **these** => treat as *perfect substitutes*

- *Each provides different services and value to society*
- *Not equivalent in terms of what each provides society*
- *Not equivalent in terms of economic efficiency*

Takeaway:

Difficult to make judgements/comparison regarding efficiency of water use or value to society from changes in water use using this measure

Unpacking GPCD

From SWRCB website....

“Factors that can affect per capita water

It is not appropriate to use Residential Gallons Per Capita Day (R-GPCD) water use data for comparisons across water suppliers, unless all relevant factors are accounted for. Factors that can affect per capita water include:

- Rainfall, temperature, and evaporation rates
- Population growth
- Population density
- Socio-economic measures
- Water prices”

-
- ⇒ Acknowledges how the “*l*” and “*t*” in equations (1), (2), and (3) matter
 - ⇒ Overlooks how the distribution of water use across sectors “*s*” within a district might matter...*even between single-family and multi-family residents*

Unpacking GPCD

Questions to consider:

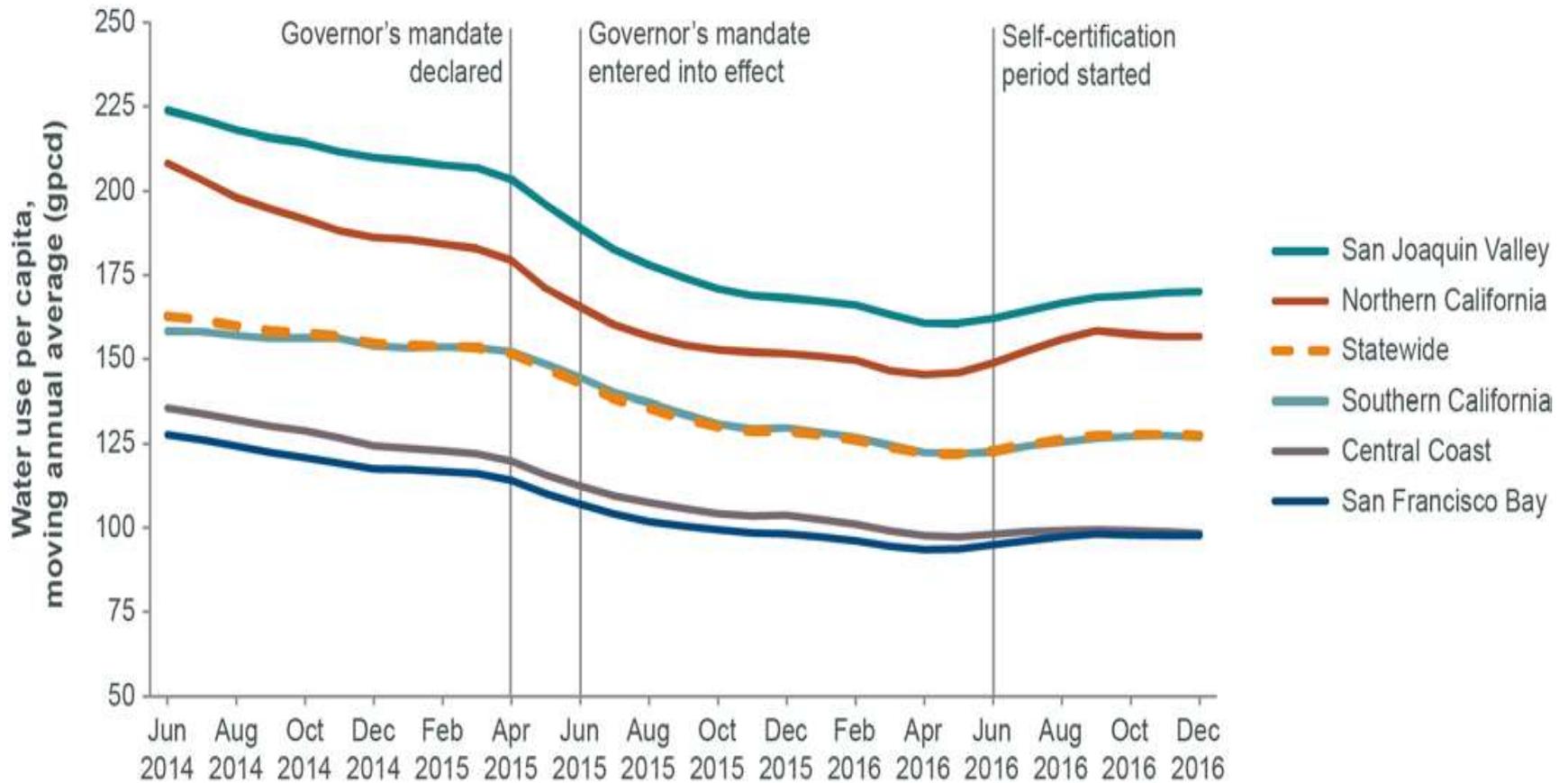
- How much does location of district and distribution of water use across sectors matter in terms of gpcd values?
- How much does location of district and distribution of water uses within district matter in terms of ability to conserve water?
- What other factors influence water districts ability to conserve water?

