IAGLR
International Association for Great Lakes Research

The Great Lakes at a Crossroads

Preparing for a Changing Climate

Find out what is happening in the Great Lakes and how it can impact your daily life. Learn how climate change in the Great Lakes differs from other regions.

Global Warming or Climate Change?

While the Earth's climate has changed many times during the planet's history because of natural factors, including volcanic eruptions and changes in the Earth's orbit, never before have we observed the present rapid rise in temperature and carbon dioxide (CO_2). In the past 100 years, the **Earth's average air temperature has risen 0.8 ºC (1.4ºF), and the average annual CO_2 concentration in the atmosphere has risen 27%.**

Human activities resulting from the industrial revolution have changed the chemical composition of the atmosphere. For the past 200 years, we have burned a steadily increasing amount of fossil fuels (coal, oil, natural gas) to provide energy to run our vehicles, businesses, and homes, resulting in a significant increase in atmospheric CO_2. At the same time, humans have removed 80% of the original primary forests that had served as an important place to store carbon dioxide (CO_2). Deforestation is now the second largest contributor to global warming, after the burning of fossil fuels. These human activities have significantly increased the concentration of "greenhouse gases" in the atmosphere.

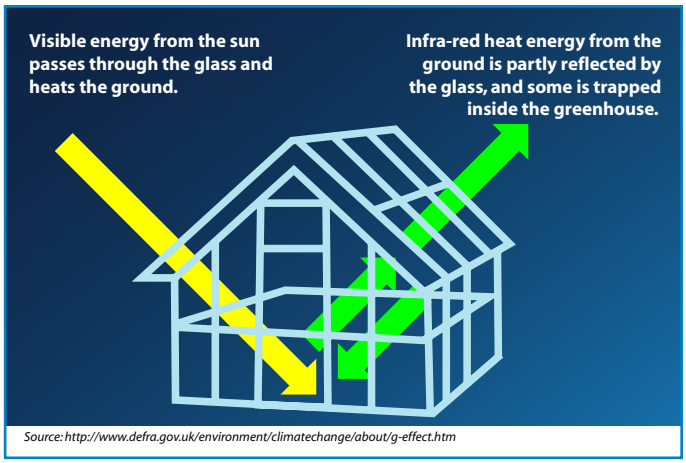
As the Earth's climate warms, we are seeing many changes: stronger, more destructive hurricanes; heavier rainfall; more disastrous flooding; more areas of the world experiencing severe drought; and more heat waves. With so many changes occurring in addition to rising temperatures, "climate change," rather than "global warming," is a more accurate term.

How can there be global warming when it's cold outside?

The Greenhouse Effect

Greenhouse gases include carbon dioxide (82%), methane (9%), and nitrous oxide (5%), which have been in the Earth's atmosphere since life first began. The gases trap heat near the Earth's surface and prevent it from escaping to space, similar to the glass panels on a greenhouse. A small amount of greenhouse gas is necessary to keep the planet's surface warm enough to sustain life. However, as human activities release more and more greenhouse gases, the Earth's average temperature continues to rise. The gases will remain in the atmosphere for decades to centuries.

Data from the National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA) confirms that the Earth's average surface temperature has increased by



Greenhouse gasses act like the glass in a greenhouse to trap warm air close to the Earth's surface and cause average global temperatures to rise.

0.8 ºC (1.4ºF) in the last 100 years. The eight warmest years on record since 1850 have occurred since 1998. Research indicates that most of the warming in recent decades is very likely the result of human activities. We call these atmospheric inputs from humans "anthropogenic contributions to global warming."

How is Climate Different from Weather?

Weather is what we experience daily—air temperature, rain, sun, snow, and wind. ***Climate*** is what happens with weather over time. Climate is the expected range of temperature, precipitation, humidity, sunshine, and windiness for a particular region at a given time of the year, averaged over a 30-year span. As one middle school student put it, *"Climate helps you decide what clothes to buy, weather helps you decide what clothes to wear."*

How Do We Know That Climate Change is REAL?

