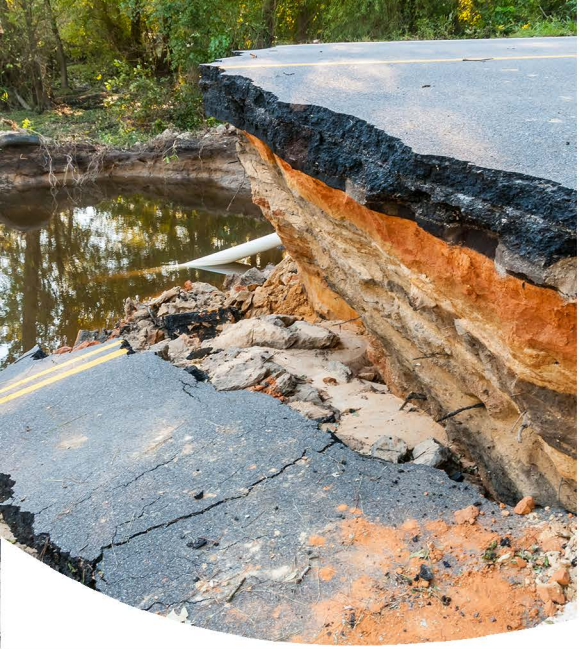


North Carolina

Climate Risk Assessment and Resilience Plan

Impacts, Vulnerability, Risks, and Preliminary Actions

Executive Summary and Key Findings

June 2020

Message from Governor Cooper

From the mountains to the coast, North Carolina is a place of hardworking, resilient people and great natural beauty. In recent years we've faced unprecedented challenges, from hurricanes and flooding to a global pandemic and economic downturn. Climate change is also testing our mettle and affecting everyday life.

We're still recovering from the damage and loss of life inflicted by two 500-year storms—Hurricane Florence and Hurricane Matthew— that hit our state within 23 months of each other. The last ten years are the warmest on record for North Carolina, and 2019 was the single hottest year. Severe storms, flooding, high temperatures, drought, and other climate stressors impact our health, safety, economy and quality of life. They contribute to crop and livestock loss, destroy endangered species and critical habitats, damage government buildings and land, disrupt business operations and economic activity and threaten our state's transportation infrastructure, cultural resources, and energy and water utilities.

As we continue to discover the many ways climate change threatens daily life for North Carolinians, we must take actions that reduce air pollution and increase resilience. Those actions can also create good paying jobs. That is why North Carolina is investing in rural and urban communities, advancing clean energy, transitioning to zero-emission vehicles, and strengthening natural infrastructure. It's also why we are supporting local governments, updating state assets, and investing in a resilient business environment. A resilient North Carolina is a strong and competitive North Carolina.

The latest climate science underscores what we already know firsthand. There will be increased temperatures, continued sea level rise, more precipitation, more intense hurricanes, more severe thunderstorms, and more storm surge flooding.

The good news is that we know the key cause of climate change—greenhouse gas emissions from human activities—and we can help control our own fate while boosting the economy. We can reduce greenhouse gas emissions and reduce our vulnerability to negative climate change impacts. In response to the Climate Crisis, I issued Executive Order No. 80 to call for a 40% drop in statewide greenhouse gas emissions by 2025, establish the North Carolina Climate Change Interagency Council, and direct state agencies to take actions that reduce emissions and strengthen our state. One of those actions is the development of this North Carolina Climate Change Risk Assessment and Resilience Plan.

This plan helps us better understand our vulnerability to climate change and how we can become more resilient to future impacts. It builds upon North Carolina's ongoing work in this area and establishes the North Carolina Resilience Strategy, which includes four elements: (1) the *North Carolina Climate Science Report*, (2) State Agency Resilience Strategies, (3) Statewide Vulnerability Assessment and Resilience Strategies, and (4) the North Carolina Enhanced Hazard Mitigation Plan.

This *Risk Assessment and Resilience Plan* is the culmination of more than a year's worth of work by state agencies and stakeholders, and I thank all who contributed to its thoughtful development. This strategic document reflects the commitment we share in creating a North Carolina where folks are healthier, better educated, and have more money in their pockets so they have opportunities to live more abundant and purposeful lives.

Governor Roy Cooper

Executive Summary

From the world-famous Outer Banks and the majestic Blue Ridge Mountains to the 18 million acres of forest and abundant agricultural resources, North Carolina is famous for its natural beauty and diversity. We are also known for our strong communities and our resilient people. These attributes make North Carolina one of the most visited tourism destinations and one of the top five states for people looking for a new place to call home.

While we enjoy all that North Carolina has to offer, our communities, economy, environment, and natural resources are increasingly at risk from the impacts of climate change. Our state has suffered from multiple natural disasters in recent years. Storms are becoming stronger and more intense, creating an enormous toll on human life, health and our economy. Hurricane Dorian in 2019 was the third significant hurricane to impact the state following Hurricanes Matthew (2016) and Florence (2018). These storms have cost lives, along with billions of dollars in damage and inflicted psychological stress on those whose lives and livelihood have been disrupted many times over.

> ***A resilient North Carolina is a state where our communities, economies, and ecosystems are better able to rebound, positively adapt to, and thrive amid changing conditions and challenges, including disasters and climate change; to maintain quality of life, healthy growth, and durable systems; and to conserve resources for present and future generations***

To make North Carolina more resilient to both climate and non-climate related stressors, Governor Roy Cooper signed Executive Order 80 (EO80) on October 29, 2018, calling for integration of climate adaptation and resilience planning into cabinet agency policies, programs, and operations. The order directed the Department of Environmental Quality (DEQ), with support of other agencies and stakeholders, to prepare the North Carolina Climate Risk Assessment and Resilience Plan (2020 Resilience Plan) and for the Climate Change Interagency Council to submit to the Governor in March 2020. EO80 called for agencies to develop resilience strategies that support communities and sectors of the economy most vulnerable to the effects of climate change and to enhance the state government's ability to protect human life and health, property, natural and built infrastructure, cultural resources, and other public and private assets of value to North Carolinians.

In response to the order, DEQ enlisted assistance from the North Carolina Institute for Climate Studies at North Carolina State University to provide the current state of climate science and change. Representatives from many major higher education institutions in the state and other subject matter experts with national recognition contributed to the development of the North Carolina Climate Science Report (NCCSR). One key finding of the NCCSR is that, "*our scientific understanding of the climate system strongly supports the conclusion that large changes in North Carolina's climate, much larger than at any time in the state's history, are very likely (90–100% probability of outcome) by the end of this century...".* State agencies developing the 2020 Resilience Plan referenced the key findings and executive summary from the NCCSR (contained in Chapter 3) to understand the historical and projected climate trends and how they will impact state assets, programs, and services.

DEQ also enlisted the assistance of federal partners, state universities, local governments, community planners, non-governmental organizations, climate justice leaders, stakeholders interested in nature-based solutions (NBS), and other interested partners to help cabinet agencies develop the 2020 Resilience Plan.

The National Oceanic and Atmospheric Administration's (NOAA) Climate Program Office and UNC Asheville's National Environmental Modeling and Analysis Center (NEMAC) supported the agencies in applying the U.S. Climate Resilience Toolkit. Following 11 months of collaborative work, this document lays out the groundwork for focusing the state's attention on climate resilience actions both within government and together with business, academic, nonprofit, and community partners. It recognizes that climate change adaptation and the concept of resilience to improve our ability to adapt and recover from future disasters are extremely complex processes.

As detailed in the sector-based analysis, there is no single means of response. Adaptation and resilience planning needs to be highly integrated processes that occur on a continuum, across all levels of government, and involving many internal and external partners and individual actions. It also calls for collaborative work with policy makers to make informed decisions and secure financial resources to implement long-range strategies that protect people and property.

This 2020 Resilience Plan establishes the North Carolina Resilience Strategy, which is a compilation of documents organized into four elements: (1) The North Carolina Science Report, (2) State Agency Resilience Strategies, (3) Statewide Vulnerability Assessment and Resilience Strategies, and (4) the state of North Carolina Enhanced Hazard Mitigation (EHMP). This plan provides updates to elements one through three, as explained further in Chapter 7.

