U.S. ENVIRONMENTAL PROTECTION AGENCY

REGION 4

Climate Change Adaptation Implementation Plan

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Cover Photo: Prescribed coastal prairie burn in the Everglades, coordinated by EVER Fire & Aviation. Image by National Park Service, Jennifer Brown via https://www.flickr.com/photos/evergladesnps/5794177994/.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

SEP 1 2 2022

DEPUTY ADMINISTRATOR

Preface

Climate change is threatening communities across the nation. Millions of Americans feel the destructive effects of climate change each year when the power goes down, rivers and lakes go dry, homes are destroyed by wildfires and communities are flooded by hurricanes. Underserved communities are especially vulnerable to the climate crisis and are more likely to experience the negative health and environmental effects of extreme weather events.

The Biden-Harris Administration is actively confronting the climate crisis while also advancing environmental justice. As part of a whole-of-government approach, the U.S. Environmental Protection Agency is strongly committed to taking the actions necessary to protect human health and the environment and to increase the resilience of the entire nation, even as the climate changes.

The EPA's commitment to action is reflected in its FY 2022-2024 Strategic Plan and in the 2021 Climate Adaptation Action Plan. Both documents present priority actions the agency will take to ensure that its programs, policies and operations remain effective under future climate conditions while we work to support states, territories, tribes and communities in increasing their own adaptive capacity and resilience to climate change impacts.

From flooding at Superfund sites, to wildfires causing air pollution, to sea-level rise affecting water quality and infrastructure, the EPA will boldly address climate impacts in both its programs and the communities it serves. We recognize the importance of tribal, state and local government partnerships in efficient, effective and equitable implementation of climate change adaptation strategies. Our plans were informed and improved by input we received in listening sessions we held to engage these and other partners as we developed these plans.

To ensure we are addressing the climate crisis in a comprehensive way, each of our national program and regional offices has developed individual Climate Adaptation Implementation Plans that outline how the EPA will attain the agencywide goals described in the broader Climate Adaptation Action Plan. These plans describe how programs and regions will integrate climate adaptation into their programs, partnerships and operations. They also describe how they will help partners build their resilience and capacity to adapt, while delivering co-benefits, including curbing greenhouse-gas emissions and other pollution, and promoting public health, economic growth and climate justice. Of course, the EPA has a major role to play on emissions reductions as well, though that is not the focus of these plans. Indeed, we must focus on both climate adaptation and mitigation to ensure our nation and communities thrive in an era of climate change.

As part of this effort, we will empower our staff and partners by increasing awareness of how climate change may affect our collective ability to implement effective and resilient programs. We will also provide them with the necessary training, tools, data, information and technical support to make informed decisions and integrate climate adaptation into our work.

The EPA will work to modernize its financial assistance programs to encourage climate-resilient investments across the nation. We will also focus on ensuring that investments funded by the Bipartisan Infrastructure Law, the Inflation Reduction Act and other government programs are resilient to the impacts of climate change. Finally, as our knowledge advances and as impacts continue to develop, our response will likewise evolve. We will work to share these developments to enhance the collective resilience of our nation.

The actions outlined in these implementation plans reflect the EPA's commitment to build every community's capacity to anticipate, prepare for, adapt to and recover from the increasingly destructive impacts of climate change. Together with our partners, we will work to create a healthy and prosperous nation that is resilient to the ever-increasing impacts of climate change — which is vital to the EPA's goal of protecting human health and the environment and to ensuring the long-term success of our nation.

Janet G. McCabe

Message from Daniel Blackman, Regional Administrator
U.S. EPA Region 4, Environmental Protection Agency

EPA Region 4 has a rich biodiversity due to its climate, large water bodies, and topography. From the Floridian Everglades to the Great Smoky Mountains, our region is home to ecosystems ranging from subtropical wetlands to mountainous forests. This region is beautiful as it is, and its natural resources sustain us both biologically and economically.

But our climate is changing.

We can feel the effects all around us. The temperature is increasing, and the number of days reaching temperatures over 95°F in the Southeast is projected to increase during this century.

We can smell it in the air we breathe. Each year over 45,000 wildfires and 1 million acres burn in the Southeastern U.S., and this number is likely to climb in the coming years.

We can taste it in the water we drink. Warmer fresh water and seas will likely contribute to increased harmful algal blooms and decrease the availability of safe drinking water.

We can see it in land we stand on. Some land is disappearing, as many locations in the Southeast are extremely vulnerable to the impacts of sea level rise, driven by both increased warming of oceans and ground subsidence (sinking). Other parts of our region are experiencing periods of extreme drying.

We can hear it as weather patterns change. The Southeast is experiencing more frequent and intense storms, and this trend is expected to increase.

Adaptation will help us prepare for the effects of climate change that are on the horizon. Recognizing this, President Biden's Executive Order 14008, "Tackling the Climate Crisis at Home and Abroad," required executive agencies to develop action plans to bolster adaptation and increase resilience to the impacts of climate change. EPA Administrator Regan further directed EPA offices to update Implementation Plans as stated in the EPA 2021 Climate Adaptation Action Plan.

EPA Region 4's Climate Adaptation Implementation Plan is intended to proactively incorporate climate adaptation planning and implementation into the Region's programs, policies, rules and operations. This plan recognizes that certain populations and communities can be especially vulnerable to climate impacts. Through this plan, we commit to actions that prioritize people, places, ecosystems, and infrastructure that are most vulnerable to adverse climate impacts.

We recognize that this plan will evolve over time to ensure that we focus the Region's resources where needed and that we deliver on our commitment to increase climate resilience for all, as an integral part of our mission to protect human health and the environment.

Daniel Blackman
Regional Administrator, EPA Region 4

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Special thanks to Kenneth Mitchell Ph.D., Deputy Director (retired), Air and Radiation Division, for his tireless devotion to climate change issues throughout his career.

2 INTRODUCTION TO THE REGION

A. Background and Direction

Pursuant to Executive Order 14008, *Tackling the Climate Crisis at Home and Abroad*, all federal agencies are tasked with developing Climate Action Plans that describe each agency's climate vulnerabilities and the steps it will take to bolster adaptation and increase resilience to the impacts of climate change.[1] Consistent with EO 14008, the United States Environmental Protection Agency (U.S. EPA or Agency) released its new U.S. EPA's Climate Adaptation Action Plan in October 2021.[2]

The Agency released its first Climate Change Adaptation Plan in June 2014,[3] followed by 17 Climate Change Adaptation Implementation Plans prepared by its National Environmental Program Offices, National Support Offices, and 10 Regional Offices. The 2021 Plan accelerates action and focuses Agency attention on priority actions it will take to fulfill its mission and increase human and ecosystem resilience even as the climate changes. Every U.S. EPA Program and Regional Office was directed to develop their own updated, independent Climate Change Adaptation Implementation Plan to identify how priorities will be met and the agency-wide plan implemented. Identified priorities are to be reflected in annual budget submissions.

The Agency's Climate Adaptation Action Plan includes a national-level qualitative assessment of U.S. EPA program vulnerabilities. The Regions are tasked with using this plan to guide their adaptation planning. Each Region is to capture its regional uniqueness, identify vulnerabilities of greatest importance, including its vulnerable people and places. U.S. EPA expects the severity and importance of identified program vulnerabilities to vary, reflecting projected regional climate change impact projections. The Regions' plans are expected to describe how climate change adaptation is to be integrated into their planning and work in a manner consistent and compatible with their own circumstances and objectives. The following provides the U.S. EPA Region 4's (Region 4 or the Region) unique considerations and provides its overarching priorities for working internally and externally to adapt and build resilience in both the Region's own resources and in the communities that we serve across the Southeast.

B. Description of U.S. EPA Region 4

The eight states comprising Region 4 are situated in the southeastern United States (U.S.). Region 4 is comprised of Alabama, Georgia, Florida, Kentucky, North and South Carolina, Mississippi, and Tennessee (see Figure 1, below in section 2.B.2.) plus six federally recognized tribes. The Region's borders are primarily large waterbodies: the Mississippi River to the west, the Ohio River to the north, the Atlantic Ocean to the east, and the Gulf of Mexico to the south. The Region lies within several major river basins. Nine large watersheds drain into the Atlantic while eight drain into the Gulf of Mexico. Consequently, the Region 4 is rich with aquatic ecosystems, barrier islands, beaches, estuaries, and wetlands supporting important fishing, recreation, transportation, and tourism industries. The Region has numerous coastal and inland

ports with associated transportation hubs providing shipping logistics for commerce, and every state within Region 4 has a port. Florida has 15 seaports, the most of any Region 4 state.[4] However, the Region has more river ports than seaports, for example the State of Mississippi has four Gulf ports and 12 river ports.[5]

1) Climate Patterns

Weather patterns are impacted by natural weather phenomena, large water bodies and the Region's diverse topography, which make the Southeast one of the most diverse regions in the U.S. The Region is characteristically hot and humid in the summer with mild winters. The Central Appalachian, Western Allegheny, and portions of the Blue Ridge and the Ridge and Valley ecoregions (see Figure 2) can experience cold winters and have the least number of frost-free days, ranging from 125 to 235 days.[6]

For most of Region 4, the number of frost-free days ranges from 200 to 360, with the coastal areas experiencing the most.[7] The southern part of Florida is nearly frost free and is the only ecoregion in the continental U.S. to have the climate, hydrology, vegetation, and terrain characteristics of tropical wet forests.[8] The annual mean temperature for Region 4 ranges from 55 to 77°F, with the more mountainous ecoregions having the coolest temperatures, ranging from 55 to 63°F.[9] Precipitation ranges from 35 to 59 inches in the Piedmont, Ridge and Valley, and Western Allegheny ecoregions, to between 43 and 65 inches for the rest of the Region.[10]

The Bermuda High is a semi-permanent high-pressure area usually centered in the vicinity of Bermuda during the spring and summer. Prolonged heat waves in the U.S. East Coast are attributed to the Bermuda High.[11] Weather fluctuates in response to its east-west migrations. The Bermuda High can move high-moisture tropical air masses west over land causing showers and thunderstorms. When it is east over the Atlantic Ocean, hurricanes tend to curve out to sea avoiding land. When it is west toward land, hurricanes tend to impact the nation's East and Gulf Coasts.

The El Niño-Southern Oscillation is a cyclic Pacific Ocean weather pattern in which the sea-surface temperature cycles between abnormal warming (El Niño) and cooling (La Niña) conditions, influenced by changes (oscillations) in atmospheric pressure between the tropical east and west Pacific (the Southern Oscillation (SO)).[12] The North Atlantic Oscillation (NAO) describes fluctuations in atmospheric pressure differences between permanent low- and high-pressure systems. While the NAO directly influences Western Europe's climate, it may impact much of eastern North America's weather.

The Mississippi and Ohio Rivers delineate U.S. EPA Region 4's western and most of its northern geographic borders, respectively. Two major coastal water bodies, the Atlantic Ocean and the Gulf of Mexico, delineate its eastern and southern borders, respectively. These water bodies strongly influence the Region's climate.[13] Large water bodies take longer to heat up and cool down than land, such that land areas in the vicinity of large water bodies remains cooler in summer and warmer in winter.

The Region's climate is strongly influenced by the Gulf Stream, which flows seven hundred miles north from Key West, FL, to Cape Hatteras, NC. It is a strong, fast moving, warm ocean current. The Gulf Stream system's warm surface temperature causes Florida and much of the Southeast to be mild year-round.[14] Warm sea-surface temperature also aids the formation and strengthening of hurricanes moving through the Gulf of Mexico.

Last, the Region's topography is highly diverse as illustrated by the following classifications: the Mississippi River Valley Plains in the western part of the Region; the southeastern and southern coastal plains of the Atlantic and Gulf Coasts; the interior Piedmont's rolling low plateaus; the Southern Appalachian Mountains; and the inland, elevated, and severely eroded Cumberland Plateau extending from Alabama to Kentucky. Various weather patterns intersect with this diverse topography to create numerous microclimates, facilitating the variety of ecosystems and species diversity characteristic of U.S. EPA Region 4.

2) Ecosystems

Because of its climate, proximity to large waterbodies, and topography, U.S. EPA Region 4 has extensive aquatic ecosystems and associated biodiversity. It is overlain by fourteen ecoregions.[15] Half are in the Southern Appalachians, where the mountains interact with local weather patterns in complex ways, creating numerous local microclimates. Precipitation responses are especially sensitive to the shape of mountain ranges and wind flow direction.[16] Two of the Region's ecoregions are riverine in character: one is the Piedmont, and the other coastal, including the Everglades' subtropical wetlands.

Figure 1. Map of Region 4 States

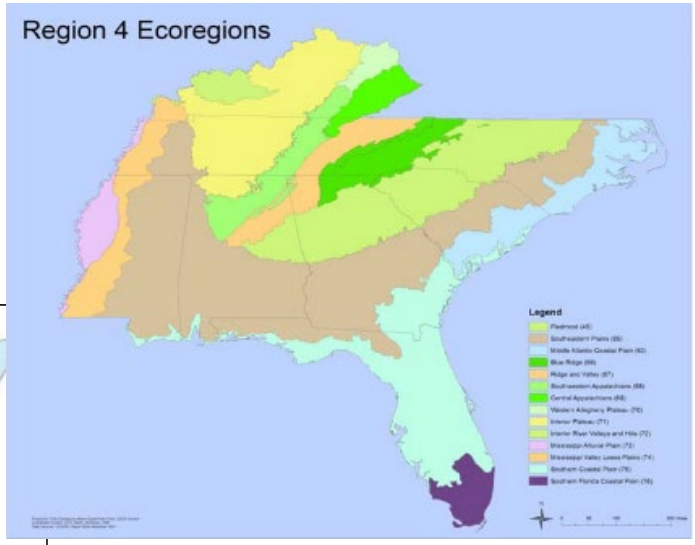


Figure 2. Map of Region 4's Fourteen Ecoregions

Most of U.S. EPA Region 4's land area lies within the Piedmont, Southeastern Plains, and the Southern Coastal Plain ecoregions, see Figure 2.[17] Three ecoregions, the Piedmont, Mississippi Alluvial Plain, and the Southern Florida Coastal Plain (the Everglades) have undergone extensive land-use changes. The Piedmont has experienced several major land-cover transformations

over the past 200 years: forest to farm, back to forest, and spreading urbanization and suburbanization. The Mississippi Alluvial Plain is one of the nation's most altered ecoregions, extensively cleared for cultivation where bottomland hardwood forests once dominated. The Everglades, or the Southern Florida Coastal Plain, has undergone extensive hydrological and biological alterations.[18]

Mountain top, surface, and underground bituminous coal mining occurs within four of the southern Appalachians ecoregions. Mining is extensive in the Interior River Valleys and Hills and the Western Allegheny Plateau ecoregions, common in the Central Appalachians, and occurs in several parts the Southwestern Appalachians ecoregion. Coal mining has resulted in significant habitat loss and water-quality degradation – particularly sedimentation and acidification of many the ecoregions' water bodies.[19] Within Region 4, the Interior River Valleys and Hills and the Western Allegheny Plateau ecoregions only occur within the Commonwealth of Kentucky.[20]

Agriculture occurs in 11 of the Region's ecoregions in the form of pulpwood and lumber pine plantations, beef pasture, cropland (planted with wheat, blueberries, corn, cotton, soybeans, peanuts, onions, sweet potatoes, melons, tobacco, or rice), citrus groves in the south, poultry and hog livestock, and dairy farming. Extensive agricultural land-use occurs in the Mississippi Alluvial Plain, with most of the ecoregion planted in soybeans, cotton, corn, rice, wheat, and pasture, as well as some sugarcane in the south. Pine plantations are common in the Southeast Plains and the Middle Atlantic Coastal Plain ecoregions, and occasionally in the Ridge and Valley. The Middle Atlantic Coastal Plain has a high density of chicken, turkey, and hog production in some areas, with North Carolina ranking as the second-largest hog producing state in the nation. The Southeastern Plains ecoregion also supports poultry and hogs.[21]

The 2018 Census of Agriculture reported aquaculture sales in the United States of $1.5 billion; the three states with the largest number of operations with sales were Florida, Louisiana and Mississippi. Catfish and crawfish are commercially produced in ponds in the Mississippi Alluvial Plain.[22] More than 50% of the total value of sales from aquaculture come from the top five states, including Mississippi, which led the nation with $216M in sales.[23]

The Region's forests are mostly located within five ecoregions. The Blue Ridge ecoregion contains one of the richest temperate broadleaf forests in the world, with a high diversity of plants within the large areas of National Forest, National Parks and state-owned lands. The Western Allegheny Plateau ecoregion is mostly forested, with public national forest lands, and logging a predominant activity.

Forest uses prevail within the Central Appalachians and Southwestern Appalachians ecoregions. The Mississippi Alluvial Plain's floodplain forest ecosystems include river and hardwood swamp forests. The ecoregion is still a major bird migration corridor despite the widespread loss of forest and wetland habitat. The Interior River Valleys and Hills ecoregion is partially forested.[24]

Between 1973 and 2000, the Southeast Climate Region had the highest rate of change due to

active forest timber harvesting and replanting.[25] In this region, forests, not cropland, are expected to be lost.[26] Projected land-use and land-cover changes likely will depend upon population rates and economic growth.[27] The exurban and suburban areas generally are projected to expand by 15% to 20% between 2000 and 2050.[28] Climate change will cumulatively impact the existing and projected land-use changes to the Region's ecoregions. Aquatic ecosystems in those ecoregions – where mining already provides significant stress and where forests are converted to other uses – may likely be less resilient to climate-change.

U.S. EPA and its state partners use aquatic bio-assessments to evaluate biological criteria to determine whether Clean Water Act (CWA) regulated surface waters are maintaining their biological integrity consistent with their designated use, e.g., cold-water fishery.[29]

To monitor stream health, states are delineated into bioregions to organize similar sampling sites together (for example, those having similar stream physical, chemical, and biological attributes). These bioregions often mirror ecoregion boundaries. Since all the streams within a bioregion generally have similar attributes, the differences in aquatic organism assemblages between reference sites (which receive high biological index scores) and stressed sites (which receive low index scores) typically reflect human impacts, such as land-use changes.

Table 1. The Number of Ecoregions and Bioregions by State

State	Level III Ecoregions[1]	Level IV Ecoregions[2]	Macroinvertebrate bioregions	Fish Bioregions	Algae Bioregions
AL	6	29	2 (high and low gradient streams)	NA[3]	NA
FL	3	16	3	NA	NA
GA	6	28	24	4	NA
KY	7	25	4	6	4
MS	4	21	4	NA	NA
NC	4	28	3	5	NA
SC	5	12	3	NA	NA
TN	8	31	15	NA	3

[1]: Ecoregions along the coast (Southern Florida Coastal Plain, Southern Coastal Plain, Mississippi Alluvial Plain, and Middle Atlantic Coastal Plain) do not have aquatic communities that currently support index development and are not included in any bioregions.
[2]: Level IV Ecoregions are subunits of Level III.
[3]: All "Not Applicable" cells represent a state that does not use that index for making regulatory decisions (though most states are in the process of developing new indices or may use that assemblage for other monitoring purposes, like evaluating best management practices.) Information was gathered from Standard Operating Procedures for biomonitoring and index development papers that states operated under in 2011.

Biological integrity is strongly correlated with stream flow,[30] and insect-rich habitat diversity tends to decrease with decreasing flow.[31] Under lower flow conditions, non-flowing (lakes and ponds) fish and insect community populations tend to increase while those requiring flowing water to survive decrease. Additionally, drought or flood-related stream-flow changes can alter

nutrient and sediment loadings and habitat availability.[32] Moreover, lower flow results in less dilution facilitating higher in stream concentrations of potentially harmful chemicals and aquatic toxicity.

In Region 4, cold-water habitat is generally associated with its mountain and high-elevation plateau ecoregions of the Southern Appalachians, i.e., the Piedmont, Ridge and Valley, Blue Ridge, Central Appalachian, Western Allegheny and Interior Plateau, Interior River Valley and Hills ecoregions.[33] Stressors to this habitat include loss of the cooler hyporheic zone due to overextraction of groundwater, higher temperatures caused by impounding waters or reduced flows due to surface or groundwater extraction, dams or diversions.

3) Watersheds

Several watersheds within U.S. EPA Region 4 cross multiple state boundaries with growing populations needing water for agriculture, energy production, navigation, drinking, and other needs. Alabama shares most of its major streams with neighboring states.[34] Five rivers originate in Alabama and flow through Florida before draining into the Gulf of Mexico. Both the Coosa and Tallapoosa Rivers originate in Georgia and flow into Alabama, where they join the Alabama River. The Tombigbee River originates in Mississippi and flows into Alabama, becoming a tributary to the Mobile River. The Escatawpa River originates in southwest Alabama and becomes a tributary to the Pascagoula River, straddling the AL – MS state line before draining into the Mississippi Sound. The Tennessee River, the largest tributary to the Ohio River, is formed at the confluence of the Holston and French Broad Rivers in northeast Tennessee. It flows through Alabama forming a small section of the AL – MS border before flowing back into Tennessee via Kentucky, then discharging into the Ohio River. Additionally, the Catawba River originates in North Carolina, eventually forming approximately 10 miles of the NC – SC border before becoming a tributary to the Wateree River of SC. The Savannah River flows along the GA – SC border before draining into the Atlantic Ocean.

Water supply and power generation are important aspects of the Region's watershed capabilities. The Region's rapid population growth and development has greatly increased water demand and drought vulnerability. Yet, drought is a normal component of the Region's climate system. U.S. EPA Region 4, state, local and tribal governments, and numerous partners face challenges in managing drought conditions in light of the Region's growing population and the anticipated climate change impacts.

