

TENNESSEE

ASSESSING THE COSTS OF CLIMATE CHANGE

CLIMATE TRENDS IN TENNESSEE

Since 1955, the average temperature in the southeastern United States has risen almost 1.8° F. Models predict that, if global greenhouse gas emissions continue at the current rate, the temperature in Tennessee could increase by 6.3° F. Scientists predict that temperatures in Tennessee, like those in most mid-latitude regions, will increase more than the global average.¹

Annual precipitation in Tennessee is forecast to increase by around 7 percent, much of which will occur during the winter.² Although summer precipitation totals are expected to change very little, the likelihood of extreme weather, such as droughts and severe storms, is predicted to increase.³

ECONOMIC IMPACTS⁴

Forestry

Tennessee has been dubbed the “Hardwood Capital of the World” for good reason—the state is the top producer of hardwood flooring and is ranked second in the nation in hardwood lumber production.⁵ In 2000, the forest product industry accounted for 6.6 percent of the state’s gross domestic product, generating \$21.7 billion in economic output and employing 180,000.⁶

Tennessee’s forests, a significant natural and economic asset, cover 55 percent of the state. Most trees on forested land are hardwoods, including oak, maple and hickory.⁷ In contrast to the national trend, forested land in Tennessee has increased in recent years due to farmland conversion.

Forest productivity is influenced by various environmental factors; slight increases in temperature or precipitation actually can stimulate forest growth. Higher concentrations of carbon dioxide also can increase productivity through “carbon fertilization.”⁸ One study found that a 50 percent increase in concentration of atmospheric carbon dioxide resulted in a 23 percent increase in forest productivity.⁹ If such an increase occurred, it would add nearly \$8.7 billion to the state’s economy by increasing forest output.¹⁰ An increase of atmospheric carbon dioxide levels of 50 percent, however, would cause a 5° F increase in global temperature that could cause catastrophic changes in sea levels, temperatures and precipitation and lead to a major disruption of the global economy.¹¹ Such pronounced climatic changes are likely to counteract any potential benefit to the state’s economy.

The concentration of ground-level ozone also affects the forestry sector. Ozone is a pollutant formed from motor vehicle and industrial emissions during warm summer months. Ozone levels are predict-

OVERVIEW

In the coming decades, a changing climate is expected to increase economic impacts on Tennessee and the nation. The most recent climate modeling predicts warmer temperatures and more precipitation for Tennessee. These changes will be more pronounced if global emissions of greenhouse gases are not reduced. Although the forestry sector may see some benefits from the changes, the state’s strained water resources may suffer, as may infrastructure, the hunting industry and public health. Since state economies are directly linked to the economies of neighboring states and regions, policymakers may wish to consider both state and regional policies that address climate change.



ed to increase nationwide as fossil fuel combustion increases and temperatures rise due to climate change. Increased levels of ground-level ozone, which is harmful to plants and human health, could counteract some of the productivity gains from carbon fertilization. Researchers estimate that, if ozone levels increase as expected, plant productivity could decline by more than 10 percent by 2100.¹² Thus, the net effect on Tennessee forestry sector production remains uncertain.

Agriculture

In 2007, crop and livestock production accounted for less than 1 percent (\$1.7 billion) of Tennessee's gross domestic product.¹³ Cattle and calves are the top agricultural commodity, followed by poultry, cotton, greenhouse/nursery products and soybeans.¹⁴

As with forestry, agriculture crops are influenced by temperature, precipitation and carbon dioxide levels. Cotton is projected to thrive under warmer temperatures and higher carbon dioxide levels. Consequently Tennessee cotton production could increase by between 6 percent and 37 percent. Such a change could increase annual cotton sales by as much as \$1.2 million.¹⁵ Soybean yields are predicted to increase between 14 percent and 30 percent, resulting in a \$350,000 to \$750,000 increase in sales.¹⁶ The positive economic effects from higher cotton and soybean yields could top \$2 million.¹⁷

Despite potential gains for the state's agricultural sector, many uncertainties exist, including precipitation variability and ozone levels. MIT researchers, for example, predict a reduction in crop yield by as much as 10 percent when changes in ground-level ozone concentration are taken into consideration.¹⁸

Tennessee's annual average precipitation is likely to increase, along with extreme events such as heat waves, droughts and floods. Because such events are highly unpredictable, it is uncertain how agricultural and forest productivity may be affected. Infrequent yet intense storm events may not maintain the continuous soil moisture that plants need to flourish. One study that examined how climate change will affect Midwestern agriculture found that climatic variability can significantly affect profit margins. The report found that, if temperature and precipitation variability increased from 10 percent to 25 percent, agricultural losses would increase by 150 percent. Variability means that temperature and precipitations extremes would be more dramatic—such as longer periods without rain and more intense rainfall when it occurs—while total

precipitation and average temperatures for the seasons would remain the same.¹⁹

Water Resources

The Mississippi River, Tennessee's western border, is surrounded by low-lying land. If climate change increases the likelihood of intense weather events along the Mississippi River system, flooding could result and cause significant economic losses to agriculture and infrastructure. Communities near similar Tennessee waterways also could experience increased flood losses.

