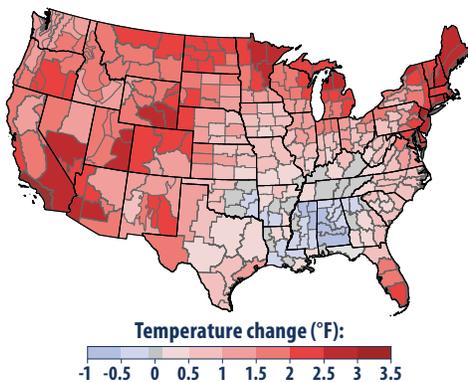


# What Climate Change Means for Minnesota

**Minnesota's** climate is changing. The state has warmed one to three degrees (F) in the last century. Floods are becoming more frequent, and ice cover on lakes is forming later and melting sooner. In the coming decades, these trends are likely to continue. Rising temperatures may interfere with winter recreation, extend the growing season, change the composition of trees in the North Woods, and increase water pollution problems in lakes and rivers. The state will have more extremely hot days, which may harm public health in urban areas and corn harvests in rural areas.

Our climate is changing because the earth is warming. People have increased the amount of carbon dioxide in the air by 40 percent since the late 1700s. Other heat-trapping greenhouse gases are also increasing. These gases have warmed the surface and lower atmosphere of our planet about one degree during the last 50 years. Evaporation increases as the atmosphere warms, which increases humidity, average rainfall, and the frequency of heavy rainstorms in many places—but contributes to drought in others.

Greenhouse gases are also changing the world's oceans and ice cover. Carbon dioxide reacts with water to form carbonic acid, so the oceans are becoming more acidic. The surface of the ocean has also warmed about one degree during the last 80 years. Although warmer temperatures cause sea level to rise, the impact on water levels in the Great Lakes is not yet known. Warmer air also melts ice and snow earlier in spring.



Rising temperatures in the last century. Northern Minnesota has warmed more than twice as much as southern Minnesota. Source: EPA, *Climate Change Indicators in the United States*.

## Heavy Precipitation and Flooding

Changing the climate is likely to increase the frequency of floods in Minnesota. Over the last half century, average annual precipitation in most of the Midwest has increased by 5 to 10 percent. But rainfall during the four wettest days of the year has increased about 35 percent. During the next century, spring rainfall and annual precipitation are likely to increase, and severe rainstorms are likely to intensify. Each of these factors will tend to further increase the risk of flooding.

## Lakes and Rivers

Flooding is occasionally a problem for both navigation and riverfront communities, and greater river flows could make these problems worse. In the Red River watershed, river flows during the worst flood of the year have been increasing about 10 percent per decade since the 1920s.

Floods are also becoming more severe in the upper Mississippi watershed. In June 2014, a flood forced two port facilities in St. Paul to stop operating, and barges waiting to unload had to be temporarily parked in Pigs Eye Lake until the river receded. Increasingly severe droughts elsewhere in the Mississippi River Basin could also pose problems for navigation in Minnesota. For example, a drought in 2012 led the U.S. Army Corps of Engineers to restrict navigation on the lower Mississippi River, which affected shipping upstream.

One advantage of climate change is that warmer winters reduce the number of days that ice prevents navigation. Between 1994 and 2011, the decline in ice cover lengthened the shipping season on the Great Lakes by eight days. The Great Lakes are likely to warm another 3° to 7°F in the next 70 years, which will further extend the shipping season.

Higher temperatures and heavier storms could harm water quality in Minnesota's lakes and rivers. Warmer water tends to cause more algal blooms, which can be unsightly, harm fish, and degrade water quality. Severe storms increase the amount of pollutants that run off from land to water, so the risk of algal blooms will be greater if storms become more severe. Increasingly severe storms could also cause sewers to overflow into lakes or rivers more often, threatening beach safety and drinking water supplies.



Flooding of the Red River in East Grand Forks in 1997. Credit: Dave Saville, FEMA.

## Ecosystems

The ranges of plants and animals are likely to shift as the climate changes. For example, warmer weather could change the composition of Minnesota's forests. As the climate warms, the populations of paper birch, quaking aspen, balsam fir, and black spruce trees may decline in the North Woods, while oak, hickory, and pine trees may become more numerous. Climate change will also transform fish habitat. Rising water temperatures will increase the available habitat for warmwater fish such as bass, while shrinking the available habitat for coldwater fish such as trout. Declining ice cover and increasingly severe storms would harm both types of fish habitat through erosion and flooding.

Warming could also harm ecosystems by changing the timing of natural processes such as migration, reproduction, and flower blooming. Migratory birds are arriving in Minnesota earlier in spring today than 40 years ago. Along with range shifts, changes in timing can disrupt the intricate web of relationships between animals and their food sources and between plants and pollinators. Because not all species adjust to climate change in the same way, the food that one species eats may no longer be available when that species needs it (for example, when migrating birds arrive). Some types of animals may no longer be able to find enough food.

## Winter Recreation

Warmer winters are likely to shorten the season for recreational activities like ice fishing, snowmobiling, skiing, and snowboarding, which could harm the local economies that depend on them. Small lakes are freezing later and thawing earlier than a century ago, which shortens the season for ice fishing and ice skating. Since the early 1970s, winter ice coverage in the Great Lakes has decreased by 63 percent. Warmer temperatures are likely to shorten the season when the ground is covered by snow, and thereby shorten the season for activities that take place on snow. Nevertheless, annual snowfall has increased in much of the Great Lakes region, which could benefit winter recreation at certain times and locations.

## Agriculture

Changing the climate is likely to have both positive and negative effects on agriculture in Minnesota. Warmer weather has extended the growing season by about 15 days since the beginning of the 20th century. Longer frost-free growing seasons and higher concentrations of atmospheric carbon dioxide would increase yields of soybeans and wheat during an average year. But increasingly hot summers may reduce yields of corn. In seventy years, southern Minnesota is likely to have 5 to 15 more days per year with temperatures above 95°F than it has today. More severe droughts or floods would also hurt crop yields.

## Air Pollution and Human Health

Changing the climate can harm air quality and amplify existing threats to human health. Higher temperatures increase the formation of ground-level ozone, a pollutant that causes lung and heart problems. Ozone also harms plants. In some rural parts of Minnesota, ozone levels are high enough to reduce yields of soybeans and winter wheat. EPA and the Minnesota Pollution Control Agency have been working to reduce ozone concentrations. As the climate changes, continued progress toward clean air will become more difficult.

Climate change may also increase the length and severity of the pollen season for allergy sufferers. For example, the ragweed season in Minneapolis is 21 days longer than in 1995, because the first frost in fall is later. The risk of some diseases carried by insects may also increase. The ticks that transmit Lyme disease are active when temperatures are above 45°F, so warmer winters could lengthen the season during which ticks can become infected or people can be exposed to the ticks.

Hot days can be unhealthy, even dangerous. High air temperatures can cause heat stroke and dehydration, and affect people's cardiovascular and nervous systems. Northern cities like Minneapolis and St. Paul are vulnerable to heat waves, because many houses and apartments lack air conditioning, and urban areas are typically warmer than their rural surroundings. In recent decades, severe heat waves have killed hundreds of people across the Midwest. Heat stress is expected to increase as climate change brings hotter summer temperatures and more humidity. Certain people are especially vulnerable, including children, the elderly, the sick, and the poor.



*A photo of a ragweed plant, a common source of allergens in Minnesota. Like many crops and pollen sources, ragweed will have a longer growing season as temperatures rise. Stock photo.*