What we know about climate change has been assembled through rigorous use of the scientific method for conducting research. The World Meteorological Organization and the United Nations Environment Programme created the Intergovernmental Panel on Climate Change (IPCC) in 1988 to evaluate the findings of climate science research in order to provide a solid basis for informed policy action worldwide. The IPCC, which consists of 2,500 scientists from countries around the world, published climate reports in 1990, 1992, 1995, 2001, and 2007. Each successive report has provided additional evidence that much of the climate change is due to human activities.

The Great Lakes At a Crossroads *Preparing for a Changing Climate (2)*

The most recent IPCC (2007) report concludes:

- The climate is warming.
- More than 50% of the increase in globally averaged temperatures since the mid-20th century is very likely due to human sources.
- Average annual world temperatures are expected to rise between 1.1 to 6.4 °C (2 to 11.5 °F) during the 21st century
- Sea levels could rise 18 to 59 cm (7 to 23 inches).

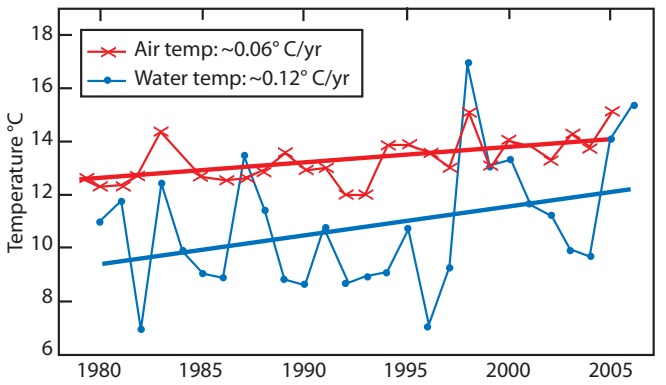
Science tells us to expect more frequent warm spells, **heat waves**, and heavy rainfall in some areas, while more **droughts**, hurricanes, and extreme **high tides** are likely in other places.

How Will Climate Change Affect the Great Lakes Region?

Warming water temperatures

- Within the Great Lakes region, air temperatures increased 0.7° C (1.26° F) between 1895 and 1999. Based on climate model predictions, summer temperatures in the Great Lakes region are projected to rise by at least 3°C (5.4°F), and as much as 11°C (19.8°F) by 2100. The last spring frost is coming earlier, and the first autumn frost is coming later. A few degrees may not sound like much, but it can have a huge impact on the ecology and economy of the Great Lakes region.
- The changes in temperature, water level, and weather patterns will affect the biology of each Great Lake differently. Summer water temperatures for Lakes Michigan, Huron, and Superior are increasing. Lake Superior's summer surface water temperature has increased by 2.5°C (4.5° F) since 1980. Not only has Lake Superior become warmer, windier, and had less ice cover since 1980, but its surface water temperature has warmed twice as fast as the air temperature.
- Warmer water temperatures reduce the extent and timing of ice cover. Ice now forms later in the fall and melts earlier in the spring on lakes and streams in the Great Lakes region. Lack of ice cover will contribute to more "lake effect" snow and leave the lakes exposed to increased evaporation, perhaps resulting in lower water levels.

Lake Superior Temperatures



Lake Superior water temperature is rising twice as fast as the air.

Declining lake levels

- Lower water levels would reduce coastal wetland areas and alter species composition
- Lower water levels would affect the shipping industry by reducing cargo capacity. This will increase the cost of consumer goods. The big three cargoes shipped on the Great Lakes—iron ore, coal and limestone—are used to make steel, generate electricity, and in the manufacturing of a host of other products.
- Lower water levels would lead to greater exposure of the shoreline. This will affect aesthetics, impact boating, and in some locations expose toxic contaminants.

Increasing weather variability and frequency of extreme weather events

Changing air and water temperatures will affect the amount of precipitation and the severity of storms. Potential impacts include:

- Increased flooding and longer droughts
- Economic impacts on the insurance industry as a result of the increased frequency and likelihood of property damage
- Increased stress on public infrastructure (roads, bridges, piers, break walls)
- Decrease in Great Lakes water quality from increased agricultural and urban stormwater runoff and combined sewer overflows dumping raw sewage
- Greater danger of heat stroke
- More frequent heat waves, droughts, tornadoes, and severe thunderstorms

Changes in diversity, behavior, and ranges of plants and animals

- Some fish and wildlife ranges will expand northward. The ranges of opossums, cardinals, and smallmouth bass have already moved north.
- Many plant species will leaf out and flower sooner. Some species of birds will migrate north and nest sooner. Many insects will emerge earlier in the spring. Will the timing for plants, birds, and insects correspond?
- Some species will be lost, especially those at the southern edges of their range. Species that do not migrate or evolve fast enough will decline in numbers or become extinct.

