American Water Works Association

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Understanding and Decreasing Future Uncertainties in Water Demand Forecasting

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Presentation Outline

- Research questions
- Importance of demand forecasting
  - Factors impacting demand forecasting
- Research team
- Research process and results
- Recommendations for water systems
- Future research needs
- Reducing uncertainties

Research Questions

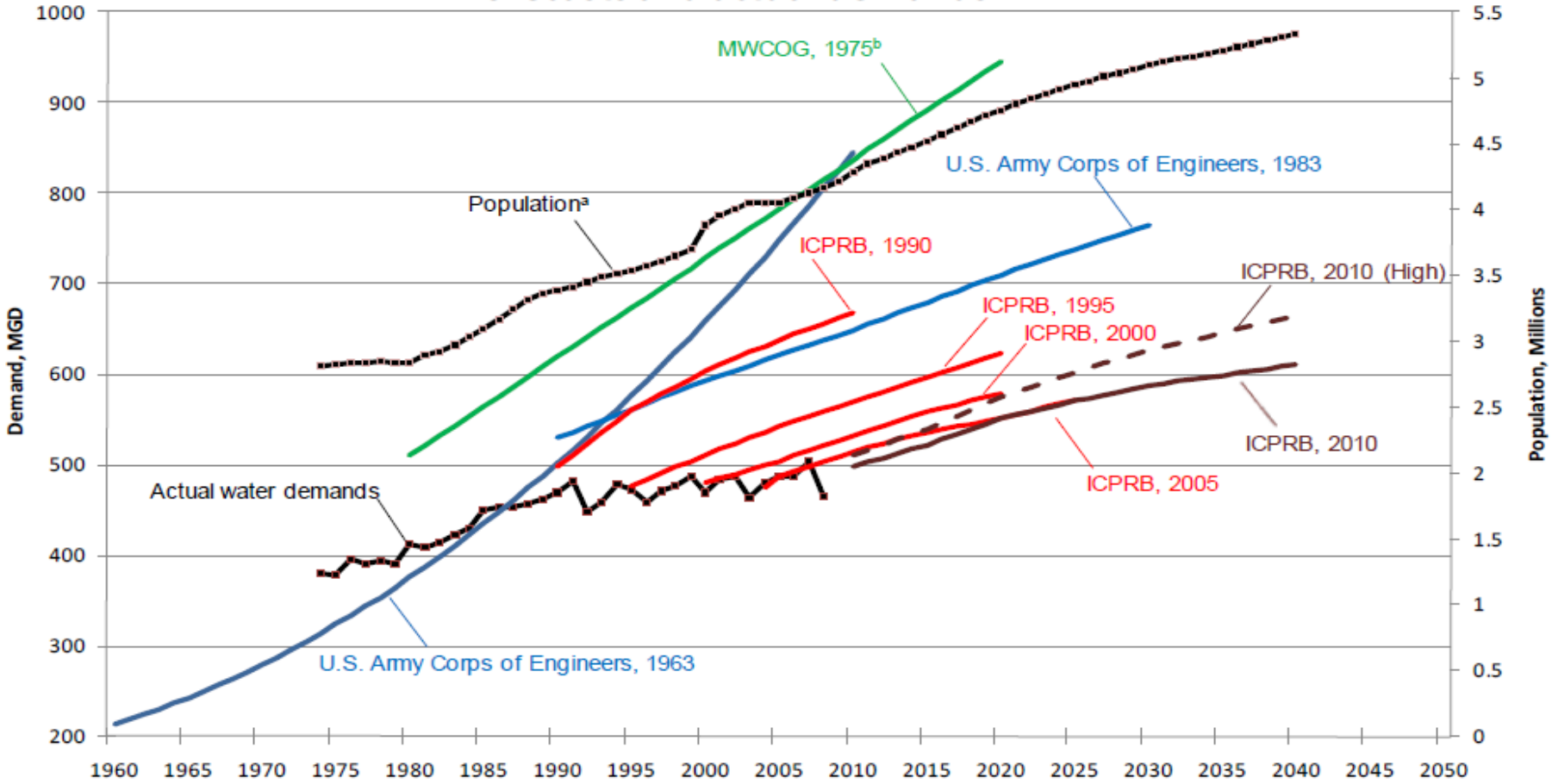
1. How might future climate change impact water demand forecasting as compared to other factors such as changing demographics, increased use of low-flow plumbing fixtures, etc.?

2. How might one understand and decrease the uncertainties in water demand forecasting?

Why is A System's Future Water Demand Important?