Urban drought study approach

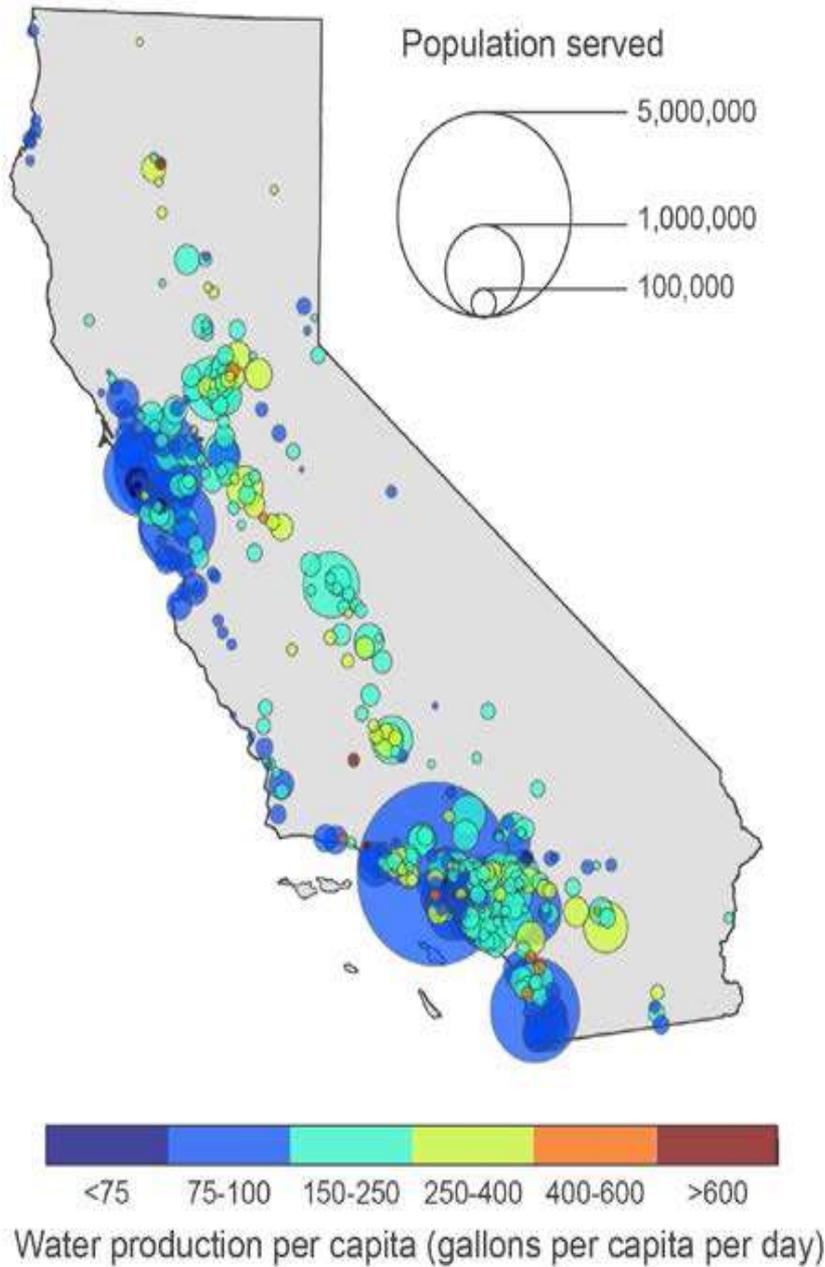
(Mitchell et al. 2017)