This plan provides the following important output: (1) our best understanding of the projected change in the climate; (2) climate justice considerations; (3) state infrastructure, assets, programs and services within 11 critical sectors that are vulnerable and at risk to climate and non-climate stressors; (4) preliminary actions currently underway or which could be taken to reduce the risk for at least three example vulnerability areas; and (5) recommendations for nature-based solutions to enhance ecosystem resiliency and sequester carbon in the state's natural and working lands (NWL). The process has led to many lessons learned, particularly the importance of increased collaboration between state agencies and statewide partners to facilitate goal setting and building internal capacity to develop long-range strategic actions.

The 2020 Resilience Plan concludes by describing next steps for implementing and updating the North Carolina Resilience Plan as well as strategic cross-cutting resilience initiatives. The Resilience Team in the North Carolina Office of Recovery and Resiliency (NCORR) will lead and coordinate state resilience planning and implementation, with support from state agencies, local governments, businesses, and community stakeholders. Elements to be addressed in future updates include: (1) incorporating new decision relevant science information, (2) state agencies expanding and implementing strategies for the 11 sectors studied, (3) developing an action plan for cross-cutting challenges, and (4) incorporating the action plan into the EHMP, which is submitted every five (5) years to the Federal Emergency Management Agency (FEMA). Supporting this ambitious path will require adequate staff, funding, expertise, time and support. Each agency will then be able to develop resilience priorities and actions that are implemented equitably and inclusively across North Carolina.

This plan is intended as a framework to guide state action, engage policy-makers and stakeholders, and facilitate collaboration among many partners to protect the state against high-impact, low frequency weather events. It serves to address underlying stressors such as the changing climate, aging infrastructure, socio-economic disparities, and competing development priorities. Strategies to advance adaptation, resiliency, and mitigation are necessary key steps.

The 2020 Resilience Plan moves North Carolina to become more resilient to the impacts of climate change, even as we work to limit the magnitude of that change by reducing greenhouse gas emissions and transitioning to clean energy. By setting clear goals, taking action, and evaluating progress on a regular basis, North Carolina can make certain that our resilient state thrives amid changing conditions and challenges.

Key Findings and Recommendations

The 2020 Resilience Plan is organized as shown in Figure 1-1 below. The discussion in this chapter highlights key findings, messages, recommendations, and next steps to taking further action.

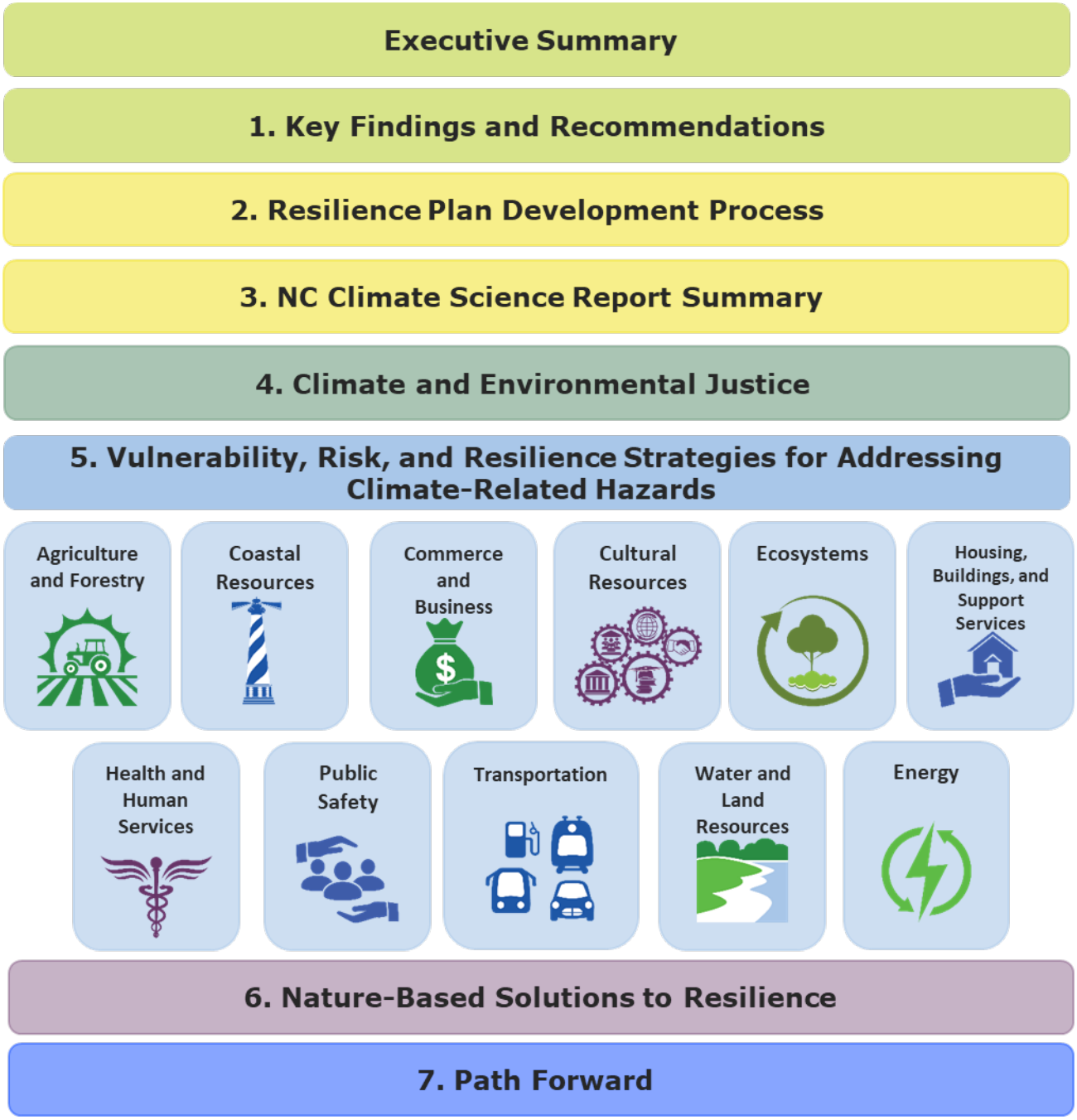
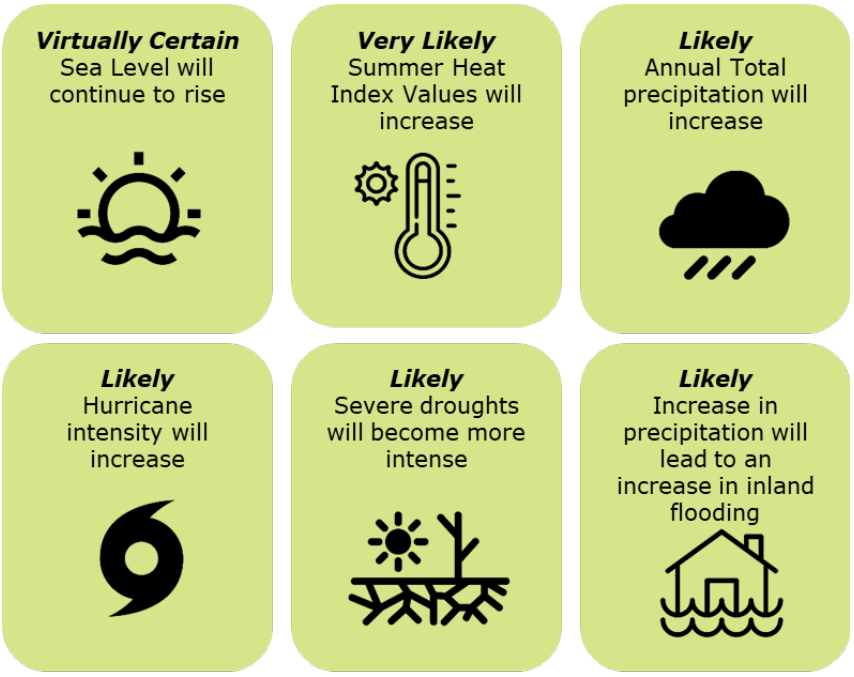


