Methods in Estimating Outdoor Water Demand

Urban Water Demand Roundtable

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Outdoor Water Demand

• Large aggregate use
• Counter-cyclical to supply
• Discretionary component of demand
• Methods
  • Satellite Data
  • Smart Meters
  • Scarcity Pricing
Landsat

Publicly available @ http://glovis.usgs.gov/

Phoenix - October 2011
Landsat

Publicly available @ http://glovis.usgs.gov/

Seattle - July 2011
NDVI

Northwest of ASU - Summer 2003
NDVI

Northwest of ASU - Summer 2003
Water and Landscape

Average Monthly Water Consumption
Phoenix: 1998-2009

- Consumption (gallons per day)
# Water Demand and Landscape

<table>
<thead>
<tr>
<th></th>
<th>(1) Base</th>
<th>(2) Landscape</th>
<th>(3) Turf</th>
<th>(4) Grass</th>
<th>(5) Static NDVI</th>
<th>(6) NDVI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time</strong></td>
<td>$-0.00882^{***}$</td>
<td>$-0.00869^{***}$</td>
<td>$-0.00885^{***}$</td>
<td>$0.00885^{***}$</td>
<td>$-0.00839^{***}$</td>
<td>$-0.00169^{***}$</td>
</tr>
<tr>
<td></td>
<td>$(-27.54)$</td>
<td>$(-27.20)$</td>
<td>$(-27.68)$</td>
<td>$(-27.69)$</td>
<td>$(-26.33)$</td>
<td>$(-5.10)$</td>
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<tr>
<td><strong>CLDD</strong></td>
<td>$-0.00523^{***}$</td>
<td>$-0.00514^{***}$</td>
<td>$-0.00513^{***}$</td>
<td>$0.00522^{***}$</td>
<td>$-0.00501^{***}$</td>
<td>$-0.000912$</td>
</tr>
<tr>
<td></td>
<td>$(-5.76)$</td>
<td>$(-5.67)$</td>
<td>$(-5.65)$</td>
<td>$(-5.75)$</td>
<td>$(-5.54)$</td>
<td>$(-1.03)$</td>
</tr>
<tr>
<td><strong>Rainy Days</strong></td>
<td>$-0.850^{***}$</td>
<td>$-0.851^{***}$</td>
<td>$-0.851^{***}$</td>
<td>$-0.851^{***}$</td>
<td>$-0.850^{***}$</td>
<td>$-0.651^{***}$</td>
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<tr>
<td></td>
<td>$(-18.69)$</td>
<td>$(-18.72)$</td>
<td>$(-18.71)$</td>
<td>$(-18.72)$</td>
<td>$(-18.75)$</td>
<td>$(-14.63)$</td>
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<tr>
<td><strong>Static NDVI</strong></td>
<td>$4.549^{***}$</td>
<td>$4.423^{***}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$(41.17)$</td>
<td>$(64.65)$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NDVI</strong></td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Landscape</strong></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Turf</strong></td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Grass</strong></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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<tr>
<td><strong>Observations</strong></td>
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<td>65097</td>
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<tr>
<td>$R^2$</td>
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<td>0.153</td>
<td>0.147</td>
<td>0.197</td>
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<td>RMSE</td>
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<td>0.550</td>
<td>0.550</td>
<td>0.549</td>
<td>0.537</td>
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</table>
Predicted Average Monthly Water Consumption

Phoenix: 1986-2012

Consumption (gallons per day)

Year


Observed
Landscape
1998-2009 NDVI

Phoenix: 1986-2012

Brent: Outdoor Water Demand
Smart Meters

- Smart Meters or Advanced Metering Infrastructure (AMI)
  - Record consumption every 30min or 1hr
- Implementation is beginning but lags electricity smart meters
  - US: Sacramento, Reno, many others
  - Aus: Kalgoorlie, Karratha, pilots in Melbourne
- Can identify patterns in water use
  - Rachel Cardell-Oliver UWA (Cardell-Oliver, WRR 2013)
Data Mining & Pattern Recognition

Cardell-Oliver; Spring/Summer
Data Mining & Pattern Recognition

Cardell-Oliver; Fall/Winter
Scarcity Pricing

• Temporary price increases
  • Tied to water scarcity
  • May not change water infrastructure (e.g. landscape)
  • Keep benefits of urban vegetation
    • Urban heat island effect
    • Additional source of supply

• More research is needed
  • How do consumers respond to temporary price increase?
  • Similar to critical peak pricing in electricity?
  • Funds for experiment w/ Michael Ward
    • Looking a utility partner for collaboration

• Daily price tiers
  • May better target outdoor water use