Within Region 4, the Tennessee Valley Authority (TVA) and the U.S. Army Corps of Engineers (U.S. ACOE) operate several dams on significant waterways. According to U.S. ACOE's National Inventory of Dams,[35] the federal government operates 404 dams within Region 4. The TVA operates 47 dams for hydropower within a region primarily encompassing Alabama, Georgia, Kentucky, North Carolina, and Tennessee (see Figure 3 below). The red boxes identify 45 of the 47 hydro-power dams. The yellow boxes identify coal-power plants. The purple boxes identify nuclear-power plants.

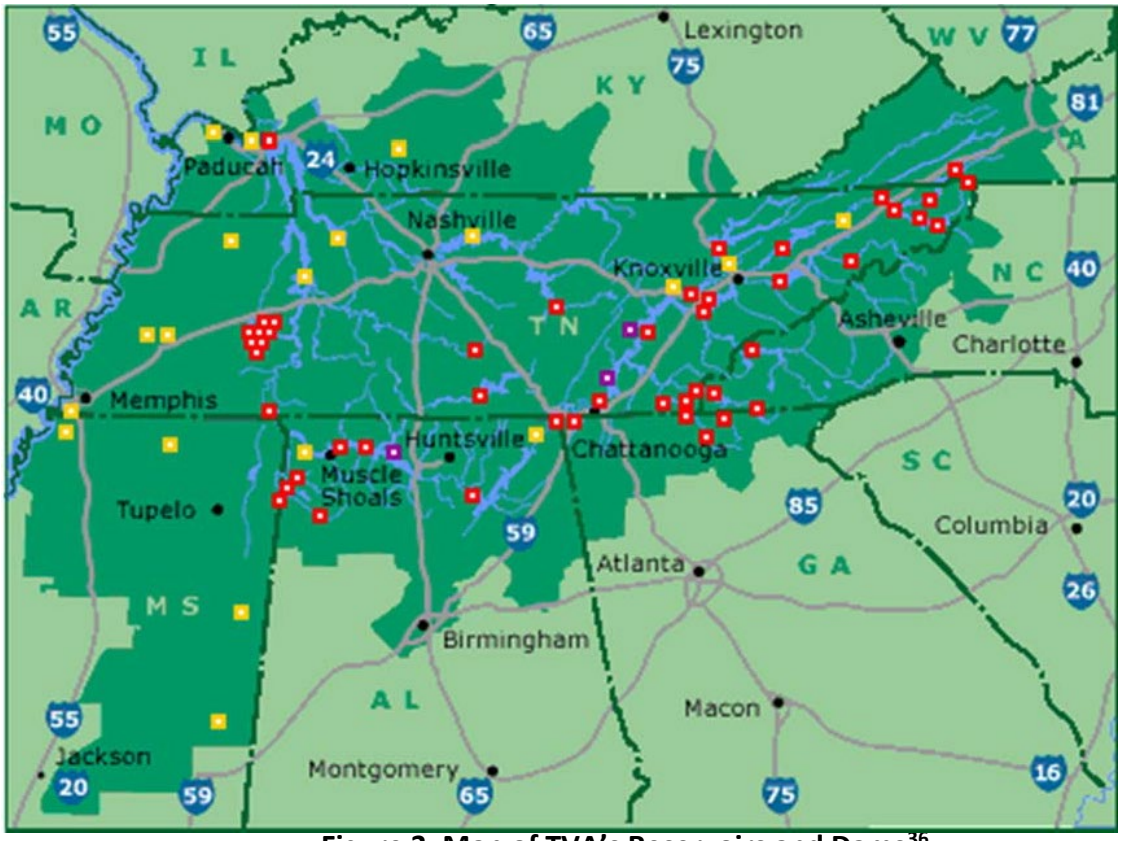


Figure 3. Map of TVA's Reservoirs and Dams[36]

The Apalachicola-Chattahoochee-Flint River (ACF) Basin (see Figure 4) is an important part of the socio-economic structure of Georgia, Alabama, and Florida's urban population, agriculture, power generation, and recreation economy, as well as North Florida's commercial fishery. This Basin overlies 19,800 square miles of southwestern Georgia and southeastern Alabama. The centerpiece of the Basin is the Chattahoochee River. Its headwaters are in northeast Georgia in the Blue Ridge Mountains, flowing southwest to Columbus, Georgia, and then south along much of the AL – GA border. After crossing into Florida, the Chattahoochee River confluences with another Georgia river, the Flint River. This confluence creates the Apalachicola River, which discharges into the Gulf of Mexico at the Apalachicola Bay.

Despite human alterations to most of the ACF Basin, it still supports a rich and abundant diversity of plants and animals. The Chattahoochee's headwaters (the Blue Ridge ecoregion) are the only cold-water fishery habitat. The Apalachicola Bay lies within the Southern Coastal Plain ecoregion while the rest of the Basin is within the Southeastern Plains ecoregion. These ecoregions represent areas where unique and localized natural processes have facilitated the Basin's noteworthy aquatic biodiversity: amphibians, fish, reptiles, and invertebrate fauna (crayfish, insects, mussels, worms).[37] Ninety-nine species of breeding birds, including migratory waterfowl and 52 species of mammals depend upon its water resources.[38]

Figure 4.[39] The Apalachicola, Chattahoochee, and Flint (ACF) Basin in Georgia

The Basin has the largest fish-species diversity of all the river basins draining into the Gulf of Mexico east of the Mississippi River.[40] Seven fish species are endemic, meaning they only live in the Basin. Sixteen fish species have been listed for protection by federal or state agencies. And the Apalachicola River Basin has the largest freshwater fish assemblage in Florida.[41]

Living in the Basin are 16 species of freshwater aquatic turtles, 21 species of salamanders, 26 species of frogs, and the American alligator. All require freshwater to complete or sustain their lifecycles.[42] Numerous snake and lizard species inhabit streams and wetlands. Fifteen species of amphibians and reptiles are noteworthy because of their rarity or protected status: two are designated as threatened and five are designated Endangered Species Act candidate species.[43] The Apalachicola River Basin's upper reaches have the highest amphibian and reptile species

density on the continent north of Mexico. Of the 116 plant species found in this area, 17 are listed as endangered, 28 threatened, and 30 are rare, with 9 plant endemic species.[44]

The source of the Apalachicola River's flow is primarily the Chattahoochee and Flint Rivers (80%), the Chipola River (11%) and the remaining from groundwater and overland flows. Because of rainfall distribution patterns, the Chattahoochee River's average annual runoff exceeds the Flint and makes a greater contribution to the Apalachicola River's peak flows. During droughts, because the Flint River's base flow is sustained by ground water, it contributes the greatest to flow into the Apalachicola River.[45] However, agriculture is the primary land use within the Flint, which depends heavily upon groundwater. Agricultural irrigation can and has depleted the lower Flint River's base flow. Drought combined with high irrigation demand, e.g., high crop prices, can cause the Flint River's component of the Apalachicola River's flow to be nonexistent.

Apalachicola Bay produced 90% of Florida's and 13% of the Nation's oyster harvest before closing harvesting in 2020 to support the recovery of the ecosystem from recent disasters. It is a nursery for shrimp, blue crab, and a variety of fish species. The largest National Estuarine Research Reserve is located in the Bay. The State of Florida has declared both the Apalachicola River and Bay to be an Outstanding Florida Water. The United Nations has designated the Bay as an International Biosphere Reserve.[46]

The Alabama, Coosa, and Tallapoosa (ACT) Basin has 16 reservoirs of significance. Its series of dams are operated by the U.S. ACOE and the Alabama Power Company primarily to meet navigation and hydropower production. Lake Martin, managed by the Alabama Power company, is the largest reservoir with 60.6% of the conservation storage. Lake Allatoona, managed by the U.S. ACOE, is the large reservoir in the ACT basin, with a significant portion allocated to conservation storage.[47]

The ACT has been called a hotspot of aquatic biodiversity, but it has lost some of its diversity to development pressures. The Coosa River in Georgia historically included 36 native mussel species; today the U.S. Forest Service knows of only four. The Etowah River once included 43 mussel species, now there is a fraction of that known species. The Oostanaula River once included 43 mussel species, now only 12 are known. The Conasauga River once included 43 mussel species, now only six are known. The Coosawattee River once included 20 mussel species, today only 11 are known.[48] Changes in the Coosa Basin are just as dramatic. The extinction rate in freshwater snails in the Coosa Basin is second only to some of the rainforests in South America.[49] Since the early 1900's, more than 40 species of freshwater snails and several mussel species are now presumed extinct. Other species being affected by the ongoing drought that began in 2007 include striped bass fishery, a world-class spotted bass fishery, and recreational fisheries and commercial shrimp and oyster fisheries in Mobile Bay.[50] Since the ACT's 16 reservoirs and associated dams are operated primarily to meet navigation and hydropower production needs, the ACT Basin's aquatic ecosystems may not prove resilient to climate change.

4) Populations

Region 4's mild climate, extensive coasts, and large river basins attract people, for both residential and recreational purposes. Within its geographic borders, the Region is home to a population of 67,210,142.[51] The State of Florida's population, 21,534,187, is greater than the individual populations of four U.S. EPA regions (see Figure 5 below). U.S. EPA Region 4's population of children (below 18) and elderly (above 65) comprise approximately 21% and 17%, respectively, of the Region's total population.[52] The Region is also home to six federally recognized tribes, with a population of 33,500 enrolled members.

Seven states had growth from 2010 through 2020, with the overall regional population growing by 6.1 million people, or about 10%.[53] The population grew fastest in Florida (14.6%), South Carolina (10.7%), Georgia (10.6%) and North Carolina (9.5%). Most growth has been in urban and peri-urban areas. Population growth is expected to compound climate related impacts. For example, increasing urban and suburban competition for finite water resources likely will affect agriculture, aquatic ecosystems, energy production, fisheries, and natural ecosystems.[54]

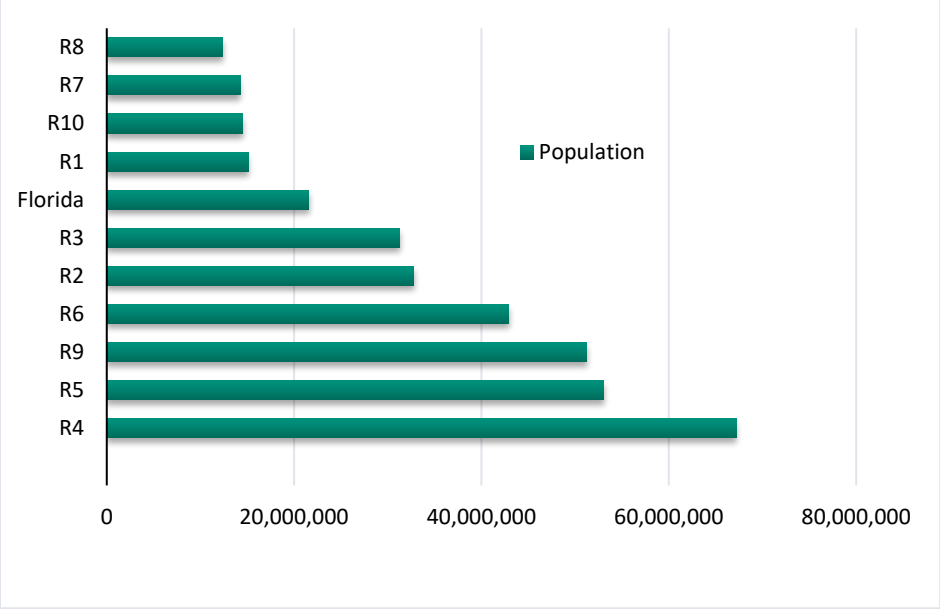


Figure 5.[55] U.S. EPA Region Population Comparisons

Florida, Georgia, and North Carolina are currently home to some of the largest elderly American populations in the United States.[56] All three are in the top 10 states projected to have the largest numbers of Americans aged 60 and older. Florida, with 9,737,256 elderly, is projected to be second only to the State of California, with a projected elderly population of 10,595,771 by 2030.

Most of U.S. EPA Region 4's population lies within the following ecoregions: Piedmont, Southern Coastal Plain, Southeastern Plains, Interior Plateau, and Southern Florida Coastal Plain. Within the Southern Florida Coastal Plain (the Everglades), urban areas are extensive

along the Atlantic Coast and include Miami, Fort Lauderdale, West Palm Beach, and other adjacent coastal cities.[57]

The Southeast Climate Region (defined below in section 3A, Observed and Projected Climate Change) includes 28 of the top 100 metropolitan statistical areas by population, and is the second most urbanized region after the Northeast, having 131 persons-per-square miles.[58] Miami, Atlanta, Tampa, Orlando, Charlotte, Nashville, Raleigh, Jacksonville, Memphis, Louisville, and Birmingham all rank in the top 50 U.S. metropolitan areas.[59] The Region is consistently home to the nation's fastest growing areas: the 2010 Census ranked the Florida areas of Palm Coast and Cape Coral-Fort Meyers, and Myrtle Beach in South Carolina within the top 10;[60] July 2020-2021 data puts Ft. Meyers, North Point, Port St. Lucie, in Florida and Spring Hill in Tennessee within the top 15.[61] Many of these areas are along the coast and vulnerable to sea level rise and storm surge.[62] Since 1980, the Southeast has had more billion-dollar weather disasters (hurricanes, floods, and tornadoes) than any other region.[63] The map in Figure 6 summarizes the cost of weather and climate disasters damages.[64]

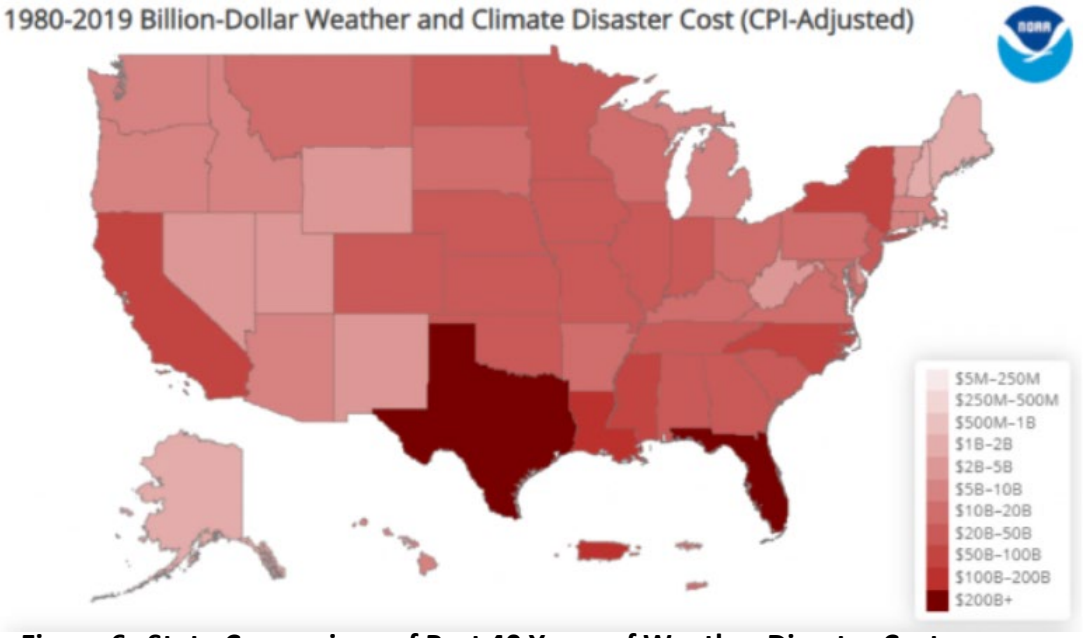


Figure 6. State Comparison of Past 40 Years of Weather Disaster Costs

3 REGIONAL VULNERABILITIES

A. Observed and Projected Climate Change

This section summarizes climate change impacts anticipated for U.S. EPA Region 4. The climate change literature defines the Southeast Climate Region differently than U.S. EPA defines its southeastern region. The Southeast Climate Region is defined to include all U.S. EPA Region 4 states plus two states in Region 6 (Arkansas and Louisiana), and one state in Region 3 (Virginia). These differences are illustrated in Figures 7 and 8, below.

Figure 7. Map of U.S. EPA Region 4

Figure 8. Map of the SE Climate Region

The Southeast Climate Region is exceptionally vulnerable to sea level rise, extreme heat events, and decreased water availability. Within this Region, the spatial distribution of these impacts and vulnerabilities is uneven, since it encompasses a wide range of ecoregions, from the Appalachian Mountains to the coast.[65] The high variability of the Region's climate makes it difficult to assess the impacts of variability from climate change.

The Southeast Climate Region is home to more than 80 million people, drawing hundreds of million visitors every year.[66] Located in low-lying coastal areas particularly vulnerable to flooding, extreme storms, and sea level rise, this Region has a disproportionate number of the country's fastest growing metropolitan areas and important economic sectors.[67] Palm Coast, FL, Cape Coral-Fort Meyers, FL, and Myrtle Beach, SC, are all vulnerable to sea level rise and storm surge.[68]

Sea level rise and temperature and precipitation changes are expected to be the most severe and widespread anticipated impacts to the Region, which ultimately may affect water availability.[69] The vulnerable Gulf and Atlantic coasts are major producers of seafood and home to several ports.[70] The Southeast Climate Region is a major energy producer of coal, crude oil, and natural gas, and the highest energy user of any of the National Climate Assessment regions.[71] Changes in land use and land cover, more rapid in the Southeast than most other

areas of the country, often interact with and serve to amplify the effects of climate change on southeastern ecosystems.[72]

Due to the nature of the Southeast's hot and humid climate and the nature of the workplace, most of its population spends 92% of its time indoors, consistent with the national population. The anticipated climate change attributes of heavy rains, increased temperatures and high humidity cycles will likely facilitate this trend to continue whereupon the population will be exposed to poorer indoor air quality (from lower ventilation levels, carbon monoxide from emergency power generators); dampness, moisture, and flooding; infectious agents and pests (which may also increase pesticide use); thermal stress; and building ventilation,weatherization, and energy use.

Average annual temperature during the last century has cycled between warm and cool periods across the Southeast Climate Region[73]: a warm peak occurred during the 1930s and 40s; followed by a cool period in the 60s and 70s; followed by another warm period lasting from 1970 to the present.[74] Since 1970, warming has increased by an average of 2°F, with more warming occurring during summer months; additionally, the number of days above 95°F and nights above 75°F have increased, while the number of extremely cold days has decreased.[75]

Temperatures across the Southeast Climate Region are expected to increase during this century, fluctuating over time because of natural climate variability, both annually and decade-to-decade.[76] Major warming consequences include significant increases in the number of hot days exceeding 95°F (see Figure 9) and decreases in freezing events (see Figures 10 and 11).[77] Projections of the region for 2100 include increases of 10°F for interior states of the Region and a regional average increase ranging from 2°F to 6°F.[78]

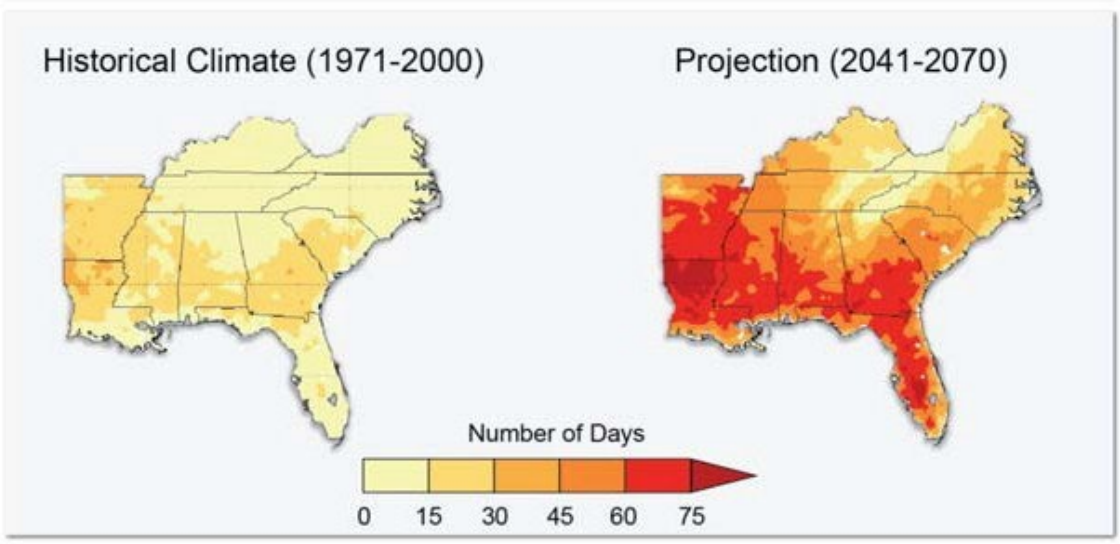


Figure 9. The Projected Number of Days Exceeding 95°F

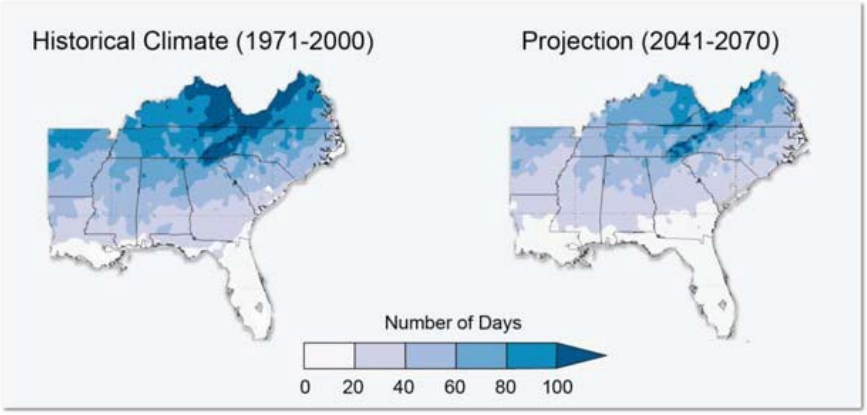


Figure 10.[79] Projected Change in Nights Below 32°F

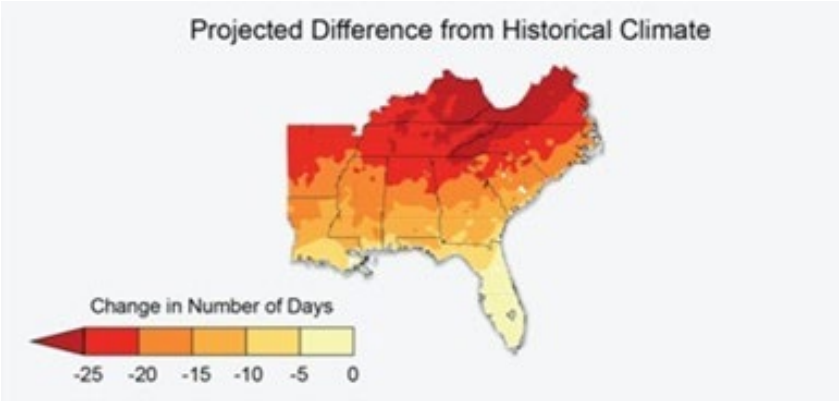


Figure 11.[80] Projected Annual Number of Days with Temperatures Less than 32°F

Within the Southeast, cities are experiencing an unprecedented change in global climate temperatures that consist of above average temperatures and below average precipitation, and is characterized by a few notable extremes, excess heat, and lack of water. In addition to climate change impacts, urbanization has had a dramatic effect in increasing higher temperatures, in a process commonly referred to as the Urban Heat Island effect (UHI). UHI increases the temperatures in urban territories and intensifies and prolongs the effects of heat waves, causing an increase in human discomfort, energy consumption during the summertime, and other adverse impacts.[81]

With respect to energy consumption, UHIs contribute to energy demands in the summer, which strains energy resources. The energy used in electric fans and air conditioning ends up contributing to an even hotter UHI. In addition, UHIs are often subject to "rolling blackouts," or power outages because, when utility companies do not have enough energy to meet their

customers' demands, they start rolling blackouts. Vulnerable populations and low-income communities are disproportionately affected by UHIs.