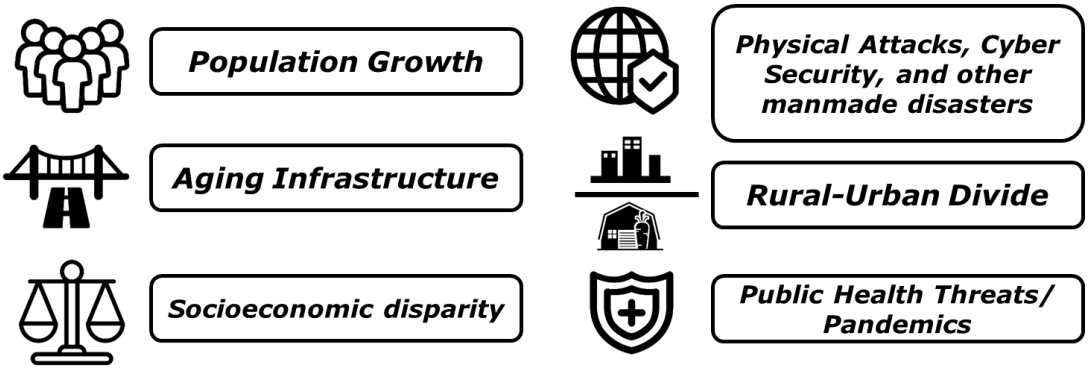
Figure 1-1: Document layout

A. Climate Change Projections in North Carolina[1]



Virtually Certain= 99-100% probability of outcome
Very Likely= 90-100% probability of outcome
Likely= 66-100% probability of outcome
About as Likely as Not = 33-66% probability of outcome
Unlikely= 0-33% probability of outcome
Very Unlikely= 0-10% probability of outcome
Exceptionally Unlikely= 0-1% probability of outcome

B. Non-Climate Stressors facing North Carolina



[1] Kunkel, K.E., D.R. Easterling, A. Ballinger, S. Bililign, S.M. Champion, D.R. Corbett, K.D. Dello, J. P. Dissen, G.M. Lackmann, R.A. Luettich, Jr., L.B. Perry, W.A. Robinson, L.E. Stevens, B.C. Stewart, and A.J. Terando, 2020: *North Carolina Climate Science Report*. North Carolina Institute for Climate Studies, 233 pp. https://ncics.org/nccsr

C. Climate Hazards Facing North Carolina[2]

Average and Extreme Temperatures

- Although regional changes in temperature can vary from global changes, it is ***very likely*** that North Carolina temperatures will also increase substantially in all seasons. Annual average temperature increases relative to the recent climate (1996–2015) for North Carolina are projected to be on the order of 2°–5°F under the current emissions scenario and 2°–4°F under a lower emissions scenario by the middle of this century.
- It is ***likely*** that the number of hot and very hot days will increase and the number of cold days (daytime maximum temperatures of 32°F or lower) will decrease.
- Warmer nights will ***very likely*** increase, reducing relief from the heat of the day and increasing heat-related stress on public health; households and people who lack access to sufficient cooling will be most vulnerable.
- Health-related problems due to heat stress such as respiratory issues will increase, young people, people of low socioeconomic status, and the elderly are especially vulnerable.
- Extreme heat events will become more frequent, longer lasting, and more intense, exacerbating demands for water.
- Plants and animals that rely on cooler temperatures may not be able to thrive in warmer temperatures and may migrate to cooler areas, and/or be out-competed for by other more heat-tolerant species.
- Warmer nights will put more stress on agricultural crops that depend on nighttime cooling.

Drought

- More intense droughts in the future due to climate change are ***likely***. This will put further stress on agriculture, forestry and municipal and agricultural water resources, causing widespread economic damage.
- Water shortages due to drought increase the risk of catastrophic wildfires, and temporarily reduce the availability of suitable habitat for wetland and aquatic animal populations.
- It is ***likely*** that future severe droughts in North Carolina will be more intense due to higher temperatures leading to more heat stress for public health, especially people who work outdoors.
- It is ***likely*** that future severe droughts in their multiple forms in North Carolina will be more **frequent** and intense due to higher temperatures leading to increased evaporation. As a result, it is ***likely*** that the frequency of climate conditions conducive to wildfires in North Carolina will increase.

Heavy Precipitation and Storms:

- Heavy precipitation accompanying hurricanes and other weather systems is ***likely*** to increase, thus increasing the potential for flooding in inland and coastal areas.
- Energy infrastructure located along inland watersheds and coastal areas will be further subject to changes in river discharge and flooding from heavy precipitation events.
- Heavy precipitation from more intense and frequent storms can cause significant damage to public and private structures such as homes, roads, utility services, etc.

[2] For a complete assessment of historical and projected climate trends in North Carolina under increased greenhouse gas concentrations, see summary of the North Carolina Climate Science Report in Chapter 3: NC Climate Science, or the full North Carolina Science Report in Appendix A.

- Vulnerable populations are most at risk of flooding and may have difficulty evacuating when necessary.

Wildfires

- Higher average temperatures and more severe droughts will lead to an increased likelihood of conditions conducive to wildfires.
- Increases in wildfires will pose a major risk for human health and emergency services, putting more lives at risk of fire related injuries, fatalities, and losses.
- Conditions more conducive to wildfires leave residents, businesses, infrastructure, forestry, and agricultural assets more at risk of related economic damages.
- Increases in population will amplify the public safety risks associated an increase in the wildfire urban interface, which increases the potential for more economic and public damage.
- More intense wildfires due to climate change will negatively impact air quality because of more fine particles in the air, exacerbating health issues such as asthma.

Coastal Flooding and Coastal Erosion

- It is ***virtually certain*** that sea level along the North Carolina coast will continue to rise due to expansion of ocean water from warming and melting of ice on land.
- It is ***virtually certain*** that rising sea level and increasing intensity of coastal storms will lead to an increase in storm surge flooding in coastal North Carolina.
- High tide flooding will a near daily occurrence at some points along the coast in the future.
- Cultural resources in fixed locations are inherently sensitive to flooding and it is difficult to reduce sites' exposures to flooding.
- Sea level rise and flooding will limit available land that is in high demand for both human (economic) and ecosystem services.
- More frequent coastal flooding will impact coastal habitats, fisheries, and the protective services that natural areas provide to local communities.
- Increased storm surges will erode shorelines and kill vegetation in maritime grasslands, tidal marshes, estuaries, lower reaches of coastal plain rivers, and low-lying wetlands near estuaries.
- Coastal erosion will reduce habitat for freshwater tidal wetlands, maritime uplands, and maritime wetlands.
- Endangered and threatened species that are vulnerable to storm surge and erosion on beaches are likely to decline.
- Coastal erosion will leave properties further at risk of flooding and storm damage, due to land or natural buffers being lost.

Hurricanes

- Intensity of the strongest hurricanes is ***likely*** to increase with warming of the oceans and atmosphere, leading to greater damage to people, communities, our economy and natural resources from more intense hurricanes and accompanying flooding and precipitation.
- More intense hurricanes will further damage wetlands and natural barriers which help to protect infrastructure and communities from storm surge, increasing the vulnerability to subsequent storms.
- Stronger hurricanes will destroy or damage public and private buildings and property.

- Vulnerable communities will be most at risk of flooding occurrences due to hurricanes; with hurricanes happening in short succession, vulnerable communities will struggle to recover between hurricanes.

Inland Flooding

- Increases in extreme precipitation is ***likely*** to increase inland flooding in North Carolina.
- Inland communities across the state are at risk from flooding due to extreme precipitation and outdated and/or undersized storm drainage infrastructure.
- Increased inland flooding caused by extreme precipitation events will further increase economic and agricultural losses after a flooding event.
- More frequent flooding will impact inland habitats, fisheries, and the protective services that natural areas provide to local communities.
- Flooding will continue to damage archaeological and historic sites on floodplains across all three physiographic regions and within every river basin in the state.
- Increased or more frequent flooding may inundate and potentially destroy more cultural resources.

