Glass Half Empty or Half Full?
Changing Climate and Wisconsin’s Drinking Water Supply

Wisconsin Water Association
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WICCI Climate Analysis
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Overview

Wisconsin’s changing climate

Wisconsin's water supply
  - Climate vulnerabilities
  - Climate benefits

Planning for adaptation
What about climate concerns us?

Humans experience climate as weather...
What about climate concerns us?

...and weather can take a human toll!
High Water
Storms of June 1-15, 2008

38 River gauges broke records
810 Square miles of land flooded
161 Communities overflowed 90 million gallons raw sewage
2,500 Drinking water wells tested - 28% contaminated

$34M in damage claims paid

Source: FEMA, WEM
Milwaukee, July 22, 2010

6.73” in one hour  (extreme rainfall)

2,000 calls for sewer backups into basements

CSO of around 2 billion gallons

Beaches closed through July 25th.

Source: Milwaukee Journal-Sentinel
Scientific consensus on climate change

“There is a strong, credible body of evidence, based on multiple lines of research, documenting that climate is changing, and that these changes are in large part caused by human activities.”

— US National Research Council, 2010

Wisconsin Initiative on Climate Change Impacts

- Understanding ways we can adapt to the consequences of climate change.

www.wicci.wisc.edu
**WICCI Mission**

Create regionally relevant climate history and climate projections;

Assess climate change impacts on specific Wisconsin natural resources, ecosystems;

Evaluate potential climate vulnerabilities of industry, agriculture, tourism, and other human activities;

Identify climate adaptation strategies;

Facilitate climate outreach and learning.

A.B. Sheldon

WDNR
Historic Temperature Change

Wisconsin has warmed by 1°–1.5°F since 1950.
Daytime High Temperature Change

Winter

Spring

Nighttime Low Temperature Change

Winter

Spring
Temperature Extremes

Sub-zero nights: much less frequent

Very hot days: little change
Dates of Spring and Fall Freeze

Wisconsin growing season lengthened by 1-4 weeks since 1950
Annual Average Precipitation Change

Wisconsin rainfall has changed ↑7" - ↓4" since 1950
Summary of Wisconsin’s **Projected** Climate

- Warmer winter and nighttime temperatures
- Frequent hot summer days, heat waves and dry periods
- Increased frequency and intensity of precipitation
- More rainfall during winter and spring

*Short term variability (weather) and extreme events cannot be projected*
Objective:
Statistically downscale global climate model simulations across the east and central Landscape Conservation Cooperatives (LCCs), to scales that are relevant for decision makers (~10 km).
Projected change in mean annual temperature
+6°F  1980-2055 (SRES A1B)
Projected change in annual mean temperature

<table>
<thead>
<tr>
<th></th>
<th>Measured</th>
<th>1980-2055</th>
<th>Projected</th>
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</thead>
<tbody>
<tr>
<td><strong>1971 - 1989</strong></td>
<td>High 46.6</td>
<td>Mean 42.8°F</td>
<td>High 52.3</td>
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<tr>
<td></td>
<td>Low 40.5</td>
<td></td>
<td>Low 45.8</td>
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<tr>
<td><strong>2046 - 2065</strong></td>
<td></td>
<td></td>
<td>(10%)</td>
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<tr>
<td></td>
<td>High 52.3</td>
<td>Mean 48.7°F</td>
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<tr>
<td></td>
<td>Low 45.8</td>
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<td>(10%)</td>
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Selecting Climate Data

Co₂ Emission Scenarios

Using: A1B as mid-range example

(not more likely)
How far do we need to look ahead?

**Planning Horizons**

- Local budgets 1-2 years
- Staffing levels 3-5 years
- Buildings 25-50 years
- Water, Sewers, etc. >50 years

*Today’s climate is what matters for most decisions*

Comparing: Late 20\textsuperscript{th} to mid-21\textsuperscript{st} century

- Projected Change in Annual TMEAN (°F) from 1980 to 2055 (SRESA1B)
  - 35 years: +6 °F

- Projected Change in Annual TMEAN (°F) from 1980 to 2090 (SRESA1B)
  - 85 years: +8-9 °F
Projected change in max annual temperature
$+6^\circ F$  1980-2055 (SRES A1B)

Source: Center for Climatic Research, Nelson Institute
University of Wisconsin – Madison
Seasonal change in max temperature 1980-2055 (SRES A1B)

