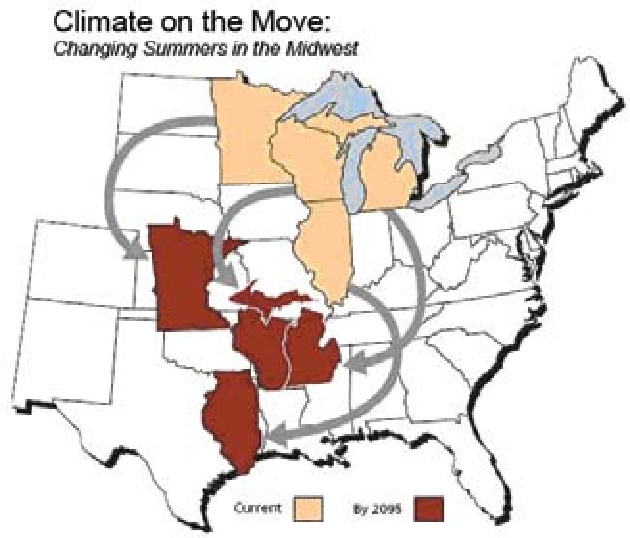
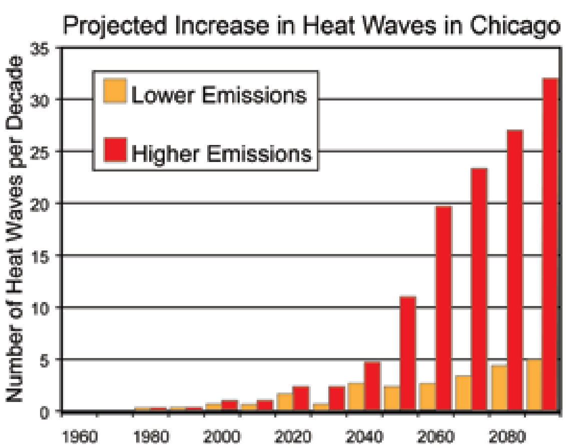
Midwest



Model projections of Midwest climate indicate that by late this century, summers in Illinois are expected to feel like current summers in Texas under business-as-usual emissions and the resulting climate change[1].

While there is year-to-year variability, average temperatures in the Midwest have increased in recent decades, with the largest increases in winter. The length of the frost-free season has increased by over a week, mainly due to earlier dates for the last spring frost, which has lengthened the growing season. Heavy downpours are now twice as frequent as they were a century ago. Both summer and winter precipitation has been above average for the last three decades, the wettest period in a century. The Midwest has experienced two record-breaking floods in the past 15 years. There has been a decrease in lake ice, including on the Great Lakes. Heat waves have also been more frequent in the past few decades[1,2,3].



(see endnote 2)

Public health and quality of life, especially in cities, will be negatively affected by increasing heat waves, reduced air quality, and insect- and water-borne diseases.

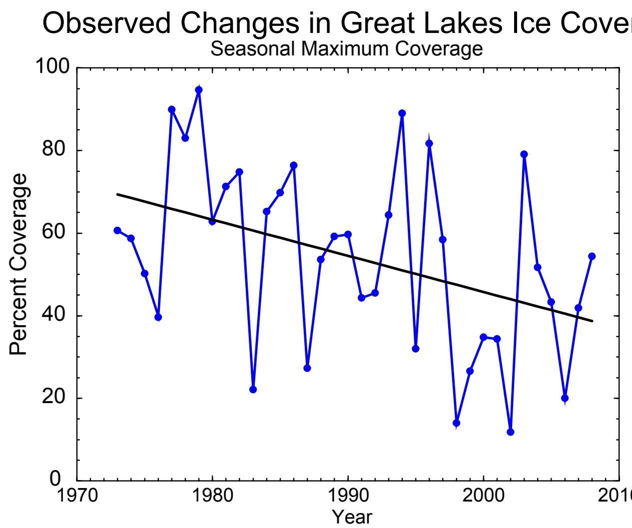
Heat waves that are more frequent, more severe, and longer-lasting are projected. The increased frequency of hot days and the longer length of the heat wave season will be more than twice as great under the higher emissions scenario than the lower[4]. Events such as the Chicago heat wave of 1995 (700-plus deaths) will become more common. Under the lower emissions scenario, such a heat wave is projected to occur every other year in Chicago, while under the higher emissions scenario, there would be about three such heat waves per year. Even more severe heat waves, such as the one that claimed tens of thousands of lives in Europe in 2003, are projected to become more frequent in a warmer world, occurring every other year in the Midwest by the end of the century under the higher emissions scenario[5].