Urban heat islands can have worse air and water quality than their rural neighbors. UHIs often have poor air quality because there are more pollutants (waste products from vehicles, industry, and people) being pumped into the air. Further, the buildings, roads, sidewalks, and parking lots within the urban landscape block these pollutants from scattering and becoming less toxic. Water quality also suffers: when warm water from the UHI ends up flowing into local streams, it stresses the native species that have adapted to life in a cooler aquatic environment.

Furthermore, before the coronavirus pandemic wreaked havoc on the U.S. economy starting in early 2020, the national poverty rate was 12.3%, according to 2019 American Community Survey data from the U.S. Census Bureau. More than half of all states had poverty rates below the national average. Among the 21 states that had rates higher than 12.3%, most were concentrated in the South. Mississippi ranks number one in the country and Alabama, Kentucky, Tennessee, and South Carolina are all in the top 10 for poverty rates. These high poverty rates impact the ability to pay high utility bills or to install energy efficient cooling systems.

Summer heat stress is projected to reduce crop productivity, especially when coupled with increased drought. As temperatures rise because of climate change, the evaporation rates of water from soil are expected to rise which will create drier soils and increase the intensity of naturally occurring droughts. This, along with other effects of climate change such as changing precipitation patterns and extreme weather events, will affect crop yield and those working in agriculture. The Southeast accounts for nearly 20% of the farmworkers in the U.S. and contributes almost $47 billion to the nation's agricultural output annually.[82] The 2007 drought cost the Georgia agriculture industry $339 million in crop losses, and the 2002 drought cost North Carolina $398 million.[83] Additionally, as the intensity of precipitation events is increasing as a result of climate change, it is important to note that these more intense rainfalls are likely to increase soil erosion even in areas where the overall amount of precipitation may remain constant.[84] The flooding associated with these precipitation events also presents a risk as floods were responsible for 19% of total crop and livestock production loss in the United States between 2008 to 2018.[85] Research indicates that for each 1˚C increase in the average growing season temperature, corn yields are expected to decline by 8.3% and wheat yields have the potential to decline by nearly 21%.[86] Further, in the Southeastern U.S., projected midcentury warming of 0.8˚C would decrease soybean yields by approximately 2.4%.[87]

In U.S. EPA Region 4, warmer water temperatures associated with climate change are expected to drive aquatic species, including cold-water taxa, to cooler waters, either north or to higher elevations. [88] Local extinctions are expected where migration barriers exist (e.g., dams, reservoirs, logging, mountain-top mining, etc.) and a lack of higher elevations. While the cold-water taxa either migrate to cooler water conditions or are subject to local extinctions, species that thrive in or are tolerant to warmer temperatures will likely increase their populations at their current location and extend their range into formerly colder-water habitat.[89] These

impacts exacerbate preexisting stressors.

Within U.S. EPA Region 4, the Piedmont (the transitional area) and Mountain (cold-water habitat) ecoregions are expected to see the greatest climate change impacts to its aquatic ecosystems.[90] However, at this time, it is uncertain where the greatest climate change-induced impacts to aquatic organisms and their ecosystems within the Region may occur. In the transitional areas, aquatic species may already be close to their temperature tolerance limits, while other species may be more sensitive to the expected warming of cold-water habitats. Predictions are further confounded by the probability that temperature change likely will not occur evenly across the Region. The Region finds it difficult to predict how warm- and cold-water taxa will respond to changing water temperatures since other environmental factors, e.g., land use changes, also strongly influence species' population densities and geographic distributions.

As discussed above, biological integrity is strongly correlated with stream flow.[91] In addition to existing stressors on flow to the U.S. EPA Region 4's aquatic ecosystems, expected climate change-related impacts to flow include longer durations of low summer stream flows, average stream flow decreases, higher flooding incidences, and increased periods of extremely high and low flows (greater flashiness), with resultant scouring. Scouring and sedimentation already negatively impact habitat and biota in Piedmont streams, and more frequent severe precipitation events may exacerbate those impacts. Overall, climate change-induced flow changes are expected to cause significant changes to the Region's aquatic communities.[92]

At a reduced flow of 20 to 90%, the Region could lose 3 to 38% of its fish species.[93] The North Carolina Department of Environment and Natural Resources (NCDENR) researched invertebrate responses to the 1999 to 2002 drought experienced by both North and South Carolina. The study found a decline in invertebrate communities. NCDENR found stream flow, drainage area, underlying geology, and the tributary stream type and size appeared to influence invertebrate species' degree of impact and resiliency, i.e., speed of recovery to drought.[94]

B. Vulnerable Communities

Certain parts of the population can be especially vulnerable to the impacts of climate change, such as children, the elderly, minorities and the poor, persons with underlying medical conditions and disabilities, those with limited access to information, and tribal and indigenous populations. Also, certain geographic locations and communities are particularly vulnerable, such as those located in low-lying coastal areas. One of U.S. EPA's guiding principles in integrating climate adaptation across its work is for adaptation plans to prioritize helping people, places, and infrastructure that are most vulnerable to climate impacts, and to be designed and implemented with meaningful involvement from all parts of society.

This Implementation Plan identifies key vulnerabilities and the priority actions that will be taken by our Programs to address those vulnerabilities over time. As the work called for in this Plan is conducted, the communities and demographic groups most vulnerable to the impacts of

climate change will be identified. The Agency will then work in partnership with these communities to increase their adaptive capacity and resilience to climate change impacts. These efforts will be informed by experiences with previous extreme weather events (*e.g.,* Hurricane Katrina and Superstorm Sandy) and the subsequent recovery efforts.

1) Children

Children are likely to suffer disproportionally from both the direct and indirect adverse health effects of climate change.[95] Children are more vulnerable to environmental health risks because of their developing systems, immature body organs, and weaker immune systems. Young children breathe more rapidly and inhale more air relative to their body weight than adults. Their metabolic rate is faster, and they proportionately consume more fluids and food than adults. Their kidneys excrete toxicants and wastes at a slower pace as compared to adults. Children are less able to protect themselves and their behavior, such as crawling on the ground and putting hands and foreign objects into their mouths, exposes them to different environmental hazards.

The Region's Children's Environmental Health (CEH) Program goals are aligned with U.S. EPA's strategic goals of improving air and water quality, cleaning up communities, ensuring the safety of chemicals and preventing pollution. With the support of the Region's Program Offices and partnership with other organizations, the CEH program has conducted education, outreach, and supported interventions at schools, daycare centers, and in communities throughout the Region. The program has also provided support to address children's health hazards associated with environmental disasters or in higher risk communities.

The climate change impacts of rising temperatures may detrimentally impact air quality in U.S. EPA Region 4 by increasing ground-level or "bad" ozone formation, formed by nitrogen oxides chemically reacting with volatile organic compounds in the presence of sunlight.[96] Ground-level ozone is a major ingredient of smog and may lead to detrimental effects to children's health, particularly asthmatics. When children spend time outdoors during high-level ozone days, they may become more vulnerable to ozone health effects, which include wheezing and coughing, inflammation of airways, lung function impairment,[97] and infections in the lower respiratory tract.[98]

Changes in long-term weather patterns may result in more wildfires and drier soils, and increased emissions of smoke and dust-related particulate matter. When inhaled, fine particles associated with wildfire smoke and dry-soil dust can cause serious respiratory health problems, such as coughing and breathing difficulty, lung-function impairment, asthma attacks, and chronic bronchitis.[99] Rates of preterm births, low birth weight, and infant mortality have been found to increase in those communities with high particulate pollution exposure. [100]

African American children ages 0 to 17 have the most disproportionately high risk, relative to their reference population, of living in areas with the highest projected increases in asthma diagnoses due to climate-driven changes in $PM_{2.5}$. Specifically, with 4°C of global warming,

African American children are 41% more likely than non-African American children to currently reside in areas with the highest projected impacts of increased asthma diagnoses.[101]

In the U.S., children spend an estimated 90% of their time indoors.[102] The anticipated climate change attributes of heavy rains, increasing temperatures, and high-humidity cycles will exacerbate this trend. Consequently, children will likely have increased exposure with identified indoor air agents of concern: heat, biological materials (such as pollen, molds and infectious agents), and air pollutants.[103]

The expected changes in temperatures and rainfall in U.S. EPA Region 4's climate is also likely to facilitate the growth, survival, and transmission of vector-borne infectious diseases. Vector-borne is a term used to describe disease transmission by insects, animals, birds, and other living organisms. Emergence of new infectious diseases – and changes in the evolution and geographic ranges of pests, infectious agents, and disease vectors – may lead to shifting patterns of indoor pesticide use and creation of new pesticides. The Region anticipates children may be detrimentally affected by anticipated changes in indoor and outdoor pesticide use.

Warmer seas could contribute to the increased intensity, duration, and extent of harmful algal blooms (HAB). Harmful algal blooms also occur in freshwaters, and as these waters warm it is expected algal blooms will increase in frequency and intensity. Children are especially vulnerable when they swim in surface waters and eat contaminated shellfish because their immune systems are developing, and they consume more food and drink more water per pound of body weight than adults.

Lack of safe drinking water may cause gastrointestinal diseases that may be fatal for some children ordetrimentally impact other children's health.[104] The climate change aspects of extreme and severe weather may result in the breakdown of sanitation and sewer systems, resulting in exposure to unsafe flood and storm water exposure and unsafe drinking water, which increases the potential for children's exposure to disease-causing organisms such as gastroenteritis and infectious diarrhea.

In addition, the Atlantic and Gulf coasts are vulnerable to storms and hurricanes. Six of the eight states that have experienced the highest number of hurricanes are in U.S. EPA Region 4.[105] Vulnerable populations, such as children, the elderly, and pregnant women could experience both direct and indirect consequences of floods. Direct exposures result in risks for drowning, injuries from debris, chemical contamination, and hypothermia. There are also risks associated with the damage done by the water to the natural and built environments which include infectious diseases, carbon monoxide poisoning, respiratory problems, malnutrition, physical and mental trauma, poverty related diseases, and diseases associated with displaced populations.

While the CEH program focuses on reducing environmental health threats to our most vulnerable populations, adequate resources and regulatory authority may present impediments to address the multitude of potential environmental health issues that may result from the

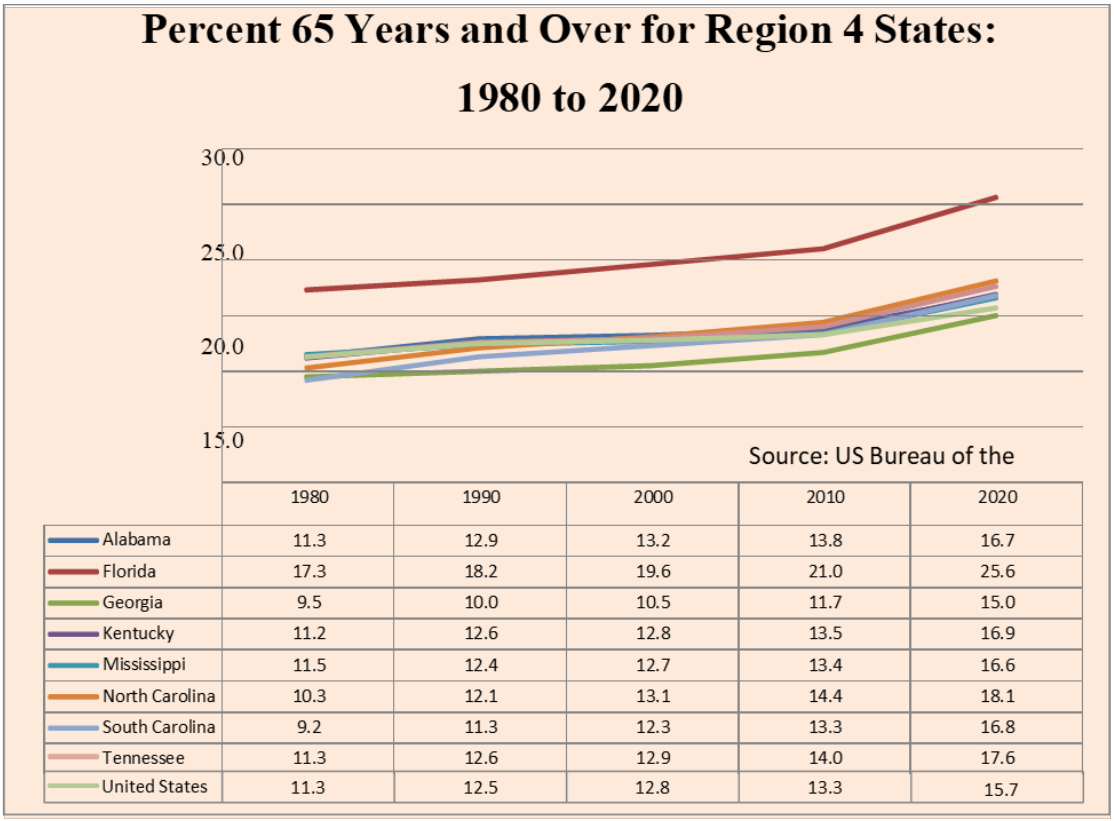
impacts of climate change. U.S. EPA Region 4's CEH Program has some tools and resources to conduct or promote limited educational, outreach and intervention activities addressing CEH issues associated with climate change. The CEH program will have to develop additional tools and resources to address the unique concerns facing the most vulnerable groups in the most vulnerable communities.

2) Elderly

Another vulnerable population includes the elderly. Elderly is usually defined as those adults who are 65 years of age or older. Approximately 17% of the population within U.S. EPA Region 4 is elderly according to the 2020 U.S. Census, with Florida having the largest number of elderly. The projections for 2020 show an increasing trend in population growth for every state. The elderly are very vulnerable and susceptible to the effects of climate change that cause extreme weather conditions such as floods, storm surges, high winds, heat waves and hurricanes.

In general, the elderly are very vulnerable during these extreme weather conditions due to various physiological, psychological, and socioeconomic factors. With 2°C of global warming, climate-driven changes in $PM_{2.5}$ are projected to result in an annual increase of 2,100 premature deaths nationwide among those 65 and older. With 4°C, this estimate increases to 5,800 annual deaths. The Southeast is projected to experience the highest increases in premature deaths due to climate-driven changes in $PM_{2.5}$.[106]

Table 2. Percent 65 Years and Over for U.S. EPA Region 4 from 1980 to 2022



	1980	1990	2000	2010	2020
Alabama	11.3	12.9	13.2	13.8	16.7
Florida	17.3	18.2	19.6	21.0	25.6
Georgia	9.5	10.0	10.5	11.7	15.0
Kentucky	11.2	12.6	12.8	13.5	16.9
Mississippi	11.5	12.4	12.7	13.4	16.6
North Carolina	10.3	12.1	13.1	14.4	18.1
South Carolina	9.2	11.3	12.3	13.3	16.8
Tennessee	11.3	12.6	12.9	14.0	17.6
United States	11.3	12.5	12.8	13.3	15.7

Physiologically, the elderly have a higher prevalence of certain chronic diseases, medical conditions, and functional limitations that may be exacerbated by climate change. Increasing ground-level ozone associated with climate change can lead to respiratory problems, such as asthma, heart disease, chronic obstructive pulmonary diseases (COPD), and premature mortality. In addition, older adults may experience increased number of emergency room visits and hospital admissions. Extreme heat can induce heat-related mortality, heat exhaustion, heat strokes, dehydration, acute renal failure, and cardiopulmonary diseases.

The elderly are also affected by functional limitations and mobility impairments that are present due to decline in muscle strength, coordination, and cognitive functions occurring from illness, chronic diseases, or injuries. The elderly are very sensitive to any extreme changes and environmental exposures resulting in decreased adaptive capacity to physically and mentally adapt to these changes. Socioeconomically, older adults living in poverty are deeply affected by an inability to pay for air conditioning or well-constructed housing which would help them handle the extreme heat waves and hotter days. Many elderly people also have difficulties with accessing adequate transportation and other social services when needed during times of crises. Finally, lack of insurance and limited personal finances may lead to an inability of the elderly to cope with climate impacts.

3) Environmental Justice

U.S. EPA defines environmental justice as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies."[107] Empirical studies have shown that certain communities tend to suffer a disproportionate impact of environmental harms. Race and income are two of the most important determinants of a community with environmental justice concerns. Communities with environmental justice concerns are also frequently impacted by multiple stressors (e.g., industrial pollution, highways, crime, limited access to quality health care, living in a flood prone area, food desert).

Climate change poses special environmental justice challenges for communities that are already overburdened with pollution and environmentally related illnesses. One challenge is a population's ability to prepare, respond, and recover when disasters occur. Hurricane Katrina helps illustrate the issue of environmental justice in the Southeast. When Hurricane Katrina struck Louisiana, Mississippi, and Alabama, it impacted the three poorest states in the country, two of which are in U.S. EPA Region 4.[108] People most disproportionally impacted by the flooding and destruction of Hurricane Katrina were disadvantaged, mainly African American communities.[109] Tables 3 and 4 below present racial and poverty status demographics across U.S. EPA Region 4 states.

Table 3.[110] Population Demographics for U.S. EPA Region 4, Based on Census Estimates for 2021

Total Population	61,082,315
% White	71.85%
% Black	22.20%
% Asian	2.86%
% American Indian	0.68%
% Native Hawaiian and Other Pacific Islander	.10%
% Multiracial	2.28%
% Hispanic or Latino (of any race)	13.73%

Table 4.[111] Poverty Trends in U.S. EPA Region 4 States, based on the U.S. Census Bureau, American Community Survey Estimates for 2020.

U.S. EPA Region 4			
Population	67,210,142 (total population, estimate for 2020)		
	Total Poverty Status Determined in Region 4	**Below Poverty Level in U.S. EPA Region 4**	**Percent below Poverty Level in U.S. EPA Region 4**
Population	64,661,545	9,383,109	14.5%
Under 18 years	14,196,913	3,094,361	21.8%
18-64 years	39,170,630	5,315,478	13.6%
65 years and over	11,294,002	1,152,555	10.2%
White (alone) not Hispanic or Latino	39,236,277	4,204,842	10.7%
Hispanic or Latino	8,468,503	1,608,638	19.0%
Black or African American (alone)	13,657,246	3,095,300	22.7%
American Indian and Alaska Native (alone)	282,975	63,370	22.4%
Asian (alone)	1,674,832	188,204	11.2%
Native Hawaiian and Other Pacific Islander (alone)	39,741	7,766	19.5%
Other Race (alone)	1,671,178	378,051	22.6%
Two or More Races	2,626,936	439,715	16.7%

Considering the individual states in U.S. EPA Region 4, the poverty status is the highest in the state of Mississippi for children, elderly people, and minorities.[112] Poverty status for these same categories, on average across the Region, is high in the states of Alabama, Kentucky, South Carolina, and Tennessee.[113] Florida, Georgia, and Mississippi have the highest percent minority of all states in U.S. EPA Region 4.[114] Florida also has the highest percent Hispanic or Latino of any race.[115]

In addition to being part of the traditional "poverty belt," U.S. EPA Region 4 has 46% of U.S.

counties with populations living in persistent poverty. Twenty-one percent of children (on average) also are living in persistent poverty across the region (see Figure 12).