- Future water demand = water sales = $$
- Economic benefits of water = community development, well being, and quality of life
- Accurate demand forecasts are important
  - Not meeting predicted/desired water sales and gross revenues and bond coverage ratios
  - Stretched utility assets and less reliability
  - Stranded utility assets
    - Facility expansions being ahead of the need
    - How can we lower the risk of being wrong?

Washington metropolitan area average annual water demand, forecasts and actual demands



[a] Population is a sum of the populations within Montgomery, Prince George's, Prince William, Loudoun, Fairfax, and Arlington Counties, as well as the District of Columbia, according to data provided by the U.S. Census Bureau.

[b] As cited in U.S. Army Corps of Engineers, 1975

What Impacts Demand Forecasting?

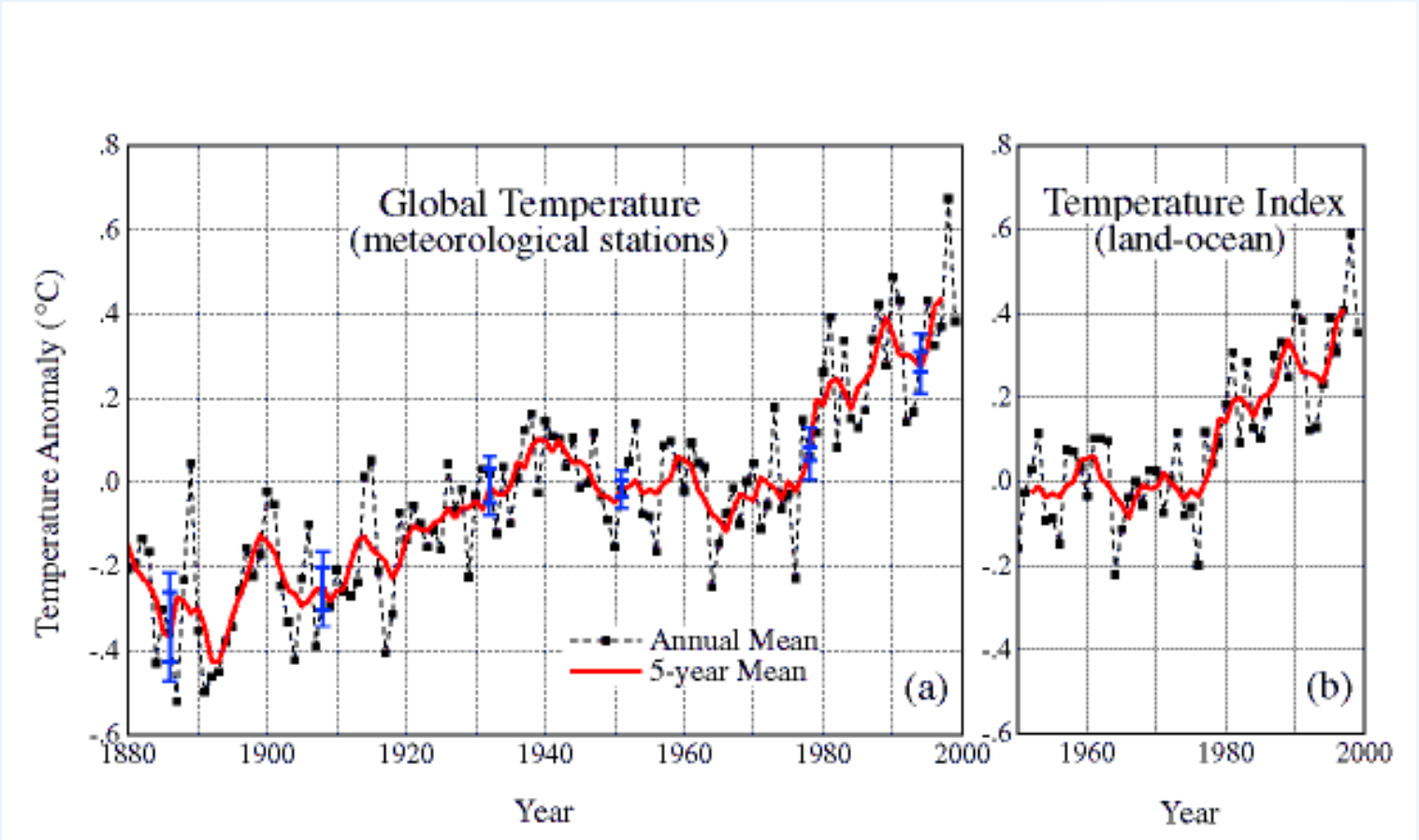
- Who has NOT seen lower per capita demand in the past five or ten years? *(Very few)*
- What are the factors causing this?
  - Increased use of low-flow plumbing fixtures
  - Socioeconomic factors
    - Change in lot sizes, family sizes, etc.
    - Recession – new Water Research Foundation project
  - Attitudes/behaviors
    - Conservation ethic, response to higher rates, etc.
  - Weather, extreme weather, climate change

Demand Forecasting

- Gallons per capita per day (gpcd) times population is still widely used
  - Simple, well accepted
  - 5-year or 10-year rolling average can be used
    - Slow to account for decreasing gpcd
      - Could miss flattening of indoor use
    - Could also miss future economic downturns
      - What is the “new normal”?

