Stormwater, Climate Change and Wisconsin’s Coastal Communities

Johnson Foundation at Wingspread Briefing
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UW-Cooperative Extension,
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Photo: WDNR
Overview

- Coastal communities and climate
- Wisconsin’s approach to climate
- Precipitation and high water
- Adapting to our changing climate
- Assisting coastal communities
Recent Warming of the Planet

Global Temperatures

- Annual Average
- Five Year Average

Source: IPCC 2007
How Vulnerable are Wisconsin’s Coastal Communities?

Wisconsin has about fifty communities on Lakes Michigan and Superior.

But upland watersheds may be a greater source of risk from changing climate.

City of Green Bay watershed -
Predicted climate includes

Average temperatures increasing 4-9°F by 2050

WICCI Human Health Working Group
Warmer summers = reduced air quality

Projected increases in ozone in Chicago (Source: Holloway et al. 2008)
Changing lake levels

“The general scientific consensus is that, water levels of Lake Michigan and Lake Superior will decline on average, while continuing to exhibit large inter-decadal variation as in the past 100 years.”

- WICCI Coastal Communities Working Group
Changing patterns of precipitation

- More rain in winter
- More intense rainfall
- More high water events
How will Wisconsin adapt to climate change?
Wisconsin Initiative on Climate Change Impacts (WICCI)

Mission:
Assess and anticipate climate change impacts on specific Wisconsin natural resources, ecosystems and regions.

Evaluate potential effects on industry, agriculture, tourism, and other human activities.

Develop and recommend adaptation strategies.

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WICCI Working Groups

- Agriculture
  - Land Use
  - Energy
- Soil Conservation
- Water Resources
- Human Health
- Milwaukee
- Coldwater Fisheries
- Stormwater
- Wildlife
- Green Bay
- Coastal Communities
- Forestry
- Central Sands Hydrology
- Plants & Natural Communities
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Understanding our changing climate

We’ve been measuring rainfall in Wisconsin since 1870
The historic record shows that annual rainfall over southern Wisconsin has increased since 1950 by 2”–6”. However, there are significant regional differences.
Measured trends in precipitation at Madison 1940 - 2009

Rising trend in typical storms?

Greatest increase in heaviest rainfall?

Steve Vavrus, CCR
Summary of historical precipitation data

“Long-term Wisconsin precipitation records indicate that over the last 140 years there have been extended periods of much greater than average annual and daily precipitation. These periods are distributed throughout the record…

…and hence neither support nor disprove the hypothesis that the magnitude and frequency of large rainfall events have increased in Wisconsin as a result of global climate change.”

– WICCI Stormwater Working Group

Take Home Message:
Wisconsin’s precipitation patterns have been changing.
Predicting Climate Change

What Global Circulation Models (GCMs) tell us

**Temperature:**
Warms by 2-6°C (3-10°F) by end of century

**Precipitation:**
Less certain and seasonally dependent
WICCI Climate Analyses

Downscale GCMs to Wisconsin scale using historic data.

Wisconsin temperature and precipitation for 15 GCMs for 1980-1999

Black line = Observed temperature and precipitation
Predicted changes in monthly temperature and precipitation to 2090
Black line = Average of all models.

January in the 20’s

Wetter spring

Drier summer (note uncertainty)
Intense Precipitation

Increasing in frequency

Moderate increase in intensity

Change in Heavy Precipitation Days (Wisconsin Average)

<table>
<thead>
<tr>
<th>Change in Frequency (%)</th>
<th>2046-2065</th>
<th>2081-2100</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-inch</td>
<td></td>
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<tr>
<td>2-inch</td>
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<td>3-inch</td>
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</tbody>
</table>

Change in Intensity of Annual Maximum Daily Precip Amount (Wisconsin Average)

<table>
<thead>
<tr>
<th>Change in Magnitude (%)</th>
<th>2046-2065</th>
<th>2081-2100</th>
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</thead>
<tbody>
<tr>
<td>Daily Maximum Precip</td>
<td></td>
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</table>

Steve Vavrus
Heaviest rainfall events (>5”) are not predicted to increase substantially in number or intensity.
Using downscaled data for a single community

Madison mid-century monthly precipitation is predicted to change

-3% (August)  +20% (January)

The % falling as rain during winter is predicted to double
A word about uncertainty

While we cannot predict the future, we can estimate the risk (probability) from changing climate.

Understanding the risk and potential consequences supports good decision-making.