Ecosystems and Habitat Loss

- Harmful algal blooms may increase due to warmer temperatures.
- Loss of organisms that rely on calcium-based shells such as oysters and clams, and organisms dependent upon them for food or habitat will be harmed by ocean acidification.
- Loss of wetlands due to sea level rise will result in habitat losses that will impact both commercial and recreational fisheries, decrease buffering capacity, adversely impacting water quality, and reducing the resilience of coastal communities.

Saltwater Intrusion

- Higher water levels due to sea level rise threaten otherwise productive land, leading to agricultural and economic losses.
- Increased saltwater intrusion due to sea level rise is expected to change the salinity of estuarine communities and to convert lower coastal floodplains from swamp forest to wetlands.
- Saltwater intrusion due to climate change will make drinking water from both groundwater and surface waters more vulnerable to contamination and/or expensive to treat and secure.
- Intrusion in freshwater sources can cause crop yields to decline and farmland to be unsuitable for growing crops due to high salinity and less available freshwater, leading to a loss of revenue in agriculture.

Public Health

- Cumulative hazards from heat and flooding are harming human health through poor air quality, flooding injuries, heat-related illness, decreased mental health, and increased infectious diseases.
- Existing inequities in environmental health exposures are exacerbated by climate change; older adults, children, low-income earners, communities of color, and veterans are disproportionately harmed.
- Changing climate can increase the areas where disease-carrying vectors such as mosquitos are present.
- Extreme weather events will put more stress on emergency management, public services, and institutions, and will require more resources to address the impacts. It will also further increase the frequency, magnitude, duration, or scale of the responses to hazards in North Carolina.

Population Growth and Other Hazards

- North Carolina's population is expected to increase, leading to more urban heat island effects and creating more heat and water related stress on people.
- Development due to population growth will lead to loss of habitat, species and natural buffers that protect communities from extreme precipitation.
- More severe climate disasters will further interrupt business activities for North Carolina's economy.
- An increase in impermeable surfaces causes more water to get funneled downstream, leading to more flooding of farmland, forested lands, and rural communities.

D. Key Observations and Recommendations: State Agency Assessment[3]

1. Agriculture and Forestry

Key Observations

- Agriculture, forestry, and endangered native plants are tied to climate due to biological, physiological, and ecological constraints. Elevated night-time temperatures will have outsized negative impacts due to disruptions in plant physiology.
- The agriculture and forestry industries must attract and retain experienced personnel as well as maintain equipment to meet a growing set of hazards.

Critical Impacts and Resilience Strategies

- Inland flooding is the greatest climate-related hazard to North Carolina Department of Agriculture and Consumer Services (NCDA&CS) assets (research stations, state forests, and nurseries) and to private farms and forests. Must focus on adaptive capacity (e.g., levees) to protect crop and pasture lands statewide.
- Research and development are needed on adaptive varieties and species for crops, livestock, and poultry to more resistant to extreme heat.
- Education of stakeholders can provide adaptive capacity for drought and wildfire. This is personnel-intensive and personnel are currently directed toward response.
- Protecting North Carolina's endemic and nearly endemic species, species that exist only in our state or a handful of places is a unique responsibility of the state.
- Regenerative practices that sequester carbon.

[3] With guidance and facilitation from National Oceanic and Atmospheric Administration's (NOAA) Climate Program Office, UNC Asheville's National Environmental Modeling and Analysis Center (NEMAC) and North Carolina Institute for Climate Studies (NCICS), State agencies used the U.S. Climate Resilience Toolkit to qualitatively assess the exposure, vulnerability, and risk of agency assets, programs and services to climate-related hazards. Out of 744 impact pairs identified, agencies undertook an abbreviated assessment for a subset of potential impacts and conducted risk assessments for 48 impact pairs. The key observations and recommendations presented here explore state agency vulnerability and provides resilience strategies to take action for this subset.

2. Coastal Resources and Infrastructure

Key Observations

- Flooding from storms and extreme tides, magnified by sea level rise, is severely affecting land use, public infrastructure, and natural resources along the coast of North Carolina
- The intensity of recent storms and flooding have challenged the state's response and recovery plans. We should plan for greater extremes in the future.
- Climate hazards intensify existing social inequalities and lack of ability to adapt in economically challenged counties in the coastal region.

Critical Impacts and Resilience Strategies

- Climate change is impacting coastal habitats, fisheries, and the ecosystem services provided in coastal communities. State monitoring, research, and education can enhance understanding of impacts and potential adaptation strategies.
- Immediate focus must be on developing strategic priorities for public and natural infrastructure improvements as well as actions that integrate climate resiliency into agency operations, local disaster recovery programs, and long-term planning.
- Future climate conditions and resiliency should be integrated into current public investment decisions in local and regional water and transportation infrastructure improvements and other critical assets.
- State leadership should model adaptive behavior and incentivize local resiliency efforts that balance protection of life, property, and the environment. Inter-agency coordination can help build local capacity and action through funding and technical assistance.

3. Commerce and Business

Key Observations

- The greatest impact of recent climate hazards was business interruption. Getting people back to work and transitioning to a more resilient economy are critical.

Critical Impacts and Resilience Strategies

- Supporting rural economies with education, training and additional resources.
- Public/private partnerships help leverage risk. Government can help build resilience into infrastructure, which helps lower risks for small businesses.
- Include resilience training in North Carolina Main Street and Rural Planning programs for small towns and Main Street communities along with the businesses they support.
- The business sector needs to drive continual improvement of resource optimization.

4. Cultural Resources

Key Observations

- Cultural resources such as state and local historic sites and museums are irreplaceable, making them inherently sensitive to sea level rise and the increasing frequency and severity of heavy precipitation and flooding.
- The North Carolina Department of Natural and Cultural Resources (DNCR) is active across all 100 counties, so resources are limited. The threat of the hazard is growing.
- DNCR has regulatory authority over destruction of any public records managed on a local level.
- Much of the technical and constituent services for cultural assets are provided in a collaborative

environment with federal, state, local, and private interests all having a stake in the solutions.

Critical Impacts and Resilience Strategies

- There is no single solution to protect cultural assets from "water where it doesn't belong".
- The focus for now, and in the near-term, should be building resilience into assets owned and managed by the state, such as state museums, historic sites and parks.
- DNCR must provide greater services such as technical assistance to locally-owned cultural resources
- Develop and enhance federal, state, local, and private partnerships to build cross-boundary resiliency capacity for cultural assets.

5. Ecosystems

Key Observations

- The North Carolina Natural Heritage Program assessed ecosystem vulnerability in 2010 and updated the assessment in 2019.
- Ecosystems in all 100 counties are affected by climate change and numerous land use changes that have occurred in recent decades.
- The ecosystems with the highest risk support a high concentration of rare species and have a low tolerance of environmental variation.
- Ecosystems are shaped by climate. Human impacts reduce ecosystems' natural resilience to disturbance and change.
- Conserving and managing land for key ecosystems yields benefits to other sectors, including water resources, tourism and commerce, and public health.
- Minimizing non-climate stressors will reduce the overall stress on ecosystems and help avoid catastrophic change and loss.
- Need multi-agency understanding of the financial value of ecosystem services.

Critical Impacts and Resilience Strategies

- To improve overall landscape resilience, create nature preserves as large as possible and maintain habitat connectivity across the landscape.
- Preserve and restore wetlands and natural areas alongside rivers and streams.
- Manage land for natural processes, such as prescribed fire and restoration of natural stream flows.
- Establish natural recreation areas such as parks, trails, and greenways that will improve resilience and public health, and become valued community assets that improve quality of life.
- Increase public awareness of the importance of land conservation, planning for resilience, and the value to people of ecosystem function and services.
- Business must adopt biomimicry practices to provide holistic regenerative economic value.

