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United States Environmental Protection Agency

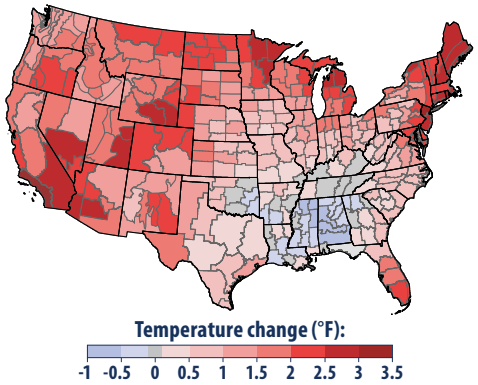
August 2016
EPA 430-F-16-044

What Climate Change *Means for* Tennessee

Tennessee's climate is changing. Although the average temperature did not change much during the 20th century, the state 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, threaten some aquatic ecosystems, and increase some risks to human health. Floods may be more frequent, and droughts may be longer, which would increase the difficulty of meeting the competing demands for water in the 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 Tennessee 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 Tennessee from warming are unlikely to persist.



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

Changing Water Availability

Annual precipitation in Tennessee 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.

Increased Flooding

Flooding is becoming more severe in the Southeast. Since 1958, the amount of precipitation falling during heavy rainstorms has increased by 27 percent in the Southeast, and the trend toward increasingly heavy rainstorms is likely to continue. To prevent serious floods, the Tennessee Valley Authority (TVA) and the U.S. Army Corps of Engineers release water from the reservoirs behind dams they operate before the winter flood season. Doing so lowers water levels and provides a greater capacity for the reservoirs behind those dams to prevent flooding. Nevertheless, the dams cannot prevent all floods. In May 2003, for example, heavy rains exceeded TVA's dam capacity, flooding low-lying areas in Chattanooga and other parts of Hamilton County; in 2010, high flows in the Cumberland River flooded Nashville.

The Cumberland River flooded parts of Nashville in 2010, damaging many businesses, including the Grand Ole Opry. Credit: USGS.

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Droughts, Navigation, and Hydroelectric Power

Droughts also pose challenges for water management. If the spring is unexpectedly dry, reservoirs may have too little water during summer. During droughts, TVA and the Corps of Engineers release water from dams to keep the Tennessee and Cumberland rivers navigable. These rivers support $35 billion in annual shipping. The agencies try to keep channels at least eleven feet deep, because lower river levels can force barges to carry smaller loads, which increases transportation costs. During the drought of 2007, however, TVA could only release enough water to keep some channels nine feet deep. This release meant that lake levels were lowered tens of feet, which caused problems for recreational swimming and boating. If droughts become more severe, TVA and the Corps of Engineers will face this type of problem more often.

Dry years diminish the amount of electricity that TVA can produce from its 19 hydroelectric dams in Tennessee, which provide 12 to 15 percent of the electricity produced in the state. During the 2007 drought, TVA's hydroelectric plants produced 30 percent less than normal, which forced TVA to meet demand by using more expensive fuel-burning power plants.

Two views of a boat ramp in Douglas Lake during the 2007 drought. The lake is nearly dry and the 330-foot ramp is completely out of the water. Credit: NOAA.

Aquatic Ecosystems

Changing the 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

Changing the climate will have both beneficial and harmful effects on 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 Tennessee: 70 years from now, that part of the state 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. Warmer temperatures are also likely to reduce the productivity of dairy and other cattle farms.

Forest Resources

Higher temperatures and changes in rainfall are unlikely to substantially reduce forest cover in Tennessee, but the composition of those forests may change. Forests cover about half the state, dominated by oak and hickory trees, and the forest products industry employs 180,000 people. Although more droughts would reduce productivity, longer growing seasons and increased carbon dioxide concentrations could more than offset those losses. Nevertheless, climate change is likely to increase the damage that certain insects and diseases cause in Tennessee's forests.

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. Warmer air 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 Tennessee Department of Environment and Conservation have been working to reduce ozone concentrations. As the climate changes, continued progress toward clean air will become more difficult.

The Smoky Mountains have always had a natural blue haze. But air pollution has increased that haze, and higher ozone levels could increase it further. This photo shows how haze obscures the view from the Look Rock Tower in Great Smoky Mountains National Park. Credit: National Park Service.

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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