

# Effects of Global Warming in TN

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The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of pollution gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of carbon dioxide pollution is undisputed. Although there is uncertainty about exactly how the earth's climate will respond to enhanced concentrations of carbon dioxide pollution, observations indicate that detectable changes are under way. The predicted increases in temperature and changes in precipitation, soil moisture, and sea level will have adverse effects on many ecological systems, as well as on human health and the economy.

## The Climate System

Energy from the sun drives the earth's weather and climate. Atmospheric global warming pollution (water vapor, carbon dioxide, and other gases) traps some of the energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as known today would not be possible. Instead, thanks to carbon dioxide, the earth's average temperature over the past 5000 years has been a hospitable 60°F. However, problems arise when the greenhouse effect is enhanced by human-generated emissions of carbon dioxide pollution.

Global warming will do more than add a few degrees to today's average temperatures. Cold spells still will occur in winter, but heat waves will be more common. Some places will be drier and others, wetter. More precipitation may come in short, intense bursts (more than 2 inches of rain in a day), which could lead to more flooding. Sea levels will be higher than they would have been without global warming.

## Local Effects of Global Warming

Over the last century, the average temperature in Nashville, Tennessee has increased nearly 1°F, and precipitation has increased by up to 10% in many parts of the state. Over the next century, the climate in Tennessee may change even more. The Environmental Protection Agency (EPA) estimates average temperatures in TN could rise by about 2-3° F by 2100 if global warming continues unabated.

## Human Health

**Heat-Related Deaths:** Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. Although Tennessee is exposed to regular, intense heat during a typical summer, hotter summers will worsen the rate of heat deaths. In Memphis, a city historically vulnerable to heat deaths, a warming of 3-4°F during a typical summer is projected to cause heat deaths to increase by about 60% from the current 40 to 65 deaths per year. The elderly, especially those living alone, are at greatest risk.

**Respiratory Illnesses:** Climate change could increase concentrations of ground-level ozone. High temperatures, strong sunlight, and stable air masses tend to increase urban ozone levels. Ground level ozone is associated with respiratory illnesses such as asthma, reduced lung function, and respiratory inflammation. Air pollution also is made worse by increases in natural hydrocarbon emissions such as emissions of terpenes by trees and shrubs during hot weather. If a warmed climate causes increased use of air conditioners, air pollutant emissions from power plants will increase. Upper and lower respiratory allergies are influenced by humidity. A 2°F warmer and wetter condition could increase respiratory allergies.

**Disease-carrying Insects:** Warming and other climate changes will expand the habitat and infectivity of disease-carrying insects, thus increasing the potential for transmission of diseases such as malaria and dengue (“break bone”) fever. Infected individuals can bring malaria to places where it does not occur now. Warmer temperatures will increase the incidence of Lyme disease and other tick-borne diseases in Tennessee because populations of ticks, and their rodent hosts, could increase under warmer temperatures and increased vegetation.

**Water-Borne Diseases:** Increased runoff from heavy rainfall will increase water-borne diseases such as giardia, cryptosporidia, and viral and bacterial gastroenteritides. Developed countries such as the United States should be able to minimize the impacts of these diseases through existing disease prevention and control methods.

### **Water Resources**

**Decreased Precipitation Models:** If runoff decreases, the reservoir systems of the Tennessee and Cumberland rivers could experience declines in hydropower generation, disruptions to navigation, degraded recreational opportunities, and decreased water availability for water supplies. Lower flows and higher water temperatures also could degrade water quality by lowering dissolved oxygen levels and concentrating pollutant levels. This could be problematic for urban areas such as Knoxville, Chattanooga, Nashville, and Memphis, which discharge their treated municipal and industrial wastes into rivers.

**Higher Water Temperatures:** Higher water temperatures will impair the cold water fisheries that have been established below many dams. In addition, higher water temperatures could reduce the efficiency of industrial and power plant cooling systems. They also could make it increasingly difficult to meet regulatory standards for acceptable downstream water temperatures, particularly during extremely warm periods.

**Increased Precipitation Models:** If rainfall and runoff increase in the Tennessee region, then higher stream flows and lake levels could benefit hydropower production, and improve water availability for water supplies. Although higher flows will dilute pollutants, erosion and levels of pesticides and fertilizers in runoff from agricultural areas could increase. It also could increase pollution in runoff from mining areas. Increased rainfall also could increase flooding, which is currently a problem in the steep terrain in eastern Tennessee, along the many unregulated streams throughout the state, and in growing urban areas such as Chattanooga-Hamilton, Nashville-Davidson, and Memphis-Shelby counties. Increased rainfall also could disrupt navigation during periods of high flow.

**Decreased Water Quality:** Sedimentation, excess nutrient and toxic loading are expected to increase in fresh water streams as a result of climate change. Higher flood peaks, a result of greater clustering of storms, could increase erosion and sediment loading to stream channels.

### **Agriculture**

The mix of crops and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns could shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, increased irrigation will decrease water supplies for other users: natural ecosystems, industry, and urban populations.

In Tennessee, production agriculture is a \$2 billion annual industry, almost split evenly between crops and livestock. Very few of the farmed acres are irrigated. The major crops in the state are corn, soybeans, hay, and tobacco. Corn yields might increase up to 15% as a result of climate change. Hay and pasture yields could rise by 30%, and soybean yields could fall by 5%. Estimated changes in the yield vary, depending on whether land is irrigated. Farmed acres are estimated to remain fairly constant. Livestock and dairy production may not be affected, unless summer temperatures rise significantly and conditions become significantly drier. Under these conditions, livestock tend to gain less weight and pasture yields decline, limiting forage.

