CLIMATE CHANGE IN THE GREAT LAKES REGION

Don Scavia
University of Michigan
Global Temperature

From Knutti and Sedlacek, 2012
Global trends are more certain than regional trends

Natural variability plays a larger role at the regional scale

Local land use changes can alter severity of climate impacts
What has Changed?

Changes are often discussed as averages ...

... but most environments are managed in terms of timing and extremes.
Today’s Outline

Changing Temperatures
• What has happened
• What is projected
• What are the likely impacts

Changing Precipitation
• What has happened
• What is projected
• What are the likely impacts
What has Changed?

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... but most environments are managed in terms of timing and extremes.
Observed Michigan Temperature

Winter temps and overnight lows increased faster than annual averages.
Observed Heat Waves

Heat waves that pose risks to human health increased in most major Midwestern cities.

Increasing overnight, minimum temperatures increased faster, limiting relief during hot periods.
Migrating Plant Hardiness Zones

Average extreme minimum temperatures migrated north.

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Longer Midwestern Growing Season

Growing season lengthened by ~1-2 weeks

Mostly due to earlier last winter frost in spring

Growing season in 2100 may be 1-2 months longer

Based on data from the National Climatic Data Center for the cooperative observer network and updated from Kunkel et al. (2004)
The Great Lakes are Warming

Average Great Lakes ice coverage **declined 71% percent** from 1973 to 2010 Wang et al., 2012

- Lake Superior water is warming twice as fast as air

- Lake Superior could have little to no open-lake ice cover during a typical winter within the next 30 years

Austin and Colman, 2007
Projection: A Migrating Climate

Future generations will experience a fundamentally different climate.

By the end of this century, Michigan summers will feel like current summers in Arkansas.

Courtesy UCS 2009, original work by Hayhoe et al.
Projected Midwest Temperature Increases

High Emissions Scenario

Low Emissions Scenario

~ 9-12°F Rise in A1F1 Scenarios

~ 4-7°F Rise in B1 Scenarios

Modified from Hayhoe et al, 2010
Changes in **temperature** and precipitation will impact both engineered and natural environments.

- Fish
- Water
- Energy
- Forests
- Agriculture
- Biodiversity
- Public Health
- Transportation
- Birds and Wildlife
- Tourism and Recreation
More Hot Days Projected

2041-2070

Increase in Days > 95°F

Increase in Consecutive Days > 95°F

Kunkel (2011)
Impacts of Declining Lake Ice Cover

- **Fishing Industry:** Harms whitefish spawning areas and increased wetland.
- **Coastal Zone:** Loss of stable platform for recreation.
- **Navigation:** Potentially lower water levels; lengthened shipping season.

Wang et al., 2012
Potential Impacts on Shipping

Every lost inch of water depth:

– Reduces cargo capacity 50-270 tons
– Costs $10k-30k per transit

...but less lake ice cover also allows for a longer shipping season
Lake Level Projections

Drew Gronewold, NOAA/GLERL
Projected Shifts in Forest Types

Current:
Maple, Beech, Birch, and Aspen

Projected:
Oak, Hickory, Elm
Impacts on Biodiversity

• Amplified existing stressors, including sensitivity to land and water use

• Some species will need to migrate to keep up with the pace of warming ...

... but, large agricultural areas and the Great Lakes are major obstacles to migration
• Some crops may benefit in the near future from increasing carbon dioxide concentrations until negated by warmer temperatures.

• Perennial crops may be more vulnerable to the pace of climate change and may face greater adaptation challenges.
Agriculture Vulnerabilities: Spring 2012 Cherry Crops

• The early warming was extreme weather event

• The seasonal warming fits a pattern of a more variable climate

• The early warming followed by a normal hard freeze was devastating to cherry buds

• $92 million loss from tart cherries alone
What has Changed?

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Precipitation increased in Winter and Fall but remained stable or have declined during Spring and Summer.
Observed Extreme Precipitation Intensity

Intensity of the heaviest 1% of precipitation events increased from 1958 to 2007.
Observed Extreme Precipitation Frequency

Frequency of heaviest 1% of precipitation events increased from 1958 to 2007.
Observed Snowfall Change

Snowfall increased in the North & decreased in the South.

More in Northern Lake Areas

Less in Southern Areas
Lake effect snow increased in some areas.

But, shorter winters led to more falling as rain.

Warmer surface temperatures also reduced snow accumulation.
Projected Precipitation

2041-2070 vs. 1971-2000

Winter
+5 to 20%

Spring
+0 to 20%

Summer
+10 to -10%

Fall
+0 to 20%

Annual
+5 to 15%

Kunkel (2011)
Impacts in the Great Lakes Region

Changes in temperature and precipitation will impact both engineered and natural environments.

Fish
Water
Energy
Forests
Agriculture
Biodiversity
Public Health
Transportation
Birds and Wildlife
Tourism and Recreation
Flooding and Stormwater

Stronger and more frequent extreme events amplify flood risks.
Impacts on Agriculture

• Increasing intensity of severe storms increases the risk of runoff and erosion.

• Shifts in the timing of precipitation will affect field preparation time in spring.

• Some crops may benefit in the near future from increasing carbon dioxide concentrations until negated by warmer temperatures.

• Perennial crops may be more vulnerable to the pace of climate change and may face greater adaptation challenges.
Conspiring Changes: Water Quality

- Stronger Storms
- More Runoff
- Greater Nutrient Loading
- Warmer Lake Temperatures
- Changed Lake Dynamics
- Algal Blooms, Dead Zones, Fish Kills
Algal Blooms and Fish Kills

Climate Change will increase the risk of many existing water quality and environmental issues.
How will we adapt?

Winter is a part of our “Sense of Place”. We are losing Winter as we once knew it.

-John Magnuson
Are we preparing to adapt?
Extra Slides
Projected Snowfall Days

Hayhoe et al (2010)