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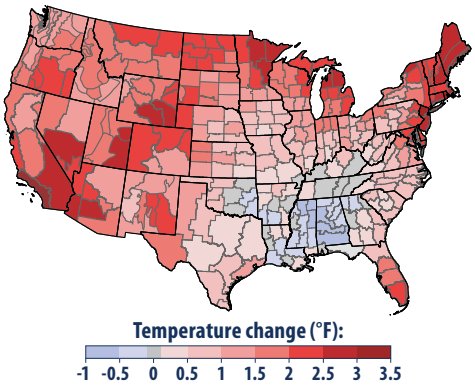
What Climate Change *Means for* Kentucky

Kentucky's climate is changing. Although the average temperature did not change much during the 20th century, most of the commonwealth has warmed in the last 20 years. Average annual rainfall is increasing, and a rising percentage of that rain is falling on the four wettest days of the year. In the coming decades, the changing climate is likely to reduce crop yields and threaten some aquatic ecosystems. Floods may be more frequent, and droughts may be longer, which would increase the difficulty of meeting the competing demands for water in the Ohio, Tennessee, and Cumberland rivers.

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 (F) 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.

Natural cycles and sulfates in the air prevented much of Kentucky from warming during the last century. Sulfates are air pollutants that reflect sunlight back into space. Now sulfate emissions are declining, and the factors that once prevented Kentucky from warming are unlikely to persist.



Rising temperatures in the last century. Kentucky has warmed less than most of the United States. Source: EPA, Climate Change Indicators in the United States.

Precipitation and Water Resources

Annual precipitation in Kentucky has increased approximately 5 percent since the first half of the 20th century. But rising temperatures increase evaporation, which dries the soil and decreases the amount of rain that runs off into rivers. Although rainfall during spring is likely to increase during the next 40 to 50 years, the total amount of water running off into rivers or recharging ground water each year is likely to decline 2.5 to 5 percent, as increased evaporation offsets the greater rainfall. Droughts are likely to be more severe, because periods without rain will be longer and very hot days will be more frequent.

Flooding, Navigation, and Hydroelectric Power

Flooding is becoming more severe in the Southeast. Since 1958, the amount of precipitation during heavy rainstorms has increased by 27 percent in the Southeast, and the trend toward increasingly heavy rainstorms is likely to continue. The Tennessee Valley Authority (TVA) and the U.S. Army Corps of Engineers operate Kentucky Dam, Wolf Creek Dam, and other dams to prevent serious floods on the Ohio, Tennessee, and Cumberland rivers. The agencies release water from the reservoirs behind these dams before the winter flood season. By lowering water levels, these releases provide greater capacity for the reservoirs behind those dams to prevent flooding. Nevertheless, dams and other flood control structures cannot prevent all floods. The Ohio River has flooded Louisville several times, for example, and flash floods have caused property destruction and deaths throughout Kentucky.

Flooding at Third and Magnolia Streets in Louisville after heavy rains in August 2009. Credit: Mike Howard, courtesy of the National Weather Service and the Louisville and Jefferson County Metropolitan Sewer District.

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Increasingly severe droughts could pose challenges for river transportation. The drought of 2005 closed portions of the lower Ohio River to commercial navigation, which delayed shipments of crops and other products between Kentucky and the Mississippi River. In 2012, a drought caused navigation restrictions on the lower Mississippi River, which cost the region more than $275 million.

A barge passes by Paducah during a period of low water on the Ohio River in summer 2005. Drought conditions caused shipping delays throughout the region. Credit: National Weather Service.

Droughts also affect the amount of electricity from hydroelectric dams. During the 2007 drought, total production from the TVA's hydroelectric plants fell by more than 30 percent, which forced the TVA to meet customer demand by using more expensive fuel-burning power plants.

Aquatic Ecosystems

Changing climate can harm aquatic ecosystems. Warmer water lowers the level of dissolved oxygen in surface water, which can severely limit fish populations. Because fish cannot regulate their body temperatures, warmer water can make a stream uninhabitable for fish that require cooler water. Warmer temperatures can also increase the frequency of algal blooms, which can be toxic and further reduce dissolved oxygen. Summer droughts may amplify these effects, while periods of extreme rainfall can increase the impacts of pollution on streams.

Agriculture

Longer frost-free growing seasons and increased concentrations of atmospheric carbon dioxide tend to increase yields for many crops during an average year. But more severe droughts and more hot days are likely to reduce yields, especially in the western half of Kentucky, which in seventy years is likely to have 15 to 30 more days with temperatures above 95°F than it has today. Even on irrigated fields, higher temperatures are likely to reduce yields of corn, and possibly soybeans. Higher temperatures are also likely to reduce livestock productivity: hot weather causes cows to eat less, grow more slowly, and produce less milk, and it can threaten their health.

Forest Resources

Higher temperatures and changes in rainfall are unlikely to substantially reduce forest cover in Kentucky, but the composition of those forests may change. More droughts would reduce forest productivity, and climate change is also likely to increase the damage that insects and diseases cause to forests. Yet longer growing seasons and increased carbon dioxide concentrations could more than offset the losses from those factors. In central Kentucky, the population of maple, beech, and birch trees is likely to decline, in favor of the oak and hickory trees that dominate forests in most of the state.

Human Health

Hot days can be unhealthy—even dangerous. High air temperatures can cause heat stroke and dehydration, and affect people's cardiovascular and nervous systems. Certain people are especially vulnerable, including children, the elderly, the sick, and the poor. Higher temperatures can also increase the formation of ground-level ozone, a key component of smog. Ozone has a variety of health effects, aggravates lung diseases such as asthma, and increases the risk of premature death from heart or lung disease. EPA and the Kentucky Department for Environmental Protection have been working to reduce ozone concentrations. As the climate changes, continued progress toward clean air will require even more reductions in the air pollutants that contribute to ozone.

The sources of information about climate and the impacts of climate change in this publication are: the national climate assessments by the U.S. Global Change Research Program, synthesis and assessment products by the U.S. Climate Change Science Program, assessment reports by the Intergovernmental Panel on Climate Change, and EPA's *Climate Change Indicators in the United States*. Mention of a particular season, location, species, or any other aspect of an impact does not imply anything about the likelihood or importance of aspects that are not mentioned. For more information about climate change science, impacts, responses, and what you can do, visit EPA's Climate Change website at www.epa.gov/climatechange.

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