### **Forests**

**Changing Ranges:** Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species composition, geographic range, and health and productivity. These changes could occur during the lifetimes of today's children, particularly if the change is accelerated by other stresses such as fire, pests, and diseases. Some of these stresses will be worsened by a warmer and drier climate. Composition changes in these forests could adversely affect diversity, forestry, and recreation. Climate change could add significantly to the stresses of these forests as conditions suitable for the growth of red spruce and Fraser Fir disappear under warmer and drier conditions

Over the past 15 years, the tree hardiness zone of TN has shifted one hardiness zone southward as a result of global warming. Tree hardiness zones are based on the average lowest temperature, and that minimum is increasing globally. In TN, the minimum of 0 to minus10° F has changed to 0 to 10° F.

**Wetter Climate:** A warmer and wetter climate could lead to trees that are better adapted to warmer conditions, such as oaks and pines. Under these conditions, forests could become more dense.

**Drier Climate:** If conditions become drier, the current range of forests could be reduced and replaced by grasslands and pasture. With changes to a drier climate, the extent of forested areas in Tennessee could change as much as 15%. Forested areas could be increasingly dominated by pine and scrub oaks, replacing many of the eastern hardwoods common throughout Tennessee. In areas where richer soils are prevalent, southern pines could increase their range and density, and in areas with poorer soils, common in Tennessee's forests, scrub oaks of little commercial value (e.g., post oak and blackjack oak) could increase their range. Climate change could also affect the success of tree plantings to stabilize and reforest disturbed areas.

Warmer, drier conditions may also increase the frequency of wildfires, hurting the commercial timber industry.

### **Species Diversity**

**Changing Diversity:** Tennessee is home to an incredible diversity of native wildlife species, including 278 birds, 76 mammals, 283 fish, 55 reptiles and 72 amphibians. Rising temperatures in the state will likely change the makeup of entire ecosystems, forcing species to shift their ranges, adapt, or become extinct.

- Under a warmer climate, the habitat available to cold water fish species such as trout is expected to decrease, thus limiting their abundance and range. Warmer temperatures will reduce the abundance and habitat range of trout in the Appalachian region, including a 61% decrease in abundance and 90% loss of habitat of brook trout in headwater streams.
- If increased evaporation exceeds any increase in rainfall during the summer months, stream flows could become intermittent, and thus favor plants and animals adapted to

ephemeral conditions (e.g., chironomids and mayflies), rather than those with relatively long life cycles (e.g., caddisflies and mollusks). The habitat for warm water fish could also be reduced by hotter temperatures.

- Breeding ranges of 34 species of songbirds - including the American redstart and the scarlet tanager - are in danger of disappearing from Tennessee's borders due to global warming.
- 75% of the ducks that migrated to Tennessee between 1990 and 2000 originated from the Prairie Pothold Region, an area in the north-central U.S. and south-central Canada. Researchers project that global warming could destroy up to 91% of these wetlands by 2080, reducing the abundance of breeding ducks.
- The Appalachian spruce-fir forests already are threatened by air pollution (acid rain and ground-level ozone) and exotic pests (hemlock wooly adelgids).
- More invasive and exotic species will dramatically alter diversity and community structure.

**Impacts on Eco-Tourism:** Loss of wildlife and habitat could mean a loss of tourism dollars. In 2001, nearly 2.7 million people spent more than \$1.7 billion on hunting, fishing, and wildlife viewing in TN, which in turn supported 35,875 jobs in the state.

### **Tennessee's Contribution to Global Warming and Solutions**

**Increasing Pollution:** Global warming pollution in TN more than doubled between 1960 and 2001, according to analysis of government data by US PIRG. Increased oil combustion for transportation accounted for 48% of this increase. The number of miles driven on TN roads increased from 12.8 million in 1960 to 67.6 million in 2001. Coal combustion to generate electricity accounted for 40% of the total increase in emissions.

**CO2 Emission Sources:** An inventory of global warming pollution from Tennessee sources was conducted for the year 1995 and reported that the state had a total equivalent CO2 emissions of 161.5 million tons. The sector breakdown for total equivalent CO2 emissions for 1995:

Utilities - 32%

Transportation - 31%

Industrial - 18%

Residential - 12%

Commercial - 7%.

**Utilities:** TVA's existing coal-fired plants are responsible for a significant portion of the region's noxious emissions: 73% of its sulfur dioxide, 33% of nitrogen oxide emissions, and other volatile organic compounds. TVA accounts for almost 40% of the total CO2 emissions in the state of TN in 1990.

**Resources:** Center for Electric Power (Tennessee Technological University): TN Greenhouse Gas Emissions Mitigation Strategies (April 1999); Southern Alliance for Clean Energy (6/20/06); National Wildlife Federation (12/11/06); EPA: "Climate Change and Tennessee": May 1999; Arbor Day Foundation (12/15/06.).

The Obed Community Association has as its purpose community appreciation and volunteer involvement in ongoing research of the natural and cultural heritage of the Obed River watershed within Cumberland County. Louise Gorenflo, OWCA director, produced this fact sheet. Those wanting to join this membership organization or more information may contact OWCA at 484-2633 or at 185 Hood Drive, Crossville, TN 38555.