Changing Climate

An Engineering challenge for today and the future

David S. Liebl
UW- Madison, EPD; UW-Extension;
Wisconsin Initiative on Climate change Impacts

Milwaukee School of Engineering
December 2, 2015
Overview

- Trends in historic and projected climate
- Climate vulnerabilities and risk
- Adapting to climate risk
- Q&A and discussion

www.wicci.wisc.edu
Do you think Wisconsin’s climate is different now than it was before your parents were parents?
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
Warmer winters: less ice cover
Wisconsin growing season lengthened by 1-4 weeks since 1950
Of 55 ecological indicators of spring, 37 advanced between 1935-47 and 1976-98

Pasque flower bloom
9 days earlier, on average

American Robin arrival
1935-1947  March 19
1976-1998  March 5

Bloodroot bloom
14 days earlier, on average

Source: Stan Temple, UW-Madison
8 of 10 of the wettest years for daily precipitation have occurred since 1978.
Annual Average Precipitation Change

Wisconsin rainfall has changed ↑7” - ↓4” since 1950
The climate idea

“Climate is properly the long average of weather in a single place”

– The Cornhill Magazine, 1860

Köppen climate subdivisions -1884 (30 year averages)
What about climate concerns us?

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

...and weather can take a human toll!
What do you think about projections of future climate?
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)
Selecting Climate Data

Co₂ Emission Scenarios

Using: A1B as mid-range example 

(not more likely)
Projected change in annual mean temperature

1971 - 1989
High 46.6°F
Mean 42.8°F
Low 40.5°F

1980-2055

2046 - 2065
High 52.3°F (10%)
Mean 48.7°F
Low 45.8°F (10%)
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 20th to mid-21st

35 years

+6 °F

85 years

+8-9 °F
Projected change in annual peak temperatures 1980-2055 (SRES A1B)

+10-25 days >90°F

+0-5 days >100°F
Seasonal change in max temperature
1980-2055 (SRES A1B)

Winter +6-7°F

Spring +5-6°F

Summer +4-5°F

Fall +6°F
Projected change in annual precipitation
+5-15% 1980-2055 (SRES A1B)
Seasonal change in precipitation
1980-2055 (SRES A1B)

Winter +20-25%

Summer +0-5%

Spring +10-20%

Fall +5-10%
Projected change in > 2” rain
2-5/10yr  1980-2055 (SRES A1B)

Source: Center for Climatic Research,
Nelson Institute
University of Wisconsin - Madison
Projected change in >2” rain, +4-7 per decade  
1980-2090 (SRES A1B)

Increase continues over time
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*
Why should we worry about future precipitation?

Flooding and extreme rainfall threaten life prosperity.
Hydrologic design is based on experience.

The statistics we use actually reflect a drier period (TP40, 1938-1958)

Are we designing for historic climate?
Historical NARCCAP Projected Return Period 1971-2000 vs. 2041-2070

Storm frequency

Storm intensity

Both are projected to increase.

-Vavrus and Behnke
**Precipitation events associated with CSOs**

increase from 3 times per decade to 4-7 times per decade by 2050

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

<table>
<thead>
<tr>
<th>Year</th>
<th>Partially treated volume (MILLION GALLONS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 23-24, 2010</td>
<td>26</td>
</tr>
<tr>
<td>July 7-8, 2010</td>
<td>2.7</td>
</tr>
<tr>
<td>July 14-16, 2010</td>
<td>25</td>
</tr>
<tr>
<td>July 22-25, 2010</td>
<td>99.2</td>
</tr>
<tr>
<td>June 21-23, 2011</td>
<td>26.8</td>
</tr>
<tr>
<td>March 11-12, 2013</td>
<td>0.23</td>
</tr>
<tr>
<td>April 9-13, 2013</td>
<td>201</td>
</tr>
<tr>
<td>April 17-20, 2013</td>
<td>130</td>
</tr>
<tr>
<td>May 12-13, 2014</td>
<td>11.6</td>
</tr>
<tr>
<td>June 18-20, 2014</td>
<td>59.91</td>
</tr>
<tr>
<td>April 9-11, 2015</td>
<td>76.9</td>
</tr>
<tr>
<td>Nov. 17-18, 2015</td>
<td>8.9</td>
</tr>
</tbody>
</table>

Source: Milwaukee Metropolitan Sewerage District

April 9-13, 2013
4.85” (2.0” & 1.4”- 24 hr)

April 17-20, 2013
3.24” (1.5” & 1.3” - 24hr)

Observed: 3.0 years
Projected: 2.3 years - Vavrus

Increased Heavy Rainfall = More Sanitary Sewer Overflows

*Precipitation events associated with CSOs increase from 3 times per decade to 4-7 times per decade by 2050*
Milwaukee, July 22, 2010 - 6.73” in one hour

2,000 calls for basement backups
Sanitary sewers overflow 100M gallons
Beaches closed through July 25th

$37M Damage
# Wisconsin Extreme Precipitation Events

## >5”/day

### 1950-2014

<table>
<thead>
<tr>
<th>Years</th>
<th># events</th>
<th>#/year</th>
<th>Total precip</th>
<th>Precip/event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-1975</td>
<td>39</td>
<td><strong>1.6</strong></td>
<td>223.7”</td>
<td><strong>5.7”</strong></td>
</tr>
<tr>
<td>1976-2000</td>
<td>61</td>
<td><strong>2.4</strong></td>
<td>367.1”</td>
<td><strong>6.0”</strong></td>
</tr>
<tr>
<td>2001-2014</td>
<td>44</td>
<td><strong>3.1</strong></td>
<td>258.0”</td>
<td><strong>5.8”</strong></td>
</tr>
</tbody>
</table>
What an extreme rainstorm can do
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
Extreme Storm Transposition

- Use an infrequent storm from one location as a design storm in another area.
- Practical, given uncertainty in climate change projections
- Objective method for assessing extreme storm vulnerabilities
June 2008 Lake Stage, Transposed Case

- Peak Stage: 853.29’
- 100 Year Flood Stage: 852.70’
- Duration above 100 Year Flood Stage: 10 Days
So,
What do we do with this information?
How should we adapt water management to projected extreme precipitation events?

Assess Vulnerability
- Floodplains
- At-risk road-crossings
- Stormwater BMPs
- Sanitary sewer inflow and infiltration
- Emergency response capacity
- Wells and septic systems
- Hazardous materials storage

Build Long-Term Resilience
- Modify structures
- Update management policies
- Change design standards
- Strengthen ordinances
- Adopt green infrastructure
Understand climate science and impacts

www.wicci.wisc.edu