During heat waves, high electricity demand combines with climate-related limitations on energy production capabilities (see *Energy Production and Use* sector), increasing the likelihood of electricity shortages and resulting in brown-outs or even black-outs, leaving people without air conditioning and ventilation when they need it most. This occurred during the 1995 Chicago/Milwaukee heat wave. In general, electricity demand for air conditioning is projected to significantly increase in summer, while oil and gas demand for heating will decline in winter.

One characteristic of human-induced warming is that nighttime temperatures are rising even faster than daytime temperatures. In addition, cities tend to retain more heat at night than the surrounding countryside because their concrete and asphalt hold heat, a phenomenon known as the "urban heat island effect." Heat waves take a greater toll in illness and death when there is little relief from heat at night, and that is what is being currently observed and projected for the future.

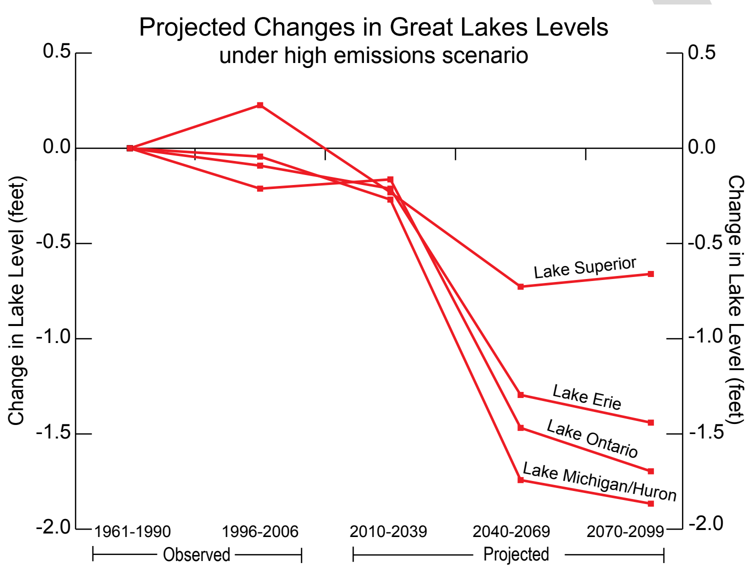
Declining air quality is a related concern. Higher summer air temperatures mean more ground-level ozone or urban smog, which causes respiratory problems for many people, especially those who are young, old, or have asthma or allergies. Unless the emissions of pollutants that lead to ozone formation are reduced significantly, there will be more ground-level ozone as a result of higher air temperatures[6].

Insects such as ticks and mosquitoes that carry diseases will survive winters more easily and produce larger populations in a warmer Midwest[7]. An increasing risk of diseases such as West Nile virus is thus a growing concern. Water-borne diseases are another public health issue as many pathogens thrive in warmer conditions.



Under higher emissions scenarios, significant reductions in Great Lakes water levels will impact shipping, infrastructure, beaches, and ecosystems.

