Precipitation Events

Overall Assessment
Trend: Increasing
Rationale: Unavailable

Purpose
To assess trends in precipitation and to examine the influence and impact(s) of climate change on the Great Lakes region.

Ecosystem Objective
The ecosystem objective is to maintain the diverse array of Great Lakes coastal wetlands by allowing, as closely as possible, the natural seasonal and long-term fluctuations of Great lakes water levels. The alteration of frequency and magnitude of precipitation events may also affect such beneficial use impairments as 'Loss of Fish and Wildlife Habitat,' 'Degradation of Phytoplankton and Zooplankton Populations,' 'Degradation of Aesthetics,' 'Restrictions on Drinking Water Consumption or Taste and Odor Problems,' 'Eutrophication or Undesirable Algae,' 'Restrictions on Dredging Activities,' 'Degradation of Benthos,' and 'Degradation of Fish and Wildlife Populations' under Annex 2 of the Great Lakes Water Quality Agreement.

Ecological Condition
In recent decades the Great Lakes region has seen pattern of above average precipitation in both summer and winter months (Kling, 2003). From 1915 to 2004, total annual precipitation increased by 4.5 inches (Hodgkins et al., 2007). Although trends indicate increases in total precipitation, precipitation has not increased uniformly over the last one hundred years. For example, over the last 90, 70, and 50 years respectively, precipitation in March and February declined. Conversely, precipitation in April, May and July through December, over the same time periods, increased (Hodgkins et al., 2007). These finding highlight the seasonal shift in precipitation patterns.

The following figure showcases trends in average annual precipitation, in inches, over the Great Lakes providing support of an overall pattern of increasing total annual precipitation.

Looking forward, in low- and high- emission climate models scenarios, average annual total precipitation is expected to be slightly above long-term averages. It is also expected that annual average precipitation will increase by 10 to 20 percent by the end of century. In terms of temporal shifts in seasonal patterns of precipitations, winter and spring rains are expected to increase and summer rains decrease by up to 50 percent.

Over the course of the last five decades, the frequency of 24-hour and 7-day intense rainfall events have been high relative to the long-term average. Furthermore, findings based on models suggest an increase in both 24-hour and multiday heavy rain events over the next century. It is predicted that such events may double by 2100 (Kling et al., 2003).

<u>Data Source</u>
Data from this report was generated using climate data from the National Oceanic and Atmospheric Administration (NOAA) climate divisions found in Table 1. These divisions were chosen based on an approximation of the boundaries of the Great Lakes basin.

Linkages

The impact of changes in the temporal distribution and magnitude of precipitation in the Great Lakes region will likely have an effect on the hydrologic system of the basin. As temperatures increase, evaporation as well is expected to increase. Additionally, an increase in surface water runoff will likely accompany an increase in total precipitation resulting in both positive and negative impacts on ecosystems. For ecosystems that rely on water level recharge during the winter season, the increase in winter precipitation may result in favorable impacts. Conversely, ecosystems that rely on summer recharge, such as some wetland ecosystems, may experience significant stress with decreases in summer precipitation (Wuebbles et al., 2004). Changes in runoff will also affect soil moisture. When compared to the long-term average from 1961-1990, soil moisture is expected to increase upwards of eighty percent during winter in some areas in the region and decrease regionally by upwards of thirty percent in the summer and fall. A shift in soil moisture may also promote the preference of crops and ecosystems that are reliant on recharge during the winter months (Kling et al., 2003).

Additional consequences of altered precipitation patterns include:

- Increased occurrence of flooding events
- Increased erosion and distribution of pollutants from upland sources
- Increased runoff relative the rate of infiltration
- Decreases in fish and invertebrate production
- Disturbance of food web interactions and fish and insect life histories (Kling et al., 2003)
- Increased lake effect snow resulting in warmer surface waters and decreased ice cover (Burnett et al., 2003).

Management Challenges/Opportunities

The realm of response options to address climate change is classified into two categories, the first of which is adaptation, or "initiatives and measures designed to reduce the vulnerability of natural and human systems against actual or expected climate change effects" (Koslow, 2010). Although a wide range of adaptation strategies exist, there are significant financial, technological, cognitive, behavioral, political, social, institutional, and cultural constraints resulting in limited implementation and effectiveness of adaptive strategies (Bernstein et al., 2007). Adaptation is one way to deal with the knowledge gaps and uncertainty of climate change science (Patino, 2010). The Wisconsin Initiative on Climate Change Impacts (WCCI) recommends a risk management approach to impacts and adaptation. With confidence in seasonal changes, there is concern for spring high water events which will increase the threat of flooding from rivers, streams, and groundwater, and promote sanitary sewer overflows into waterways. Understanding the forecasted impacts and vulnerabilities is a first step toward implementing adaptation strategies (David S. Liebl, 2011)

In the Great Lakes basin there has been significant progress in defining what adaptation means for conservation and restoration efforts in the region. For example, tools to help managers incorporate adaptation strategies into planning efforts have been developed by such organizations as the National Wildlife Federation, the Climate Adaptation Knowledge Exchange, regional Sea Grant offices, NOAA, and Natural Resources Canada to name a few (Koslow, 2010 and Natural Resources Canada). A few examples of projects or programs which have integrated adaptive strategies into management processes relevant to increased precipitation and altered distribution of precipitation events include the following:

- Wisconsin Imitative on Climate Change Impacts: The Wisconsin Imitative on Climate Change Impacts partnered with the Milwaukee Sewage Department on a project designed to provide estimates of the effects of altered precipitation patterns on sewage overflows to allow for better stormwater management.

