WRF: Water Demand Forecasting Research Overview

SESSION TUE03
March 27, 2018

Maureen Hodgins, Water Research Foundation
Agenda

- WRF – who/what
- Research funded
- Drivers
- Research results
  - Climate
  - Economy
  - Efficiency
  - Forecasting approaches
Integrated 1/1/2018

WE&RF + WRF = WRF or The Foundation

The integrated organization represents the evolution of water research issues, the overlap between water and wastewater, and efficiencies to be gained through a consolidated research program.

Learn more at www.waterrf.org and www.werf.org
Research Programs

• Legacy programs more ALIKE than different!
• 2018 just like 2017
• 2019 programs TBD
Leaders Innovation Forum for Technology - LIFT

Utility Peer Network
Technology Scans
LIFT Link
FAST Water Network

Technology Survey
SEE IT
University-Utility Partnership
Hubs, Partners, and Affiliates

- http://www.werf.org/lift
- Drinking water input at ACE 2018
## Water demand research funding 2009-2017

<table>
<thead>
<tr>
<th>Idea</th>
<th>Funding</th>
<th># Projects</th>
<th>WRF Cash</th>
</tr>
</thead>
<tbody>
<tr>
<td>WRF ¹, ²</td>
<td>WRF</td>
<td>11</td>
<td>$2,922,836</td>
</tr>
<tr>
<td>Utilities ³</td>
<td>Utility &amp; WRF</td>
<td>4</td>
<td>558,000</td>
</tr>
<tr>
<td>Ideas pop up ⁴</td>
<td>WRF &amp; Partners</td>
<td>3</td>
<td>89,392</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>18</strong></td>
<td><strong>$3,570,228</strong></td>
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</tbody>
</table>

### Research Programs
1. Research Advisory Committee
2. Focus Area Program
3. Tailored Collaboration
4. Emerging Opportunity

Published: 13
Published within 6 months: 2
Ongoing: 3
Knowledge Portals: Water Efficiency

Water efficiency is the pursuit of reducing water wastage. Utilities can reduce the amount of water wasted in their systems by accurately calculating water use estimates, adopting demand management strategies, accurately forecasting future water demand, and pursuing water loss control initiatives.
Context: Trends in Urban Water Use

- Per capita water use has declined in many places
- Acute declines in some areas in the recent past
- Net revenue problems, unused capacity, stranded capital
- Case for improved water efficiency becomes harder to sell

Slide courtesy of Jack Kiefer
Example: Declining residential use

-16% over 30 yrs

Context: Risks Tied to Water Demand Forecast Inaccuracies

- Revenue “surprises”
  - Insufficient cash flow and borrowing costs
  - Unexpected need for rate changes
  - Credit rating downgrades
- Over-sized systems
  - Unused capacity (you still have to pay for)
  - Opportunity costs (environment, financial)
- Under-sized systems
  - Chronic or more frequent shortages (economic damages)
  - Lost water sales

Slide courtesy of Jack Kiefer
What would you consider to be the **3 main drivers of uncertainty** about water demands over the next 20 to 30 years?

<table>
<thead>
<tr>
<th>Factor</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Future population or number of customers</td>
<td>59%</td>
</tr>
<tr>
<td>Future climate</td>
<td>47%</td>
</tr>
<tr>
<td>Future economic conditions</td>
<td>41%</td>
</tr>
<tr>
<td>Irrigation and outdoor water using behaviors</td>
<td>40%</td>
</tr>
<tr>
<td>Future water efficiency technologies</td>
<td>28%</td>
</tr>
<tr>
<td>Characteristics of individual large customers</td>
<td>22%</td>
</tr>
<tr>
<td>Future regulations or legislation on water use</td>
<td>18%</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>16%</td>
</tr>
<tr>
<td>Cumulative effects of existing plumbing standards</td>
<td>15%</td>
</tr>
<tr>
<td>Potential need to serve neighbor communities</td>
<td>12%</td>
</tr>
</tbody>
</table>

Water Use Reflects Technology

National plumbing fixture standards have had a marked influence on residential use.
Water Use Reflects Technology

Average Residential Indoor Use, GPHD

-22%

REUWS 1 (1999) 177
REUWS 2 (2016) 138

Toilet & Clothes Washer Use, GPHD

-27%

toilet
45.2
33.1

clothes washer
29.3
22.7

-23%

• Average behavioral aspects about the same


Slide courtesy of Jack Kiefer
Water Use Reflects Technology

Likely -37%
• Under existing technology
• Without change in behaviors
What next?