- Qualitative information on drought preparation and response
 - Urban supplier survey (~170 suppliers, representative sample)
 - Focus groups and interviews with state officials and local suppliers
 - Historical lit review
- **Quantitative analysis of demand response**
 - **All urban suppliers (~410) at the utility level**
 - **Cal Water Service districts (24) at customer category and household level**

Statewide per capita water use by region (2014-2016) (produced water / population)



- June 2015 to Feb 2016: statewide savings ~ 23.9%
- June 2016 to Dec. 2016: statewide savings ~ 19.5%



Urban water supplies by size and water use in 2013

(Escriva-Bou et al. 2017)

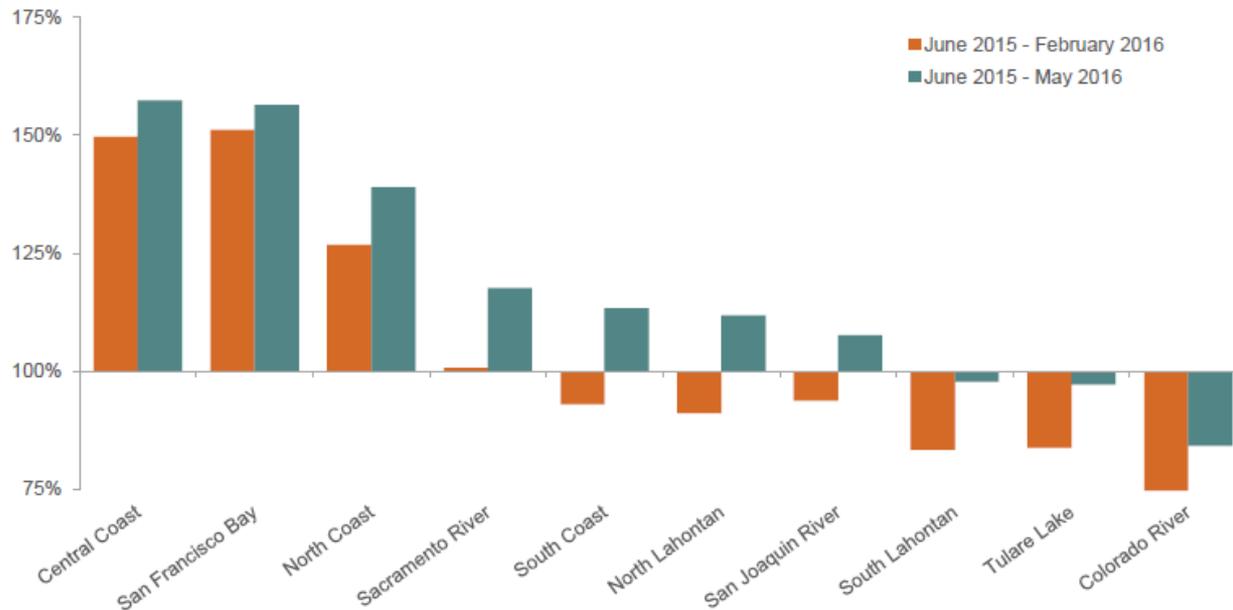
- Coastal areas
 - greater population
 - greater population density
 - milder climate
 - higher incomes
- Milder summer climate + smaller lots and landscaped area = lower water use (Hanak and Davis 2006)

Degree of Conservation Compliance: Location matters

(Escriva-Bou et al. 2017)

FIGURE A5

Compliance ratios during the water conservation mandate period for the initial conservation mandate period (June 2015–February 2016) and for the full conservation mandate period (June 2015–May 2016)



SOURCE: Author calculations using data from State Water Board "Water Conservation Portal – Conservation Reporting."

NOTE: A compliance ratio of 100 percent means that the region cumulatively saved as much water as required by the state mandate.

