CLIMATE IMPACTS – SOUTHEAST

From the Adaptation Workbook: www.adaptationworkbook.org/explore-impacts

This region was defined in the National Climate Assessment (2014) and includes the states of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia. For additional details, see: National Climate Assessment (2018) - Southeast

Summary of Climate Impacts (details and citations on subsequent pages):

Temperatures in the Southeast are projected to increase by 4.5 to 8.5 degrees Fahrenheit by 2085.

The Southeast is expected to experience between 5 and 30 more days per year with a maximum temperature exceeding 95 degrees Fahrenheit by the middle of the century.

The Southeast is expected to experience between 0 and 14 fewer days per year with a minimum temperature below 10 degrees Fahrenheit by the middle of the century.

Average annual precipitation is projected to increase slightly in the northeast portion of the Southeast, but may decrease in the southwest half of the region.

The number of days per year with more than 1 inch of precipitation will increase across the Southeast by the middle of the century.

Red spruce, balsam fir, and and eastern hemlock are projected to decline substantially across the Southeast by the end of the century, and conditions for pines may also deteriorate.

Climate change will amplify many existing stressors to forest ecosystems in the Southeast, such as invasive species and insect pests.

Wildfire risk is projected to increase across the Southeast by the end of the century.

Damage from hurricanes and sea-level rise may increase in the Southeast by the end of the century.

Low-diversity systems are at greater risk from climate change.

Systems that are more tolerant of disturbance have less risk of declining on the landscape

Species in fragmented landscapes will have less opportunity to migrate in response to climate change.

Systems that are limited to particular environments will have less opportunity to migrate in response to climate change.

Temperatures in the Southeast are projected to increase by 4.5 to 8.5 degrees Fahrenheit by 2085.

All climate models agree that temperatures are projected to increase over the 21st century across the Southeast. The spatial variations are projected to be relatively small across the region, with the largest temperature changes occurring in the northwest part of the region (Arkansas, Kentucky, Mississippi, and Tennessee), the smallest variations occurring in southern Florida. Temperature increases will be the greatest in summer. The greatest warming during summer is expected in the northwest portion of the region. Compared to all other seasons, winter temperature increases are projected to be more mild.

K. Kunkel, L. Stevens, and others. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment - Southeast. NOAA.

The Southeast is expected to experience between 5 and 30 more days per year with a maximum temperature exceeding 95 degrees Fahrenheit by the middle of the century.

The smallest increase of 4 days per year is expected in areas with a currently low number of 95-degree days, including the highest elevation areas along the spine of the Appalachians where historically days above 95-degrees occur fewer than 10 days out of the year. The largest increase in the number of 95-degree days per year (35 days) is expected in south-central Florida, where these kinds of hot days are already common. The western portion of the region is expected to experience the largest number of consecutive 95-degree days, with as many as 16-20 additional days by mid-century.

K. Kunkel, L. Stevens, and others. 2013. [Regional Climate Trends and Scenarios for the U.S. National Climate Assessment - Southeast](). NOAA.

The Southeast is expected to experience between 0 and 14 fewer days per year with a minimum temperature below 10 degrees Fahrenheit by the middle of the century.

The largest decreases are expected in Kentucky, Virginia, Tennessee, North Carolina and the northern part of Arkansas. The smallest decreases in cold days are expected along the coastal and southern areas, where these kinds of cold days rarely occur. Similarly, the Southeast region is expected to have more than 20 fewer days with a minimum temperature below 32 degrees by the middle of the century.

K. Kunkel, L. Stevens, and others. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment - Southeast. NOAA.

Average annual precipitation is projected to increase slightly in the northeast portion of the Southeast, but may decrease in the southwest half of the region.

There is uncertainty between different climate scenarios for future precipitation projections in the Southeast. Generally, there is a southwest-to-northeast gradient in annual precipitation projections. The greatest increases are projected in North Carolina and Virginia (3-9% increase by the end of the century), and the greatest decreases are projected in Louisiana and Arkansas (3-12% decrease by the end of the century). Overall changes in precipitation for the Southeast are projected to be slight and comparable to current year-to-year variations.

K. Kunkel, L. Stevens, and others. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment - Southeast. NOAA.

The number of days per year with more than 1 inch of precipitation will increase across the Southeast by the middle of the century.

Most of the region is projected to experience 6% to 25% more days each year with more than an inch of precipitation by the middle of the century. The largest increases (up to 25% increases) in extreme precipitation are expected across the Appalachian Mountains. The smallest increases (less than 10%) are expected across Arkansas, Louisiana and Mississippi. Days with more than 2 inches, 3 inches, and 4 inches of precipitation are also expected to occur more frequently by the middle of the century. Heavy precipitation associated with hurricanes and tropical storms could result in more flooding and damage in coastal forests.

