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Approaches to Demand & Conservation Forecasts and Dealing with Data Gaps

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Agenda

- Introduction
- Background/purpose
- Case studies
- Data variables considered
- Forecasting benefits
- Concluding remarks
The Water Demand Reduction Challenge

Why are U.S. water utilities under intense pressure to reduce consumption?

- Hydrologic deficit
- Rulings by judges
- Water use reduction targets set by politicians
- Difficultly in building new supplies
- Other reasons including economics, long term changes in weather (climate) and environmental goals
- Pressure to defer expensive capital improvement projects
- State requirements for conservation planning and implementation
At the Same Time Dynamics in Water Demand Abound – Water Use Trends Fluctuating

- Increase or decrease in economy
- Extreme weather (droughts, floods, etc.)
- Climate change
- Water rate changes
- Water efficient devices and fixtures
- Drought restrictions and rebound
- Political changes
  - New legislation
  - Judgments/legal rulings
The Reality of the Last Few Years

1. Recession and/or droughts caused revenues to fall
2. Water conservation funding becomes more challenging
3. Need for creative ways to continue conservation programs
4. Need for better understanding of water demands and factors
A Look at 105 Years of Data...

Population, Accounts, Water Production and Rainfall
1910-2015
Marin Municipal Water District

Acre Feet (AF) = 325,850 gallons

Inches of rain
Demand Forecasting: Old methods are no longer accurate

- Originally many forecasts were based on population or employment.
- This worked well in the past, but no longer tracking water use.
- Need for more detailed methods that include larger number of water demand variables.
## Independent Variables Evaluated in an Econometric Analysis

<table>
<thead>
<tr>
<th>Variable Type</th>
<th>Variables</th>
<th>Units</th>
<th>Data Source</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather</td>
<td>Precipitation</td>
<td>Inches per month</td>
<td>NOAA Weather Data</td>
<td></td>
</tr>
<tr>
<td>Weather</td>
<td>Avg Daily Max Air Temp</td>
<td>Fahrenheit</td>
<td>NOAA Weather Data</td>
<td></td>
</tr>
<tr>
<td>Weather</td>
<td>Avg Air Temp</td>
<td>Fahrenheit</td>
<td>NOAA Weather Data</td>
<td>Max temp better</td>
</tr>
<tr>
<td>Weather</td>
<td>Min Air Temp</td>
<td>Fahrenheit</td>
<td>NOAA Weather Data</td>
<td>Max temp better</td>
</tr>
<tr>
<td>Weather</td>
<td>Reference ETo</td>
<td>Inches</td>
<td>Not available</td>
<td></td>
</tr>
<tr>
<td>Economy</td>
<td># of Jobs</td>
<td>Jobs per capita</td>
<td>ABAG</td>
<td>Unemployment better</td>
</tr>
<tr>
<td>Economy</td>
<td># of Jobs</td>
<td>Jobs</td>
<td>ABAG</td>
<td>Unemployment better</td>
</tr>
<tr>
<td>Economy</td>
<td>Unemployment</td>
<td>Unemployment rate</td>
<td>CA EDD / BLS</td>
<td></td>
</tr>
<tr>
<td>Service Area Demographics</td>
<td>SF Units</td>
<td>Dwelling units</td>
<td>DOF</td>
<td>Insufficient variation</td>
</tr>
<tr>
<td>Service Area Demographics</td>
<td>MF Units</td>
<td>Dwelling units</td>
<td>DOF</td>
<td>Insufficient variation</td>
</tr>
<tr>
<td>Service Area Data</td>
<td>Rates</td>
<td>$/HCF</td>
<td>Provided by Agencies</td>
<td></td>
</tr>
<tr>
<td>Service Area Data</td>
<td>Population</td>
<td>People</td>
<td>ABAG or other selected source</td>
<td></td>
</tr>
<tr>
<td>Service Area Data</td>
<td># Customers</td>
<td>Accounts</td>
<td>Agency billing data</td>
<td>Not favored, collinear with population</td>
</tr>
<tr>
<td>Conservation</td>
<td>Conservation</td>
<td>Conservation activity</td>
<td>BAWSCA WCDB</td>
<td>Used to convert actual GPCD to baseline GPCD</td>
</tr>
</tbody>
</table>
Analyzing Historical Demand w/Recession

- $R^2 = 0.95$
- 13 Factors analyzed, 4 were statistically significant:
  - **Weather** – Precipitation, $Eto$, Air Temp
  - **Economy** – Unemployment, Employment, Household income
  - **Service Area Data** – SF/MF Housing Units, Rates, Population, # Accounts
Using Factors to Forecast Demand Scenarios