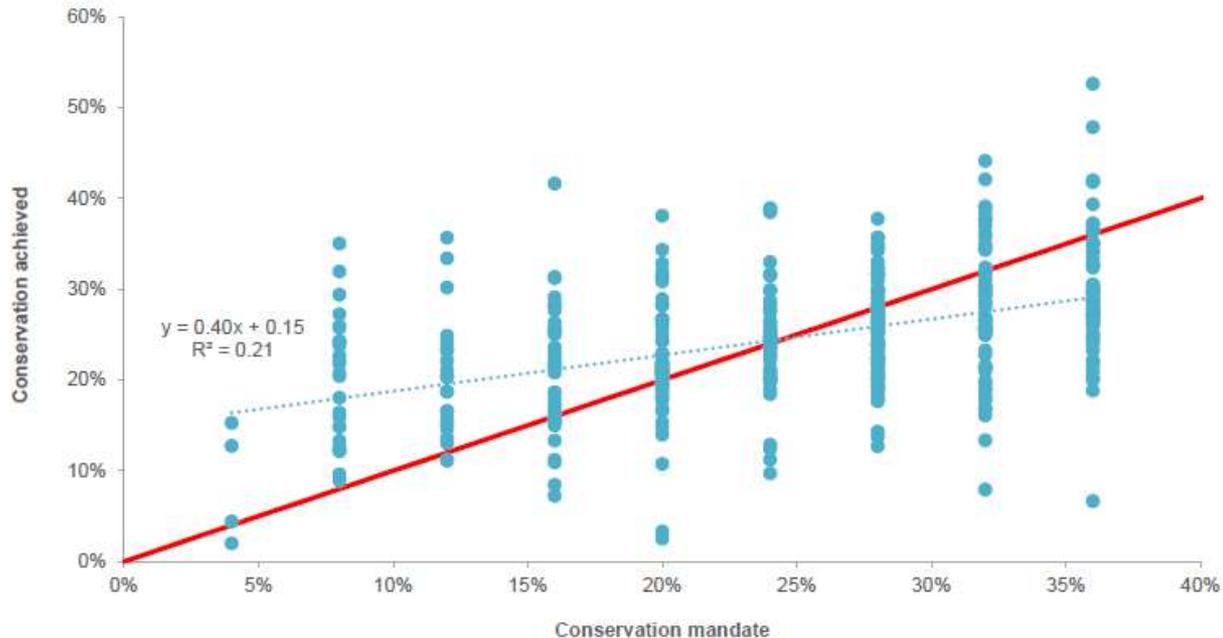
EQUATION A1

$$compliance\ ratio = \frac{savings\ rate}{water\ conservation\ requirement}$$

Conservation mandate vs conservation achieved during conservation period

(Escriva-Bou et al. 2017)

FIGURE A9
Conservation mandate vs. conservation achieved during the conservation period

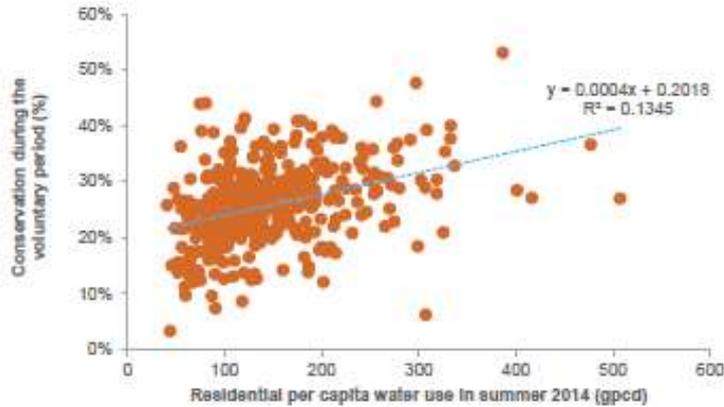


SOURCE: Author calculations using data from State Water Board "Water Conservation Portal – Conservation Reporting."

NOTES: Each dot represents a supplier. Water conservation is calculated for the period June 2015 – February 2016. The red line is a 1:1 slope line representing the point where the suppliers should be to achieve their mandate: suppliers above the line met the mandate for this period, whereas suppliers underneath the line failed to achieve the mandate.