Higher water temperatures, combined with agricultural runoff, encourage bacterial and algal growth that can create or worsen water quality problems. A decline in water resource quality could increase the already high cost of treatment. Tennessee saw a 54 percent increase in its water treatment needs between 2000 and 2004.²⁰ Research of Texas water treatment facilities found that increased water contamination resulted in 27 percent higher treatment costs.²¹ If the costs increased by the same percentage in Tennessee, water treatment would require an additional \$305 million in expenditures in addition to the current treatment costs of more than \$480 million.²² Climate change threatens Tennessee's already troubled water quality since many of the state's aquifers are already impaired. More sporadic rainfall and warmer temperatures also could decrease water supplies for municipalities along the Tennessee and Cumberland rivers.²³

Figure 6. Tennessee's Unified Watershed Assessment Categories
Watersheds in red are over 15 percent impaired



Source: Tennessee Department of Environment, 2008.

Tennessee has nearly 787,000 acres of wetlands, which provide the state with natural water purification. Wetlands are susceptible to higher temperatures and changes in precipitation, and Tennessee's fresh water supplies could be harmed if wetlands shrink. One study that quantified the cost of lost wetlands due to road and other infrastructure development, for example, estimated the replacement cost at \$350 to more than \$25,000 per acre.²⁴ A 20 percent loss of wetland acreage could cost the state from \$55 million to nearly \$4 billion.²⁵



Hunting

Hunting brings significant revenue to Tennessee; expenditures in 2006 totaled \$495 million, and migratory bird hunting alone brings in more than \$33 million annually.²⁶ Many game bird species that nest in the Prairie Pothole region of Canada and the northern United States migrate south to winter in Tennessee wetlands. Climate change threatens the critical breeding grounds of the Prairie Pothole region and the migratory bird populations that rely on it. Changes in precipitation and temperature patterns caused by climate change, along with land use changes, could shrink Prairie Pothole nesting grounds by as much as 90 percent, significantly reducing migratory bird populations.²⁷ A warming climate also could push the birds' winter habitat northward out of Tennessee. If these changes cause the bird population to decline and result in a 10 percent decrease in hunting revenues, the state would lose more than \$80 million annually in total foregone benefits.²⁸

Infrastructure

Higher temperatures and altered precipitation patterns could lead to an increase in drought, flooding and extreme weather events that could damage property and infrastructure. Soil under drought conditions is less permeable, which increases the likelihood of flooding when severe precipitation occurs.²⁹ Flooding is most likely to occur in central Tennessee, where an array of rivers and streams has carved out the Tennessee Valley. The Tennessee Valley Authority (TVA) estimates it prevents \$230 million in flood damage each year.³⁰ The TVA, however, does not have sufficient capacity to deal with all flood threats; damages caused by the 2003 Chattanooga flood reached \$52 million.³¹

Health

Tennessee could experience a range of health effects due to climate change, since higher temperatures increase the production of pollutants such as ozone and smog, which worsen asthma and other respiratory conditions. East Tennessee, already suffering from smog and poor air quality, could see the air pollution get worse as temperatures increase.³² An estimated 12 percent of the state's population suffers from asthma, although the percentage of high school students who suffer from asthma may approach 20 percent.³³ Asthma costs the nation \$16.5 billion annually. If it is assumed that expenditures are distributed evenly throughout the country, Tennessee spends approximately \$625 million each year to treat the disease.^{34,35} If worsening air quality increases the number of hospital and doctor visits by asthma sufferers by 30 percent, an additional \$187 million will be required to cover additional visits and treatment.³⁶ The higher costs

would affect many sectors of the economy, resulting in nearly \$360 million in losses.³⁷

The increased number of hot days and heat waves that climate change is expected to bring also could increase the number of heat-related death and illness. The poor and elderly are most susceptible to rising temperatures that climate change will bring.

CONCLUSION

Tennessee's greatest challenge is likely to be adapting to the effects climate change could have on water resources and infrastructure. Understanding how climate change will affect water quality and availability will be crucial to balancing development and population growth in areas where water supplies may be compromised. Policymakers may wish to investigate the degree to which changes in water quality will increase water treatment and management costs. This information could be helpful in determining how planning and budgeting can be adapted to various scenarios.

Since the likelihood of flooding is predicted to increase, policymakers can promote additional state-specific research on potential precipitation changes. Creating assessments that designate which regions are most susceptible to increased flooding and revising flood response and mitigation plans also would be helpful. Revisiting and modifying zoning and development in susceptible areas could be helpful in avoiding flood-related disasters and their associated costs.

Because climate change is likely to place more stress on wildlife, policies that create large, interconnected wildlife preserves with varied ecosystems will help flora and fauna adapt to changes.

MISSING INFORMATION AND DATA GAPS

Although some economic sectors in Tennessee actually could gain from climate change, this projection depends upon the availability of timely precipitation, lack of disease-causing pests, and sufficient soil moisture; all of which are affected by climate change. Higher ozone levels also may counteract the positive effects of carbon dioxide on plant growth. A much better understanding of these factors will be necessary to assess potential outcomes, as will a better assessment of the effects of increased severe weather on infrastructure and agriculture.



NOTES

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3. Ibid.
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These reports are the result of collaboration between the National Conference of State Legislatures and the University of Maryland's Center for Integrative Environmental Research. Funding for these publications was provided by the Environmental Defense Fund.