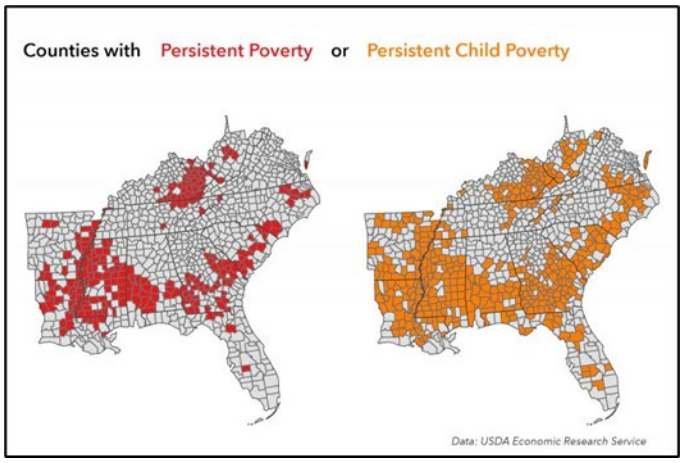


Figure 12.[116] Persistent Poverty in the Southeast (released May 2015)

Communities with environmental justice concerns are frequently presented with multiple environmental stressors, including emissions from local industry and historical contamination from past activities. According to the American Lung Association, African Americans are twice as likely to die from asthma attacks and Puerto Ricans have the highest asthma prevalence.[117] Moreover, African-American, Hispanic, and Asian-Pacific Islander women who were pregnant were more likely than pregnant White women to live in areas with higher levels of air pollution.[118]

Climate change will have an adverse effect on human health, especially within communities with environmental justice concerns. Some of the human health consequences of climate change include increased asthma, respiratory allergies, airway diseases, cancer, cardiovascular disease and stroke, food borne diseases and nutrition, heat and weather-related morbidity and mortality, and waterborne diseases.[119]

4) Tribal

The United States has a unique legal relationship with Tribal governments based on the Constitution, treaties, statutes, Executive Orders, and court decisions. This relationship includes recognition of the right of Tribes as sovereign governments to self-determination, and an acknowledgment of the federal government's trust responsibility to Tribes. U.S. EPA works with federally recognized Tribes on a government-to-government basis and, in keeping with the federal trust responsibility, consults with and carefully considers the interest of Tribes when making decisions and taking actions that may have Tribal impacts.[120]

Under the Constitution, treaties with tribal nations are part of the supreme law of the land, establishing unique sets of rights, benefits and conditions for the treaty-making tribes who were forced to cede millions of acres of their homelands to the United States, in return for

recognition of property rights in land and resources as well as federal protections. Tribal treaty rights have the same legal force and effect as federal statutes and they should be integrated into and given the fullest consideration throughout U.S. EPA's collective work. Reserved rights are the rights tribes retain that were not expressly granted to the United States by tribes in treaties. Treaty and reserved rights, including but not limited to the rights to hunt, fish and gather, may be found both on and off-reservation lands. Agencies should consider treaty and reserved rights in developing and implementing climate adaption plans in order to protect these rights and ensure the Agencies meet their legal and statutory obligations and other mission priorities as we work to combat the climate crisis.

In September 2021, U.S. EPA joined 16 other federal agencies in signing a Memorandum of Understanding that committed those parties to identifying and protecting tribal treaty rights early in the decision-making and regulatory processes.[121] Accordingly, U.S. EPA will consider and protect treaty and reserved rights in developing and implementing climate adaptation plans through strengthened consultation, additional staff training and annual reporting requirements.

Tribal communities are disproportionately vulnerable to climate change impacts, largely as a result of their close connection to the land, water, and natural resources. Tribes have limited relocation options due to reservation boundaries, and often depend upon their traditional homelands for natural resources to sustain economic, cultural, and spiritual practices. The accumulated knowledge and understanding of a Tribe's environmental connection with their homelands, or Traditional Ecological Knowledge (TEK), is intrinsically linked to Tribal cultural practices and threats to resources on which they depend.[122] A combination of qualitative data, gathered with TEK, and western science is needed to comprehensively understand and address Tribal climate change impacts. In U.S. EPA Region 4, shifting habitats of traditional food sources and medicinal plants have been observed based on TEK.

Economic impacts related to climate change are also anticipated for tribal communities. For example, the Eastern Band of Cherokee Indians manages a successful commercial trout fishery that attracts thousands of fishermen to the area year-round. North Carolina trout populations are predicted to experience significant reduction because of climate change; the estimated welfare loss is $5.63 to $53.18 per angler per single occasion.[123] A loss of this magnitude could drastically impact the viability of the Tribe's fishery program and overall economic well-being.

There are six federally recognized Tribes in U.S. EPA Region 4: Eastern Band of Cherokee Indians, Mississippi Band of Choctaw Indians, Catawba Indian Nation, Seminole Tribe of Florida, Miccosukee Tribe of Indians of Florida, and Poarch Band of Creek Indians. Each Tribe is geographically diverse with unique government structures, priorities, and challenges. U.S. EPA is committed to strengthening its partnership with Tribes on priorities related to climate change adaptation and to supporting the development of Tribal adaptive capacity.[124] The vulnerabilities listed below identify potential areas in which U.S. EPA Region 4's ability to be responsive to Tribal climate change adaptation priorities and adaptive capacity building needs may be impacted.

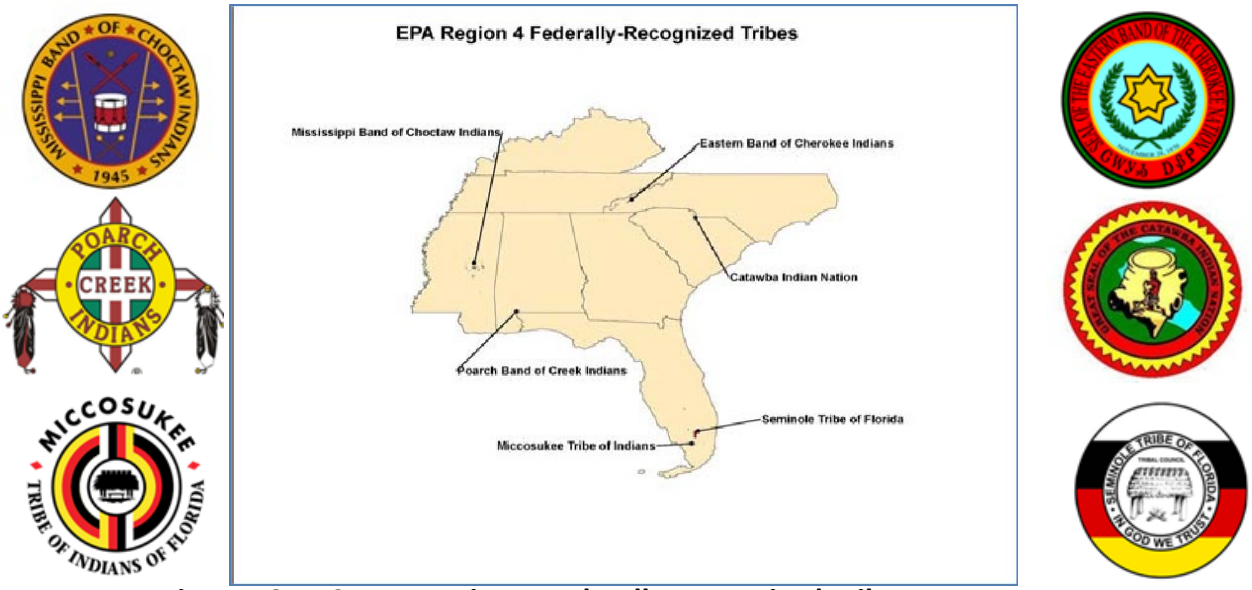


Figure 13: U.S. EPA Region 4 Federally Recognized Tribes

Tribal environmental programs are understaffed and underfunded. Anticipated U.S. EPA Region 4 resource vulnerabilities include:

- Lack of funding to assist Tribes in climate change adaptation planning and related activities, such as increased air quality monitoring due to the potential of more frequent wildfires.
- Increased demand for technical resources, such as access to climate change information, tools and professionals, as well as innovative approaches to assist in developing climate change adaptation plans or address climate change priorities due to limited staff availability at Tribal level.
- Increased demand for training and information dissemination regarding climate change adaptation and potential adverse effects of climate change.

Tribes are subject to geographical impacts and, as sovereign nations, have unique government structures, planning processes, and capabilities for adaptation and response. Generally, there are few resources available to U.S. EPA for ascertaining regional and individual Tribal climate change impacts, priorities, and readiness capabilities. Anticipated U.S. EPA Region 4 education

and outreach vulnerabilities include:

- General lack of staff education and awareness of climate change priorities and impacts unique to U.S. EPA Region 4 Tribes, including those related to Tribal boundaries and economic, cultural, and spiritual practices.
- Lack of knowledge of existing Tribal climate change readiness and adaptive capacity.
- General lack of staff education, awareness, and incorporation of TEK in Agency decision-making and planning, including traditional practices that may exclude climate change adaptation planning.

Climate change related priorities, responsibilities and activities vary by governmental agency. Tribes work with federal, state, and local governments, and are often required to be responsive to complementary or duplicative requests for consultation and information sharing. Anticipated U.S. EPA Region 4 communication and collaboration vulnerabilities include:

- Need for increased federal coordination and collaboration to share climate change adaptation efforts, as well as to inform, discuss and consult with Tribes on climate change actions, concerns, interests, and priorities. Federal coordination, collaboration and consultation have been requested by U.S. EPA Region 4 Tribes.
- Need for increased cross-program coordination and collaboration to inform, discuss, and consult with Tribes on U.S. EPA and U.S. EPA Region 4 specific climate change actions, decisions, and opportunities, such as adaptation planning process and anticipated climate change impacts to the Region.
- Jurisdictional challenges with adjacent local and state governments may impact collaboration opportunities and access to resources.

C. Extreme Weather

1) Heat Events

Rising temperatures and the associated increases in frequency, intensity, and duration of extreme heat events are expected to affect public health, natural and built environments, energy, agriculture, and forestry.[125] The negative effects of heat on human cardiovascular, cerebral, and respiratory systems have been established.[126] Within U.S. EPA Region 4, Atlanta, Miami, and Tampa have already seen increases in the number of days with temperatures exceeding 95°F, during which the number of deaths was above average.[127] The expected increase in the elderly population of the Region enhances the health risks of extreme heat events. By 2100, the Southeast Climate Region is expected to have the highest increase in heat index (the measure of comfort combining temperature and relative humidity) of any region of the country.[128]

Additionally, higher temperatures can contribute to the formation of harmful air pollutants and allergens, with associated health impacts.[129] Ground-level ozone is projected to increase in the Southeast Climate Region's largest urban areas, potentially leading to increased deaths.[130]

Hospital admissions for respiratory illnesses, emergency room visits for respiratory illnesses, emergency room visits for asthma, and lost school days may increase.[131]

2) Precipitation Events

The Southeast generally receives a lot of rain. Much of northern Kentucky, the central sections of the North and South Carolinas, and Georgia receive between 40 and 50 inches of precipitation annually.[132] The Gulf Coast regions of Mississippi, Alabama, and the Florida Panhandle receive over 60 inches of precipitation. [133] Higher amounts of precipitation are found along the Atlantic coast and across the Florida Peninsula due in part to the lifting of the air associated with sea breeze circulation.[134] Tropical cyclones also contribute significantly to annual precipitation totals in the Region, especially over the Southeast Atlantic coast.[135] However, contrary to these general trends, the Southeast Climate Region's wettest locations occur in southwestern North Carolina.[136] The Region's daily and five-day rainfall intensities have increased while summers have been either extremely wet or increasingly dry.[137] Only along the northern Gulf Coast has precipitation increased during the last 100 years.[138]

Across the Southeast Climate Region's northern tier, the average annual snowfall ranges from 5 to 25 inches, except at the higher elevations of the southern Appalachians in North Carolina and Tennessee.[139] These locations can receive up to 100 inches of snowfall annually, comparable to annual snowfall amounts experienced in New England.[140] The Region's southern extent experiences very little snowfall (i.e., less than 1 inch per year) and several years may elapse before any measurable snowfall occurs.[141]

Future precipitation pattern projections are more uncertain than temperature projections.[142] Under a high greenhouse-gas-emission scenario, projections for later this century in average annual precipitation range from nearly 10% reduction in the far southern and western portions of the Region – with most of that reduction in the summer – to about 5% increases in the northeastern part of the Region.[143] Average annual precipitation is projected to decrease by 2% to 4% over South Florida, while increases in precipitation of up to 6% are projected across North Carolina.[144] Precipitation is expected to increase across most of the Southeast Climate Region in all seasons except summer, where a decrease of 15% is noted for South Florida.[145]

Extreme precipitation event frequency has been increasing across the Region, particularly pronounced over the last two decades.[146] This increase is pronounced across the lower Mississippi River Valley and along the northern Gulf Coast.[147] Despite a long-term increase in extreme precipitation events, no discernible trend exists in flood magnitude for the Region.[148] An increased risk of flooding of the Region's urban areas is expected from increases in extreme precipitation events and the associated increased runoff, compounded by the magnitude of impervious surface that has resulted from increased urbanization.[149] The annual number of days with extreme precipitation is expected to increase across most of the Region by the mid-21st century, particularly along the southern Appalachians as well as parts of Tennessee and Kentucky.[150]

3) Tornado Events

Thunderstorms are frequent across the Southeast Climate Region, especially during the warmer months. Severe thunderstorms (storms characterized by winds in excess of 58 miles per hour, hail a minimum one inch in diameter, or a tornado) occur most frequently in the late winter and spring months. Within U.S. EPA Region 4, damaging winds and large hail occur most frequently across Alabama, Mississippi, and western Tennessee.[151] These states also experience the highest number of strong tornadoes (F2 and greater) and experience more killer tornadoes than the notorious "Tornado Alley" of the Great Plains.[152]

Cloud-to-ground lightning is a significant hazard during storms. The greatest lightning-strike frequency within the nation occurs across the Gulf Coast and the Florida Peninsula.[153] Additionally, eight of the eleven states comprising the Southeast Climate Region rank in the top 20 for lightning related fatalities from 1959 to 2006.[154] Cloud-to-ground lightning has started house fires and wildfires across the Southeast.

4) Wildfire Events

Existing evidence suggests that climate change may cause increasing frequency or intensity of wildfires. Wildland fires contribute an estimated 15% of total PM and 8% of carbon dioxide (CO_2) emissions over the southeastern U.S. and will therefore have an impact on air quality in the region.[155] An increase in wildfire activity would cause more frequent elevated PM events, which would be hazardous to human health.

A study conducted in 2017 by the federal Joint Fire Science Program (JFSP) that looked at the relationship between wildfires and PM emissions found that summertime $PM_{2.5}$ emissions will increase significantly as a result of increased fire activity.[156] The 2017 JFSP study found that there is an expected shift in the cause of deaths associated with $PM_{2.5}$ exposure, such that in 2050 and 2100, a higher percentage of these deaths will be attributed to smoke $PM_{2.5}$ rather than non-fire PM emissions. As illustrated in Figure 14, premature mortality (deaths) per year in the U.S. that are caused by $PM_{2.5}$ exposure resulting from fires in the continental U.S. and non-continental U.S. (i.e., Canada and Mexico) are expected to increase over the remainder of this decade, while non-fire sources (mostly anthropogenic emissions) are expected to decrease.[157]

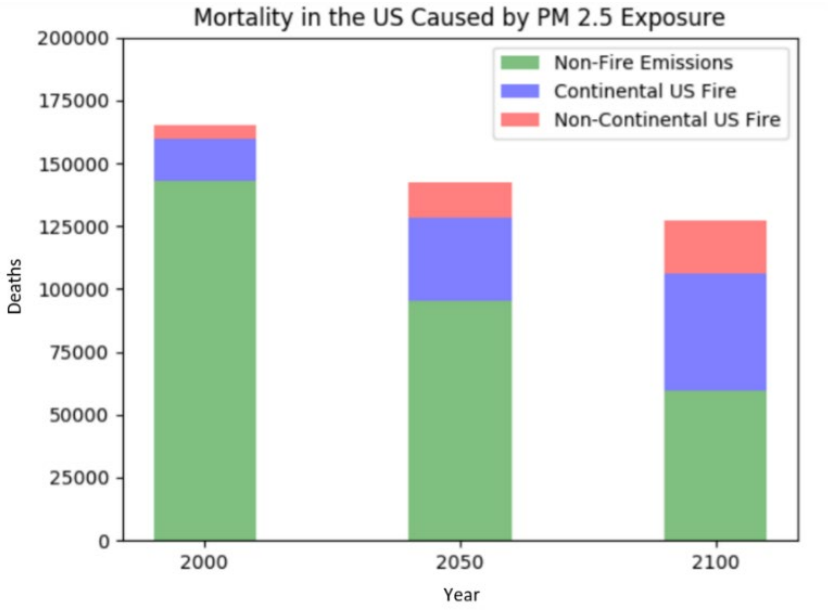


Figure 14:[158] Mortality from $PM_{2.5}$ Exposure

5) Hurricane Events

Climate change is expected to impact the intensity of tropical storms and hurricanes that impact the Southeast Climate Region, while the frequency of such storms has also increased since the 1980s.[159] Tropical storm and hurricane associated precipitation contribute significantly to the Southeast Climate Region's precipitation, surface and ground water levels, water supply, and soil moisture.[160] Heavy rainfall also periodically causes deadly inland flooding, especially when a storm is large or is stalled by a weather front.[161]

In the Southeastern Climate Region, tropical storms and hurricanes frequently make landfall along North Carolina's Outer Banks and south Florida; such storms rarely appear to land along the concave portions of the coastline, the western bend of Florida, and the Georgia coast.[162] Major hurricane (categories 3 to 5) landfalls have been most frequent in South Florida (once every 15 years) and along the northern Gulf Coast (once every 20 years).[163] While these storms primarily impact the coast, significant effects are experienced several hundred miles inland.[164] Storms with wind gusts exceeding 75 mph have occurred every five to 10 years across portions of the Region's coastal plain and every 50 to 75 years across portions of the Carolina Piedmont, central Alabama, and Mississippi.[165] Hurricane landfalls appear to have declined slightly over the past century from a decadal frequency perspective.[166]

Tropical storm and hurricanes may negatively impact species in U.S. EPA Region 4. For example, NCDENR has studied tropical and hurricane storm-related flooding impacts to invertebrate species and stream health. In 2004, North Carolina experienced five tropical Storms (Bonnie, Frances, Gaston, Ivan, and Jeanne) and two hurricanes (Alex and Charley) during a two-month period (August 3 – September 27). During its study, NCDENR documented a decline in biological

index scores associated with the invertebrate species' responses to the storm-related flooding.[167]

D. Sea Level Rise

The National Water Level Observation Network's 150-years database consistently depicts a rise in sea level. From this data, a 0 to 3 millimeter-per-year sea level rise rate has been estimated off the west Florida, Alabama, and Mississippi coasts.[168] Steadily rising sea level off of North Carolina's coast is indicated by two data sources, the historical tide-gauge records over the past century and geologic evidence over the past several centuries. The NC Coastal Resources Commission's Science Panel on coastal hazards recommended a projected sea level rise of one meter by 2100 be adopted for policy development and planning purposes.[169]

Large portions of the Region are highly vulnerable to sea level rise, although how much sea level rise is experienced in any particular place depends upon whether and how much the local land is sinking (i.e., subsidence) or rising, and offshore current changes.[170] Global sea level rise over the 20th century has averaged approximately eight inches. The rise rate is expected to accelerate through the end of this century.[171]

Figure 15 below depicts the relative risk, as determined by the Coastal Vulnerability Index, that physical changes will occur as sea level rises. The Coastal Vulnerability Index is based on tidal range, wave height, coastal slope, shoreline change, landform and processes, and historical rate of relative sea level rise. The index estimates a coastal system's susceptibility to change and its natural ability to adapt to changing environmental conditions to formulate an estimation of a system's natural sea level rise vulnerability or risk.[172]

Figure 15:[173] The SE Climate Region's Vulnerability to Sea level Rise

In the Southeast Climate Region, numerous cities, roads, railways, ports, airports, oil and gas facilities, and water supplies are in low elevation areas, making them vulnerable to sea level rise. The major cities of Miami and Tampa, Florida are among those most at risk.[174] The North Carolina Department of Transportation is raising U.S. Highway 64's roadbed by four feet; 18 inches of which is to address sea level rise projections.[175]

Sea level rise impacts upon agriculture may decrease freshwater availability and increase land loss and saltwater intrusion. Saltwater intrusion is projected to reduce the availability of groundwater for irrigation, thereby limiting crop production in some areas.[176] Agricultural areas around Miami-Dade County with shallow groundwater tables are at risk of enhanced inundation and associated cropland loss; an estimated 37,500 acres in Florida are projected to be lost to production with a 27-inch sea level rise.[177]

Additionally, higher sea levels are expected to accelerate saltwater intrusion into rivers, streams, and groundwater sources of freshwater in coastal areas. In areas with porous aquifers, groundwater is particularly vulnerable to saltwater intrusion. Saltwater intrusion impacts water quality for agriculture, drinking water, and industrial purposes. For example, in the City of Hallandale Beach, Florida, officials have already abandoned six of the city's eight drinking water wells due to saltwater intrusion.[178]

4 STRATEGIC PROGRAM VULNERABILITIES

The Agency's 2021 Climate Adaptation Action Plan defines "climate adaptation" as *taking action to prepare for and adjust to both the current and projected impacts of climate change*. U.S. EPA Region 4's various programs implement the Agency's strategic plan goals and statutory mandates in the southeastern eight states and the fourteen ecoregions described earlier. This chapter contains an assessment of the vulnerabilities of key U.S. EPA Region 4 Programs to the impacts of climate change.

A. Air Quality

Communities within the Southeast face public health and environmental challenges from ambient and indoor air pollution. Climate change will increase these challenges. U.S. EPA Region 4 partners with federal, state, tribal and local agencies to protect public health and the environment by directly implementing programs that address air quality (indoor and outdoor), toxic pollutants, climate change, energy efficiency, pollution prevention, industrial and mobile source pollution, radon, acid rain, stratospheric ozone depletion, and radiation protection.