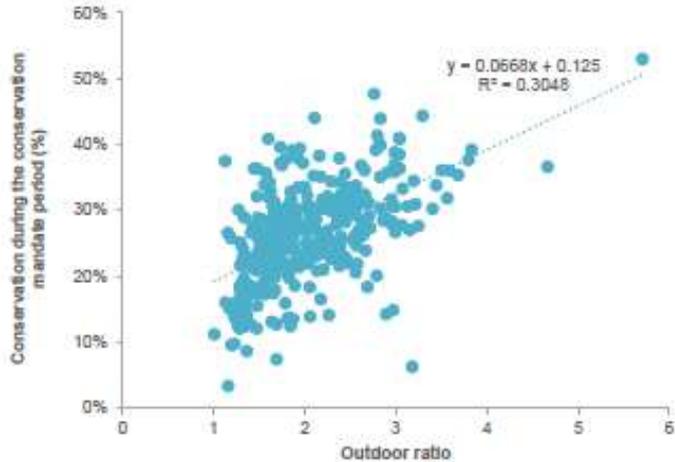
Conservation with respect to outdoor water use

(Escriva-Bou et al. 2017)



Conservation during voluntary period relative to R-GPCD in summer 2014

=> higher R-GPCD in summer, greater conservation achieved

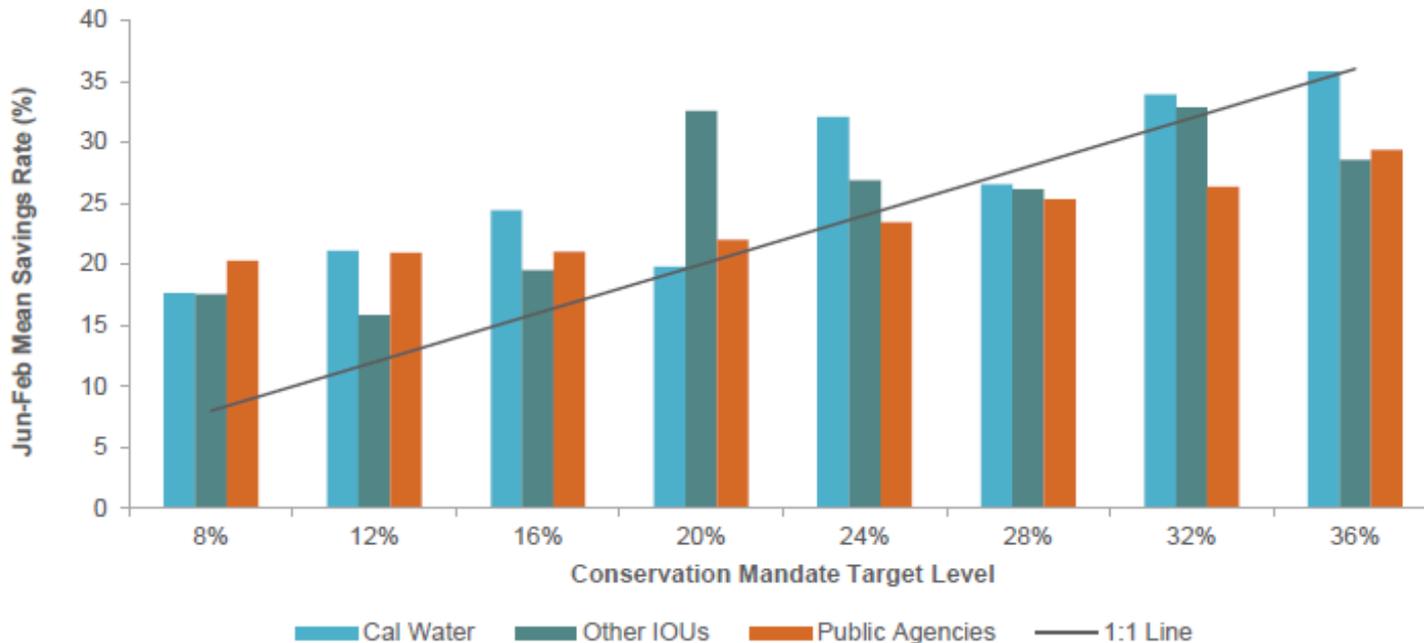


Conservation during mandate period relative to outdoor water use ratio (outdoor/indoor in 2013)