6. Health and Human Services

Key Observations

- The health of the environment impacts the health of all people.
- Cumulative hazards from heat and flooding are diminishing health.
- Existing inequities in environmental health exposures are exacerbated by climate change.

Critical Impacts and Resilience Strategies

- Ongoing medical and public health services to residents are impacted.
- Increased staffing needs during hurricanes, especially for NC Emergency Operations Center, emergency shelters, coordinating emergency services, and seeking administrative waivers for benefits.

- Need additional support for North Carolina Department of Health and Human Services (DHHS) programs: Building Resilience Against Climate Effects program, Back@Home program, mold and moisture education, and infectious disease tracking.
- Strategies for creating resilience should address existing toxic exposures, such as hazardous waste and lead in water or homes, in low-income communities and communities of color.

7. Housing, Buildings, and Support Services

Key Observations

- Critical infrastructure and cross-agency assets make this sector important but difficult to prioritize.
- Need to have detailed, quantified risk assessments at a local level.

Critical Impacts and Resilience Strategies

- Flooding is the biggest hazard.
- Aging infrastructure is vulnerable, so many solutions will be costly and take time to implement.
- State-managed recovery is an immediate and growing need which shows that building resilience is important to reduce recurring impacts.
- Meet the growing demand of housing for veterans. Promote building resilience strategies for vulnerable VA hospitals.
- Waste management and its planning are important prior to and after any damage caused by environmental impacts.

8. Public Safety

Key Observations

- A permanently funded resiliency office, requiring personnel and budget, is needed.
- Public Safety is the largest state government cabinet agency with over 25,000 employees. It manages response and recovery for climate hazards and the growing number strains resources. North Carolina is viewed as a nationwide leader for these services.
- Resilience services will require greater interagency support and resources. Operational, logistical, maintenance, and resiliency challenges are synergistic in nature. All must be simultaneously addressed.
- Correctional facilities will require substantial upgrades. North Carolina is responsible for the custodial care of more than 35,000 inmates and 200 juveniles, vulnerable groups with higher exposure and low adaptive capacity.

Critical Impacts and Resilience Strategies

- Building resilience into critical infrastructure that supports response and quality of life must be an immediate priority.
- Working with local governments to build resilience is critical but will require time to build trust, institute new policies and regulations, and properly allocate resources.
- Long-term master planning is needed to determine the most cost-effective means to address, maintain, and operate resiliency plans through their life cycles.
- New and more strategically located facilities may serve well during a natural disaster.
- Training, tabletop exercises and continuity of Operation Plans for each of our divisions need to occur on an annual basis.

9. Transportation

Key Observations

- The core of North Carolina Department of Transportation (NCDOT)'s is to connect people, products and places safely and efficiently is heavily impacted by a growing number of climate-related hazards.
- NCDOT directly owns and maintains a large and diverse number of assets statewide. Storm-related damages are threatening public safety, creating economic disruptions, and causing budgetary shortfalls that require a strategic refocusing.

Critical Impacts and Resilience Strategies

- Maintaining critical connections and access must be the immediate near-term priority, whether along the coast during major storms, in the piedmont during heavy precipitation, or in the mountains due to landslides.
- All modes of transportation must be assessed for resilience to build adaptive capacity and redundancy moving forward.
- NCDOT is committed to collaborating and partnering with communities and businesses to build the resilient infrastructure they require.
- NCDOT will develop and apply resilience policies in three main areas: (1) long range transportation planning; (2) individual project planning and design; and (3) operations and maintenance.

10. Water and Land Resources

Key Observations

- Reliable, clean supplies of freshwater and land resources are essential to human and ecological health.
- Water availability affects all sectors and is vulnerable to climate change and increased demands from a growing population.
- The Water and Land Resources sector has directly managed assets and provides a number of services that require a uniquely trained and experienced workforce.
- Water infrastructure funding programs cannot meet existing demand to help communities meet their water infrastructure needs without considering additional needs due to climate change.

Critical Impacts and Resilience Strategies

- Dam and water infrastructure impacts from flooding are a big concern.
- Landslides are increasing due to extreme rainfall events.
- Water quality impacts to our drinking water and ecosystems as a result of polluted runoff are a continuing issue. Sediment is the largest pollutant by volume of our surface waters and carries excess nutrients and many other pollutants with it.
- Stormwater requirements and design specifications including rainfall intensity statistics should be assessed for future needs and revised as needed.

11. Energy

Key Observations

- Energy drives commerce, transportation, environmental controls, emergency response, agriculture, housing, and many other parts of our economy and therefore solutions must be integrated across these sectors.
- Energy resources, regulations, technology innovation, consumer demand, carbon reduction goals, and market pressures are rapidly changing the industry. This creates an opportunity to build resilience through the modernization of the energy supply and delivery infrastructure.
- North Carolina utilities, regulators, policy makers, energy planners, and emergency response planners should develop resiliency metrics to quantify human and economic costs of power

outages and apply a risk-based framework to accelerate decision making related to energy infrastructure planning and operations.

Critical Impacts and Resilience Strategies

- Disruptions to the electric power grid from increased storm intensity can be mitigated by securing a diverse source of utility scale and distributed generation assets such as microgrids equipped with renewable energy and battery storage devices, hardening the grid/transmission infrastructure, reducing demand for power, and modernizing existing grid assets with smart meters, controllers, automation, and analytics to manage a diverse source of power supply, transmission, and distribution system components.
- Stress on thermoelectric power plant cooling due to drought can be addressed with non-traditional water and energy sources, water capture and dry cooling to protect water quantity and quality, and demand side management programs.
- Fuel supply chains disruption from increased storm intensity may benefit from alternative fuel infrastructure and hardening existing pipelines, terminals, and fuel stations to facilitate evacuation routes and protect critical infrastructure.
- The North Carolina Disaster Recovery Framework, led by NC Emergency Management, should expand to focus on how to integrate resiliency planning for both storm-related outages and cyberattacks into its disaster recovery planning. The effort should evaluate how new and existing infrastructure can best be deployed to reduce recovery efforts.

E. Climate Justice Recommendations

To address the climate justice issues described in this chapter, the following recommendations are put forth by the authors of this chapter. These recommendations should be implemented with sufficient funding, staff or contracting support, as well as interagency cooperation to ensure effective action. Table 1-1 lists recommendations for cabinet agencies, Table 1-2 lists recommendations for the entire state government, and Table 1-3 lists research related recommendations.

Table 1-1: Climate Justice Recommendations for Cabinet Agencies

Entity Responsible	Recommendation
Interagency Climate Council	Develop an equitable public participation framework for all climate change mitigation and resilience efforts. For use by state agencies as well as boards and commissions.
	Design an interagency process to survey and educate staff on unified definitions of equity, vulnerability, climate risk, resilience, and other terms needed to demonstrate state's understanding and to ensure common ground within resilience work.
	Release a North Carolina Climate Justice Report as part of future North Carolina Resilience Plans with opportunities for public involvement.
North Carolina Emergency Management	Increase emphasis on communication with non-English speakers, older adults, rural communities, etc. Explore new risk communication methodologies.
	Continue to update existing state hazard mitigation, emergency preparedness, and response plans with increased emphasis on protecting, communicating with, and serving low-income populations, communities of color, older adults and people with disabilities during and after emergencies.
	Continue to support development of local hazard mitigation plans.
	Provide recommendations and guidance to local governments on maximizing the quality and effectiveness of local or regional hazard mitigation plans, especially in rural areas.
	Provide recommendations and guidance on stakeholder engagement in development and implementation of meaningful hazard mitigation plans and the inclusion of equity, diversity, and inclusion in local plans.
North Carolina Office of Recovery and Resiliency	Increase communication and interaction with all communities, including (especially) vulnerable and historically marginalized communities.
	Develop university partnerships to address gaps in research on climate resilience, especially issues that affect populations differently, and to offer capacity in the state to smaller and more rural communities to do effective and equitable resilience work.
	Develop a strategic plan for resilience-focused capacity building within socially vulnerable communities.

