CLIMATE HAZARDS AND IMPACTS IN THE GREAT LAKES

Great Lakes Regional Changes

- **Average air temperature in the Great Lakes region has increased by 2.5°F.**
- **Average air temperature is projected to rise 3°F to 6°F by the mid-21st century.**
- **Total annual precipitation has increased by 16% in the region with significant intra-regional variation.**
- **The total volume of rain falling in the most extreme 1% of events has increased 37%.**
- **Total annual precipitation will likely increase in the future, though types of precipitation will vary (i.e., more winter precipitation in the form of rain).**

Rising temperatures are contributing to more storm activity in our atmosphere, helping to fuel extreme weather and increased precipitation. While heat, drought, and other changes associated with climate change remain a concern for the future, many areas of the region are already facing challenges associated with more total precipitation and more frequent downpours.

Temperature

- Average annual temperatures in the Great Lakes region have increased by 2.5°F since 1951, faster than the global and national rates. Most of this warming has been observed during the late spring and early winter, and in overnight low temperatures.
- The average temperature for the Great Lakes region is projected to increase in the future (additional 3°F to 6°F by the mid-21st century), and northern parts of the region will likely experience the most change.
- The region is projected to see increases in the number of hot and very hot days by the end of the 21st century, with projections indicating the region will see 28 to 66 more days over 90°F in an average year compared to the late 20th century.

Precipitation

- Total annual precipitation has increased by an average of 16% since 1951 across the region.
- Heavy precipitation (over 1.25” of rainfall in 24hrs) has increased rapidly throughout the region. The amount of rain falling in the most extreme events (heaviest 1% of storms) has increased by 37% and these events have generally become more frequent since 1951.
- Precipitation trends vary widely across the region. For example, total annual precipitation increased by 42.9%in Ann Arbor MI, and by 10.1% in South, Bend, IN, compared to 16% averaged across the region. Therefore, local data should be used where available.
- Much of the region is projected to experience more average annual precipitation with total amounts ranging from an additional 1 to 6 inches per year by the end of the 21st century.
- With warmer conditions, the atmosphere can hold more water vapor. This increase in moisture combined with rising temperatures, contributes to storm formation and will likely produce more intense storms in the future.
- Outside of the lake-effect zones, snowfall in the region has decreased, with more winter precipitation falling as rain. Lake-effect snow has increased in response to warming lake temperates and declining ice cover in recent decades.

Climate change will accelerate in the future

- The observed trends in temperature, precipitation, and seasonality are projected to continue or accelerate into the future.
- The rate of warming has been fastest during the winter, with some locations experiencing twice the annual warming rate of the Great Lakes region.
- Temperatures will continue to warm at a pace near or faster than the current rate, and precipitation will likely continue to increase, though variability and multi-year dry periods should still be anticipated.

Preparing for more changes

- The climate system is dynamic and will continue to change rapidly due to greenhouse gas emissions and inherent feedback systems.
- The challenges, priorities, and risks of the current and future generation climate will continually change and will affect all sectors.
- Long-term planning efforts should regularly evaluate continually changing climate and be flexible and adaptable.

The following table summarizes how various climate hazards in the Great Lakes region are expected to change in the future.

- The number and direction of arrows indicate the relative projected trend for mid-century and end of century.
- A single arrow indicates a projected moderate increase or decrease, and two arrows indicate a substantial increase or decrease.

Climate Hazards in the Great Lakes Region

Risk	By Mid Century	By End of Century	Summary
Convective Weather (Severe Winds, Lightning, Tornadoes, Hail)	↑	↑	Warmer temperatures and additional moisture increase the potential for severe weather (e.g., tornadoes and hail) and allow for a longer severe weather season.
Severe Winter Weather (Ice/Sleet Storms, Snow Storms)	↑	↑	Warmer, shorter winters will reduce winter-related impacts, though lake-effect snow will continue increasing in the near future. Due to natural variability, cold air outbreaks are still possible and can lead to ice, sleet, freezing rain, and wet snow.
Extreme Heat	↑	↑↑	The number of extremely hot days (over 95°F and 100°F) will likely increase. Overnight lows have warmed faster than daytime highs, which may lessen opportunities for relief during heat waves. Increased heatwaves and humid conditions elevate the risk of heat-related deaths and illnesses.
Extreme Cold	↓	↓↓	The number of extremely cold days (i.e., days below 10°F) have decreased in the region and are projected to decrease even more in the future. However, cold air outbreaks are still possible due to natural varibility.
Dam Failures	↑	↑↑	Stronger and more extreme precipitation events coupled with aging dam infrastructure will increase the probability of dam failure.
Flood Hazards	↑↑	↑↑	Stronger and more extreme precipitation events will be more likely to overwhelm stormwater infrastructure.
Drought	↑	↑↑	Summer drought and the number of consecutive dry days will likely increase, interspersed with periods of increased rainfall.
Wildfires	↑	↑	Increased summer drought and the number of consecutive dry days will increase the risk of wildfires, particularly in the northern portions of the region.
Infestation	↑	↑↑	Shorter, warmer winters and longer growing seasons will create more suitable conditions for the spread of invasive species and pests (e.g., ticks, mosquitoes) and associated vector-borne illnesses.

The arrows in this table reflect a qualitative assessment made by the GLISA team based on analysis in the Fourth National Climate Assessment. These trends represent an average across the Great Lakes region, and will vary by location due to the localized nature of extremes.