=> higher proportion of outdoor, greater conservation

How does the distribution of water use by sector matter?*

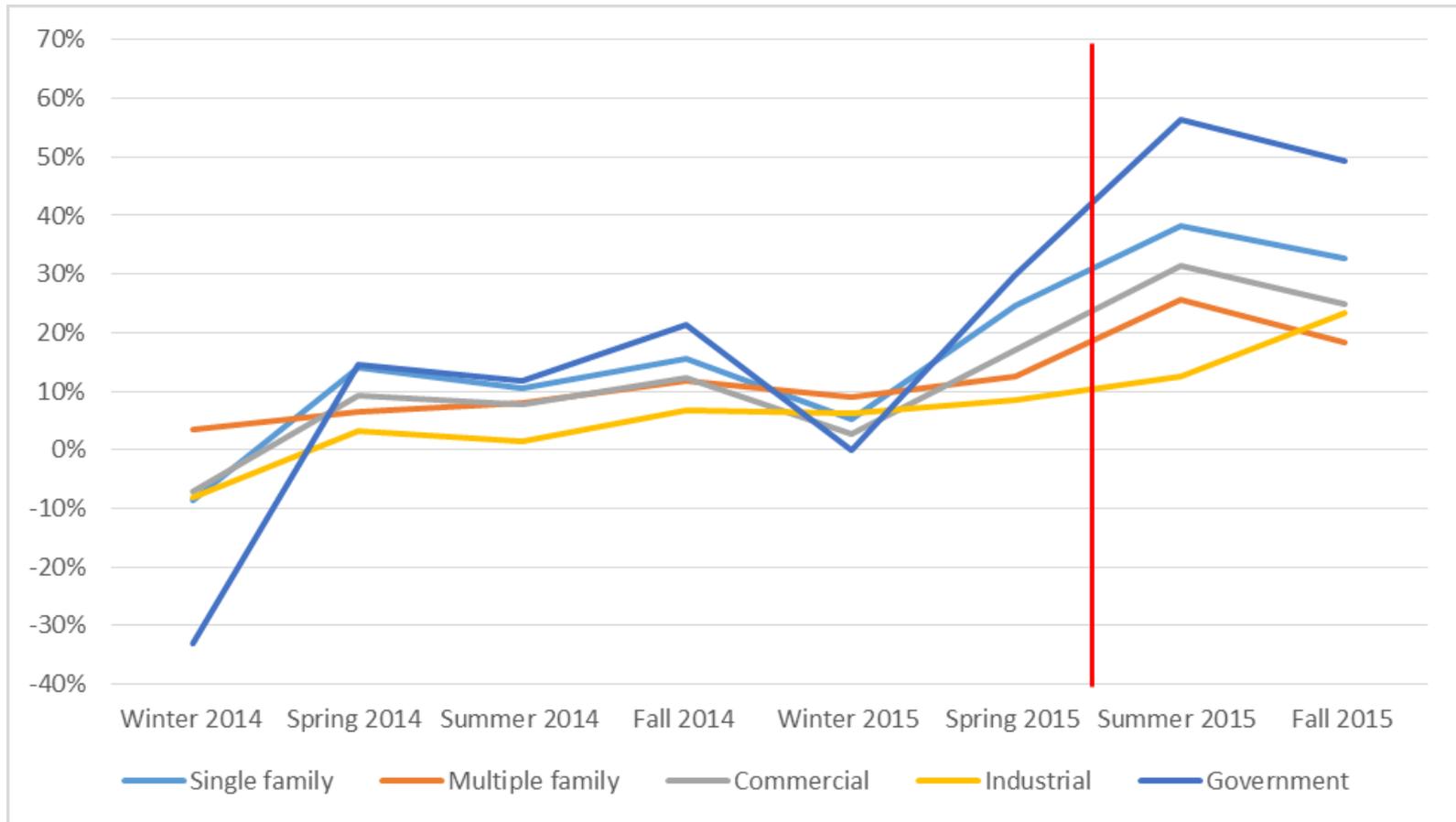
Comparison of Cal Water savings rates across conservation mandate levels



NOTES: Other IOUs are investor-owned utilities other than Cal Water. The 1:1 line shows the savings rate required for each mandate level. When the bars cross the line, average savings by that group exceeded the savings required by the mandate.

