4.10 Future Climate Change and Global Warming

Climate is an important influence upon our economy and the lifestyles of people in communities throughout Kentucky. However, climate is not constant. Examination of temperature and precipitation data since 1895 shows both periods of warming and cooling, along with periods when precipitation was relatively more and less abundant. Kentucky's climate has been warming since the most recent cool period of the 1960s and 1970s. The average annual temperature in the Western, Central, and Bluegrass divisions now exceeds that of the prior warm period during the 1930s and 1940s. The average temperature in the Eastern division is also rising but remains below the earlier peak. Average annual precipitation has been trending upward in the Western, Central, and Bluegrass divisions and is at or near its highest level since 1895. The historical record includes a dry period commencing in the 1930s and persisting in the early 1960s, followed by a wet period that peaked in the 1970s to early 1980s. In contrast, the Eastern division has experienced a decline in average precipitation since the mid 1990s and is near the minimum reached in the late 1930s.While the focus is on climate change, it should be noted that the annual variability of both temperature and precipitation far outweigh the changes in their respective averages.[146]

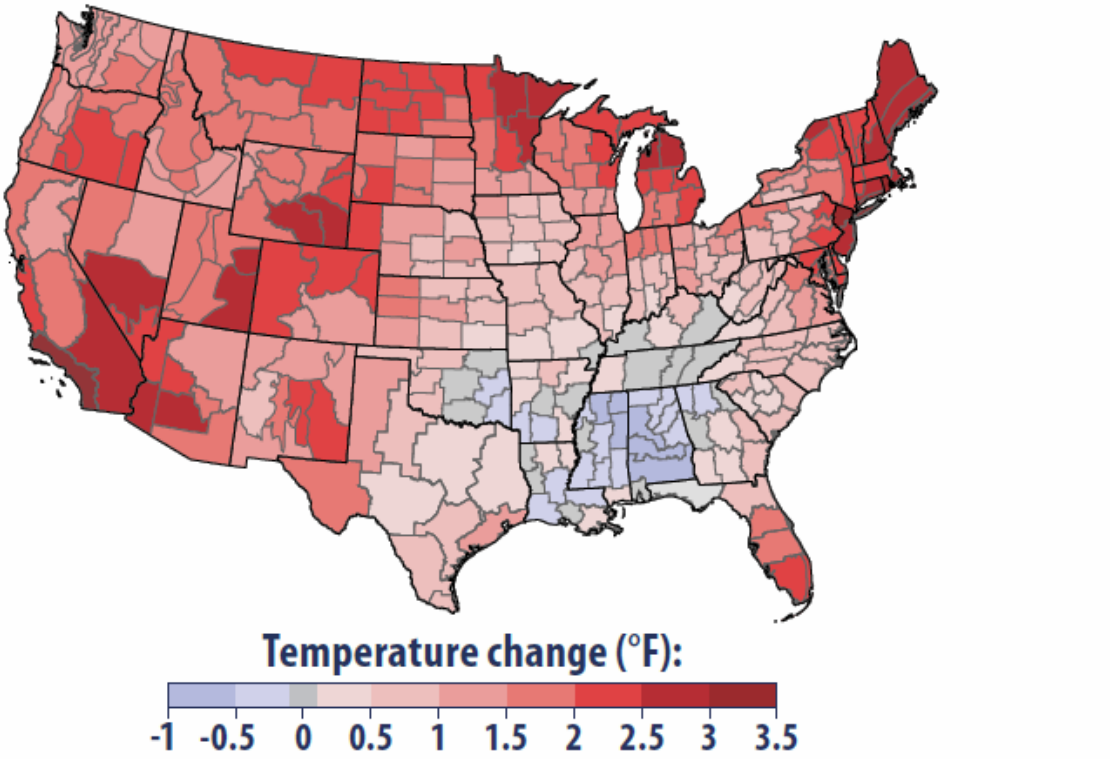
Kentucky's climate is changing. Although the average temperature did not change much during the 20th century, most of the commonwealth has warmed in the last 20 years. Average annual rainfall is increasing, and a rising percentage of that rain is falling on the four wettest days of the year. In the coming 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.

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.

[146] Kentucky Climate Center, Summary of Kentucky Temperature and Precipitation Trends; http://www.kyclimate.org/graphlets/climatechange.html

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.



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.

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.

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.[147]

Summary

[147] US Environmental Protection Agency, What Climate Change Means for Kentucky
https://www3.epa.gov/climatechange/Downloads/impacts-adaptation/climate-change-KY.pdf

Hazard Location:

- State of Kentucky and Lake Cumberland Region

Potential Damage:

- No Regionalized Damage Estimates are available

Scale / Extent:

- Possible damage/losses in the Lake Cumberland Region to Aquatic Ecosystems, Agriculture, Forest Resources, and Human Health

Previous Occurrences:

- Limited data available for Lake Cumberland Region

Likelihood of Future Occurrences:

- Probable, however damaging outcomes will be over an extended time period measured in decades