Los Angeles Residential Water Consumption: Patterns and Key Drivers

Terri S. Hogue
Associate Professor
Colorado School of Mines
Stephanie Pincetl and Caroline Mini
UCLA

UCLA Symposium
February 26, 2013
Goals of Our Work

- Understand temporal and spatial patterns of urban water consumption in southern California

- Determine key drivers behind water use (pricing structure, socio-demographics, landscape patterns, etc.)

- Develop models that can be used to predict future residential consumption under climate and land use scenarios

- Provide guidance for targeted conservation efforts across the City
Residential Water Consumption Patterns

- Data from Los Angeles Department of Water & Power (LADWP)

- Average Single-Family Residential (SFR) per Census tract for 2000-2010

- Census tract average = 387 gal/SFR/day
Landscape Vegetation Patterns

- 10-year average EVI from NASA MODIS Satellites

- **Enhanced Vegetation Index (EVI)** measures the concentration of green leaf vegetation at 250m resolution every 8 days.
Single Family Residential Monthly Consumption

Economic recession, voluntary and mandatory outdoor restrictions

Single-family water use (HCF/hsld)
Residential Water Demand Model

- Grass landcover percentage
- Median household income
- Average household size
- Total precipitation
- Average daily maximum temperature
- Cumulative greenness (EVI)
- Tier 1 & 2 block rates
- Tier 1 volume allocation per household

Single-Family water use (per SFR customer)
Key Findings from Developed Model

- Single-family water use and vegetation greenness patterns are positively related.

- Single-family water demand is influenced by household income, landscape greenness, water rates and Tier 1 volume allocation

- Less influence of climate variability on water use

- Volume allocation and pricing structure impacts:
  - High water users are less sensitive to changes in Tier 2 Pricing than low water users
  - Low income customers are more sensitive to changes in Tier 2 Price and Tier 1 Volume allocations than higher income customers
Established Outdoor Use Estimate Methods

- Outdoor use = Total water use − Indoor use

- **Los Angeles DWP billing data**

- **Minimum use** *(Pacific Institute, 2003)*:
  Identify monthly minimum water use for each fiscal year and tract

- **Average minimum use** *(Pacific Institute, 2003)*:
  Calculate average of the three minimum water use months for each fiscal year and tract

http://www.pacinst.org/reports/urban_usage/
(Last accessed December, 2012).
Outdoor use estimates are highly variable and generally under-predict outdoor use across LA.

<table>
<thead>
<tr>
<th>Outdoor Use Method</th>
<th>Mean (1000L/SFR/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum use</td>
<td>158</td>
</tr>
<tr>
<td>Average minimum use</td>
<td>130</td>
</tr>
<tr>
<td>DeOreo California SFR homes study (2011) (data logging)</td>
<td>329</td>
</tr>
<tr>
<td>Pacific Institute Las Vegas study (2007)</td>
<td>~400</td>
</tr>
</tbody>
</table>
Development of Advanced Outdoor Use Models

• **Biophysical model**
  - Precipitation + Pool Use + Landscaping irrigation (%tree/grass) + Runoff groundwater recharge

• **Remote-sensing model**
  - Explore relationship between single-family water use (including landscaping irrigation) and residential vegetation greenness

Single-family water use (per SFR customer) → Greenness level (EVI)

Difference in greenness due to irrigation

SFR water use (mm/SFR acct/month) vs. EVI surplus

Irrigated landscape

Non-irrigated landscape
Key Insights and Policy Implications

- Income is a key driver in water consumption across LA and is strongly correlated to landscape patterns and amounts.

- Even during drought periods the City stays green. There is room for conservation efforts even during drought periods.

- Pricing:
  - Lower income and lower water use customers appear more sensitive to price and volume thresholds.
  - A 15% decrease in Tier 1 volume allocation per SFR customer could potentially have a larger impact than increasing Tier 1 price by 10%.
  - Social equity impacts need to be considered in pricing and volume structure.
Key Insights and Policy Implications

- Landscape change, over time, can likely yield huge reductions in residential water use.

- Those that can afford water will continue to use it without substantial DWP education programs or 3rd tier rates targeted at very high use.

- Generated funds can provide resources for other water use reductions needed, like upgrading irrigation systems in city parks as well as paying for landscape changes in lower income neighborhoods.

- WATER CONSUMPTION DATA IS NECESSARY ACROSS ALL WATER DISTRICTS IN THE REGION, OR SUBSTANTIAL CHANGE AND DEPENDENCE ON MWD WATER WILL NOT DECLINE SUFFICIENTLY.
Acknowledgements

A special thank you to LADWP for supplying the water consumption data, and especially to Mark Gentili and Mariko Marianes for their efforts

Funding Sources:
NSF ULTRA-EX #BCS-0948914
NSF Hydrologic Sciences Program CAREER #EAR0846662
NASA Earth System Science (ESS) Fellowship (#NNX07AO53H)

Questions?