* Focus on 24 California Water Service districts (Perez-Urdiales, Baerenklau, Schwabe, and Mitchell 2017)

How does saving differ across season by sector?



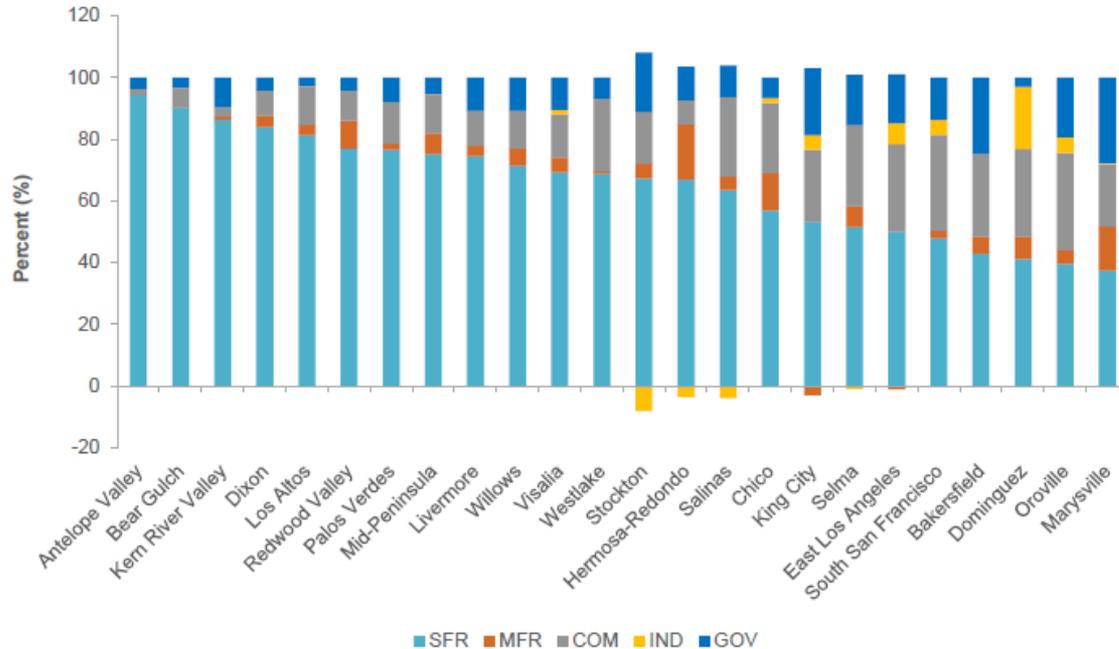
* Focus on 24 California Water Service districts (Perez-Urdiales, Baerenklau, Schwabe, and Mitchell 2017)

Water conservation response to conservation mandate by customer class

	Full Sample	Single-Family Residential (SFR)	Multi-Family Residential (MFR)	Commercial (COM)	Industrial (IND)	Government (GOV)
Average savings rate ¹	29%	31%	18%	25%	14%	42%
Number of districts meeting mandate ¹	15	18	8	12	6	21
Slope of trend line ²	0.48	0.36	0.68	0.41	0.69	0.28
R ² statistic ³	0.21	0.19	0.24	0.24	0.06	0.05

Sector-level water savings overall

Water savings proportions by customer class



Sector's contribution to overall water savings by district

* Focus on 24 California Water Service districts (Perez-Urdiales, Baerenklau, Schwabe, and Mitchell 2017)

Water Savings Intensity by Sector across districts

$$\text{Water savings intensity}_{d,c} = \frac{\text{proportion of total water savings}_{d,c}^{2015}}{\text{proportion of water use}_{d,c}^{2013}}$$

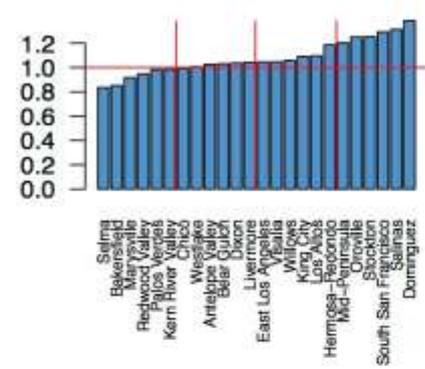
Illustrates degree to which a particular sector “punches” above (or below) its class