Several program areas are vulnerable to future climate conditions, such as elevated baseline temperatures, increased frequency and duration of heat waves, more extreme swings in weather conditions (drought and precipitation events), more severe hurricanes and coastal storms. These future conditions will present challenges to U.S. EPA to achieve its core mission.

The Clean Air Act (CAA) requires U.S. EPA to establish National Ambient Air Quality Standards (NAAQS) for 6 criteria pollutants. U.S. EPA is required to review and consider revisions to these criteria pollutant standards every five years. When EPA establishes a new NAAQS, the Clean Air Act requires states to develop a general plan – a State Implementation Plan (SIP) – to attain and maintain the standards in all areas of the country and a specific SIP to attain the standards for each area designated nonattainment. In other words, the states must demonstrate how its areas will achieve and maintain compliance with standards.

Two criteria pollutants – ozone and particulate matter (PM) – are particularly at risk for future ambient level increases caused by a warming climate. Tropospheric (ground-level) ozone pollution is likely to increase due to meteorological conditions that would become more favorable to ozone formation, including in the southeastern U.S.[179] Ambient particulate matter levels would likely be affected in some areas by an increase in frequency or intensity of wildfires.[180] Particulate matter may increase in areas where storm debris is burned. Another area of vulnerability to climate change is indoor air quality.

1) Ozone

The current health-based ozone NAAQS is 0.070 parts per million (ppm) on an 8-hour average, established in 2015.[181] In December 2020, U.S. EPA retained the 0.070 ppm, but in 2021 U.S.

EPA announced that it will reconsider the December 2020 decision and may reassess whether to change the standard. Figure 16 shows the projected increases in ground level ozone pollution in 2050 as compared to 2001, using a mid-range emissions scenario (A1B, assuming some decrease from current emissions growth trends).[182]

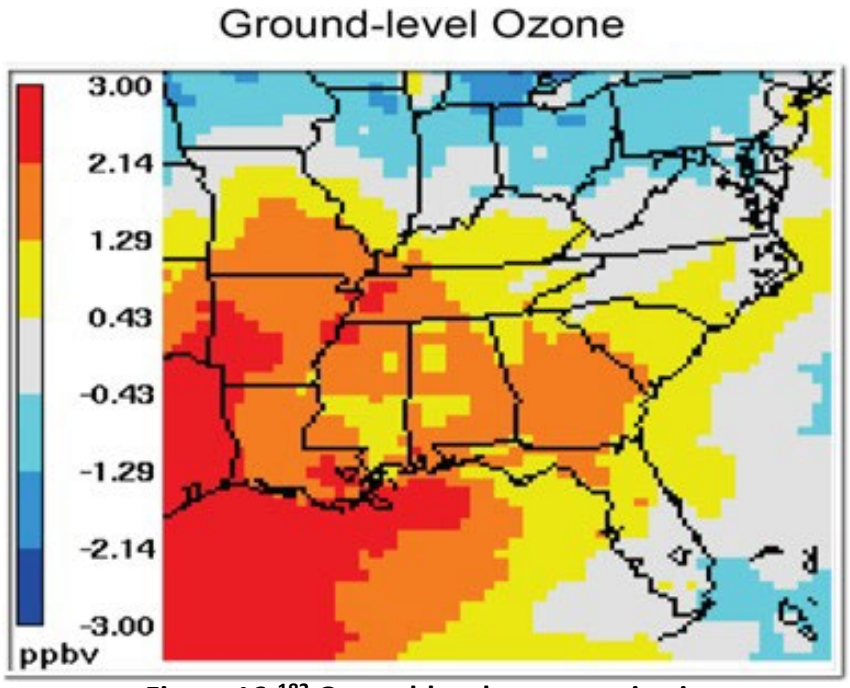


Figure 16:[183] Ground-level ozone projections

Impacts on ozone programs

- A warming climate could induce ambient ozone level increases, which may require more stringent pollution controls to attain and maintain the ozone NAAQS than would be necessary under the present-day climate.
- Higher air pollution, including from ozone, could be increased by a warming climate, reduced nighttime cooling, and a further increase in temperatures due to the urban heat island effect, which in turn can adversely affect human health.[184] Other human health impacts from higher temperatures include increased general discomfort, exhaustion, heat stroke, and heat-related mortality.
- While the link between ozone variability and increased temperatures is unclear, warmer and drier autumns are expected to result in a longer ozone season, increasing the period of ozone exposure.[185]
- As we transition to carbon-free energy sources, emissions of ozone precursors, such as nitrogen oxides (NOx), are expected to increase from fossil-fuel burning power plants due to increased demand that accompanies increased ambient temperatures.
- Complying with the ozone NAAQS may become more difficult for some U.S. EPA Region 4 states, especially those with areas already facing existing ozone problems. Figure 16 presents the results of a modeling study which predicts increases of

ground-level ozone concentrations across the Southeast up to approximately 3 parts per billion in some urban areas.

2) Particulate Matter (PM)

The current PM NAAQS comprise standards for fine particulate matter ($PM_{2.5}$) and coarse particulate matter (PM_{10}). The existing health based $PM_{2.5}$ NAAQS are a short-term (24-hour average) standard of 35 micrograms per cubic meter ($\mu g/m^3$) and a long-term (annual average) standard of 12 $\mu g/m^3$.[186] The health-based PM_{10} NAAQS is a short- term (24-hour average) standard of 150 $\mu g/m^3$.[187] U.S. EPA is currently considering a new standard for PM, which may cause certain areas in U.S. EPA Region 4 to be designated as nonattainment.

While the impact of climate change on ambient PM levels remains somewhat uncertain, existing evidence suggests that climate change may cause increasing frequency or intensity of wildfires.[188] As discussed in the Wildfire Events section, this increase of wildfires would result in more frequent elevated PM events and an increase in summertime $PM_{2.5}$ emissions, which are both hazardous to human health. This increase could potentially offset anticipated reductions in anthropogenic emissions of PM.[189]

In addition to wildfires, Region 4 is frequently impacted by large storms (including hurricanes, tropical storms, and tornadoes) that often leave a substantial amount of debris in the form of downed trees in their wake. Depending on the circumstances, the response to these storms often involves a significant amount of open burning of the debris, which may last for multiple months. As storm frequency or severity increases, PM resulting from debris cleanup may increase in impacted areas.

Impacts on PM program

- The potential for greater PM concentrations due to wildfires (and debris cleanup) may need to be considered when preparing SIPs to demonstrate attainment with the PM NAAQS. For example, increasing background $PM_{2.5}$ levels when modeling future $PM_{2.5}$ concentrations may need to be assumed.
- The 2017 JFSP Study modeled the change in visibility for the 20% worst and 20% best days as expected by 2050 and 2100 and found that when including wildfire smoke, visibility on these days could become worse. It was noted that agricultural burning is also a contributing factor to smoke issues in certain parts of the Southeastern U.S.
- More information is needed about the potential for increases in both short-term exposure and long-term exposure to PM due to an increase in wildfires and other fire events.
    - For a short-term exposure assessment, more data is needed on the human population in areas that are most likely to be in close proximity to wildfire activity.
    - To assess the vulnerability to long-term exposure, additional data is needed on how many wildfires per year can be expected, the expected total $PM_{2.5}$

emissions from those wildfires, and modeling to estimate the impact of those emissions on ambient $PM_{2.5}$ levels. This data gap has been identified as a research need by the federal land management agencies.[190]

B. Water Quality

U.S. EPA Region 4's waters are extensive and diverse, including the following waterbodies: the Gulf Coast; the Florida Keys; the South Atlantic Coast; and the Coastal Plain, the Southern Appalachian Mountains, the Tennessee River, the lower Ohio River, and the southeastern Mississippi River watersheds. The region includes a wealth of ecological and economic resources, such as rivers and streams, barrier islands, extensive estuaries, coral reefs, coastal and freshwater wetlands, busy shipping ports, major metropolitan cities, extensive agricultural production, and important commercial and recreational fishing resources. The Southeast has over 380,000 farms on more than 75 million acres, over 138 million acres of timberland, and is home to over one third (1,935 miles) of the lower 48-states' continental coastline, 33% of U.S. coterminous estuaries, and nearly 30% of all U.S. wetlands.[191,192,193,194,195] Pressures from the continuing population and business growth in the southeastern states on the coastal, Piedmont and mountain zones of this region are compounded by increased incidence of drought as well as increased flooding, sea level rise, intense tropical storms and heat-related stress on aquatic ecosystems and human health.

1) Watershed Management

U.S. EPA Region 4, working with its state, local and tribal partners, is responsible for managing regulatory and non-regulatory programs to protect and improve water quality in the Southeast's watersheds and estuarine, coastal and ocean waters. As better information is developed for local decision making, changes may be needed in how U.S. EPA Region 4 and its partners implement water quality programs, including Water Quality Standards, monitoring and assessment and listing, Total Maximum Daily Loads (TMDL), Effluent Guidelines, National Pollutant Discharge Elimination System (NPDES), nonpoint pollution control programs, stormwater management and other watershed management programs. Potential vulnerabilities to U.S. EPA Region 4 Watershed Management efforts include:

- Changing climactic patterns will alter ecosystem dynamics and exacerbate existing impacts in ways that may intensify pollutant concentrations and enhance pollution, resulting in the impairment of additional water bodies.
- Areas experiencing periods of less precipitation, drought, lower stream flow and limited ground water recharge may result in less water flow for dilution of permitted discharges, alterations of aquatic environments, and increased impairments from existing hydrologic alteration.
- Areas with increased intensity of drought, or those that may experience increases in events such as wildfires, may see alterations in the structure and function of watersheds, potentially affecting regional and state wetlands delineation and protection programs.

- Increased intensity of rainfall events and storms may cause an increase in stormwater runoff, as well as increases in the number of sewer overflows and wastewater bypasses, which may pollute streams and require increased action of both the Water Division and the Enforcement and Compliance Assurance Division.
- Increased flooding due to more frequent, intense storms will exacerbate existing impacts throughout watersheds, such as scouring of riverbeds, erosion, increased pollutant loads from runoff, and habitat alteration.

2) Water Quality Standards

Water Quality Standards are the foundation of the Clean Water Act – they designate the goals and uses for water bodies, set criteria to protect those uses, and establish provisions to protect water bodies. States, territories, and authorized tribes establish water quality standards, and U.S. EPA reviews and approves those standards. Potential vulnerabilities to the U.S. EPA Region 4 Water Quality Standards efforts include:

- Warmer waters and other ecological shifts will threaten aquatic habitats and aquatic species, such as cold-water fisheries.
- Exacerbation of already existing flow alterations, increased erosion and sedimentation, increased hypoxia will threaten aquatic habitats and aquatic species and impair uses
- Salinity changes due to sea level rise may cause some water bodies to convert from fresh to salt water, impairing use. Sea level rise may also result in a shifting from freshwater communities to saltwater communities, such as is happening in the Chassohowitzka River System in Florida.
- Increased anthropogenic use of freshwater upstream and hydrologic alteration may be a significant contributor in converting fresh to salt water.

3) Monitoring, Assessing, and Reporting

Our nation's waters are monitored by state, federal, and local agencies, universities, dischargers, and volunteers. Water quality data are used to characterize waters, identify trends over time, identify emerging problems, determine whether pollution control programs are working, help to direct pollution control efforts to where they are most needed, and respond to emergencies such as floods and spills. Potential vulnerabilities to U.S. EPA Region 4 monitoring, assessment and reporting efforts include:

- State and tribal resources, monitoring capabilities, and assessment efforts will become strained as new environmental problems emerge, extreme weather events increase, and the scientific complexity of issues expands. There will likely be a need for expanded regulatory guidance, enhanced technical assistance, and additional funding resources from U.S. EPA.
- States and tribes may need to consider updating assessment and listing methodologies to address climate change-impacted stressors, such as flow,

temperature, dissolved oxygen, nutrients.

- Stream ecosystems will be affected directly, indirectly, and through interactions with other stressors. Biological responses to these changes will vary regionally and could include altered community composition, interactions, and functions.
- Monitoring locations may need to be re-located to effectively monitor and assess changes in stream ecology or water quality.
- Timing of monitoring may need to change to address seasonal shifts and the full range of climate vulnerability, especially for recreational and aquatic life uses.

4) Total Maximum Daily Loads

Under Section 303(d) of the Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters. These are waters that are too polluted or otherwise degraded to meet the water quality standards set by states, territories, or authorized tribes. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop Total Maximum Daily Load ("TMDLs") for these waters. A TMDL is a calculation of the maximum amount of a pollutant a waterbody can receive and still safely meet water quality standards. Potential vulnerabilities to U.S. EPA Region 4 TMDL efforts include:

- Some areas may experience periods of less precipitation, drought, lower stream flow and limited ground water recharge resulting in less water flow for dilution of permitted discharges, alterations of aquatic environments, and increased impairments. These considerations will need to be considered in the development of new TMDLs and potentially result in the need for revision of existing TMDLs.
- Some areas may experience more frequent episodes of intense precipitation resulting in increased runoff of pollutants. These considerations will need to be taken into account in the development of new TMDLs, and potentially result in the need for revision of existing TMDLs.

5) National Pollutant Discharge Elimination System

Water pollution degrades surface waters making them unsafe for existing uses, including drinking water, fishing, swimming, and other water recreation. As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. NPDES permits have a five-year permitting cycle. Potential vulnerabilities to U.S. EPA Region 4 NPDES efforts include:

- Areas experiencing periods of less precipitation, drought, lower stream flow and limited ground water recharge will result in less water flow for dilution of permitted discharges, alterations of aquatic environments, and increased impairments. NPDES permits will need to take these factors into consideration during permit renewal or new permit issuance. These precipitation changes are compounded in certain areas by increased human uses of the water resources.

- Increased intensity of rainfall events and storms may cause an increase in the number of sewer overflows and wastewater bypasses, fouling streams and requiring increased water enforcement.
- Increased aquatic temperatures may result in the need to modify existing discharge limits.

6) Nonpoint Source Management

Nonpoint source pollution comes from many diffuse sources and is caused by rainfall runoff that picks up natural and human made pollutants and deposits them in lakes, rivers, wetlands, coastal waters, and ground water. State and tribal nonpoint source programs, developed under the Clean Water Act (CWA) Section 319 Program, are working to meet this challenge. Potential vulnerabilities to U.S. EPA Region 4 Nonpoint Source Management efforts include:

- Increased intensity of rainfall events and storms will cause increased pollutant loads in runoff, and the velocity of runoff will scour and erode creek beds.
- Accounting for greater quantities of runoff and pollutants, with more variability from both urban and suburban stormwater and agricultural sources will stress existing nonpoint source best management programs.
- Nonpoint source best management practices may be stressed due to decreasing frequency of precipitation days and more concentration of runoff in intense storms, which may damage aquatic habitats and carry more erosion-related pollutants into water bodies.

7) Wetlands

U.S. EPA has a role in reviewing projects proposed for permitting under Section 404, whether by the U.S. ACOE or by a state or tribe that has assumed administration of a Section 404 program. Wetlands function to protect ecosystems, streams, and other aquatic resources. Wetlands provide crucial climate change functions including: 1) coastal protection in the face of sea level rise and increased hurricane intensity, including the ability to reduce wave energy; 2) protection of water supplies in the face of increased drought conditions by providing groundwater recharge and maintaining minimum stream flows; 3) flood mitigation in the face of increased precipitation and storm frequency; and 4) carbon sequestration. The capacity of wetlands and headwater streams to reduce flood peaks, detain stormwater, and filter pollutants is critical to the protection of life, property, and water quality. Potential vulnerabilities to U.S. EPA Region 4 Wetlands Program efforts include:

- Sea level rise combined with coastal development will challenge the ability of coastal wetlands to migrate inland, irreversibly impacting the extent, structure and function of coastal wetlands and coastal wetland protection programs. Coastal wetland loss is anticipated in areas where development has restricted natural migration pathways.
- Any loss of coastal wetlands can also increase the risk that rising sea levels and storm surge pose to coastal infrastructure. Additionally, sea level rise induced

saltwater intrusion may put drinking water sources and infrastructure at risk.

- Increased intensity of rainfall may cause increased sedimentation and other water quality impacts resulting from increased runoff. Increased use of intentional alteration of 404 resources to provide functions such as flood storage may result in the overall modification of the wetland ecosystem.
- Increased storm intensity may result in physical damage or elimination of wetlands and dune structures that protect coastal wetlands and could affect wetland delineation and restoration efforts.
- Increased intensity of drought may dry out seasonal wetlands which could affect base flow and water supplies. Changing temperatures and frequency of precipitation can alter structure and function of wetlands and ultimately wetland delineations.

8) Ocean Dumping (Dredged Sediment)

The Ocean Dumping Management program, established by Congress in 1972, prohibits ocean dumping of materials that would unreasonably degrade or endanger human health or the marine environment. Potential vulnerabilities to U.S. EPA Region 4 Dredging/Ocean Dumping efforts include:

- Increased need and frequency of dredging and ocean dumping due to increased precipitation and rainfall intensity that increases sedimentation and introduction of pollutants into channels and harbors.
- Shifting sediments and forming of shoals due to higher intensity storms that impede safe navigation in harbors and channels may require increased use of emergency dredging.
- Increased stresses, due to climate alteration, could stress existing living resources making ocean dumping more impactful to the ecosystem even while increasing the need to have ocean disposal as an option.
- Need for clean dredged materials to protect shorelines, beaches, dunes, and marshes from sea level rise may stress existing regulatory programs.

9) National Estuary Program

The National Estuary Program (NEP) was established in 1987 to restore and protect the physical, chemical, and biological integrity of “estuaries of national significance” by focusing our Clean Water Act authorities in these highly productive ecosystems. There are 28 NEPs across the country, six of which are entirely or partially within U.S. EPA Region 4. U.S. EPA Region 4 NEPs promote collaborative actions and best management practices to accelerate and embellish implementation of “core” Clean Water Act programs. Lessons learned by the NEPs are shared across the network of 28 programs nationally, as well as with other coastal watersheds facing similar water pollution and water quality impairments. This approach has proven to be a success over the past 25 years and the NEP is seen as a model for other comprehensive watershed and community-based programs. Potential vulnerabilities to U.S. EPA Region 4 National Estuary Program efforts include:

- Successful implementation of NEP Comprehensive Conservation and Management Plans (CCMPs) may be adversely affected. Efforts to restore or enhance water quality, habitat, living resources, hydrologic alterations, and human uses may be affected. The ability of NEPs to meet the goals and objectives identified in their CCMPs largely depends on their inclusion of a risk-based vulnerability assessment to prepare for the effects of climate change.
- U.S. EPA's funding to NEPs may not be sufficient to address the increase in the scale and cost of restoration efforts from climate stressors.
- Increasing water temperatures, sea level rise, and changes in water chemistry may alter existing ecology, which may adversely affect existing and future restoration efforts.
- Previous restoration projects and U.S. EPA investments may be irreparably damaged.
- Priorities of restoring and protecting ecosystems could shift to protecting human life and rebuilding damaged or destroyed infrastructure. These shifting priorities may de-prioritize responses to environmental impacts due to other competing social and infrastructure needs.

10) South Florida Program

The U.S. EPA Region 4 led South Florida Program largely provides granting opportunities to the area for projects related to improving or restoring aquatic systems and shorelines that support the local economy. The Florida Keys Water Quality Protection Program (FKWQPP), which is one component of the regional South Florida Program, was established in 1994 and is administered by U.S. EPA and Florida Department of Environmental Protection (FDEP), and includes a working group consortium of local, state, federal agencies, and non-government representatives. The FKWQPP works to recommend and implement management activities designed to maintain and restore the water quality needed for healthy native plant and animal populations in the Florida Keys National Marine Sanctuary waters. Through the Water Quality Protection Program, water quality, seagrass meadows, and coral reefs have been monitored in the sanctuary since the mid-1990s. Potential vulnerabilities to the South Florida Program efforts include:

- Increased ocean temperatures, storms, sea level rise, and acidification will degrade sensitive coastal ecosystems. Monitoring of coastal systems (coral, seagrasses) is a core component of the program and may become obsolete based on climate projections.
- Habitats that provide protection from storm events – such as coral, mangrove, and seagrass habitats – may be impacted, causing increased vulnerability of people, infrastructure, and ecosystems.
- Increases in rainfall may increase nutrient loading, which will impact all waters in south Florida.
- Increasing water temperatures, sea level rise, and changes in water chemistry may

alter existing ecology, which may adversely affect existing and future restoration efforts.

- Priorities related to restoring and protecting ecosystems could shift to protecting human life and rebuilding damaged or destroyed infrastructure. These shifting priorities may de-prioritize responses to environmental impacts due to other competing social and infrastructure needs.

11) Drinking Water, Wastewater, and Stormwater Infrastructure

Extensive networks of drinking water, wastewater and stormwater infrastructure help provide clean and safe water across the Southeast. U.S. EPA recognizes that this infrastructure is aging, and it is difficult for state, local and tribal governments to meet increasing needs with limited resources. The threats posed by climate change compound this challenge. Potential vulnerabilities to U.S. EPA Region 4 Drinking Water, Wastewater, and Stormwater Infrastructure Program efforts include:

- Higher air and water temperatures combined with nutrient pollution will result in increased growth of algae and microbes, which affect drinking water treatment needs.
- Increased intensity of rainfall events and storms could contribute to additional infiltration and inflow in wastewater conveyance systems, which could cause an increase in the number of sewer overflows and wastewater treatment plant overloads, requiring expensive modifications and improvements to both wastewater conveyance and treatment systems. Reduced annual precipitation or increased intensity and duration of drought in some regions will place demands on both surface and ground water resources, causing drinking water providers to reassess water supply plans and consider alternative pricing, allocation, and water conservation options.
- Reduction in assimilative capacity of existing surface waters due to reduced stream flows and/or increased temperatures could lead to more stringent discharge limits on existing wastewater facilities, which may require expensive upgrades.
- Sea level rise could cause saltwater intrusion into wastewater collection systems, leading to sewage overflows and increased corrosion of collection and treatment infrastructure.
- Sea level rise can also contribute to elevated water tables and failing septic systems in low elevation coastal areas causing nonpoint source release of sewage and nutrients into aquatic habitat. Clean Water State Revolving Fund (SRF) resources can be used to connect decentralized wastewater systems to collection and treatment systems.
- Increases in flooding from extreme precipitation, storm surges, and loss of wetlands could cause damage to infrastructure that results in increased needs for SRF funding.
- Source water intake changes may be needed due to droughts and summertime extreme heat. Coastal aquifers may experience saltwater intrusion where withdrawals are outstripping recharge and increased pressure head from higher sea

levels may worsen this problem, resulting in the need for relocation of water and wastewater facilities.

