Climate Change Impacts in the Great Lakes Region

There is a high level of scientific certainty that climate has changed in significant ways in recent decades. This sheet provides an overview of recent historical trends and projections for the future climate in the Great Lakes region. The potential impacts described here summarize the best peer-reviewed literature available from many sources and experts across many fields of research.

Projections of future climate include assumptions on the future rate of greenhouse gas emissions and interactions between elements of the Earth system. Therefore, no single model or projection is capable of making a deterministic prediction of the future climate of the region. Climate projections merely are able to describe a range of probable futures.

Temperature

Historical: Average temperatures in the Great Lakes region increased by 2.3 °F (1.3 °C) from 1968 to 2002.

Future: By 2050, average annual air temperatures will likely increase 1.8 to 5.4 °F (1 to 3 °C). By 2100, an average annual increase of 3.6 to 11.2 °F (2 to 6.2 °C) is projected. Winter temperatures may experience a greater increase than the summer months during the first half of the 21st century.

Precipitation

Historical: Annual and seasonal precipitation is highly variable across the region. Overall, total annual precipitation in the Midwest is increasing, and the seasonal distribution and form of precipitation has also changed. Less precipitation has been falling as snow in the late fall and early spring months due to increased temperatures.

Future: Model projections of precipitation vary widely. A majority of models project a slight increase in total annual precipitation, with greater increases in winter precipitation and potential increases in autumn and spring, as well. The largest increase in winter and spring precipitation projected by any model was 20-30 percent.

Extreme Weather Events, Water Quality, and Stormwater Management

Historical: The frequency and intensity of severe storms, flooding events, and droughts have increased. The frequency of heavy rain events (defined as occurring on average once per year during the last century), doubled from 1931 to 1996. The increase in multi-day and heavy precipitation events in several Midwestern states has lead to more stormwater management problems.

Future: These trends will likely continue as the effects of climate change become more pronounced. Changes in land use, such as increased coverage of impervious surfaces, may facilitate runoff during periods of intense precipitation and lead to increased frequency of flooding. Intense downpours and flooding interfere with transportation infrastructure, increase erosion, sewage overflow, and introduce more contaminants into the water supply.

Water Availability

Historical: From 1920 to 1995, input of water into Lakes Michigan and Huron has shifted to autumn and winter, resulting in less runoff and lake level rise in the spring. In Lake Superior, decreased runoff has been observed in the autumn and summer, and no change in runoff in winter or spring, suggesting that the seasonality of Lake Superior water levels has decreased.

Future: Warmer temperatures may lead to more winter rain and earlier snowmelts. Streamflow in the autumn and winter winter will likely increase, while streamflow in the summer will likely decrease overall and become more variable.

Snow and Ice Cover

Historical: Since 1975, the number of days with land snow cover has decreased by 5 days per decade, and the average snow depth has decreased by 1.7 cm per decade.

Future: Snow and ice levels on the Great Lakes and on land will likely continue to decrease overall. Reduced lake freezing will result in more exposed water that could increase lake-effect precipitation downwind of lakes. But earlier spring warming may decrease the length of the snow season and cause precipitation in some lake-effect events to fall as rain rather than snow.

Lake Levels of the Great Lakes

Historical: Water levels in the Great Lakes have been decreasing since a record high was reached in 1980. Lake levels throughout the 20th century were highly variable. Lake levels are now rising and falling a month earlier than during the 19th century.

Future: Because many factors, such as land use and lake regulation, affect lake levels, it is still unclear how much of the recent trend in lake levels may be attributed to climate change. Model projections of lake levels vary, though most indicate a greater decline in lake levels with increasing greenhouse gas emissions.

Lake Temperature and Stratification

Historical: From 1968 and 2002, temperatures in Lake Ontario increased by 1.6 °C and in Lake Huron by 2.9 °C. From 1979 to 2006, summer temperatures in Lake Superior increased by 2.5 °C.

Future: Both inland lakes and the Great Lakes will likely experience a longer warm season. Warmer water surface temperatures may increase the stratification of the Great Lakes, decrease vertical mixing in the spring-winter, and potentially lead to more low-oxygen, hypoxic “dead zones.”

Forests

Historical: An overall increase in vegetation during the 20th century has been attributed to increased concentrations of atmospheric CO_2.

Future: Climate change will likely have mixed effects on forests that vary based on the species involved and other factors. In general, the distribution and composition of tree species will likely shift northward as temperatures rise. With increasing atmospheric CO_2, forest productivity will likely increase until other impacts of climate change, such as increased risks of drought, forest fire, and invasive species present additional stressors to forests.

Fish and Wildlife

Historical: Environmental and biological factors have stressed many fish populations in the Great Lakes and lead to the decline or extinction/extirpation of some species.

Future: Temperature stratification in aquatic environments could increase the frequency and severity of hypoxic conditions that negatively affect overall biomass productivity in lakes and waterways. Additionally, many animal species may need to migrate from their current habitats to adapt to rising temperatures and increased evaporation rates that may decrease total wetland area in the region.