Under-performing

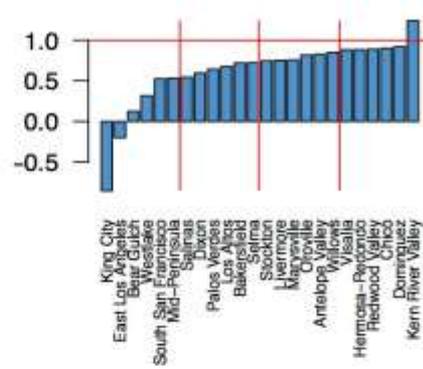
- MFR
- Industrial
- Commercial

Over-performing

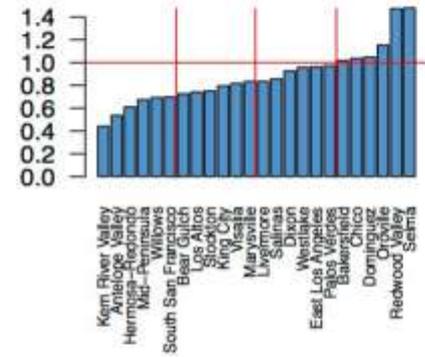
- SFR
- Governmental



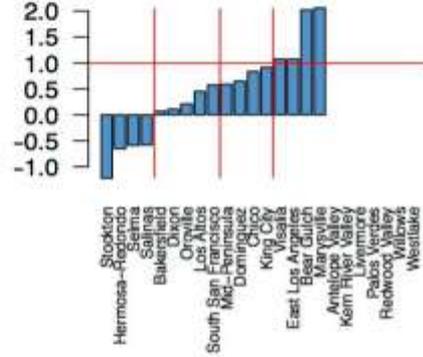
(a) Single family



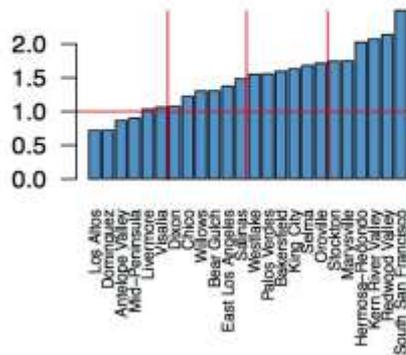
(b) Multiple family



(c) Commercial



(d) Industrial



(e) Government

Indoor Conservation, Recycling, and Imported Water: An Example

	Baseline (A)			Recycled Use by Downstream (B)			(B) w/ Indoor Conservation 20% Upstream		
	Upstream	Downstream	Region	Upstream	Downstream	Region	Upstream	Downstream	Region
	Agency	Agency		Agency	Agency		Agency	Agency	
Total Water Demand	155	155	310	155	155	310	144	155	299
Indoor Water Use	55	55	110	55	55	110	44	55	99
Outdoor Water Use	100	100	200	100	100	200	100	100	200
Recycled Water Available	0	0	0	0	44	44	0	35.2	35.2
Imported Water Purchases	155	155	310	155	111	266	144	119.8	263.8
Relative to Baseline A (B)									
% Change in Water Use	--	--	--	0%	0%	0%	-7%	0%	-4%
% Change in Water Imports	--	--	--	0%	-28%	-14%	-7%	-23% (8%)	-15% (-1%)

Takeaway: degree to which conservation reduces imports depends on relative fraction of indoor versus outdoor conservation and extent of recycling (read: *recycling may not be as drought proof as often suggested*)

Summary

- Gallons Per Capita per Day (GPCD) – a single confusing measure without context
 - Location, time, distribution of water use across sector matters
 - Significant heterogeneity exists across California in water use
 - => Water use differences arise due to differences in natural/environmental, institutional, economic, demographic, and cultural factors
 - Comparisons regarding efficiency of water use and value of water use reductions challenging
- Water use efficiency measures need to be contextual and will require more than a single measure to understand
- Recycling and conservation are integral parts of California's portfolio to address water scarcity
 - Yet they may work against one another in certain cases
 - Suggests cooperation across agencies within linked and devolved systems

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