- Drinking water and wastewater utilities' emergency planning for extreme weather events may need to be reviewed and modified to account for climate change. Vulnerable and disadvantaged communities may be particularly at risk, both for access to clean and safe water as well as for their ability to respond to emergencies during extreme events. Coastal and mountain communities will be particularly vulnerable to flooding.
- Changes in rainfall patterns may lead to additional water supply infrastructure, with associated impacts on ecosystem fragmentation, aquatic life, physical stability, water quality, disruption of sediment and nutrient dynamics, downstream users, and system losses due to increased evaporation from impoundments. CWA Section 404 permit applications for reservoir creation in response to drought have increased in some states.

12) Drinking Water Quality

The Safe Drinking Water Act (SDWA) is the main federal law that ensures the quality of Americans' drinking water. U.S. EPA sets standards for drinking water quality and oversees the state, local, and water suppliers who implement those standards. U.S. EPA Region 4 ensures that the public water supply systems comply with national drinking water quality standards and underground sources of drinking water are protected from contamination. Potential vulnerabilities to U.S. EPA Region 4 Drinking Water Quality efforts include:

- Higher air and water temperatures will promote increased growth of algae and microbes, which will increase the need for drinking water treatment and potentially affect the aesthetic quality of drinking water supplies, in addition to potential harmful algal bloom health risks.
- Increased storm water runoff will wash sediment and other contaminants into drinking water sources, potentially requiring additional treatment.
- Sea level rise could increase the salinity of both surface water and ground water through saltwater intrusion, encroaching upon coastal drinking water supplies. Additionally, extreme weather events such as hurricanes and extreme droughts could impact and potentially permanently affect both the availability and quality of drinking water sources. In southeastern areas with saltwater intrusion, U.S. EPA Region 4 states may receive more permit applications and issue more permits for Class V aquifer recharge injection wells under the Underground Injection Control (UIC) program to combat the effects of saltwater intrusion caused by sea level rise.
- In areas with less precipitation, public water supply systems' water demand may rely more heavily on underground aquifers or development of underground storage of treated water to supplement existing sources. Changes in the salt front of estuaries and tidal rivers due to sea level rise and overuse of fresh surface and ground water that result in flow changes may result in increased pressure to manage freshwater reservoirs to increase flows and attempt to maintain salinity regimes, to protect

estuarine productivity and drinking water supplies.

C. Contaminated Sites

Contaminated site cleanup occurs under a variety of U.S. EPA programs, most commonly Superfund (i.e., remedial, time-critical removal, emergency response programs), the Resources Conservation and Recovery Act (RCRA), the Toxic Substances Control Act (TSCA) (e.g., PCBs), Brownfields, Underground Storage Tanks (UST), Leaking Underground Storage Tanks (LUST), and the Oil Pollution Act (OPA). A high percentage of cleanups, including most brownfields sites, are regulated through State programs.

For the Southeast, the impacts that most likely pose risks to contaminated site cleanups and waste management facilities are sea level rise, extreme storm events (precipitation and wind), temperature extremes, wildfires, decreasing precipitation days, and increasing drought intensity. Ocean acidification and increased water temperatures may also pose additional risks to coastal facilities and affect the natural biodegradation of chemicals released to the environment. Potential environmental conditions arising from these impacts and specific examples illustrating how they could potentially influence contaminated sites are described below. The likelihood and severity of climate change impacts can also be expected to vary considerably from site-to-site depending on the location, cleanup technologies and approaches, and many other factors.

Longer-term response cleanups such as the Superfund remedial program and the RCRA corrective action program are intended to protect human health and the environment, maintain protection over time, minimize the amount of untreated waste, and reduce ecological risks to levels that will result in the recovery and maintenance of healthy local populations and communities of biota. These cleanups are generally viewed as “permanent” solutions. Other cleanup programs such as the Superfund time-critical removal program address more immediate threats; however, in many cases these may also result in long-term cleanup remedies.

1) Impacts on Longer-term Cleanups

Cleanups, monitoring and maintenance activities where waste is left in place (e.g., landfills, cap-in-place remedies) or cleanups that involve treatment that occurs over a long period of time (e.g., ground water pump & treat systems) could be especially vulnerable to changes in climate. For cleanup operations that are typically of much shorter duration (e.g., soil vapor extraction, enhanced thermal treatment), the impacts of climate change are more predictable and easier to factor into the selection and design of a particular remedy.

Programmatic Vulnerabilities

- Physical impacts to Superfund actions of all durations are likely to include the following:
    - Both removals and remedial actions may involve labor-intensive operations,

sometimes for an extended length of time, and are therefore vulnerable to the acute impacts of climate change: e.g., flooding, ground water hydrology, temporary or long-term power outages, extreme heat, wind impacts.
    - Such impacts may complicate assessment phases, as well as remedial, and operation and maintenance phases.
    - There may be heightened risk of physical damage to buildings and other components of the existing site and the remedy, such as storm movement of drums or other containers, or damage to booms and other containment structures.
    - Off-site disposal, waste transport, equipment capabilities and laboratory capabilities may be overwhelmed by extreme storm events. Temporary on-site staging of hazardous materials may be compromised.
    - Extreme storm events may provide increased hazards for U.S. EPA staff and contractors on site.
    - Climate impacts to infrastructure may hamper response time and capability, including, but not limited to, the ability to move equipment and to transport hazardous materials for disposal.
- Programmatic impacts to the Superfund program may involve the ability to adequately plan for and execute in a changed environment, including the following:
    - The preliminary assessment/site investigation (PA/SI) phase of time-critical removal actions or a Remedial Investigation/Feasibility Study (RI/FS) are based on existing information – typically historical information, not future predictions. Without incorporating potential climate change impacts, an accurate risk may not be factored into planning or prioritization. Assumptions and modeling previously relied upon in an area may no longer be valid.
    - The remedy selection process must also adequately consider climate impacts. For example, precipitation records and floodplain maps used for remedy selection and design may not account for future climate change impacts. Another example is the impacts of surface water runoff in remedies including a cap.
    - More robust remedies such as excavation and removal of wastes may be required for sites that are potentially vulnerable to sea level rise and flooding, increasing short-term costs.
    - Climate change may increase the mobility of contaminants and reduce the effectiveness of containment as a remedy.
    - Designs may have to be based on conservative assumptions to reflect uncertainty over future environmental conditions, including drought and extreme storm events that increase surface water runoff or infiltration.
    - Future population growth will most likely result in people living in areas near Superfund sites that have previously been less occupied, contributing to a need for reassessment of scoring, risks and protectiveness of existing sites and remedies. Reevaluation of sites previously considered for the NPL may be necessary.

- Changes in exposure pathways for both human and ecological receptors will result from sea level rise, coastline alteration and other factors. These may include such aspects as changes to drinking water system intakes, floodplain reach to residential areas, and rates of erosion. Remedy design and standards may need to reflect projections.
- Climate impacts may also alter the biological communities impacted by a Site, such as increasing risk to seafood sources.
- Health and Safety Plans should adequately anticipate extreme storm events, such as providing state and local contacts to communicate with pre and post storm events.
- Not only will potential impacts on ecological receptors differ from past experience, but also the ecological receptors themselves may differ due to migration of species and habitat alteration. Remedies should anticipate additional future impacts.
- Increased sophistication of modeling and planning may raise engineering costs as well as execution costs.
- Uncertainty of climate impacts may lead to differing impacts of climate change. For example, U.S. EPA may need to evaluate and incorporate climate change impacts at national priority list sites with waste in place.

State by State Assessment

- *Alabama*: Coastal areas will be susceptible to flooding and saltwater intrusion. Out of the 10 largest population centers in Alabama, only Mobile is located on the coast. Most other large cities that are located on or near waterways may be more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 17 Superfund or Superfund Alternative Sites are in the State; 14 of these sites have ongoing five-year reviews required by residual waste.
- Florida: Most of the state will be susceptible to flooding, and coastal areas will be susceptible to saltwater intrusion. Seven out of 10 of the largest population centers in Florida are located on the coast (Jacksonville, Miami, Tampa, St. Petersburg, Port St. Lucie, Cape Coral and Ft. Lauderdale). Because of population and groundwater impacts, there are more Superfund Remedial sites in Florida than other U.S. EPA Region 4 states. Currently, 92 Superfund or Superfund Alternative Sites are in the State; 66 of these sites have ongoing five-year reviews required by residual waste.
- *Georgia*: Coastal areas will be susceptible to flooding and saltwater intrusion. Out of the 10 largest population centers in Georgia, only Savannah is located on the coast. Most other large cities that are located on or near waterways may be more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 23 Superfund or Superfund Alternative Sites are in the State; 18 of these sites have ongoing five-year reviews required by residual waste.
- *Kentucky*: There are no coastal areas, and saltwater intrusion will not be a concern. Large cities located on or near waterways, such as the Ohio River, may be more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 20 Superfund or Superfund Alternative Sites are in the State; 16

of these sites have ongoing five-year reviews required by residual waste.

- *Mississippi*: Coastal areas will be susceptible to flooding and saltwater intrusion. Out of the 10 largest population centers in Mississippi, only two (Gulfport and Biloxi) are located on the coast. Most other large cities that are located on or near waterways may be more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 13 Superfund or Superfund Alternative Sites are in the State; 6 of these sites have ongoing five-year reviews required by residual waste.
- *North Carolina:* Coastal areas will be susceptible to flooding and saltwater intrusion. Out of the 10 largest population centers in North Carolina, only Wilmington is located on the coast. Most other large cities that are located on or near waterways may be more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 48 Superfund or Superfund Alternative Sites are in the State; 33 of these sites have ongoing five-year reviews required by residual waste.
- *South Carolina:* Coastal areas will be susceptible to flooding and saltwater intrusion. Out of the 10 largest population centers in South Carolina, only Charleston, North Charleston, and Mount Pleasant are located on the coast. Other large cities that are located on or near waterways may be more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 39 Superfund or Superfund Alternative Sites are in the State; 30 of these sites have ongoing five-year reviews required by residual waste.
- *Tennessee:* There are no coastal areas, so saltwater intrusion is not a concern. Large cities located on or near waterways, e.g., the Cumberland and Mississippi Rivers may be more susceptible to flooding; infrastructure in cities may be overwhelmed, leading to releases. Currently 29 Superfund or Superfund Alternative Sites are in the State; 19 of these sites have ongoing five-year reviews required by residual waste.

2) Emergency Response Programs

U.S. EPA coordinates and implements a wide range of activities to ensure that adequate and timely response measures are taken in communities affected by hazardous substances and oil releases where state and local first responder capabilities have been exceeded or where additional support is needed. U.S. EPA's emergency response program responds to chemical, oil, biological and radiological releases, and large-scale national emergencies, including homeland security incidents. U.S. EPA conducts time-critical removal actions when necessary to protect human health and the environment by either funding response actions directly or overseeing and enforcing actions conducted by potentially responsible parties.

U.S. EPA Region 4 has an approximate total coastline of 2,035 miles (see Table 5) that may be impacted by large weather events, such as hurricanes. An increase in storm severity and sea level rise may cause large storm surge damage in communities and industrial facilities along U.S. EPA Region 4's coastline. In addition, inland flooding due to intense and frequent storms may cause extensive flood damage in communities and industrial facilities that were not predicted to be affected under current flood maps. These large events will require the need for ample resources of On Scene Coordinators, Remedial Project Managers and Response Support Corps (RSC) members to be deployed during responses.

Table 5. State Comparisons of Coastline, River Miles, Superfund Sites, and Population

	AL	GA	FL	KY	MS	NC	SC	TN
General Coastline (Statute miles)	53	100	1350	0	44	301	187	0
Tidal Coastline (Statute miles)	607	2344	8426	0	359	3375	2876	0
River Miles	77,242	69,547	25,949	49,105	81,316	37,853	29,898	61,075
Superfund and SASSites	17	23	92	14	13	41	30	25
Five-Year Review Sites	14	18	66	12	6	25	22	10
Population	4,822,023	9,919,945	19,317,568	4,380,415	2,984,926	9,752,073	4,723,723	6,456,243

Impacts on Emergency Response Programs

- Smaller entities with hazardous materials may lack resources for emergency planning, which may increase the risk of abandoned hazardous materials during a flooding or storm event.
- Local capacity to treat and dispose of hazardous and municipal waste may be overwhelmed by surges in mixed waste from climatic events.
- Releases of hazardous materials, chemicals, or oil discharges through high winds, flooding, and storm surges may create a need for increased frequency and intensity of emergency responses to hazardous materials and oil spills. Current response resources, including laboratory capacity, may not be adequate and may need to be supplemented in order to respond to extreme events.
- Coastal hazardous material and oil facilities may be impacted by extreme events and storm surge. The United States Coast Guard (U.S. CG) has jurisdiction over hazardous material and oil spills within the coastal zone, but U.S. EPA has interagency agreements in place to support the U.S. CG during responses.
- Extreme storm and flooding damage to homes and businesses will produce an increase in the amount of household hazardous waste, white goods (e.g., refrigerators, air conditioners), and orphan containers that may need to be collected and placed in landfills. A large increase in storm debris, household hazardous waste, and industrial waste collected during disaster events may strain waste landfill

capacity and require the construction of additional landfill capacity.

- Storm surge, extreme rainfall and high winds caused by coastal storms and hurricanes may adversely impact industrial facilities located within 100- to 500-year floodplains and may produce the following significant impacts:
  - Releases of chemicals, discharges of oil and mobility of orphan containers (i.e., above-ground storage tanks, drums, and totes) in the affected area.
  - Increased number of brown and black outs that may potentially lead to impacts on facility processes (i.e., runaway reactions, heat reactions, failure of chemical processes).
- Oil facilities that are required to have Facility Response plans or Spill Prevention, Control, and Countermeasure (SPCC) plans may experience large impacts due to extreme rainfall and/or wind events.
- The Region will need to maintain a robust Response Support Corps to provide for additional personnel during the Agency response to Federal Emergency Management Agency (FEMA) disaster declared responses. This will require the continued recruiting, training, and exercising of RSC members.
- Pest type and range may change with climate change, and there may be an increase or change in type of pesticides stored and transported across the region, resulting in a potential increase in releases.
- Additional planning for emergency response may be needed:
  - Brown and blackouts related to emergency situations may cause releases.
  - The frequency and intensity of storms may need to be incorporated into current national and area contingency plans.
  - Facility Response Plans (FRP) and SPCC plans may not consider climate impacts.
  - Current regional debris management plans rely on historical climate assumptions and do not address the increasing uncertainty in climatic extreme events.
  - Additional planning may be needed as Stafford Act declaration (federal emergencydeclaration) may be more frequent with a changing climate.
  - Current energy infrastructure (oil, natural gas, nuclear) in the Southeast may not include climate change assumptions for emergency planning.

State by State Assessment

- *Alabama:* Mobile is the largest city on the State's coast, and it is the 20th busiest container port in the U.S.[196] Areas surrounding Mobile Bay have various chemical and oil facilities that may be impacted by storm surges caused by very large hurricanes.
- *Florida:* The State has 1,350 miles of coastline and is the State that gets impacted the most by hurricanes and tropical storms within U.S. EPA Region 4. Of the 10 largest population centers in the State, seven (Jacksonville, Miami, Tampa, St. Petersburg, Port St. Lucie, Cape Coral, and Ft. Lauderdale) are located on the coast. The Ports of Jacksonville, Miami, Everglades, Palm Beach and Tampa, are ranked as

the 12th, 13th, 16th, 26th, and 28th busiest container ports in the nation, respectively.[197] These cities have a significant industrial and population base that has the potential to produce a large amount of household hazardous and industrial waste resulting from storm surge impacts, flooding, and high winds resulting from large hurricanes.

- In 2017, Hurricane Irma sank many recreational boats along the Florida coastline. U.S. EPA and the U.S. CG received a FEMA Emergency Support Function (ESF)-10 mission assignment to assist the State recover oil and hazardous materials from them.
- The State has a large phosphate mining and phosphate fertilizing processing industry mostly concentrated in the central Florida region. One of the byproducts of phosphate fertilizer production is phosphogypsum. There are currently about 1 billion tons of phosphogypsum stored in 24 stacks in Florida and about 30 million new tons are generated each year.[198] One of the concerns is a large weather event (hurricane) could affect the stability of one of these stacks and may cause a release of low acidic process water to the environment.

- *Georgia:* The Georgia coast has two ports: Savannah and Brunswick. The Port of Savannah is the nation's fourth busiest container port and the second busiest in the East Coast.[199] Large hurricanes could be devastating to the area and produce a large amount of hazardous materials and debris to be spread through the area.
- *Kentucky:* The Commonwealth has experienced major impacts due to flooding and tornados and increase in severe weather may cause severe weather-related environmental impacts within the Commonwealth. In 2021, due to large tornado event, U.S. EPA Region 4 received an ESF-10 mission assignment to assist the Commonwealth with the assessment of industrial facilities and the assessment and recovery of orphaned containers and household hazardous waste.
- *Mississippi:* The State's coastline has three cities: Pascagoula, Gulfport and Biloxi. These cities were affected heavily by Hurricane Katrina and produced large amounts of household hazardous waste and industrial debris caused by the storm surge. The Port of Gulfport is the 25th busiest container port in the U.S. and was heavily affected by Hurricane Katrina.[200] A large amount of the port's cargo was dispersed by the storm surge into the bordering community. The Pascagoula coast has one of the largest refineries in the U.S. and the facility may be impacted by major storm surges.
- *North Carolina:* The Port of Wilmington is the 24th busiest container port in the nation and may be vulnerable to storm surge damage and flooding resulting from hurricanes.[201] The State is prone to large flooding associated with rains caused by hurricanes passing through the State.
    - In 1999, Hurricane Floyd caused extensive flood damage in eastern North Carolina. In 2004, Hurricane Ivan caused extensive flooding in the Appalachian Mountain region of western North Carolina. In 2018, Hurricane Florence produced record flooding east of I-95. In 2021, western North Carolina experienced extreme flooding due to remnants of Tropical Storm

Fred. These extreme events produced large amounts of orphaned containers and household hazardous waste.

- Due to groundwater contamination, U.S. EPA Region 4's Superfund Removal program has had to supply an alternative water source to various communities in the State. An increase in extreme rainfall events the size of the contaminated area within the aquifer. The groundwater wells may start to pull contaminated groundwater and may require U.S. EPA to provide these communities an alternative water source.

- *South Carolina:* Most of the State has experienced major flooding events. In 2015, excessive rainfall caused major flooding in the Midlands area of the State. In 2019, Hurricane Florence produced major flooding in the Pee-Dee region of the State due to excessive rainfall. Flooding from Hurricane Florence impacted a removal site causing the migration of Polychlorinated Biphenyl (PCB) contaminated sediments into several homes and required an emergency removal action. The coastal zone of the State contains the City of Charleston. Charleston has a major port and is ranked the 8th busiest container port in the nation.[202] South Carolina's coastal zone is susceptible to flooding and coastal storm surge from a major hurricane.
- *Tennessee:* Historically, heavy rainfall has caused major flooding events within the State. During May of 2010, the City of Nashville and surrounding counties experienced large rainfall over a two-day period that caused extensive flooding in the area. U.S. EPA Region 4 Emergency Response program responded to the area and conductedassessments of major oil and industrial facilities and recovered orphan containers that were dispersed by the flood waters. The increase of the severity of rainfall events due to climate change will produce major flooding within the State.

3) RCRA Hazardous Waste Management Facilities

RCRA regulates the treatment, storage, and disposal of hazardous wastes (among other statutory requirements). Owners/operators of these treatment, storage, and disposal (TSD) facilities must generally obtain a permit for those activities. Facilities that generate hazardous waste and store it for less than 90 days are also regulated under RCRA. In U.S. EPA Region 4, the individual states are authorized to implement this program in lieu of U.S. EPA.

To operate as a TSD facility, the owner/operator must comply with numerous technical requirements, which ensure that covered activities are conducted in a manner that is protective of human health and the environment. These requirements apply to on-going hazardous waste management units (e.g., drum and tank storage, surface impoundments, waste piles), as well as to the closure (i.e., cleaning and decommissioning) of those units that are no longer in use. TSD facilities must also conduct cleanup of past and present releases of hazardous constituents. The same climate change impacts that could affect contaminated site cleanups may also affect the management and operation of hazardous waste facilities.

Impacts on Hazardous Waste Management Facilities Program

- Flooding may disrupt the transportation system in place to handle waste. For example, flooding may disrupt waste collection in neighborhoods and business, or the work performed at transfer stations. Cities with transfer stations along waterways are at particular risk.
- A major storm event may increase the amount of solid waste generated and lead to the release of fuel or hazardous materials.
- Changes in precipitation may impact waste management practices such as composting by affecting biological processes.
- Vegetative cover on landfills may be compromised due to dry soil conditions.
- Tanks containing hazardous waste could be damaged by high winds or flying debris during hurricanes.
- Integrity of drums and drum storage areas could be compromised by flooding, allowing drums to be floated out of containment barriers, or cause intermingling of incompatible wastes, etc.
- The potential for failure of process equipment (e.g., pressure relief valves, emergencyvent fans and pumps) could increase with increases in winter rain and ice storms.
- Over-pressurization of tanks containing volatile wastes and the emergency venting of these wastes could occur with extreme ambient temperatures.
- Buildings or other structures used for indoor storage of waste piles could be damaged or flooded in a hurricane causing the release of this material.
- Emergency evacuation routes for facility personnel and the surrounding community, as well as facility access by fire and other emergency response vehicles, could be flooded or otherwise restricted due to an extreme storm event.
- States may need to alter selected financial assurance remedies to ensure protection.