The Great Lakes are a natural resource of tremendous significance, containing 20 percent of the planet's fresh surface water, and serving as the focus of the industrial heartland of the nation. Higher temperatures will mean more evaporation and hence a likely reduction in the Great Lakes' water levels. Reduced lake ice increases evaporation in winter, contributing to the decline. Under a lower emissions scenario, water levels in the Great Lakes are projected to fall no more than one foot, but under a higher emissions scenario, they are projected to fall between one and two feet. The greater the temperature rise, the higher the chance of a major decrease in lake levels. Even a decrease of one foot, combined with normal fluctuations, can result in significant lengthening of the distance to the lakeshore in many places. There are also potential impacts on beaches, coastal ecosystems, dredging requirements, infrastructure, and shipping. For example, lower lake levels reduce "draft," or the distance between the water line and the bottom of the ship, which lessens the ship's ability to carry freight. Ocean-going vessels, sized for passage through the St. Lawrence Seaway, lose about 100 tons of capacity for each inch of draft lost[7]. These impacts will have costs, including increased shipping, repairs and maintenance costs, and lost recreation and tourism dollars.



Average Great Lakes levels depend on the balance between precipitation (and corresponding runoff) in the Great Lakes Basin on one hand and evaporation and outflow on the other. Evaporation depends on the extent of ice cover in winter. As a result, lower emissions scenarios with less warming show less reduction in lake levels than higher emissions scenarios.

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Increasing precipitation in winter and spring, more heavy downpours, and greater evaporation in summer will mean more periods of both floods and water deficits.

Precipitation is projected to increase in winter and spring, and to become more intense throughout the year. This pattern is expected to lead to more frequent flooding and resulting infrastructure damage. Heavy downpours also tend to overload drainage systems and water treatment facilities, increasing the risk of water-borne diseases. Such an incident occurred in Milwaukee in 1993 when the water supply was contaminated with the parasite *Cryptosporidium*, causing 403,000 reported cases of gastrointestinal illness and 54 deaths.

In Chicago, rainfall of more than 2.5 inches per day is an approximate threshold beyond which combined water and sewer systems overflow into Lake Michigan. This generally results in beach closings to reduce the risk of disease transmission. Rainfall above this threshold is projected to occur twice as often during this century under the lower emissions scenario and three times as often under the higher emissions scenario[8]. Similar increases are expected across the Midwest.

More intense rainfall can lead to floods that cause significant impacts regionally and even nationally. For example, the Great Flood of 1993 caused catastrophic flooding along 500 miles of the Mississippi and Missouri River systems, affecting one-quarter of all U.S. freight (see *Transportation* sector)[9]. Another example was a record-breaking 24-hour rainstorm in July 1996, which resulted in flash flooding in Chicago and its suburbs, causing extensive damage and disruptions, with some commuters not being able to reach Chicago for three days (see *Transportation* sector).[10] Another record-breaking storm took place in August 2007. Increases in such events are likely to cause greater property damage, higher insurance rates, a heavier burden on emergency management, increased clean-up and rebuilding costs, and a growing financial toll on businesses, homeowners, and insurers.

In the summer, with increasing evaporation rates and longer periods between rainfalls, the likelihood of droughts will increase and water levels in rivers, streams, and wetlands is likely to decline. Lower water levels could also create problems for river traffic, reminiscent of the stranding of more than 4000 barges on the Mississippi River during the drought in 1988. Reduced summer water levels are also likely to reduce the recharge of groundwater, cause small streams to dry up, and reduce the area of wetlands in the Midwest.

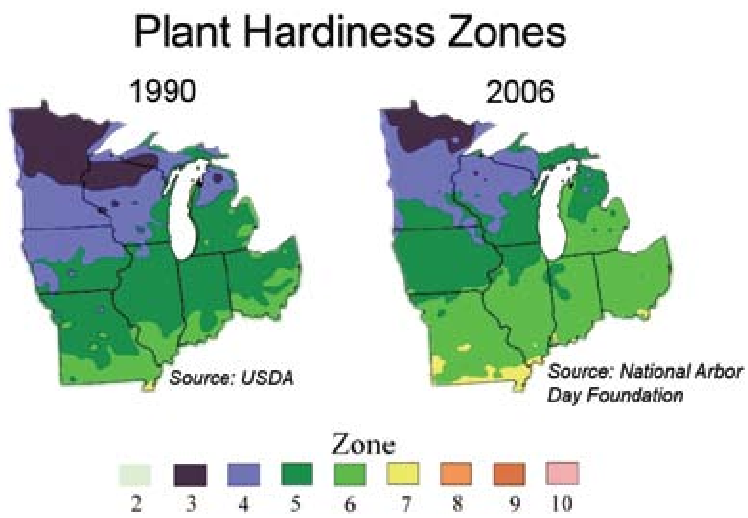
While a longer growing season provides the potential for increased crop yields, increases in heat waves, floods, droughts, insects, and weeds will present increasing challenges to crops, livestock, and forests.