Economy: Great Recession Impacts

Water Demand Forecasting in Uncertain Times: Isolating the Effects of the Great Recession

Magnitude of water demand decline during recent recession from pre-recession levels (% of 87 respondents who answered question - 88 reported water use decline)

- 26% <5% decrease
- 41% 5% - 10% decrease
- 24% 11% - 20% decrease
- 8% >20% decrease

Is water efficiency the cause of this?

~17% drop

Slide courtesy of Jack Kiefer
Tampa Bay Water


Peaks in Unemployment Rate → Troughs in Water Use
Economy: Great Recession Impacts

Case studies
- 5-15% water use reductions
- Recessionary forces
- Lag

- Include economic data in forecasts
- Macro-economy has both short and long run effects on water use
Water Demand Varies with Climate

Seasonal climatic patterns explain 50% or more of inter-annual variability in demand

- Irrigation
- Cooling
- Pools
- Other

WRF 4263 Case Study Process

Weather station(s) within utility service area

Historical Observed Weather

Downscaled GCM/GHG scenarios for grid cell(s) containing utility service area

Δ or %Δ weather

Water Demand Model

Predictions under historical weather

Predictions under climate change scenarios

## Summary of Mean Estimated Changes in Annual Demand

<table>
<thead>
<tr>
<th>Utility</th>
<th>Δ Mean Estimated Demand 2055 Climate (%)</th>
<th>Δ Mean Estimated Demand 2090 Climate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Colorado Springs Utilities</td>
<td>5.9%</td>
<td>23.2%</td>
</tr>
<tr>
<td>Durham Region (Ontario)</td>
<td>1.6%</td>
<td>4.3%</td>
</tr>
<tr>
<td>MWRA (Massachusetts)</td>
<td>1.7%</td>
<td>5.0%</td>
</tr>
<tr>
<td>SNWA (Nevada)</td>
<td>3.9%</td>
<td>9.4%</td>
</tr>
<tr>
<td>San Diego County</td>
<td>3.5%</td>
<td>12.7%</td>
</tr>
<tr>
<td>Tampa Bay Water</td>
<td>1.2%</td>
<td>5.3%</td>
</tr>
</tbody>
</table>

Urban Landscape Water Use

• Research needs
• Database, 650 refs tagged to 14 topics on ASU website
• Who does research, where is it published, who uses it?

sustainability.asu.edu/dcdc/publications/technical-papers/urban-landscape-water-use-research-evaluation/
Data & Forecasting
Customer Data

Recommendations

• Develop standardized water customer classifications

• Geographically reference water customers with their unique locations.

• Historical record (10 years)
Forecasting f/ Operations & Revenue

Short-Term Water Demand Forecasting Manual

Project #4501B

Improving the Accuracy of Short-Term Water Demand Forecasts

Project #4501A
Forecasting f/ Operations & Revenue

operational forecasting - days / weeks
  - simple regression models

budgetary and revenue planning
  - econometric models

Highly complex and data-intensive models not more accurate than relatively simple models

Use expert judgment, statistical techniques, good data
Forecasting for CIP & Supply Planning

- Scenarios
  - Capital projects - High use
  - Financial plans - Low use
- Utility actions
  - Monitor / adjust
  - Flexible projects
  - Financial innovations
- Incorporate risk
- Educate decision makers
Forecasting – ongoing work

**Long Term Water Demand Forecasting Practices for Water Resources and Infrastructure Planning** - 4667

- Completion Year: 2020
- Research Value: $345,663.00
- Research Manager: Ms. Maureen Hodgins
- Principal Investigator: Jack Kiefer
- Contractor: Hazen and Sawyer

**Probability Management for Water Finance and Resource Managers** - 4742

- Completion Year: 2020
- Research Value: $291,066.00
- Research Manager: Ms. Maureen Hodgins
- Principal Investigator: Thomas Chesnutt
- Contractor: A & N Technical Services, Inc.
Water Demand

Technology Prices

Climate Change
Economic Cycles
Urban development

Slide courtesy of Jack Kiefer
Summary: Water Demand

- Improve your customer data
- Match your forecast goals to your data, resources, and approach
- Assess forecast accuracy
- Monitor water use trends & adjust
- Incorporate risk
Use research reports
  • Improve your knowledge
  • Illustrate ways to analyze your own data

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