Climate Change

- Do you see a trend in this data?
  - But what does it mean to utilities??



Climate Change and Water Demand

- Extreme weather versus climate change
  - Impacts such as higher temperatures & changes in precipitation are the same in either case
- Downsizing Global Climate Models (GCMs) to a watershed can be challenging
- Draft National Climate Assessment
  - http://www.globalchange.gov/what-we-do/assessment
- Water Research Foundation: Analysis of Changes in Water Use under Regional Climate Change Scenarios

The Research Team

- American Water Works Association – PI
- Kearns & West
  - Environmental facilitator
- George Washington University (GWU)
  - Literature review on models
- University of Colorado (CU)
  - Extreme value analysis
- Hazen and Sawyer

The Research Process

- GWU conducted literature search
- CU started extreme value analysis
- AWWA and K&W started stakeholder process through interviews & surveys
- Two workshops in 2011 – DC & Denver
  - Mix of utilities, consultants, & academics
  - Blend of demand experts and management

Research Process (cont.)

- Initial draft report developed in late 2011
- Two key sections (recommendations and research needs) refined through webinars in the first half of 2012
- Second draft report sent for second review in late 2012
- Final report was completed in 2013

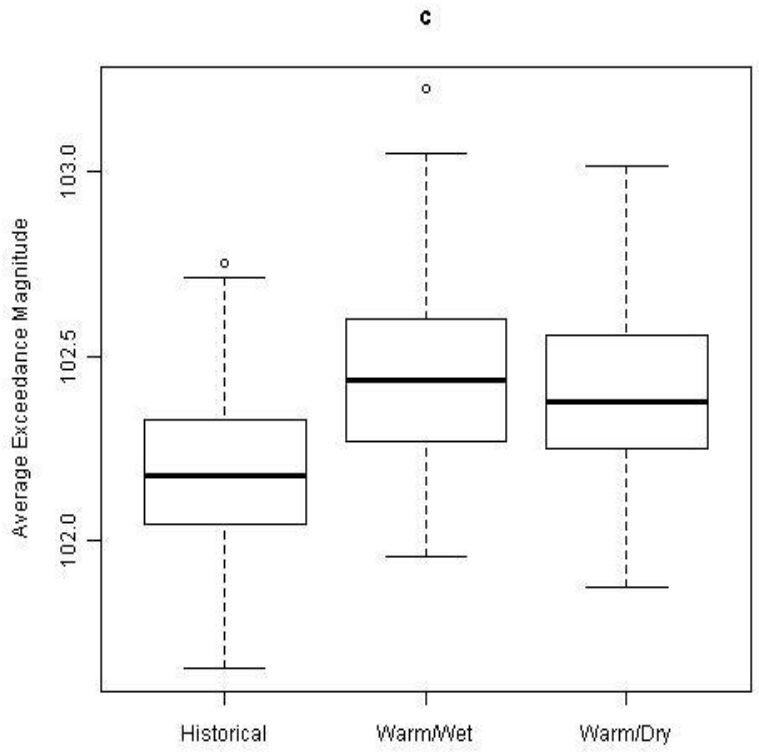
Research Results - GWU

- Wide range of demand models used
  - Range from simple to complex
    - Gpcd X population is still widely used (simple)
    - Complex models require a certain level of knowledge/sophistication of utility planning staff
- Model timeframe is important
  - Short-term demand for operations staff
  - Medium/long-term for planning staff

From Donkor, et al, ASCE Journal of Water Resources Planning and Management

Research Results - CU

- Risks are inherent with any forecasting
- Simple approach
  - Scenario of 10% increase in demand, and decrease of 10% in supply
- Extreme value analysis is a more complex approach to project water demand extremes



From Haagenson, et al, Feb. 2013 Journal - AWWA

Recommendations

1. Collect the necessary data
2. Analyze water use and related data
3. Evaluate potential changes in demand
4. Evaluate potential changes in demographics
5. Understand & incorporate uncertainty
6. Plan for drought to be able to cope with it