Entity Responsible	Recommendation
	Assist local governments in identifying additional resources to aid in advancing resilience.
	Seek funding that would be distributed to fund community-based resilience projects.
	Create a Local Government Climate Resiliency Toolkit.
	Create and strengthen working relationships among state agency advisory boards that focus on equity and inclusion, such as the DEQ Environmental Justice and Equity Advisory Board.
NC Department of Commerce	Set aside clear, numerical percentages for the number of newly established jobs/contracts/projects that should go to vulnerable communities & for which historically marginalized business receive priority bidding.
	Partner with the DOA Office of Historically Underutilized Businesses, NC Institute of Minority Economic Development, and other entities to increase outreach efforts of bidding and contracting opportunities for marginalized communities.
	Increase outreach efforts in impacted communities.
	Leverage Disaster Recovery Funds and other sources of capital to promote equitable job creation and inclusive business development in communities most vulnerable to climate change.
NC Department of Environmental Quality	Provide updated mapping when detailed climate projections come out, including overlap with socially vulnerable communities using 2020 Census and other up-to-date data.
	Continue enhanced engagement strategies for potentially underserved communities and translation and interpretation services for non-English speakers (as laid out in the DEQ's Public Participation and LEP Language Access Plans).
	Pursue continuation and expansion of Weatherization Assistance Program (WAP).
NC Department of Health and Human Services	Support the Building Resilience Against Climate Effects (BRACE) program and expand the tracking of epidemiological health impacts of climate change in North Carolina.
	Support increasing Back@Home initiative funding (post Hurricane housing initiative) to $16 million.
All Agencies Administering Disaster Recovery Funds	Increase outreach efforts in impacted communities. Implement a coordinated, strategic approach to increase communication and interaction, with an emphasis on vulnerable and historically marginalized communities.
	Offer adequate social services support to North Carolinians navigating the multitude of government processes during recovery.

Entity Responsible	Recommendation
	Increase the ability of community groups to communicate with state agencies on disaster recovery needs and the effectiveness of disaster recovery efforts
	Publish clear percentages of newly established jobs or contracts that should go to vulnerable communities and for which historically marginalized businesses receive priority bidding. Increase outreach efforts for hiring in communities where work will be completed.
	Continue to partner with the DOA Office of Historically Underutilized Businesses, NC Institute of Minority Economic Development, and other entities to increase outreach efforts of bidding and contracting opportunities for underserved communities.
	Leverage disaster recovery funds and other sources of capital to promote equitable job creation and inclusive business development in communities most vulnerable to climate change. Other sources of capital to explore include: Opportunity Funds, Donor Advised Funds, New Markets Tax Credits, Low Income Housing Tax Credits, activities of Community Development Financial Institutions, Small Business Investment Companies, Rural Business Investment Companies, and investments required by the Community Reinvestment Act.

Table 1-2: Climate Justice Recommendations for State Government

Recommendation Type	Recommendation
State Policy Changes	Adopt the targeted universalism approach for resilience, in which policies and programs begin by addressing the needs of those who are most vulnerable to climate change, and seek to improve the resilience of the entire state.
	Develop metrics to determine progress of equity and resilience initiatives.
	Adopt incentive or funding programs that encourage best practices for equitable resilience within state government and quasi-governmental organizations and among local governments, businesses, and non-profit organizations. For example, competitive funding programs within the state might include a resilience component in their scoring rubric.
	Advocate for funding from the General Assembly for climate science specific to North Carolina and for resiliency programs, policies, and interventions that support our shared efforts to prosper into the twenty-first century and beyond.
	Work with agency Human Resource offices to set goals and strategies for diversifying staff and leadership in recovery and resilience, and for hiring disaster survivors into recovery and resilience positions.
	With agency communications offices, set goals and strategies to increase interaction with communities that have historically frayed relationships with government and government officials.
	Reduce substandard housing and increase access to adequate cooling and other climate risk reduction measures.
	Advocate for funding for new or continuing weatherization programs that target low-income homeowners.
State Role in Building Local Sources of Resilience	Build capacity and leadership within communities most vulnerable to climate change impacts by promoting, supporting, and leveraging community-specific strategies, projects, and events. This recommendation could be accomplished through the North Carolina Resilient Communities program detailed in Chapter 7. These initiatives could be led by local governments or by community or faith-based organizations.
	Identify and communicate resilience resources, including educational and funding opportunities, already available to local governments and communities.
	Fund a grant program to support community or regionally-based resilience projects. This program could be sponsored by public and private funds.

Recommendation Type	Recommendation
	Engage community and faith-based organizations that work on disaster response to incorporate other elements of resilience into their programming.
	Explore opportunities to provide financial resources for climate preparation efforts to culturally specific organizations.
	Improve local resilience by ensuring that recovery programs, plans, and investments leave the community with additional capacity to cope with the next event. For example, a recovery program might include formal capacity building activities, a recovery fund might facilitate regional gatherings for grantees to share lessons learned, and planning efforts might identify clear, realistic implementation steps for after the plan is complete.
Information Needs	Improve the accessibility of hazard and climate change data to non-experts through web portals, infographics, classroom education modules, or other communication channels.
	Provide resources for community and K-12 education on climate change and resiliency.

Table 1-3: Climate Justice Research Recommendations

Research Recommendations
Examine the distribution of climate hazard exposure and impact, adaptive capacity, and benefits and burdens of resilience interventions among different groups of socially vulnerable populations.
Identify opportunities for citizen science and community observations to add value to research used by the state. For example, analyze ways for risk assessment to include qualitative methods and local knowledge.
Evaluate the effectiveness of methods for engaging different underrepresented groups in climate resilience plans, programs, and policies.
Investigate under-recognized sources of community resilience by learning more about the support systems local communities have created to 'fill in gaps' of disaster response.
Continue to map climate risks and social vulnerabilities together. Re-visit this mapping based on 2020 Census data. Use geospatial and other analyses to understand the distinction among different regions of the state and in urban, suburban, and rural areas. Extend this research to identify "hotspot" areas where climate justice issues are likely to be most severe.
Determine the best ways to measure and capture compounding vulnerabilities, or climate impacts that are experienced in the context of inequalities across health, housing, and economy.
Analyze the business and workforce development opportunities in risk and resilience fields. The results of such a study should inform programmatic decisions in the state's workforce development systems and organizations.
Analyze insurance coverage among socially vulnerable populations, especially in light of changing insurance markets and new developments with the National Flood Insurance Programs. Recommend strategies to improve insurance coverage among low-income households, including renters, in high-risk areas. Analyze insurance coverage of public assets in all communities, especially those with smaller budgets where insurance may have fallen to the wayside.

F. Key Observations and Recommendations: Nature-Based Solutions

The Natural and Working Lands (NWL) stakeholders developed 25 nature-based solutions (NBS) to build climate change resilience in communities and ecosystems and sequester carbon while also meeting other economic, ecologic and societal goals that are detailed in Appendix B: North Carolina Natural and Working Lands Action Plan.

Key Observations

- NWL stakeholders recommend that the state of North Carolina act quickly to protect, restore, and manage sufficient land area as "green-infrastructure" to provide community and ecosystem resilience.
- State agencies can build resilience using the NBS presented in the North Carolina NWL Action Plan.
- Voluntary landowner participation in carbon offset markets could be used to finance specific NBS that sequester significant amounts of atmospheric carbon and build community and ecosystem resilience.
- Important actions the state can take in building community and ecosystem resilience and sequestering carbon include:

    1. Sustainable management and financial support of the 14 million acres of privately-owned forests through new policies and economic opportunities.
    2. Protection and restoration of critical portions of the 13 million acres of floodplains and wetlands to mitigate floods as shown in the map given below.
    3. Protection, restoration and proper management of North Carolina's pocosins and coastal estuaries to build coastal resilience, sequester significant amounts of carbon, and mitigate the risk of wildfires and floods.[4]

Mapping Opportunities for Nature-Based Solutions to Build Resilience

The map presented in Figure 1-2 shows that increasing forested land area and reforesting both marginal forests and woody wetlands builds community resilience by reducing flood risks. The areas marked by the two purple colors represent land protection and reforestation opportunities to reduce flood risks. The areas marked in pink and magenta colors represent opportunities to both reduce flood risk and improve water quality. The map shows these opportunities primarily lie in the Coastal Plains, especially along major rivers. Protecting and restoring forests also sequesters carbon by removing carbon dioxide from the atmosphere and storing it in trees and soil.