4) Vulnerabilities for U.S. EPA's Oversight Role

While U.S. EPA Region 4 states are authorized to implement the RCRA hazardous waste management program, U.S. EPA retains oversight authority to ensure compliance with the statute and regulations and there may be a need for increased coordination to respond to climate change impacts. U.S. EPA Region 4 will work with state programs and industry to modify operating facility permits to include enhanced emergency preparedness requirements appropriate for climate change impacts.

Impacts on Hazardous Waste Management Facilities Program include:

- Uncertainties in the underlying assumptions that could affect the design, operation, and management of hazardous waste facilities, including contingency planning (e.g., RCRA TSD facilities must meet specific requirements if waste management units are located within a 100-year floodplain).
- Financial assurance estimates for closure and post-closure may not reflect changing climate impacts on those activities.

5) Oil Program and Underground Storage Tanks

EPA also prevents, prepares for, and responds to oil spills that occur in and around inland waters of the United States. EPA is the lead federal response agency for oil spills occurring in inland waters and the U.S. Coast Guard is the lead response agency for spills in coastal waters and deepwater ports. EPA's oil spill prevention program includes the Spill Prevention, Control, and Countermeasure (SPCC) and the Facility Response Plan (FRP) rules issued under authority of 311(j) of the Clean Water Act and published at 40 CFR Part 112. The SPCC rule, originally published in 1973, helps certain facilities prevent a discharge of oil into navigable waters or adjoining shorelines. The FRP rule, originally published in 1994 as result of the Oil Pollution Act (OPA) amendments to the Clean Water Act, requires certain facilities to submit response plans to prepare to respond to a worst-case oil discharge or threat of a discharge.

U.S. EPA created the Office of Underground Storage Tanks to carry out a Congressional mandate to develop and implement a regulatory program for UST systems. U.S. EPA works with its state, territorial, and tribal partners to prevent and clean up releases from UST systems. The greatest potential threat from a leaking UST is contamination of groundwater, the source of drinking water for nearly half of all Americans. U.S. EPA, states, and tribes work together to protect the environment and human health from potential UST releases.[203]

Impacts on Oil Program and Underground Storage Tanks Program

- U.S. EPA Region 4 has a universe of USTs that may be vulnerable to flooding events. Of particular concern is groundwater contamination from leaks from at risk tanks and damage to the supporting piping.
- Coastal FRP and SPCC facilities may be compromised by sealevel rise. FRP and SPCC facilities located along inland rivers may be compromised by flood events.
- Secondary containment systems for ASTs and other oil equipment at FRP and SPCC facilities may become damaged and/or flooded.
- Alterations in shoreline geology and/or sea level rise may increase exposures of USTs or underground pipeline, increase pressure differences and gradients, and/or alter the flow of oil and hazardous substances in pipelines.
- Increase in precipitation and floods may have many impacts, as follows:
    - Decrease the effectiveness of secondary containment.
    - Increase flow and pressure to underground infrastructure/structures (i.e., pipelines,wastewater treatment facilities, power plants, and paper mills). Increased flow and pressure to containment systems may result in back feed and flow of product resulting in increased discharges of oil.
    - Decrease tank headspace thereby displacing buffer space available to prevent overflow and overfill, potentially leading to increased oil spills.
    - Increase weathering of underground and aboveground storage tanks (ASTs and USTs).
    - Increase flow and changes to surface water depths, thereby increasing FRP planning distances and difficulty preparing and implementing response strategies (booming strategies, and recovery strategies) for worst-case

discharges of oils.

- Failure of infrastructure (e.g., pipelines, and secondary containment) and damage or displacement of tanks due to increased intensity of hurricanes and resulting winds and storm surges. Damage to storage tanks would increase the likelihood of spills to navigable waters, coastlines, and oceans.
- Increased degradation and weathering of pipelines and infrastructure due to ocean acidification resulting in oil spills.
- Change in the number of facilities regulated under FRP and SPCC based on climate impacts to nearby water bodies nearby water bodies (for example, drought intensity or increased flooding events).
- Change in native or endemic organism availability for biotic degradation of oil due to increase in water temperatures.

6) Brownfield Program

While Brownfields Cleanup Sites will potentially be impacted much the same as Superfund, RCRA Corrective Action, and TSCA sites (discussed previously), effects of climate change may also be felt by other aspects of the Brownfields Program.

Impacts on Brownfield Program

- Brownfield Grantees may have to make changes to their Master Plans as shorelines and flood zones change. Applicants who receive brownfield grant funds are encouraged to follow a community-developed Master Plan for redevelopment. Developing such a plan is an eligible grant expense but preference is generally given to communities who already have such a plan in place. U.S. EPA Region 4 Project Officers should be prepared to allow changes as needed for climate adaptation.
- Development of a climate adaptation strategy for a brownfield site is an eligible grant expense. U.S. EPA Project Officers will have to become familiar with these types of plans so they can properly advise grantees.
- More sites may enter the brownfields inventory as natural disasters lead to release of hazardous substances and petroleum. U.S. EPA may begin experiencing even more competition for the already dwindling brownfields grant funding.
- Flooding could disrupt or delay work at existing Brownfield sites.

7) Chemical Safety and Pollution Prevention

U.S. EPA and the states (usually the state Department of Agriculture) register or license pesticides for use in the U.S. In addition, anyone planning to import pesticides for use in the U.S. must notify U.S. EPA. U.S. EPA receives its authority to register pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

Climate change may lead to an increase in pesticide use, due to an increase in pests and diseases which favor warm and humid climates. In the Southeast, currently pesticides are widely used as the climate is hot and humid, and there is not a cold winter to kill off pests in

most areas, resulting in year-round pest problems. Many models now show the winter months in the Southeast will become warmer as time goes on. The freeze-free seasons are lengthening and may result in the cessation of freezing in some areas, which may only increase the already high pest populations particularly in the northern areas of the region. The southeast region has 12 major marine ports, and thus the introduction of non-native pest species is a constant concern.

Invasive species are currently found in large numbers across the Southeast, and it is likely that climate change will continue to exacerbate this problem. The potential impacts of increasing pesticide usage include concerns about human exposure as well as concerns about non-target organism impacts (for example, impacts to pollinators and beneficial insects, endangered species, and aquatic organisms). Concerns for groundwater contamination will continue to be an issue in Florida, where the water table is high and soils are permeable. Karst topography is dominant in the southern part of the region and in parts of Kentucky and Tennessee.

Impacts on Pesticides Program

- U.S. EPA Region 4 will experience new pest problems, many of which will be from exotic invasive species.
- Changes in pests and pest pressures will result from increases in temperatures and variations in rainfall patterns.
- There would be a potential increase in the need for emergency exemptions und FIFRA Section 18 (Section 18). These FIFRA exemptions are granted when an emergency pest problem appears which cannot be controlled effectively by the current pesticides registered for that pest or commodity, allowing temporary use of chemicals which are not registered for that use. The Section 18 requests are approved by U.S. EPA Headquarters. The regional role is to provide technical assistance to the states as needed.
- Increasing pesticide usage to control pests could also lead to increased resistance of the pest to the chemical being used. Resistance management will therefore become increasingly important.
- The increase in amount and variability of precipitation projected for U.S. EPA Region 4 can create an expanded mosquito habitat, which could increase exposure to more diseases like dengue fever and malaria.
- The Region will need to be prepared to address needs for aggressive mosquito control as well as support continued local monitoring of mosquito populations, which is currently being done by most large mosquito control districts in the Southeast. Emergency exemptions for mosquito control may increase, especially after major weather events such as floods and hurricanes, which tend to spur populations of *A. aegypti* and *A. albopictus*.
- As more Section 18 requests may be anticipated, and more pesticides may be used in response to climate change, impacts to non-target endangered species will need to be considered and monitored.

- There will likely be an increase in fungal organisms in agricultural and non-agricultural settings due to extreme rainfall.
- Climate impacts may change chemical and non-chemical agricultural practices due to extreme storms and farmers' inability to work in their fields (e.g., increases the likelihood of run-off and off-target movement of chemical products; limits on the potential use of certain non-chemical methods such as cultivation because it may not be possible to bring heavy farm equipment onto wet fields and saturated soils).
- Increased use of aerial applications are likely to result in increased pesticide drift due to extreme storm events.
- Drought may lead to an increase in dry condition pests (e.g., mites that feed on a variety of field, vegetable, and fruit crops).

These changes in pesticide choices and quantities will require changes to the pesticide applicator certification and training programs. Changes in chemical selection could result in new and increased chemical exposures, especially for indoor applications.

Types of new pest problems

- Indoor and outdoor molds and microorganisms which are controlled by disinfectant and pesticide products,
- Public health pests such as mosquitoes and ticks,
- Forest pests,
- Aquatic pests including weeds, and
- Various agricultural pests including weeds, insects, and plant diseases.

8) RCRA Coal Combustion Residual Facilities

RCRA Subtitle D regulates coal combustion residuals (CCR) in landfills and surface impoundments. Owners/operators of facilities subject to the rule must comply with specific requirements for both existing and new CCR landfills and surface impoundments, including lateral expansions of any existing unit. The rule also covers surface impoundments that have ceased receiving waste by the effective date of the rule (i.e., inactive units). The regulations within the rule help protect human health and the environment by requiring minimum design and operation standards, groundwater monitoring and corrective action, and both closure and post-closure care.

The Land, Chemicals, and Redevelopment Division (LCRD) works closely with the Enforcement and Compliance Assurance Division (ECAD) in prioritizing CCR units that may be vulnerable to the adverse impacts of climate change. EPA also recognizes the crucial role that state partners play in implementation and in ensuring compliance with regulatory requirements, particularly in complex situations such as corrective action and closure. States seeking EPA approval to administer their own CCR permit program must have regulations that are at least as protective as the federal CCR requirements and a permit process that includes public participation. Currently, Georgia's program has been approved and several other Region 4 states are developing their CCR permit programs.

Impacts on the CCR Program

Many CCR units are built in areas prone to flooding, such as along rivers or within floodplains. Therefore, flooding may impact these units, or in a worst-case scenario, contribute to a catastrophic failure and release. Other impacts could include:

- River flooding may overtop the berms of a surface impoundment, leading to erosional releases of CCR from within the unit.
- Rising floodwaters from major flood events could damage containment structures (such as dams and berms) and contribute to an increased risk of a catastrophic release.
- Vegetative cover on CCR landfills may be compromised due to prolonged rain events or dry soil conditions.
- Increased seasonal precipitation could overwhelm permitted discharge points, leading to releases of contaminated surface water.
- Increased seasonal precipitation may contribute to an elevated groundwater table, which could impact how much CCR is in contact with groundwater.
- Engineering controls designed to drain water from the CCR unit could become overwhelmed due to prolonged contact with an elevated groundwater table.
- Extreme weather events could make it difficult for facility owners or operators to achieve the regulatory closure performance standards, especially if CCR is closed in place.
- Corrective action equipment could be impacted by power failures during an extreme storm event such as a tornado.

D. Enforcement and Compliance

The Enforcement and Compliance Assurance Division (ECAD) is responsible for developing and implementing U.S. EPA Region 4's enforcement and compliance assurance programs under statutes that U.S. EPA administers in the Southeast. ECAD works closely with the other U.S. EPA Region 4 Divisions, Office of Regional Counsel, Criminal Investigations Division, and Department of Justice to deliver a comprehensive enforcement and compliance assurance program that relies on the entire spectrum of compliance assurance tools available to the Region. This includes strategic planning for enforcement; compliance monitoring and compliance assistance activities; conducting inspections; developing enforcement cases; preparing and issuing administrative actions; assessing penalties; developing judicial enforcement actions; negotiating settlements; and measuring and reporting results of the Region's enforcement efforts.

The Superfund and Emergency Management Division (SEMD) also conducts enforcement activities through the implementation of the federal government's program for identifying, investigating, and cleaning up contaminated sites and protecting public health and the environment from releases of hazardous substances.

U.S. EPA Region 4 is coordinating closely at the national level with the U.S. EPA's Office of Enforcement and Compliance Assurance to incorporate climate adaptation measures throughout the enforcement process and across all media. Through this coordination, several priority actions have been identified that fall into the following categories:

1) Targeting

U.S. EPA Region 4's compliance/inspection targeting process will incorporate consideration of climate adaptation and mitigation into U.S. EPA Region 4's enforcement priority-setting activities. U.S. EPA Region 4 will incorporate climate change as a factor in the National Compliance Initiative (NCI) selection and implementation process by prioritizing facilities that are more vulnerable to natural disasters and are located in underserved communities.

2) Capacity Building, Training and Outreach

U.S. EPA Region 4 will support the creation of a headquarters and regional climate adaptation team to be consulted for assistance on climate adaptation solutions across the enforcement and compliance programs, as well as to promote such work. Initially these individuals would help others identify existing climate adaptation tools and policies but, as expertise develops, the team's mandate could be expanded to provide specific technical assistance to case teams and to establish a Community of Practice.

U.S. EPA Region 4 will support the development of an enforcement-specific climate adaptation training module for all OECA HQ and Regional staff. U.S. EPA Region 4 will support the establishment of an online repository for model documents and tools, which would be accessible to all stakeholders to facilitate the inclusion of climate adaptation considerations throughout the compliance and enforcement process. Examples of online tools include:

- A list of potential adaptation-specific supplemental environmental projects (SEPs), as well as model language for each type of SEP.
- Guidelines with useful information for state, local, and tribal authorities in the event of a threatened or actual flood or wildfire.
- Policy documents.
- Model documents and language, including the following examples: consent decrees, administrative settlement orders, remedial Investigation/feasibility study language, and statements of work.

3) Tracking of Mitigation-related Enforcement Activities

U.S. EPA Region 4 will establish measures to track and report case resolutions with climate adaptation components, including climate change-related injunctive relief, adaptation, mitigation, outreach, or SEPs.

E. Regional Facilities and Operations

Climate change poses a range of risks to U.S. EPA Region 4's facilities and operations. The following sections explain the general risks and delve into the risks specific to each facility. Note that each facility does not operate in isolation: the climate impacts experienced by each facility will be greatly influenced by the larger systems (utilities, transportation, communities) of which it is a part.

1) Severe Weather Preparedness

In response to severe weather conditions that may be attributed to Climate Change, U.S. EPA Region 4 has worked with the Federal Agencies at the Sam Nunn Atlanta Federal Center (SNAFC), the Atlanta Federal Executive Board (FEB), the Fulton County Emergency Management Agency, and FEMA to develop procedures to monitor severe weather and provide emergency alert advisories and notifications to Federal Agency Heads in the metro Atlanta area.

U.S. EPA, FEMA and Health and Human Services (HHS) co-chair the Emergency Preparedness and Employee Safety, Security Council, known as Strategic Goal 1 (SG1), of the Atlanta FEB. When potentially hazardous weather approaches the Metro Atlanta area, the FEB convenes a weather alert committee (i.e., the Emergency Task Force Workgroup) by conference call to discuss the potential impact on Federal Buildings and employees. These calls include representatives for many Federal, State, and Local emergency and law enforcement agencies to provide the latest projection and assessment of weather impacts on the Atlanta area.

The FEB Emergency Task Force Workgroup issues emergency advisory notices via FEB's mass alert notification system (MANS) that initiates email, text and telephone message on early dismissal, delayed opening, and closure of Federal Offices. These alerts may be issued during the workday or after early morning conference calls.

The U.S. EPA lead Interagency Occupant Emergency Command team at the SNAFC has incorporated weather emergencies into the building's Occupant Emergency Plan (OEP). For the past 3 years, the SNAFC has conducted Shelter-in-Place exercises as part of Georgia's annual state-wide Tornado Drill and Georgia's Great Southeast Shakeout Earthquake Drill. Over 3,100 federal and non-federal tenants and visitors participate in these exercises at the SNAFC each year.

U.S. EPA Region 4 has established a Continuity of Operations (COOP) site at the LSASD facility in Athens, Georgia. A limited number of essential personnel will report to and work out of this primary COOP site if the SNAFC were to be damaged by severe weather. The Region has a secondary site established at the Emergency Response Warehouse in Norcross, Georgia, in case the LSASD facility in Athens is not operational. In this instance, the executive leadership team would work out of the Norcross facility. Other employees would work remotely as needed using established Telework procedures. U.S. EPA, FEMA, and the Atlanta FEB have joined to plan and conduct Multi-Agency COOP and or Emergency Exercises every year.

2) Overview of Potential Climate Change Impacts

From the facilities and operations perspective, the vulnerabilities associated with climate change encompass issues of energy, security, water quality and supply, severe weather damage, personnel safety, physical security, and communication interruptions. These facilities and operations support the broader agency mission of protecting air, water, and human health through the provision of functional, appropriate, and safe working spaces for personnel. Beyond the infrastructure and utilities that serve U.S. EPA rented or owned facilities and the operations that support the function of those facilities, the broader impacts of climate change on transportation and communication systems are also vulnerabilities that U.S. EPA Region 4 could experience while meeting agency goals. While telework policies are in place to address these vulnerabilities, the magnitude of these impacts may extend to those alternate work locations, causing significant disruption to employee work and ultimately the U.S. EPA Region 4 mission.

However, while operations may be vulnerable in the areas described above, U.S. EPA Region 4 has developed a Continuity of Operations Plan (COOP) to maintain emergency functions should any particular facility or location be compromised. This plan provides guidance for continued uninterrupted operations and the performance of essential functions during emergency situations.The COOP includes provisions for physical relocation from current facilities and resource planning for up to 30 days.

3) U.S. EPA Region 4 Property Details

The Sam Nunn Atlanta Federal Center (SNAFC) Building/Complex

The SNAFC Building is located on four acres in downtown Atlanta on the edge of the central business district, at the MARTA (Metropolitan Atlanta Rapid Transit Authority) Five Point Station mass transit train system. SNAFC houses 1.1 million sq. ft. of office space and 103,000 sq. ft. of joint use spaces (daycare, fitness center, health unit, cafeteria, conference spaces, parking garage) occupied by an estimated 25 Federal Agencies and non-federal tenants. The complex consists of four connected structures: a twenty-four-story high-rise tower; a ten-story mid-rise tower; a six-story, historic department store, restored to office use; and an eight story "Bridge" that spans the street and links the high-rise and mid-rise office buildings. U.S. EPA Region 4 is housed in the high-rise tower structure, occupying 256,474 usable sq. ft. (USF), on floors 9 through 16, and a 3rd floor Bridge Conference Center. The building is serviced by underground utilities for domestic water and power/electricity, while natural gas is serviced above. All building mechanical systems are on the roof and the Bridge building has the exhaust and fresh air exchange with two air handler units per floor in the Tower. Chillers are in the basement.

Laboratory Services and Applied Science Division (LSASD) Lab

The Regional 4 laboratory, located at 980 College Station Road, Athens, Georgia, is built on a hill

at an elevation of 714 feet above mean sea level, obviating any risks of direct flooding. Located on approximately eleven acres of land, the laboratory is a single-story structure of 57,760 rentable square footage (RSF) and open parking. The LSASD Laboratory is U.S. EPA Region 4's COOP site, located approximately 50 miles North of the SNAFC Complex. For COOP preparedness, this Laboratory has been equipped with an emergency generator for back-up power that provides power to all private offices, training room, library and TS rooms. The emergency power is estimated to last 48 hours between refueling requirements. This time can be extended by minimizing the laboratory operations and additional fuel deliveries. Water reclamation systems and interstitial service corridors for service and utilities between back-to-back laboratories located adjacent to the ORD Laboratory. The Laboratory is connected to well water as well as a mail and supply room for continued support during COOP activation.

LSASD Field Equipment Center

LSASD's Field Equipment Center is located approximately 7 miles from the LSASD Laboratory is a single-story metal structure, occupying 13,800 RSF. Laboratory storage and cleaning/ sterilization of laboratory equipment is conducted at this center. This metal structure building has large bay doors and open parking.

EERB Warehouse

Co-located property with connected structures in a single-story building with open parking and large bay doors. The space is a combination of office and warehouse space, occupying 15,120 RSF. The Warehouse is approximately 20 miles North of the SNAFC Complex and is U.S. EPA Region 4's secondary COOP location for the executive leadership team.

Office of Water South Florida Office

U.S. EPA Region 4 occupies 3,011 RSF on the first floor of the three-story structure that was the former Florida Power and Light Hurricane Command Center. U.S. EPA Region 4 is in the process of downsizing this space to approximately 500 RSF for two remaining employees. All the utilities and power lines are external, above ground utilities and power lines, which often lose electricity. There is also limited emergency back-up power, including an emergency battery uninterruptible power supply to maintain U.S. EPA server, local area network and router connections. There is a Water Supply Lake approximately 1000 feet away and Intercoastal waters about 1 mile away that do not pose high threats for flooding.

Gulf of Mexico Division

The Gulf of Mexico Division, an U.S. EPA geographic program, occupies office space leased from NASA at Stennis Space Center (SSC) in Hancock County, Mississippi. The leased space is located on the 2nd floor of NASA Building 1100 (Main Administrative Bldg.). NASA operates and maintains the office building U.S. EPA occupies, as well as all other facilities and operations, inclusive of security, fire and emergency services, police, highways, parking, power, water,

sewer, and climate control. NASA has redundant power supply to the Stennis Space Center from two separate power grids located in the region. In 2012, U.S. EPA participated on a NASA SSC Stakeholder Conference focused on understanding potential climate change impacts to the SSC and beginning the adaptation planning process for the facility.