- Whitefish and other fish that need ice cover for the development of their young may not survive should ice fail to develop in a warmer Lake Erie.
- The length of the growing season will increase, changing the types of crops grown, and making it easier for pests, diseases, and invasive plants and insects to expand their ranges north.

Economic Impacts of Climate Change

- The Great Lakes are the economic engine of the region: 40% of the Canadian and 15% of the US Gross Domestic Product originates within the basin. Around 300 of the nation's Fortune 1000 firms are located here. The Great Lakes directly impact the lives of 35 million people.
- Economists are studying climate change and are developing estimates of the economic impacts. Researchers from the University of Maryland's Center for Integrative Environmental Research (CIER) estimate that climate change in three Great Lakes states (IL, MI, and OH) will cost billions of dollars due to lower water levels impacting water supplies and shipping.

The Great Lakes will always be a valuable source of fresh water.

While the water levels of some of the Great Lakes are expected to change because of climate change, they will remain the largest reservoir of surface freshwater in the United States and Canada, and maybe even the world. As a result, industries and people looking for reliable water supplies are likely to migrate to the region. As more areas experience water shortages, there will be growing pressure to divert Great Lakes water. We need to plan now for population growth and to ensure the protection of the Great Lakes.

What Can YOU Do to Help Reduce Global Warming?

1. Reduce your energy use for transportation.

- Drive less. Walk, ride a bike, car pool, or use public transportation. Combine errands into one trip instead of many. Travel by train rather than plane. ***www.energyrefuge.com/archives/Driving_savings_tips.htm***
- Turn off idling engines. Just ten seconds of idling can use more fuel than turning off the engine and restarting it. ***www.consumerenergycenter.org/myths/idling.html***
- Buy a fuel efficient or alternative fuel vehicle. A car that gets at least 14 kilometers per liter (32 miles per gallon) can save 2,359 kilograms (5,200 pounds) of CO_2 per year. Some vehicles can get 21 kilometers per liter (50 miles per gallon). Biodiesel, made from any vegetable oil, reduces CO_2 emissions by up to 80% and produces 100% less sulphur dioxide, the major component of acid rain.

Natural Resources Council of Maine

- Avoid speeding, rapid acceleration, and hard braking. It wastes gas and can lower highway gas mileage by 33%. Driving faster than 100 kilometers per hour (~60 mph) causes gas mileage to drop rapidly.
- Buy locally produced products to reduce the energy used to transport them.

2. Reduce, reuse, and recycle paper to reduce pollution, and save trees, energy, water, and landfill space.

- Producing 907 kilograms (1 ton) of copy paper creates 2,581 kilograms (5,690 pounds) of greenhouse gas, or the equivalent of 6 months of car exhaust, and uses 11,134 kWh, the same amount of energy used by an average household in 10 months.
- One tree can absorb the amount of CO_2 released by a car driven 6,437 kilometers (4,000 miles). ***papercalculator.org***

3. Practice efficient use of electricity

- Replace incandescent light bulbs with compact fluorescent bulbs. Compared to the standard incandescent bulb, a compact fluorescent bulb uses 75% less electricity, lasts up to 10 times longer, and saves $30 or more in electricity costs over the life of the bulb. If every American home replaced just one light bulb with an energy efficient bulb, we would save enough energy to light more than 3 million homes for a year, save $600 million in annual energy costs, and prevent greenhouse gas emissions equivalent to more than 800,000 cars! ***www.energystar.gov/index.cfm?c=cfls.pr_cfls***
- Unplug your house! Heat and electricity use makes up one-third of the average family's greenhouse gas emissions. Phantom energy use—the result of having appliances plugged in when not in use—totals 20% of the average household's energy use. Turn things off, unplug them, and minimize the use of appliances.
- Change to ENERGY STAR appliances and products. ENERGY STAR is an international standard to help businesses and individuals practice energy efficiency. For a listing of qualified products, visit: ***www.energystar.gov***
- Reduce the use of coal to generate electricity and change to cleaner energy sources, such as wind, solar, hydropower, biomass, and geothermal energy.
- Plant trees to consume CO_2 (carbon dioxide) in the air, and to shade and cool houses in the summer.