- Normal Year
- Good or Bad Economy
- Wet or Dry Year
- Bad Economy, Wet Year

Current Situation

Future Scenarios

Water Demands Graph (AFY)
“End Use” Concept: Why It Matters…

- Total Consumption
- Single Family Consumption
- Indoor
  - Toilets
  - Clothes Washers
  - Showers
  - …
DSS Model – Demand & Conservation

- DSS Model created in 1999
- Updated model to make it more user friendly in 2013 and use regression data
- Used across the U.S. and internationally for hundreds of utilities
- Metric and English units
- Endorsed by the California Urban Water Conservation Council (now the California Water Efficiency Partnership)
- Based on End-Uses Verified with Billing Data
Case Studies

1. *Simplified approach*: Duck River Water Authority in Tennessee – 7 water systems for the state of Tennessee
2. *Moderate approach*: Water utilities in Utah
3. *Sophisticated approach*: Northern California utilities’ econometric demand analysis (sophisticated statistics) conducted for 26 water agencies (service area population of 1.7 million people) on water demands from 1995-2013 to study the water use patterns
Tennessee Case Study – simplified approach

Duck River Water Authority in Tennessee – 7 water systems for the state of Tennessee

- **Demand forecasting trigger**: water supply becoming less reliable for region
- **Demand forecasting approach**: use recent historical water use
- **Demand drivers**: population
- **Forecasting challenges**: data gaps and inconsistency, no employment forecast
- **Benefits**: regional consensus to base regional supply infrastructure needs on
- **Next steps**:
  - data management refinement
  - conservation analysis
Duck River Watershed and Water Supply Plan Study Areas

Data challenges – Duck River, TN

- Data challenge: water use not available by customer category for resale/bulk/wholesale categories
- Widely varying types of customers within individual customer categories.
- Minimal consistency between customer category nomenclature within region for regional planning
Challenges of Characterizing uses within Large Volume Bulk/Resale Water Categories; Duck River, Tennessee

Columbia Power and Water Systems
Customer Category Average Water Distribution Use Percent

- Residential, 49%
- Commercial, 19%
- Industrial, 12%
- Bulk/Resale, 20%

Lewisburg Water and Wastewater
Customer Category Average Water Distribution Use Percent

- Residential, 38%
- Wholesale, 37%
- Commercial, 25%
- Industrial, 17%
Regional Average Day Water Demands (MGD) – Duck River, TN

![Graph showing regional average day water demands in Duck River, TN from 2010 to 2050, with trends for historical demand, total demand with no plumbing code savings, and total demand with plumbing code savings.](image-url)
Utah Case Study – moderate approach

- **Demand forecasting trigger:** need to cost-effectively meet the State’s goal of decreasing per capita water use 25% by 2025 and 35% by 2060
- **Demand forecasting approach:** based on continuation of recent historical per capita water use
- **Demand drivers:** population and employment
- **Forecasting challenges:** second home water use
- **Benefits:** water supply portfolio reliability
- **Next steps:**
  - customize a demand management plan and develop an implementation plan
  - foster regional cooperation
  - set budget
  - plan staffing
  - establish schedule
Project Goals and Approach – Utah

Goal – Evaluate Long-Term Water Conservation

• Consider water conservation as key part of the water supply portfolio
• How to cost-effectively meet the State’s goal of saving 25% by 2025 and 35% by 2060

Approach

• Update and analyze historical water use data and population and demand projection forecasts
• Hold conservation measure screening to gather feedback on individual measures appropriate for the area
• Evaluate Long-Term Water Conservation Measures
  • 27 measures analyzed
  • Analyze implementation feasibility and cost effectiveness
  • Design three program options
Washington County, UT Water Use – 2010

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of Accounts*</th>
<th>Water Consumption gpd/a</th>
<th>Water Consumption MGD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Family</td>
<td>32,494</td>
<td>589</td>
<td>19.13</td>
</tr>
<tr>
<td>Multifamily</td>
<td>1,706</td>
<td>1,200</td>
<td>2.05</td>
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<tr>
<td>Commercial</td>
<td>2,306</td>
<td>4,556</td>
<td>10.50</td>
</tr>
<tr>
<td>Institutional</td>
<td>299</td>
<td>11,434</td>
<td>3.42</td>
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<tr>
<td>Secondary Use</td>
<td>1</td>
<td>7,587,499</td>
<td>7.59</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>36,806</strong></td>
<td></td>
<td><strong>42.69</strong></td>
</tr>
</tbody>
</table>