U.S. EPA's Gulf Ecology Division Laboratory Campus

In the wake of Hurricane Ivan in 2004, six of the U.S. EPA's Gulf Ecology Division Laboratory campus' 40 buildings were destroyed. Located on the 16-acre Sabine Island, off the Florida Panhandle coast, it was especially vulnerable to Ivan's devastating winds and rain. The destroyed buildings were rebuilt incorporating sustainable technologies to protect it from coastal hazards and minimize its environmental footprint. Aluminum was chosen as the primary roofing material since shingles tend to come loose in high winds. Its light color reflects sunlight to keep cooling costs down. Local building codes required windows to be equipped with storm shutters or made of high-impact glass. U.S. EPA selected high-impact glass to provide safety and durability and added skylights to reduce artificial lighting use. Because the buildings are exposed to frequent rain, high humidity, and corrosive ocean spray, U.S. EPA selected a sturdy wood pulp, sand, and cement composite made of recycled material for the building's siding. The siding is a reflective, UV-resistant, and white color to reflect solar radiation during day-time hours. And large front porch lines the front to help lower the building temperatures.

5 PRIORITY ACTIONS

U.S. EPA Region 4 has prioritized a number of actions during Fiscal Years 2022 and 2023 to support the Agency's Climate Action Plan. The efforts identified below also include separate Division- and Office-specific priorities that will further support the advancement of climate adaptation-related actions across the Region, while furthering the plans developed in close collaboration with the National Program Managers.

The Agency has established priority and supporting actions, as well as the initial performance metrics and is developing an assessment of potential resource issues to provide a foundation to work effectively with U.S. EPA's partners going forward. To further these goals, the Region has set ambitious actions to stress the need for acting internally, enhancing our partners' capabilities, and supporting the capacity of those that are most vulnerable across the Southeast to adapt to climate impacts affecting their communities.

The Region is committed to supporting the activities that are critical to building a region that is more resilient to climate challenges. Supporting Resiliency, Loans and Grants, Partner Engagement, Training and Accountability will drive our priority actions for the next two years, as further described below.

A. Process Resiliency:

Integrate climate adaptation into U.S. EPA programs, policies, rulemaking processes, and enforcement activities.

Priority Action 1

Develop updated U.S. EPA Region 4 Implementation plan.	
Fiscal Year Start-Complete	2022
Performance metric	Completion of U.S. EPA Region 4 Climate Adaptation Implementation Plan by required deadline.
Associated Vulnerability	Time to craft a plan that adequately represents Regional climate change issues and approaches to move out and address U.S. EPA - internal and community climate adaptation needs is a challenge. Close work with States, locals, tribes, and communities requires time and effort on U.S. EPA staff time and regional resources. Capacity and resources amongst these external partners may not be able to support these efforts, even though they are collaborative in nature.

Co-benefits	Prepares U.S. EPA Region 4 to target adaptation actions with co-benefits in the future. Public health, economic growth, and job creation as communities are better prepared to manage climate impacts (such as natural disasters) with strategies that improve water infrastructure strategies, urban heat island mitigation, stormwater management and habitat protection.
Resource requirements	Existing resources are being used for this effort.

Priority Action 2

Develop and begin implementing Standard Operating Procedures (SOPs) to integrate climate adaptation into Regional programs, policies, rulemaking processes, oversight, and enforcement activities, with an emphasis on assisting underserved and overburdened communities.	
Fiscal Year Start-Complete	2023 – ongoing
Performance metric	Develop SOPs to integrate climate change into Regional programs, policies, rulemaking processes, oversight, and enforcement activities, with an emphasis on assisting underserved and overburdened communities.
Associated Vulnerability	Regulatory and statutory hurdles. Limits on staff expertise to adequately recognize need and integrate needed solutions into work products.
Co-benefits	TBD: this will depend on the projects that are implemented through this process.
Resource requirements	TBD: Headquarters will need to first provide national guidance and may then need to help U.S. EPA Region 4 identify gaps to fill in needed SOPs.

B. Mission Resiliency:

Implement measures to protect the agency's workforce, facilities, critical infrastructure, supply chains and procurement processes from the risks posed by climate change.

Priority Action 1

Evaluate and begin to implement, in partnership with Office of Mission Support (OMS), opportunities to enhance the resilience of U.S. EPA Region 4's internal workforce, facilities, and processes (e.g., building and equipment resilience to the changing climate, U.S. EPA staff safety when deployed to disasters).	
Fiscal Year Start-Complete	2022 – ongoing
Performance metric	Create an assessment that identifies resilience projects for U.S. EPA Region 4 buildings and equipment, workforce, and staff activities. Number of resilience projects implemented for U.S. EPA Region 4 buildings and equipment, workforce, and staff activities.
Associated Vulnerability	Available funding for identified projects. Incomplete guidance on identifying vulnerabilities and ways to mitigate issues.
Co-benefits	Some activities may improve U.S. EPA Region 4 facility energy profile, resulting in decreased energy use.
Resource requirements	TBD: resource needs will be based on vulnerability assessment and subsequent resource needs to mitigate vulnerabilities.

Priority Action 2

Enhance the reliability of logistics support operations by coordinating within the Region to increase local stockage level of critical response, monitoring, and enforcement expendable materials.	
Fiscal Year Start-Complete	2022 – Ongoing
Performance metric	Minimum stockage levels and reorder points established.
Associated Vulnerability	Increased frequency of severe weather events.
Co-benefits	Economic growth and job creation.
Resource requirements	Existing.

C. Grants and Loans:

Modernize U.S. EPA financial assistance programs to encourage climate-resilient investments across Region 4.

Priority Action 1

Provide timely grant awards and oversight for climate adaptation-related work.	
Fiscal Year Start-Complete	2022 – 2023
Performance metric	Grants with climate adaptation-related elements will be awarded within statutory and regulatory timeframes.
Associated Vulnerability	Continuing Resolutions may impact the awarding of financial resources.
Co-benefits	TBD: this will depend on the specific projects supported.
Resource requirements	Additional staff may be needed to support any influx in grant monies under new legislation.

Priority Action 2

Consider climate adaptation in expenditure of Bipartisan Infrastructure Law (BIL) funds. *U.S. EPA Region 4 will take steps to ensure the outcomes of infrastructure investments using Infrastructure Investment and Jobs Act (IIJA, or Bipartisan Infrastructure Law [BIL]) funds are resilient to the impacts of climate change. U.S. EPA Region 4 will explore opportunities to integrate climate change considerations into its financial assistance programs in order to expand support for projects that increase climate resilience while delivering co-benefits for public health, the mitigation of greenhouse gases, and the reduction of other pollution. U.S. EPA Region 4 will also provide technical assistance to recipients of BIL funds to help them make climate smart infrastructure investments.*	
Fiscal Year Start-Complete	2022 – ongoing
Performance metric	2022 – create SOP to incorporate consideration of climate adaptation into BIL funding. 2023 – number of BIL funding awards considering climate change.
Associated Vulnerability	Continuing Resolutions may impact the awarding of financial resources.

Co-benefits	TBD: this will depend on the specific projects supported.
Resource requirements	Additional staff may be needed to support any influx in grant monies under new legislation.

D. Staff Training:

Train U.S. EPA Region 4 staff on climate change in order to integrate climate change across regional work.

Priority Action 1

Provide training for U.S. EPA Region 4 staff on the principles of climate change, climate change adaptation, and their role in promoting the Region's climate adaptation activities now and going forward	
Fiscal Year Start-Complete	2022 – Ongoing
Performance metric	Complete Training of Regional Staff. (see also Section 6, REGIONAL TRAINING)
Associated Vulnerability	None
Co-benefits	Training will enhance integration of climate adaptation principles into specific job programmatic activities and provide opportunities for integrating activities and leveraging resources to adapt and meet other environmental needs.
Resource requirements	Existing resources, but assistance from Headquarters may be necessary to present to staff assuming a virtual format. Headquarters will be responsible for developing training materials.

E. Partner Engagement:

Consult and partner with states, tribes, territories, local governments, environmental justice organizations, community groups, businesses, and other federal agencies to strengthen adaptive capacity and increase the resilience of the nation, with a particular focus on advancing environmental justice.

Priority Action 1

Provide resources, education, and training for external stakeholders on the principles of climate change and climate change adaptation; on an ongoing basis, provide updated information about opportunities and resources to help them assess and implement adaptation activities going forward.	
Fiscal Year Start-Complete	2023 - Ongoing
Performance metric	Complete initial round of training for external stakeholders.
Associated Vulnerability	Ability to reach all climate affected stakeholders.
Co-benefits	Training will provide states, local, tribes, industry, and communities with a basis for understanding the need to adapt and the available tools and resources to evaluate, plan, and implement adaptation projects.
Resource requirements	Existing resources, but assistance from Headquarters may be necessary to present to staff assuming a virtual format. Headquarters will be responsible for developing training materials.

Priority Action 2

Meet with U.S. EPA Region 4 state, local, tribal, and other key stakeholders to catalog their current adaptation work and identify gaps where U.S. EPA Region 4 can assist.	
Fiscal Year Start-Complete	2022 - Ongoing
Performance metric	Developed catalog of adaptation work in each state, the key stakeholders performing the work, and identified needs and opportunities for U.S. EPA Region 4 assistance.
Associated Vulnerability	Ability to identify all stakeholders performing adaptive-related work across the region.
Co-benefits	TBD: this will depend on the projects that are implemented through this process.
Resource requirements	Existing, but assistance from Headquarters may be necessary to help identify all relevant stakeholders (i.e., those known to HQ, but not to the Region).

Priority Action 3

Perform a targeted assessment to determine areas of focus for providing resources, education, and training to external stakeholders. Emphasize areas where climate change impacts will be the greatest and communities would be disproportionately affected.	
Fiscal Year Start-Complete	2022 – 2023
Performance metric	Completion of the assessment and a resulting list of areas of focus.
Associated Vulnerability	Based on available information, an inability to adequately identify all communities disproportionately impacted by climate change.
Co-benefits	Partnership building and focused planning to address areas with the most pressing needs but the least ability to adapt.
Resource requirements	Health, demographic, and downscaled climate data, analysis tools, and expertise to fully assess and capture critical areas of focus at a local level.

Priority Action 4

Develop and launch a U.S. EPA Region 4 "one-stop" internet site for southeastern climate adaptation stakeholders to include climate adaptation tools, resources, funding opportunities, an interactive map of climate adaptation projects in U.S. EPA Region 4, and links to U.S. EPA Region 4 state, local, and tribal climate adaptation programs.	
Fiscal Year Start-Complete	2023
Performance metric	Develop and launch prototype in FY23.
Associated Vulnerability	Limits on staff resources to find all the information, build the platform, and keep it up-to-date and relevant.
Co-benefits	A one stop shop will allow stakeholders to quickly identify issues, analyses, collaborators, and resources to address adaptation issues (not have to reinvent the wheel).
Resource requirements	This will be a significant effort and may require additional FTE to gather the information, create the website, and maintain it going forward.

Priority Action 5

Consider climate change in future communications and publications; and evaluate and revise, if appropriate, existing communications and publications to incorporate climate change considerations.	
Fiscal Year Start-Complete	2023
Performance metric	Developed procedures to (1) incorporate climate change into future communications and publications; and (2) review/evaluate/revise existing communications and publications to include climate change.
Associated Vulnerability	Limits on staff resources to develop SOPs.
Co-benefits	Increase awareness of climate change through repeated messaging.
Resource requirements	Existing resources.

F. Accountability:

Measure and Evaluate Performance

Priority Action 1

Develop U.S. EPA Region 4-specific goals, metrics, and a tracking system to evaluate and report progress in adaptation activities both internally and at the external stakeholder level. Track and report on national metrics.	
Fiscal Year Start-Complete	2022 and 2023 – Ongoing
Performance metric	Provide requested input to national metrics reporting. Determine if additional regional metrics are needed (2022) and report on these as well (2022, 2023, ongoing)
Associated Vulnerability	Ability to develop and track data necessary to show meaningful progress in building adaptation in U.S. EPA Region 4 internal assets and in communities across the Southeast.
Co-benefits	Tracking will show where we are making progress and refocus efforts where we are not.

Resource requirements	Existing resources.

6 REGIONAL TRAINING

Developing a sound knowledge base will be the primary focus of training efforts across staff during the coming year. As part of the on-boarding process, the Mission Support Division will work with the U.S. EPA Administrator's Office of Policy to begin implementation of the Climate Adaptation 101 training for all new employees. In addition, existing staff will begin taking the 101 training. The 101 training will use the materials developed by the Office of Policy and will be augmented to present U.S. EPA Region 4 specific information (e.g., who works on Adaptation in the Region, some of projects being carried out by U.S. EPA Region 4 partners).

National Program Managers (NPMs) are developing training programs that will be specific to Long-term Performance Goals for their mission critical responsibilities. Three trainings are expected to be available for program staff in Fiscal Year 2022 and the remaining NPMs are projected to be completed in 2023. Trainings will provide the foundation for staff to not only understand the basics of climate adaption efforts, but also the implication for these challenges for implementing program specific goals and objectives. In addition, program specific trainings will improve the ability of staff to integrate climate adaptation into their work and assist with achieving the Priority Actions in the U.S. EPA Region 4 Climate Adaptation Implementation Plan.

Table 6. Tentative Schedule of Training Module Release Dates and Training

Climate Adaptation Training Module by Lead Office	Tentative Training Modules Available	Tentative Administration	Targeted Staff and Management Trained
Office of Policy (OP) Climate Adaptation 101	Fall 2022	Winter 2022, Continuous New Hire	All U.S. EPA Region 4 Employees
Regulation Writers	End of 2022	Spring 2023 & 2024	All U.S. EPA Region 4 Employees
Office of Water (OW)	End of 2022	Spring 2023 & 2024	All WD
Office of Land and Emergency Management (OLEM)	End of 2022	Spring 2023, Spring 2024	LCRD & SEMD
Office of Air and Radiation (OAR)	End of 2023	Spring 2024	ARD
Office of Chemical Safety and Pollution Prevention (OCSPP)	End of 2023	Spring 2024	LCRD
Office of Enforcement and Compliance Assurance (OECA)	End of 2023	Spring 2024	ECAD
Office of Mission Support (OMS)	End of 2023	Spring 2024	MSD
Office of Homeland Security (OHS)	End of 2023	Summer 2024	All U.S. EPA Region 4 Employees
Office of International and Tribal Affairs (OITA)	End of 2023	Summer 2024	All U.S. EPA Region 4 Employees
Office of Research and Development (ORD)	End of 2023	Summer 2024	All U.S. EPA Region 4 Employees

7 SCIENCE PRIORITIES

U.S. EPA's Office of Research and Development (ORD) has been working with Regional and National Program Offices to identify the Agency's Fiscal Year 23-26 Strategic Research Action Plan (StRAP). U.S. EPA Region 4 developed cross-division science needs to support the ORD Climate Research Workshop held in late 2021 in anticipation of a concerted effort at developing a whole of Agency approach to supporting program activities for the coming years.

A. Issues of Concern

ORD was interested in understanding the regional context of issues the Agency will be addressing across the country. In U.S. EPA Region 4, there were four key areas that were identified as important areas of concern. These included impacts from sea level rise, freshwater availability, human health, as well as impacts to ecosystem and agriculture. The top concerns for each of these impact areas that could use additional scientific understanding included.

Sea level rise impacts on coastal resources and infrastructure

- Erosion of shorelines, wetland inundation and impaired operation of coastal infrastructure.
- Low-lying coastal areas at higher risk from frequent flooding and storm surge.
- Flooding impacts on stormwater drainage systems, seawater inundation and slow draining.
- Economic impact of damages to build infrastructure: road, rail, water, ports, oil, and gas.
- Long-term effectiveness of Superfund remedial/removal actions in marshes and uplands.

Impacts of climate-related factors on freshwater availability

- Sea level rise, hurricane activity and storm surge stresses of salinity to coastal ecosystems.
- Temperature changes to evaporation, water loss from plants, and freshwater availability.
- Saltwater intrusion into coastal drinking water supplies and new drilling impacts inland.
- Increased demands for agricultural irrigation water.
- Impacts to Superfund groundwater remedial actions.

Impacts on human health

- Heat wave impacts to heat stress, respiratory illnesses, and heat-related deaths.
- Warm waters and spread of bacteria and frequency of climate-sensitive disease outbreaks.
- Harmful algal blooms and disease-causing organism illness from algae produced toxins.

- Drought driven wildfire air quality and direct injury impacts.
- Increased vector-borne disease transmission and spread.
- Emergency management and health implications from flooding and hurricane intensity.

Impacts to ecosystems and agriculture

- Crop pesticide changes from freshwater declines, saltwater intrusion, land loss, and drought.
- Food production changes on vulnerable communities and subsistence practices.
- Economic implications of heat stress to dairy cows, poultry, and other livestock production.
- Sea level rise salinity impacts on estuaries, wetlands, tidal rivers, and swamp ecosystems.
- Barrier islands loss impacts on inland habitats and loss of important fishery habitats.
- Ocean warming challenges to seafood harvest, migration patterns and species presence.

B. Collaboration Opportunities

Science will need to support working with new and existing partners, and the Region will need to identify adaptation and mitigation strategies as well as incentives to address the concerns noted above. Innovation in tools to support capacity of local communities have been a focus of U.S. EPA for several years. Some of these new tools can be adapted to prepare communities for extreme events.

New approaches to working with greenspace valuations in adapting to climate change could provide innovation in support of long-term economic sustainability. Green infrastructure technical assistance and stormwater calculators may need to be refined to better understand opportunities and challenges for addressing flooding issues that can adversely impact vulnerable communities. Blue carbon (carbon sinks found in seagrass, mangroves, and tidal marshes) can provide an important benefit to managing storm surges and hurricane impacts in coastal communities. Wetland restoration can provide new opportunities for building resiliency for coastal and inland communities across the Region.

Developing new cost/benefit valuation tools can assist with scaling green infrastructure projects and ecosystem protection strategies for investments in creating resiliency parks for social, environmental, and economic benefits. Better alignment of recreation opportunity developments that leverage habitat conservation, carbon sequestration, wetland mitigation banking, and endangered species crediting can provide a new public/private partnership for rural, vulnerable, and limited capacity communities.

Equitable access to economic resources, greenspace (parks, trails, and recreation) and the social/cultural assets across the Region supports strong community health and wellbeing.

Research opportunities that support collaboration with vulnerable communities and identify U.S. EPA technical and funding assistance resources should be encouraged to support community preparation for recovery planning from flooding, fires and hurricanes that can be employed during initial disaster response efforts.

Valuing urban heat island mitigation and adaptation impacts of tree planting and high albedo surface changes should be developed to support air quality strategies and reduction of adverse health impacts on vulnerable communities. Using light reflective materials and vegetation to improve resiliency of vulnerable populations during heat waves in urban areas can assist with ambient cooling. Tree planting can also assist with flood reduction during increased rain events.

Recreational landscapes improve public health and provide a basis for developing economic opportunities. New impact assessment tools that can evaluate the environmental, human, and economic benefits from connecting existing parks, regional trail systems, cultural and historical assets, and recreational assets are needed to better link downtown businesses districts and economic resiliency development opportunities for rural and vulnerable communities across the Southeast.

C. Supporting Vulnerable Communities

Understanding the needs of communities with limited capacity is critical in allocating resources. Providing equitable access to financial and technical resources that can have a direct impact on risk reduction and ecosystem resiliency benefits will take time and require partnerships that support knowledge of the issues, grant writing skills, project management and strong financial accountability. Community capacity considerations for rural communities and vulnerable populations must be evaluated to balance the resources available.

Identification of important landscapes, distressed economies and vulnerable populations are needed to support climate adaptation in an equitable manner. Some additional challenges to supporting communities include: 1) understanding cumulative and cascading (negative) effects of climate factors on resiliency, 2) connecting all Agency programs and other federal agencies resources in building relationships, 3) developing economic approaches to incentivize more resilient and sustainable planning, 4) integrating resiliency in existing plans to reduce time, energy and resources for recovery, and 5) applying research on nature-based solution benefits to community resiliency planning.

Improving resiliency planning at the local level to achieve more efficient and effective use of resources across city, state, tribal and federal agencies will require time and effort. Solutions driven by community needs should leverage multiple program resources as well as cross federal agency assistance to accomplish environmental, social and economic benefits from a whole of government approach to address climate change and equity issues.

8 CONCLUSION

This plan provides U.S. EPA Region 4 with an opportunity to work more effectively across Divisions in support of some of the most vulnerable populations being affected by climate related impacts. This includes climate-related air quality impacts and the effects on Ozone, $PM_{2.5}$, Urban Heat Island, and Indoor Air Quality on human populations. In addition, contaminated site cleanups occurring under Superfund (such as remedial, time-critical removal, emergency response programs) are intended to be effective long-term. The effects of climate change may result in the need for additional actions.

This is the case with many other U.S. EPA program efforts such as water infrastructure projects and ecosystem protection efforts in the Gulf of Mexico. The natural resources across the Southeast are recognized worldwide for their biological diversity, economic value, cultural heritage, social value and ecosystem services provided. Effectively responding to emerging environmental and public health concerns will continue to place U.S. EPA at the forefront of resilience strategies.

Integrating forward thinking about climate into the actions taken by Agency programs will make them more resilient and protect nearby communities, especially vulnerable populations found near many of our project sites. Though faced with various challenges posed by climate change, this plan provides the foundation needed to ensure effective responses to emerging conservation needs, environmental and public health concerns as well as continuing with existing efforts on conservation and resilience related to climate change. As the Region aligns priority actions, training, and science needs to the vulnerabilities of our communities and natural resources, U.S. EPA is ready for the challenges that will confront our partners across the Region.

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