The projected increase in winter and spring precipitation and flooding would delay planting and crop establishment. Longer growing seasons and increased carbon dioxide have positive effects on some crop yields, but this is counter-balanced by additional disease-causing pathogens, insect pests, and weeds (including invasive weeds) which have negative effects on yields. Livestock production is expected to become more costly as higher temperatures stress live-stock, decreasing productivity and increasing costs associated with the needed ventilation and cooling equipment.

Plant hardiness zones in the Midwest are likely to shift one-half to one full zone about every 30 years. By the end of the century, plants now associated with the Southeast will be found throughout the Midwest. Impacts on forests are likely to be mixed as higher carbon dioxide and nitrogen levels act as fertilizers, increasing growth, but decreasing air quality. In addition, more frequent droughts and hence, fire hazards, and more destructive insect pests such as gypsy moths, hinder plant growth. Insects, historically controlled by cold winters, more easily survive milder winters and produce larger populations in a warmer climate (see *Agriculture* sector).

Native species will face increasing threats from rapidly changing climate conditions, pests, diseases, and invasive species moving in from warmer regions.

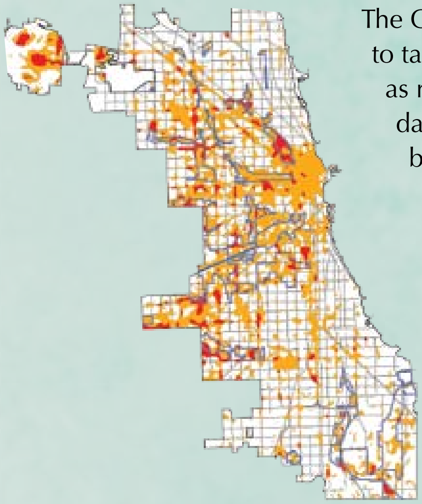
As air temperatures increase, so will water temperatures. This will lead to earlier and longer vertical separation of the layers of the lake water in summer, which will effectively cut off oxygen from bottom layers, increasing the risk of oxygen-poor or oxygen-free "dead-zones" that kill fish and other living things. Warmer water and low-oxygen conditions in the bottom layer of lakes also mobilizes mercury and other contaminants in lake sediments. These increasing quantities of contaminants will be taken up in the aquatic food chain, adding to the existing health hazards to all species that eat fish from the lakes, including people.



Populations of cold-water fish, such as brook trout, lake trout, and whitefish, are expected to decline dramatically, while populations of cool-water fish such as muskie, and warm-water species such as small-mouth bass and bluegill, will take their place. Aquatic ecosystem disruptions will likely be compounded by invasions by non-native species, which tend to thrive under a wide range of environmental conditions. Native species, adapted to a narrower range of conditions, are expected to decline.

All major groups of animals, including birds, mammals, amphibians, reptiles, and insects, will be changed by local extinctions and other species moving into the Midwest region. The potential for animals to shift their ranges to keep pace with the changing climate will be inhibited by major urban areas and the presence of the Great Lakes.

Adaptation: Chicago Tries to Cool the Urban Heat Island



The City of Chicago produced a map of urban hot spots to use as a planning tool to target areas that could most benefit from heat island reduction initiatives such as reflective or green roofing and tree planting. Created using satellite images of daytime and nighttime temperatures, the map shows the hottest 10 percent of both day and night temperatures in red, and the hottest 10 percent of either day or night in orange.

The City is working to reduce urban heat buildup and air conditioning use by making the roofs of some buildings reduce or reflect heat rather than absorb it. This thermal image shows that City Hall's "green roof" – covered with soil and vegetation – is 77°F cooler than the nearby conventional roofs.