[4] Peatland pocosins are saturated wetlands of Coastal Plain flats, swales, and Carolina bays, with organic matter accumulation, and with distinctive vegetation characterized by Pond Pine (Pinus serotina) and a suite of dense evergreen shrub species, which sequester and store a high volume of carbon per acre above and below ground.

Source: Nicholas Institute for Environmental Policy Solutions at Duke University

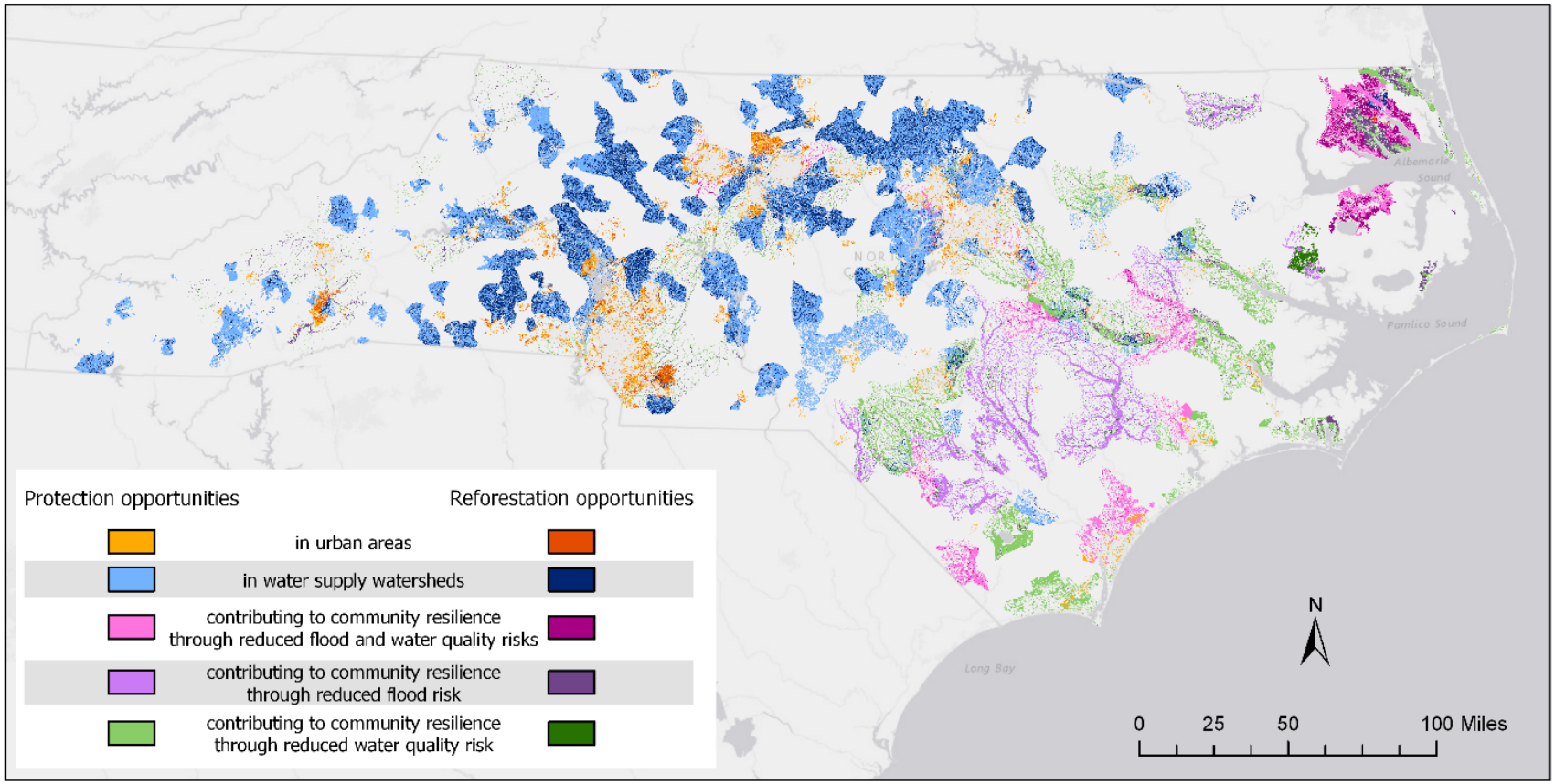


Figure 1-2: Protection and reforestation opportunities with community resilience benefit

Table 1-4 lists all the priority recommendations developed for North Carolina's Natural and Working Lands (NWL)Action Plan.

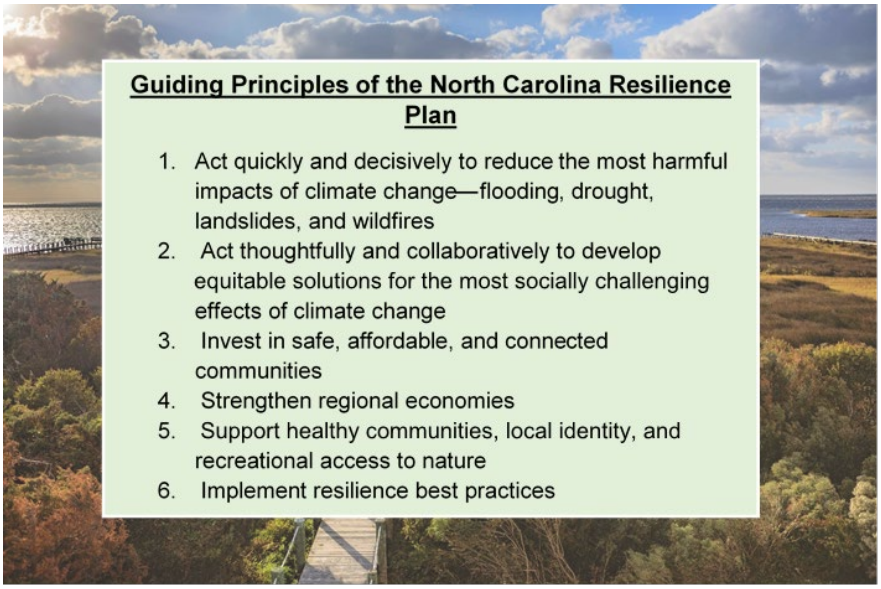
Table 1-4: Natural and Working Lands (NWL) Recommendations

Recommendation Type	Strategy
Transformative	1. Protect and restore forests and wetlands within flood prone areas.
	2. Facilitate voluntary landowner participation in carbon offset and ecosystem services markets.
	3. Build a multi-state NWL solutions toolbox.
	4. Integrate climate adaptation and resiliency strategies into local government comprehensive plans.
Protect Forest Lands	5. Conserve forest lands through easements and acquisition.
	6. Modernize forest policy and tax incentives.
Restore Forest Land	7. Expand restoration efforts on publicly owned lands.
	8. Encourage restoration and reforestation on private lands.
Enhance Forest Lands	9. Increase landowner access to forest management technical and financial assistance.
	10. Support the wood products markets.
Protect and Restore Floodplains and Wetlands	11. Coordinate the state's floodplain buyout and restoration program to increase resilience.
Restore Pocosins	12. Rewet hydrologically altered peatlands to prevent soil loss and catastrophic fire.
	13. Reforest peatlands with Atlantic White Cedar.
Enhance Pocosins	14. Enhance soil health and retention on working peatlands via best management practices and drainage management.
	15. Implement targeted interventions to protect peatlands from sea level rise and saltwater intrusion guided by scenario-based modeling.
Protect Coastal Habitats	16. Provide incentives to stakeholders for coastal habitat protection.
	17. Facilitate migration of coastal habitats through protection of migration corridors.
Restore Coastal Habitats	18. Prioritize climate change and sea level rise in coastal habitat restoration planning.
Protect and Restore Urban Lands	19. Promote urban forests through statewide programs to foster the retention of urban trees and their proper management.
	20. Protect and restore forested lands in water supply watersheds.
Enhance Urban Lands	21. Improve site preparation and soil amendment during land development.
	22. Research urban forestry climate adaptation and canopy baseline needs.
Enhance Agriculture	23. Encourage adoption of high mitigation agricultural conservation practices on croplands and pasturelands.
	24. Improve manure management on farms.
	25. Encourage food system efficiency through reduced food loss and waste.