K. Kunkel, L. Stevens, and others. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment - Southeast. NOAA.

A majority of climate models suggest that precipitation in the Southeast will increase in the winter, spring, and fall by the end of the century, but summer is generally expected to become drier.

Simulated changes in summer precipitation by the end of the century range from a 0-10% decrease, with the largest decreases occurring in southern Florida and Arkansas and Tennessee. The means of several climate models indicate that winter and spring precipitation may increase around 15% by the end of the century, particularly in the northern part of the region. Fall precipitation may also increase, with the greatest expected increases along the Gulf Coast. Overall, only minimal change or slight increases in precipitation are projected along much of the Atlantic and Gulf Coasts. These projections are averaged outputs from a climate scenario with higher emissions (A2), and under mild climate scenarios changes are generally expected to be smaller.

K. Kunkel, L. Stevens, and others. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment - Southeast. NOAA.

The annual freeze-free season is expected to increase by 20 to 30 days in the Southeast by 2055.

The freeze-free season is defined as the period of time between the last spring frost (daily minimum temperature below 32 degrees F) and the first fall frost. The length of the annual freeze-free season has been increasing since the 1980s, and all climate models agree that it will continue to increase in the future across the Southeast. The largest increases of 25-30 days are mainly expected in Louisiana, Tennessee, Kentucky, Virginia, and North Carolina. The smallest changes are expected in southern Florida, which is not surprising because freezing events are already rare in this part of the Southeast.

K. Kunkel, L. Stevens, and others. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment - Southeast. NOAA.

Red spruce, balsam fir, and and eastern hemlock are projected to decline substantially across the Southeast by the end of the century, and conditions for pines may also deteriorate.

Red spruce and eastern hemlock are already declining in some areas, and these species are projected to be extirpated from the southeast by 2100 as a result of the combined stresses of warming, air pollution, and insects. If temperature continues to increase and precipitation becomes more variable, conditions for pine growth may begin to deteriorate. Even if regional forest productivity remains high for pine species, the center of forest productivity could shift northward into North Carolina and Virginia, causing significant economic and social impacts.

J. Vose, D. Peterson, and others. 2012. Effects of Climate Variability and Change on Forest Ecosystems: A Comprehensive Science Synthesis for the U.S. Forest Sector.. USDA Forest Service Pacific Northwest Research Station.

Climate change will amplify many existing stressors to forest ecosystems in the Southeast, such as invasive species and insect pests.

Forest ecosystems throughout the Southeast Region are exposed to a range of natural, introduced, and anthropogenic stressors. Stressors such as invasive plants, forest pests, and diseases are expected to become more damaging under climate change, and these factors may interact in unpredictable ways. The southern pine beetle is already the most destructive pest in the region's forests, and longer growing seasons could allow populations of the pest to expand more rapidly. Cogongrass and kudzu are expected to expand into new territory under climate change, and both of these species have cascading effects on disturbance regimes and diversity.

J. Vose, D. Peterson, and others. 2012. Effects of Climate Variability and Change on Forest Ecosystems: A Comprehensive Science Synthesis for the U.S. Forest Sector.. USDA Forest Service Pacific Northwest Research Station.

Wildfire risk is projected to increase across the Southeast by the end of the century.

Prescribed fire is currently more common than wildfire in Southeastern forests. As fire seasons lengthen in the future, the window for prescribed burning may decrease because of increased fuel flammability. Decades of wildfire suppression has increased the potential for crown fires, and model projections indicate that wildfires are likely to occur more frequently in the Southeast in the future. Annual fire probability, calculated solely with climate data and physical principles, is projected to increase by 20% to 80% across the Southeast by the end of the century, with the greatest increases in the southern Appalachians. The incidence of atmospheric conditions that contribute to large and erratic fire behavior, measured by the Haines Index, is also projected to occur more 8 to 11% more frequently by the end of the century. The limitation for these sorts of projections is that they do not account for changes in land use, fire suppression rates, or vegetation changes.

J. Vose, D. Peterson, and others. 2012. Effects of Climate Variability and Change on Forest Ecosystems: A Comprehensive Science Synthesis for the U.S. Forest Sector.. USDA Forest Service Pacific Northwest Research Station.
Y. Tang, S. Zhong, and others. 2015. The Potential Impact of Regional Climate Change on Fire Weather in the United States. Annals of the Association of American Geographers.
R. Guyette, F. Thompson, and others. 2014. Future Fire Probability Modeling with Climate Change Data and Physical Chemistry. Forest Science.