Winter: +6-7°F
Spring: +5-6°F
Summer: +4-5°F
Fall: +6°F
Warmer winters: less ice cover
Climate Vulnerability

Warmer winters + less ice cover:
Increased surface evaporation

Lower Great Lakes water levels

Winter +6-7°F

December 2012
Increasing water temperature:
Higher surface wind speeds

Lake Superior regional wind speeds
- Desai, et al 2009

Southern Lake Michigan Turbidity Index 1956–2000
(10 and 25 mg/L exceedances)
- Schwab, et al 2006

Higher wind speeds:
Increased turbidity
Increasing surface water temperature:

More frequent algal blooms
Projected change in annual peak temperatures 1980-2055 (SRES A1B)

+10-25 days >90°F

+0-5 days >100°F
Likelihood of the Warmest Day of the Year

Warmest Day of the Year, 1981–2000  Wausau

Warmest Day of the Year, 2046–2065

Extremes shift too
Increase in heat waves

1981-2000 vs. 2046-2065

Heat Wave (5 days or more above 90°F) Frequency by Duration

More frequent and longer
Heat waves and drought: 
Increased water use

**Madison Water Usage**
2011 vs. 2012

- **Heat and Drought**
- **Rain and Cooling**
Projected change in annual precipitation

+5-15%    1980-2055 (SRES A1B)

Source: Center for Climatic Research,
Nelson Institute
University of Wisconsin - Madison
Seasonal change in precipitation
1980-2055 (SRES A1B)

Winter +20-25%

Spring +10-20%

Summer +0-5%

Fall +5-10%
Climate Vulnerability

Summer rainfall +0-5%

Less precip + higher summer temp: Drought

Summer temperature +4-5°F

An incentive to irrigate?
Climate Vulnerability

Potential competition for municipal water supply?
Winter and Spring precip:
Increased groundwater recharge

Evan Murdock
45%

Black Earth Creek Watershed
1971-1999 vs 2041-2069
Increased recharge:
Groundwater flooding

Rising water table can result in groundwater contamination

Especially in communities that do not disinfect

Gotkowitz & Liebl, 2013
Climate Vulnerability

Winter Precip +20-25%

Winter Temp +6-7°F

Seasonal shift in temp and precip:

Riverine flooding during winter and spring
Projected change in > 2” rain
2-5/10yr  1980-2055 (SRES A1B)
Both are projected to increase
Increased heavy rainfall: More sanitary sewer overflows

Milwaukee’s projected frequency of ↑2.5-inch daily rainfalls (=CSOs)

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<tr>
<th></th>
<th>1971-2000</th>
<th>2041-2070</th>
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<tbody>
<tr>
<td>Observed</td>
<td>3.0 years</td>
<td></td>
</tr>
<tr>
<td>Projected</td>
<td>2.3 years</td>
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Precipitation events associated with CSOs increase from 3 times per decade to 4-7 times per decade by 2050
Climate Change and Water Utilities

*Is the glass half-empty or half-full?*

**Increased rainfall infiltration:**
- $+\frac{1}{2}$ GW supply
- $-\frac{1}{2}$ GW contamination

**Summer heat and drought:**
- $-\frac{1}{2}$ Irrigation demand for GW
- $-\frac{1}{2}$ Cost and GHG from additional pumping

**Surface water supply quality:**
- $-\frac{1}{2}$ Blue-green algal blooms
- $-\frac{1}{2}$ Shoreline recession, wind = turbidity
- $-\frac{1}{2}$ Extreme rainfall increasing TSS and SSOs
Planning for Climate Adaptation

USEPA Climate Ready Water Utilities

Delivering reliable, high-quality water requires a delicate balance between water supplies and customer demands. While water managers continually have strived to maintain this supply-and-demand balance through long-term water resources planning and demand management, new challenges exist due to the impacts of climate change, putting the world’s water resources at risk.

From extreme rainfall events and flooding to prolonged drought, watersheds throughout the world are experiencing greater variability in weather patterns. Solely relying on historical data to predict future precipitation, snowpack, runoff and river and stream flows no longer is practical. In addition to climate change, population growth, increased water demands, water quality concerns and endangered species-related issues make the availability of water resources a critical concern for water providers.

The Water Utility Climate Alliance is dedicated to collaborating on climate change issues affecting drinking water utilities. By enhancing climate change research and developing adaptation strategies, water utilities will be positioned to respond to climate change and protect our water supplies.
Questions?

Slides and references available from:

http://www.wiawwa.org/