Collect the Necessary Data

- Complete and accurate data is the heart of modeling (at least good modeling)
- Weather
  - Temperature and precipitation are common
    - National Climatic Data Center (NCDC) daily data is commonly available
      - Need to know how to handle missing data
        - » Several statistical techniques available

Process More Weather Data

- Beyond daily temperature
  - Frequency of hot days (pick a threshold)
  - Number of consecutive days over a threshold
- Beyond daily precipitation
  - Frequency of precipitation events
  - Intensity of precipitation events
  - Number of consecutive days with or without precipitation

Collect More Demand Data

- The more categories in which demand data are collected, the greater the opportunity to better understand demand
- Automated Meter Infrastructure (AMI) can provide very detailed demand data
  - Need to be able to collect, store, and analyze “big data”
  - Data needs to be converted to information

Analyze Water Use & Related Data

- After collecting the data, analyze the data
  - Need a data analysis plan
    - Always ask “What are we collecting this data for?”
      - What question(s) are we trying to answer??
- Changes in outdoor water use
  - The ability of restrict outdoor demand
  - The potential for “demand hardening”
- Regularly update water demand forecasts

Evaluate Potential Demand Changes

- Increasingly efficient plumbing fixtures and appliances
  - Increasing market penetration
- Socioeconomic factors
  - Density of development
  - Mix and types of businesses
  - Population, employment, housing
    - Relative shift from single family to multi-family
  - Future costs and pricing

Demand Changes (cont.)

- Customer attitudes and behaviors
  - Conservation ethic
  - Changes in landscape patterns
- Climate change and extreme weather
  - Changes in amount and intensity of rainfall
  - Changes in snowpack
  - Changes in temperature

Evaluate Potential Demographic Changes

- Understand the inherent uncertainties with forecasts of population and job growth
- Systems should talk with their local demographers
- Systems should talk to their customers to better understand what influences demand at a local level

Understand Uncertainty

- Future demand forecasts are typically shown as a straight line
  - Gives a mistaken impression of confidence surrounding these forecasts
- Management and governing boards need to understand these uncertainties as they impact future investment decisions

Drought – Planning & Coping

- Every water system needs a drought plan
  - Typical drought plan has an increasingly stringent set of conservation & use measures
- How is ongoing conservation affecting your ability to cope with a drought?
- Every drought plan should be re-evaluated on a regular basis

Research Needs

- Understanding baseline conditions and potential changes to the baseline
  - What % of service area has installed low-flow plumbing fixtures? How might future gpcd change?
  - What % of service area has installed residential sprinklers?
  - How is household size changing?
  - How are business/industrial customers changing?
  - How do higher water rates impact water demand?

More Research Needs

- Potential Impacts of Demand on Design
  - Have peaking factors changed over time?
  - Have the requirements for storage changed?
  - How could changes in water demand forecasting change wastewater design
    - Both collection system and treatment plants
  - What are the potential impacts from the use of reclaimed water for outdoor irrigation?

More Research Needs

- System data
  - A minimum data set of water demand data and demographic data is needed
- System revenues
  - More detailed information on demand/sales from different customer class categories
- Data integration and information management research
  - Combining utility data with outside data
  - Defining industry “best practices”

More Research Needs

- Historical drought/water shortage analyses
  - Has demand been reduced as predicted after water restrictions?
- Value of information (VOI) studies
  - VOI studies not used by water sector
    - How much should you spend now to reduce the uncertainty about a future decision?
    - Could be used as a sensitivity analysis for investment decisions

More Research Needs

- Social Science Research
  - Effectiveness of conservation efforts
  - Effectiveness of turf replacement programs
  - Effective of customer education
- Tools for investment decisions
  - Relationships between all of the data

Recommendations for Reducing Uncertainties in Forecasting

- A “real” reduction in the uncertainties from multiple factors is not likely
  - Need to develop a better understanding
  - Could mean you become more uncertain before you become more certain!
- Data, data, and more data
  - Utilities need to become comfortable with collecting, managing, and analyzing “big data”
    - Automation means more data but what good does it do if it is too difficult or too costly to analyze and management does not use it to make decisions?

Recommendations (cont.)

- The presentation of uncertainties in future demand and future revenue forecasts is typically not done and is critical
  - Future demand = future water sales = $$
  - Upper management and governing boards need some understanding of the future
    - Need to understand the “new normal”

QUESTIONS?

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Final Report:
http://www.awwa.org/portals/0/files/legreg/documents/noaagrantreportdemandforecasting.pdf