Damage from hurricanes and sea-level rise may increase in the Southeast by the end of the century.

Global sea level rise is projected to rise between 1 and 4 feet by the end of the century. Sea level rise and related increases in storm surges pulsing farther inland will continue to exacerbate ongoing land loss in low-lying coastal areas and may result in excessive saltwater inundation of coastal forests. The number of Category 4 and 5 hurricanes has increased since the 1980s, and this trend can be attributed both to natural variability and climate change. Damage from these kinds of storms can be intense and extend for hundreds of miles inland, including windthrow and blowdown, inundation, and damage to infrastructure on land.

L. Carter, J. Jones, and others. 2014. National Climate Assessment – Southeast. U.S. Global Change Research Program.

Low-diversity systems are at greater risk from climate change.

Studies have consistently shown that diverse systems have exhibited greater resilience to extreme environmental conditions and greater potential to recover from disturbance than less diverse communities. This relationship makes less diverse communities inherently more susceptible to future changes and stressors. The diversity of potential responses of a system to environmental change (response diversity), is a critical component of ecosystem resilience. Response diversity is generally reduced in less diverse ecological systems. Genetic diversity within species is also critical for the ability of populations to adapt to climate change, because species with high genetic variation have better odds of producing individuals that can withstand extreme events and adapt to changes over time.

T. Elmqvist , C. Folke, and others. 2003. Response diversity, ecosystem change, and resilience. Frontiers in Ecology and the Environment.

A. Hoffman and C. Sgrò. 2011. Climate change and evolutionary adaptation. Nature.

Systems that are more tolerant of disturbance have less risk of declining on the landscape

Disturbances such as wildfire, flooding, and pest outbreaks are expected to increase in the future. Forests that are adapted to gap-phase disturbances, with stand-replacing events occurring over hundreds or thousands of years, may be less tolerant of more frequent widespread disturbances. Mesic hardwood forests can create conditions that could buffer against fire and drought to some extent, but these systems are not expected to do well if soil moisture declines significantly. Forest systems that are more tolerant of drought, flooding, or fire are expected to be better able to withstand climate-driven disturbances. This principle holds true only to a given point, because it is also possible for disturbance-adapted systems to experience too much disruption. For example, dry pine forests and woodlands might benefit from drier conditions with more frequent fire, but these systems might also convert to savannas or open grasslands if fire becomes too frequent or drought becomes too severe.

G. Nowacki and M. Abrams. 2008. The Demise of Fire and "Mesophication" of Forests in the Eastern United States. BioScience.

E. Gustafson and B. Sturtevant. 2013. Modeling Forest Mortality Caused by Drought Stress: Implications for Climate Change. Ecosystems.

Species in fragmented landscapes will have less opportunity to migrate in response to climate change.

Habitat fragmentation can hinder the ability of tree species to migrate to more suitable habitat on the landscape, especially if the surrounding area is nonforested. Modeling results indicate that mean centers of suitable habitat for tree species will migrate between 60 and 350 miles by the year 2100 under a high emissions scenario and between 30 and 250 miles under milder climate change scenarios. Based on data gathered for seedling distributions, it has been estimated that many northern tree species could possibly migrate northward at a rate of 60 miles per century. Fragmentation makes this disparity even more challenging, because the landscape is essentially less permeable to migration.

L. Iverson, M. Schwartz, and others. 2004. How fast and far might tree species migrate in the eastern United States due to climate change?. Global Ecology and Biogeography.

C. Woodall, C. Oswalt, and others. 2009. An indicator of tree migration in forests of the eastern United States. Forest Ecology and Management.

Systems that are limited to particular environments will have less opportunity to migrate in response to climate change.

Some species and forest types are confined to particular habitats on the landscape, whether through requirements for hydrologic regimes, soil types, or other reasons. Similar to species occurring in fragmented landscapes, isolated species and systems face additional barriers to migration. Widespread species may also have particular habitat requirements. For example, sugar maple is often limited to soils that are rich in nutrients like calcium, so this species may actually have less available suitable habitat than might be projected solely from temperature and precipitation patterns. Riparian forests are not expected to be able to migrate to upland areas because many species depend on seasonal flood dynamics for regeneration and a competitive advantage. Similarly, lowland conifer swamps contain a unique mix of species that are adapted to low pH values, peat soils, and particular water table regimes. These species face additional challenges in migration compared to more-widespread species with broad ecological tolerances.

A. Jump and J. Peñuelas. 2005. Running to stand still: adaptation and the response of plants to rapid climate change. Ecology Letters.