Wisconsin will warm by 4 – 9° F by mid-21\textsuperscript{st} century
Summary of predicted precipitation patterns

- Moderate increase in total precipitation and intense precipitation events
- Significant increase in rain during winter
- More spring runoff and flooding
- High groundwater in some locations

Take home message:
We can manage more high water events, if we prepare.
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
Heavy Rainfall

Between 1950 and 2007 more than 135 rainfall vents greater than 5" were recorded across the state.

Heavy rainfall can happen anywhere.
Spring Flooding

Wisconsin’s high water events occur during spring in many areas of the state.

Climate predictions suggest that early season flooding will increase.
Urban Flooding

Flooding of streets, homes and businesses may become more frequent as rainfall patterns change.

Critical infrastructure is also at risk from high water events, e.g. City of Reedsburg POTW required $800K in repairs.
Upland runoff and sanitary sewer overflows

- Drinking water contamination
- Beach closures
- Wetland and aquatic habitat damage
Coastal Erosion

Warmer and wetter winters =
- Increased infiltration;
- More freeze/thaw cycles;
- Increasing coastal erosion;
- Bluff collapse and landslides.

Photos: D. Mickelson
Adapting to Climate Change

Humans have always adapted to climate. But predicted changes lead us into unknown territory.
WICCI and Adaptation

*Mitigation* is the idea that we can avoid, prevent or minimize undesirable things happening in the future.

*Adaptation* is the idea that changes are occurring or will occur, and we can manage the impacts of those changes.

**Use a risk management approach**

- Climate presents hazards of varying severity and likelihood.

**Encourage no-regrets strategies**
- Clear present benefit
- Building future capacity
- Don’t gamble on uncertainty
- Flexibility to respond to new information
Successful Adaptation Strategies

Update our hydrologic design process

Identify our high water vulnerabilities

Education and research

Long-range planning

Information
Our designs are based on experience (i.e. history)

The records used may actually reflect a drier period (1938-1958).

We are designing for a historic climate.
Vulnerability Analysis

“Build upon the experiences of communities that have experienced recent extreme rainfalls to guide a state-wide evaluation of vulnerabilities….”  - WICCI Stormwater Working Group

Consider:

– Floodplains and surface flooding;
– Areas of groundwater flooding;
– At-risk road-crossings
– Stormwater BMPs;
– Sanitary sewer inflow and infiltration;
– Emergency response capacity;
– Wells and septic systems;
– Hazardous materials storage.
Education and Research

- Periodically reevaluate and revise climate and hydrologic design models and criteria.

- Develop tools to distinguish the hydrologic effects of human activities from climate change.

- Evaluate and improve strategies for managing high water.

- Establish curriculum to build professional capacity among water resource managers.
Promote long-range planning

- Planning for impacts 25 or 50 years out is challenging

- Adaptation to low-risk, high-cost events requires political support

- Use simulations to understand high water impacts

- The next generation of planners needs to be trained today
Better Information is Needed

- Real time stream-flow data
- Robust groundwater monitoring
- Fine scale rainfall data
- Detailed understanding of sub-watershed characteristics
- Updated estimates of flood profiles
Assistance to coastal communities

Extension outreach to provide local decision-makers with climate adaptation capacity.

Identify areas and infrastructure in the community that are vulnerable to large storm events.

- Economy
- Environment
- Infrastructure
- Land use

Funded by NOAA through Wisconsin Sea Grant, with UW-Extension and UW-Madison College of Engineering
Coastal Vulnerabilities

Economic -
Climate change impacts, including beach health and aesthetics, may impact tourism in coastal communities.

Environmental -
Natural plant communities along the Great Lakes, including coastal wetlands, damaged by persistent extreme lake levels.

Source: Michigan Sea Grant
Coastal Vulnerabilities

**Infrastructure -**

- Drinking water intakes
- Wastewater treatment systems
- Roads and rail
- Harbors and marinas
Coastal Vulnerabilities

Land Use -
Residential and commercial structures and property on the coast are vulnerable to erosion and flooding.

The migration of the Ordinary High Water Mark (OHWM) towards the lake during extended periods of low lake levels may encourage development in hazardous areas.
WICCI take home messages

Our climate has and will continue to change.
Wisconsin’s coastal communities are vulnerable.

We have and can continue to adapt:

- Update our design process
- Identify our high water vulnerabilities
- Education and research
- Long-range planning
- Better information

Assistance to communities is available today.
Synthesis of climate impact assessments by WICCI Working Groups.

Initial recommendations on adaptation strategies for decision-makers.
Questions? …wade right in

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