- City of Chicago: The city currently utilizes green roofs as a means of reducing the amount of impervious surface and thus reducing stormwater runoff.
- City of Detroit: The City of Detroit uses green alleys, or concrete alleyways fitted with permeable pavement and open-bottom catch basins, to reduce stormwater runoff. Although only one alleyway has been built thus far, it is capable of holding up to a 10-year storm without water going into the storm drain (Koslow, 2010).
- Updating flood profiles to locate at risk areas (e.g., hazardous materials, wells and septic, roadways) can assist in prioritizing resource spending. Mapping hydric soils, regulating development of these lands, and restoring or enhancing existing ecological buffer zones can improve stormwater storage capacity and reduce downstream flood magnitudes. Collectively, enhancement of stormwater storage capacity and the disconnection of stormwater inputs to sanitary systems will reduce the frequency and magnitude of sanitary overflows in combined stormwater and sanitation systems (Liebl, David 2011).

Adaptation is not explicit to infrastructure, but also to programs and policy. Adaptation in programs and policy calls for ongoing and permanent monitoring for re-assessment and adjustment (Policy Horizons Canada 2010). At minimum, programs and policy should embed mechanisms for adjustments informed by monitoring. Flood management and the protection of ground water resources will benefit from the restoration and enhancement of surrounding wetlands and open space (Adapting to Climate Change, NOAA 2010 & Liebl, David 2011). However, areas of functional conservation will likely migrate or perish. To provide continued protection to these areas as they migrate with climate change requires particular mechanisms. Rolling easements, for example, are designed to promote the natural migration of shorelines. Defined by physical characteristics such as the line of vegetation, the delineation of the easement is adapted to change in accordance with changing water levels (Adapting to Climate Change, NOAA 2010).

The other way in which climate change can be addressed is through mitigation, or technological change and substitution that reduce resource inputs and emissions per unit of output (Koslow, 2010).

Assessing Data Quality

This check-box section is intended to provide a summary of the author's assessment of key elements of the data that underlie each report. Please place an X in the appropriate column for each data characteristic that is listed. You may provide clarifying text or caveats in the text box called "Clarifying Notes."

Data Characteristics	Strongly Agree	Agree	Neutral or Unknown	Disagree	Strongly Disagree	Not Applicable
1. Data are documented, validate or quality-assured by a recognized agency or organization	X					
2. Data are traceable to original sources	X					
3. The source of the data is a known, reliable and respectable generator of data	X					
4. Geographic coverage and scale of data are appropriate to the Great Lakes basin		X				

5. Data obtained from sources within the U.S. are comparable to those from Canada						X
6. Uncertainty and variability in the data are documented and within acceptable limits for this indicator report	X					
Clarifying Notes						

Acknowledgments

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Last Updated
State of the Lakes Ecosystem Conference (SOLEC) 2011

State	Climate Division
Minnesota	3,6
Wisconsin	1,2,3,6,9
Illinois	2
Indiana	1,2,3
Michigan	1,2,3,4,5,6,7,8,9,10
Ohio	1,2,3,4
Pennsylvania	10
New York	1,9,10

Table 1. Climate Divisions
Source: NOAA

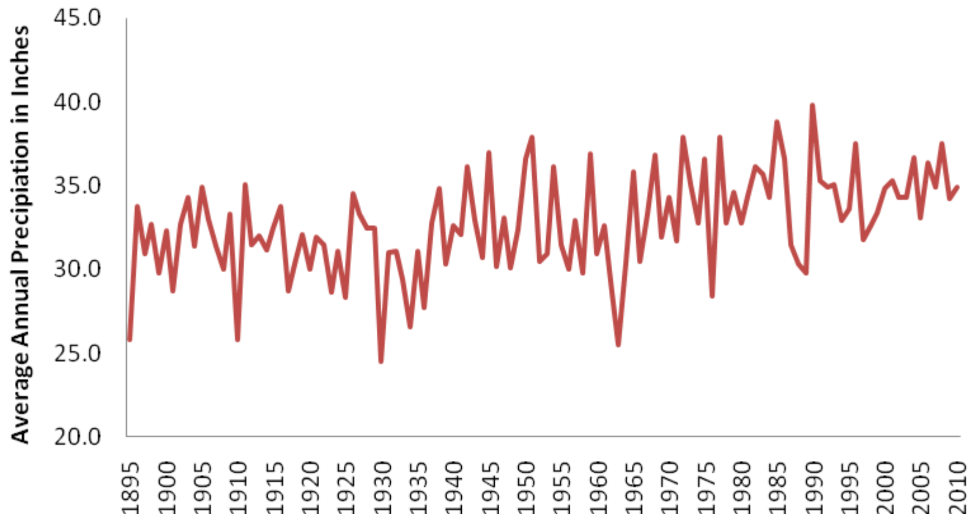

Figure 1. Trends in Precipitation in the Great Lakes
Source: NOAA