*Secondary use represents untreated water for outdoor irrigation use. Total value is for consumption and does not include Non-Revenue Water.
## Projected GPCD Reductions & Water Demand to 2060 with Conservation

<table>
<thead>
<tr>
<th>Year</th>
<th>UDWR Projections from customer category use without Plumbing Code</th>
<th>UDWR Projections from customer category use with Plumbing Code</th>
<th>Program A with Plumbing Code</th>
<th>Program B with Plumbing Code</th>
<th>Program C with Plumbing Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>Baseline</td>
<td>Baseline</td>
<td>Baseline</td>
<td>Baseline</td>
<td>Baseline</td>
</tr>
<tr>
<td>2015</td>
<td>0</td>
<td>0</td>
<td>-1</td>
<td>-2</td>
<td>-5</td>
</tr>
<tr>
<td>2020</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>-7</td>
<td>-22</td>
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<tr>
<td>2025</td>
<td>3</td>
<td>-2</td>
<td>-2</td>
<td>-11</td>
<td>-34</td>
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<tr>
<td>2030</td>
<td>4</td>
<td>-4</td>
<td>-5</td>
<td>-14</td>
<td>-40</td>
</tr>
<tr>
<td>2040</td>
<td>4</td>
<td>-7</td>
<td>-8</td>
<td>-16</td>
<td>-43</td>
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<tr>
<td>2050</td>
<td>4</td>
<td>-9</td>
<td>-10</td>
<td>-17</td>
<td>-45</td>
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<tr>
<td>2060</td>
<td>3</td>
<td>-11</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Program A = Existing program**

**Program B = Add additional conservation activities**

**Program C = All measures analyzed**
Northern California Case Study – sophisticated approach

Northern California utilities’ econometric demand analysis (sophisticated statistics) conducted for 26 water agencies (service area population of 1.7 million people) on water demands from 1995-2013 to study the water use patterns.

- **Demand forecasting goal:** regional long-term water reliability
- **Demand forecasting approach:** econometric modeling
- **Demand drivers:** population and employment
- **Forecasting challenges:** multiple service areas with large change in demands due to economic downturn while active conservation and significant price increase
- **Benefits:** regional consensus with consistent methodology
- **Next steps:**
  - ongoing revisions and updates to demand forecasts - drought rebound
  - active conservation program implementation
Bay Area Water Supply & Conservation Agency

- Special district representing the interests of
  - 26 cities, water districts, and water companies in San Mateo, Santa Clara, and Alameda counties
  - 1.8 million residents, over 40,000 businesses
- All rely on the San Francisco Regional Water System
Project Demand Modeling Approach

- Data was collected for 26 individual BAWSCA agencies from 1995-2013, including:
  - Water Production/Consumption
  - Pricing
  - Unemployment
  - Weather
  - Population/Employment
  - Conservation Data

- Individual model for each agency created
Econometric modeling is a statistical approach used to determine the impact on water demands of factors like:

- Economic conditions
- Weather
- Rates
- Conservation

Analysis of historical data provides helpful information for answering questions such as:

- How much and at what rate will demand rebound as the economy expands?
- How much will future price increases continue to depress demand?
- How does demand respond to weather?

R-squared: indicates the explanatory power of a statistical model. High R-squared is good (Higher the value the better the model)
BAWSCA Econometric Models: Price Data 1995-2020

- 1995-2004: 14.4%
- 2004-2012: 58.9%
- 2012-2020 (projected): 26.5%
Econometric Models: BAWSCA-Wide
Historical Results

BAWSCA Service Area: Actual vs. Predicted

Demand Decrease from 2008-2011 BAWSCA-Wide

- 28% due to weather
- 23% due to unemployment
- 50% due to rates/passive/active conservation and service area changes
BAWSCA Projected 60% Population Increase with Only 8% Demand Increase (1986-2040)

32% decrease in per capita water use between 1986 and 2040
Demand Patterns Changed Significantly During the Drought
New Considerations for BAWSCA Demand Forecasts

- Rate Increases
- Changing Projections
- New Regulations
- Additional Active Conservation
- “Making Conservation a Way of Life”
- Drought Rebound

Future Water Demands

- Data collection underway for 2014-2017 information to be used in revised demand forecasts
Summary and Conclusions

1. New sophisticated methods are needed to deal with fluctuations in water demand and new drivers for forecasts, particularly the rebound from downturns in demands.

2. Planning and implementing programs in a declining water use and revenue environment is challenging.

3. With a good, in-depth analysis it is easier to justify spending money on conservation and hiring staff.
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