G. Path Forward

The Path Forward is a vision for building a resilient North Carolina where our communities, economies, and ecosystems are better able to rebound, adapt, and thrive amid changing conditions and challenges, including natural hazards and climate change. Developing a shared vision of resilience will enable us to maintain and improve quality of life, nurture healthy growth, and ensure long lasting and sustainable social, economic, and environmental systems. A resilient North Carolina will also safeguard our ability to conserve resources for present and future generations.

The Path Forward first lays out guiding Principles that frame the state's action on climate resilience. It is based on the analysis and recommendations of this plan's authors and contributors, recommendations from local and community partners, and the progress that the state has made to date. The guiding principles (shown to the right) are both values and goals. The threat of climate change requires effective and decisive action, made with a clear-eyed understanding of the very real challenges we face in our state and in our world. These principles light the path.



1. Statewide Climate Vulnerability Assessment and Resilience Strategy

To guide the Path Forward, the state will maintain and update the North Carolina Resilience Plan. The North Carolina Resilience Plan is a compilation of documents organized into four elements: (1) The North Carolina Science Report; (2) State Agency Resilience Strategies; (3) Statewide Vulnerability Assessment and Resilience Strategies; and (4) the North Carolina Enhanced State Hazard Mitigation Plan (EHMP). Detailed discussion of these elements is provided in Chapter 7.

Table 1-5: North Carolina Resilience Strategy Elements

North Carolina Resilience Plan Element	Current Components	Earlier Versions	Update Cycle
1. Science Report	2020 North Carolina Climate Science Report	Chapter 2 ("Climate Trends") of 2012 Climate Ready NC	As needed to incorporate new decision-relevant information
2. State Agency Resilience Strategies	Chapter 5 ("Climate Impacts, Risks and Vulnerabilities") of 2020 Resilience Plan		March 2021, and annually thereafter.
3. Statewide Climate Vulnerability Assessment with Goals and Action Steps	Chapter 4 ("Climate Justice"), Chapter 6 ("Nature-Based Solutions"), Chapter 7 ("Path Forward")	Chapter 3 ("Impacts, Risks and Vulnerabilities for North Carolina"); Appendices B through E; Chapter 4 ("Cross-Sector Strategies"), 2012 Climate Ready NC	• Priority 1: 2022 and every 4 years thereafter • Priority 2: 2024 and every 4 years thereafter
4. State Hazard Mitigation Plan	2018 North Carolina State Hazard Mitigation Plan	2013, 2010, 2007, 2004 SHMP	Current FEMA mandate: every 5 years

Table 1-6: Elements of the North Carolina Resilience Plan Going Forward

PLAN ELEMENTS	NEXT STEPS	PARTICIPATION	RESOURCE NEEDS
1. North Carolina Climate Science Report	• Update 2020 Climate Science Report as deemed necessary • Synthesize decision-relevant studies and contracted analysis from Elements 2, 3	• Universities • Federal agencies • State agencies • External contractors	• U.S. National Climate Assessment updates • Contracting funds for scientific expertise • State agency staff participation

2. State Agency Resilience Strategies	• Develop Agency strategies based on 2020 Resilience Plan Chapter 5 ("Climate Impacts, Risks, and Vulnerabilities")
	• Agencies seek advisory capacity on strategies from NCORR State Disaster Recovery Task Force Recovery Support Function teams (RSFs) as needed
	• Agencies publish Agency Resilience Strategy
		• State agency resilience lead staff
		• NCORR resilience staff (general guidance; administration of SDRTF RSFs)
		• Universities
		• External contractors
		• Local governments
		• Stakeholders representing agency priority areas
			• Funding for state agency resilience leads (1 new FTE per agency)
			• Each agency will have different resource needs for implementing resilience in its programs, which may include:
			  ○ Contracting funds for agency-specific quantitative and qualitative risk and vulnerability assessments
			  ○ Contracting funds for facilitating prioritization discussions and strategy development
			• NCORR guidance

3. Statewide Climate Vulnerability Assessment and Resilience Strategy	Identify, perform supporting vulnerability assessment, and develop Resilience Action Plan for Cross-Cutting Challenges: • Priority 1 Challenges: extreme events and actions potentially eligible for federal funding, such as Enhanced Hazard Mitigation Plan funding • Priority 2 Challenges: long-term issues not addressed through Priority 1.	• Statewide Strategy development process established by NCORR, with advisory input from Interagency Resilience Team and SDRTF RSFs	• Contracting funds for facilitating prioritization discussions and strategy development to gather input and prioritize actions
4. State Enhanced Hazard Mitigation Plan	• Incorporate climate science data into FEMA required Risk and Vulnerability Assessment process • Incorporate Element 3 Priority 1 Cross-Cutting Resilience Action Plan items into FEMA required Hazard Mitigation Strategy	• NCEM Hazard Mitigation, with advisory input from NCORR resilience staff (Resilience Strategy support and SDRTF administration)	• Contracting funds for quantitative and qualitative risk and vulnerability assessments • Contracting funds for facilitating prioritization discussions and strategy development to gather input and prioritize actions across levels of government

Priority Resilience Initiatives

Certain priority resilience initiatives are recommended first steps in providing opportunities for education and collaboration across stakeholder groups and sectors. Some recommended initiatives require additional dedicated funding to be successful. If this funding is not secured, these programs will not be able to move forward or will need revisions in proposed scale and scope.

The first initiative to prioritize is to **manage and coordinate statewide resilience**. The North Carolina Office of Resiliency and Recovery (NCORR) team will lead the state's resilience efforts. This involves supporting coordination among state agencies and maintaining productive relationships and partnerships between state, tribal, local, and regional governments; business and non-profit partners; and community stakeholders. Collaboration and interaction among partners inside and outside of state government helps all entities leverage expertise throughout the state to build a more resilient North Carolina.

The NCORR team provides resilience expertise to state government across the executive and legislative branches and all state agencies. The CRO also facilitates strategic planning and supports state agencies and offices as they continuously expand their capacity for and attention to resilience. Among other responsibilities, the NCORR team issue guidance to state agencies as they develop and annually update their Agency Resilience Strategies.

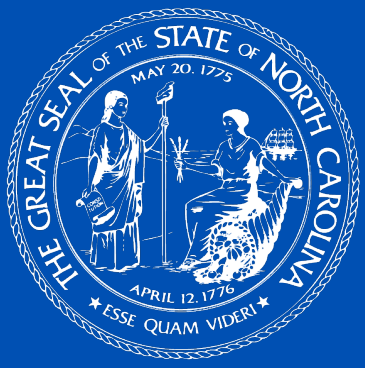
Additional priority resilience initiatives are discussed in full detail in Chapter 7 and listed below:

- Convene a dedicated Interagency Resilience Team
- Continue resilience efforts through the North Carolina Climate Change Interagency Council
- Establish the North Carolina Resilient Communities Program

Cross-Cutting Resilience Strategies

Various cross-cutting resilience strategies would advance resilience planning and implementation across agencies, sectors, and communities statewide. These recommended strategies include the following:

- Consider resilience criteria in making state investments
- Update plans, standards, and design values
- Increase resilience capacity in state agencies
- Identify sustainable funding sources for resilience
- Increase communication and outreach on climate change



NORTH CAROLINA
Department of Environmental Quality

deq.nc.gov/NCResiliencePlan