4. Encourage your political leaders to promote use of non-fossil-fuel energy sources

- Provide financial incentives to encourage households, businesses, and utilities to choose renewable energy technologies, such as biofuel (from switchgrass and woody biomass), waste-to-energy, geothermal, co-generation, hydroelectric, photovoltaic, solar heating/cooling, and wind in order to reduce greenhouse gas emissions and conserve fossil fuels.

5. Become a citizen scientist and help track environmental changes.

- Project BudBurst – records the timing of leaf out and flowering for more than 3,900 plant species around the USA. ***www.windows.ucar.edu/citizen_science/budburst***
- Globe Program – tracks weather and other environmental measurements. ***www.globe.gov***
- Project FeederWatch – counts the highest numbers of each bird species at local feeders from November through April. ***http://www.birds.cornell.edu/pfw***
- Great Lakes Marsh Monitoring Program – provides long-term monitoring of marsh-dependent bird and anuran (frog and toad) species in marsh habitats throughout the Great Lakes basin. ***www.bsc-eoc.org/volunteer/glmmp/index.jsp***
- Great North American Secchi Dip-In – measures the water clarity of lakes, rivers, and estuaries by taking a transparency measurement at the same time each year. ***dipin.kent.edu***
- Journey North – engages K-12 students in a global study of wildlife migration and seasonal change. Students track the coming of spring through the migration patterns of monarch butterflies, robins, hummingbirds, whooping cranes, gray whales, bald eagles, and other birds and mammals, as well as the budding of plants, changing sunlight, and other natural events. ***www.journeynorth.org***

6. Use a Carbon Footprint calculator to measure your impact and identify ways that you can reduce or offset your emissions.

A "Carbon Footprint" is a measure of the impact human activities have on the environment by the amount of carbon dioxide produced. Here's one example: ***www.carbonfootprint.com/calculator.aspx***

7. Inform yourself about the science behind the climate change debate

- Share your knowledge on climate change and potential impacts with your community.
- Include scientific perspectives on potential climate change impacts in your community's long-term infrastructure planning.
- Ask your decision-makers, leaders, and candidates how they will address the climate change challenge.
- Inform public leaders of your support for proactive emission reductions and energy technology changes, including a willingness to pay the higher costs for goods and services that may result.
- Engage your community in reducing energy use and greenhouse gas emissions.

How Scientists Can Help

- Help assess potential climate impacts within your area of expertise and look for evidence of climate change impacts in your region.
- Publish your research in resource management and education journals that are accessible to more people, as well as in scientific journals.
- Share the results of your research with public outreach educators, K-12 teachers, and decision-makers.
- Share your expertise in your local community.
- Participate in forums to establish research priorities and identify gaps in scientific research needs. (See a recent scientific assessment at: ***www.climatescience.gov/Library/scientific-assessment***

How Policy-Makers Can Help

- Request information and advice from scientists.
- Use the weight of scientific evidence in climate change decision-making.
- Support long-term planning that incorporates the mitigation and reduction of harmful greenhouse gases and effective responses to anticipated climate change.
- Support adequate funding for climate change research and forecasting.
- Support the development of new industries that focus on alternative energy sources.
- Support efforts to encourage youth to pursue career opportunities in engineering and science to address current and future challenges.

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International Association for Great Lakes Research (IAGLR)

A scientific organization comprised of researchers studying the Great Lakes, other large lakes of the world, and their watersheds, as well as those with an interest in such research. IAGLR is committed to sharing its collective expertise with the media, policymakers, and the general public to inform public policy and decision-making that will protect the environmental health of large lakes and their watersheds. ***www.iaglr.org***