Future Climate Change Scenarios for Lake Michigan Levels

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Introduction

- Water Supply Planning in Illinois
- Climate Change
- Impact of future climate change on Lake Michigan
Water Supply Planning in Illinois

- Initiated by executive order in 2006

- Projected demand of 20 to 50 percent more water in coming decades.

- Where will we get this water?

- How much will it cost?

- Need to plan now
Water Supply and Lake Michigan

- Lake Michigan is a key source of fresh water
- Communities within the basin have unlimited access
- Chicago is allowed by the Supreme Court to divert 3,200 cfs down the Chicago River
- Change in Lake Michigan water levels
  - Impact water intakes & water quality
  - Diversion
Illinois Diversion

Graph showing cubic feet per second from 1981 to 2005. The x-axis represents accounting years, and the y-axis represents cubic feet per second. The graph compares allowed diversion with certified flow.
Impact of Climate Change on Lake Michigan

- Concern with changing temperature & precipitation
- Lack of ice cover in winter – more evaporation
- Warmer and drier conditions will strain water resources throughout NE Illinois
CO$_2$ Concentration in Global Atmosphere
2007 IPCC report

“Most of the observed increase in global average temperature since the mid-20\textsuperscript{th} century is likely due to the observed increase in anthropogenic “greenhouse gasses” concentrations.”
Geographical pattern of surface warming

(°C)
Methodology

- Great Lakes Environmental Research Lab (GLERL)
  - Advance Hydrologic Prediction System (AHPS)
    - Used in both operations and research
    - Daily runoff models for each of 121 watersheds
    - Lake thermodynamic model of each lake
    - Hydraulic models for connecting channels and outflow points, taking into account operating plans
IPCC models

- General Circulation Models
  - Modeling the Earth-Ocean system
  - Limited by our knowledge of the system
  - Limited by our ability to model finer details
- Between 18 and 23 GCMs used, depending on scenario
- Examined three CO2 emission scenarios
Three scenarios used

CO2 Concentrations for Select Scenarios

- A2
- A1B
- B1
Annual Temperature – A2 scenario

Great Lakes Annual Temperature Departure from 1971-2000 Normal

Temperature Departure (°F)

Year

20th Century
A2 5th
A2 95th
Winter Temperature – A2 scenario

Great Lakes Winter Temperature Departure from 1971-2000 Normal

- Temperature Departure (F)
- Year

- 20th Century
- A2 5th
- A2 95th
Annual Temperature – B1 scenario

Great Lakes Annual Temperature Departure from 1971-2000 Normal

Temperature Departure (°F) vs Year

-2 0 2 4 6 8 10 12 14

1900 1925 1950 1975 2000 2025 2050 2075 2100

20th Century, B1 5th, B1 95th
Annual Temperature – all scenarios

Great Lakes Annual Temperature Departure from 1971-2000 Normal

Temperature Departure (F)

Year

20th Century  A2 5th  A2 95th  A1B 5th  A1B 95th  B1 5th  B1 95th
Great Lakes – Annual Precipitation

Great Lakes Annual Precipitation Departure from 1971-2000 Normal

- Precipitation Departure (in)
- Year

Legend:
- 20th Century
- A2 5th
- A2 95th
- A1B 5th
- A1B 95th
- B1 5th
- B1 95th
Input GCM results into GLERL model


- These functions used to adjust the finer resolution GLERL model climatology of 1970-1999.

- Functions included temperature (high, low, mean), winds, humidity, and cloudiness.
A2 – high emission scenario
A1B – moderate emission scenario
B1 – low emission scenario

B1 Lake Level Departures for Lakes Michigan and Huron

Lake Level Departure (ft)

2020 2050 2000
2050 Lake Levels

Lake Michigan 2050 Lake Level Departures

Lake Level Departure (ft)

A2  A1B  B1

Scenarios
2080 Lake Levels

Lake Michigan 2080 Lake Level Departures

Lake Level Departure (ft)

Scenarios

A2
A1B
B1
Summary

- GCM simulations show **increases** in temperature of:
  - 2 to 7 F in the low emission scenario (B1)
  - 6 to 12 F in the high emission scenario (A2)

- GCM simulations show ranges in precipitation of:
  - -2 to +5 inches in the low emission scenario (B1)
  - -2 to +8 inches in the high emission scenario (A2)
Summary

- Majority of scenarios showed a drop in lake levels.
- Some showed an increase in lake levels.
- The high emission scenario (A2) showed the strongest response with the widest range.
- Lake level response was strongest in 2080.