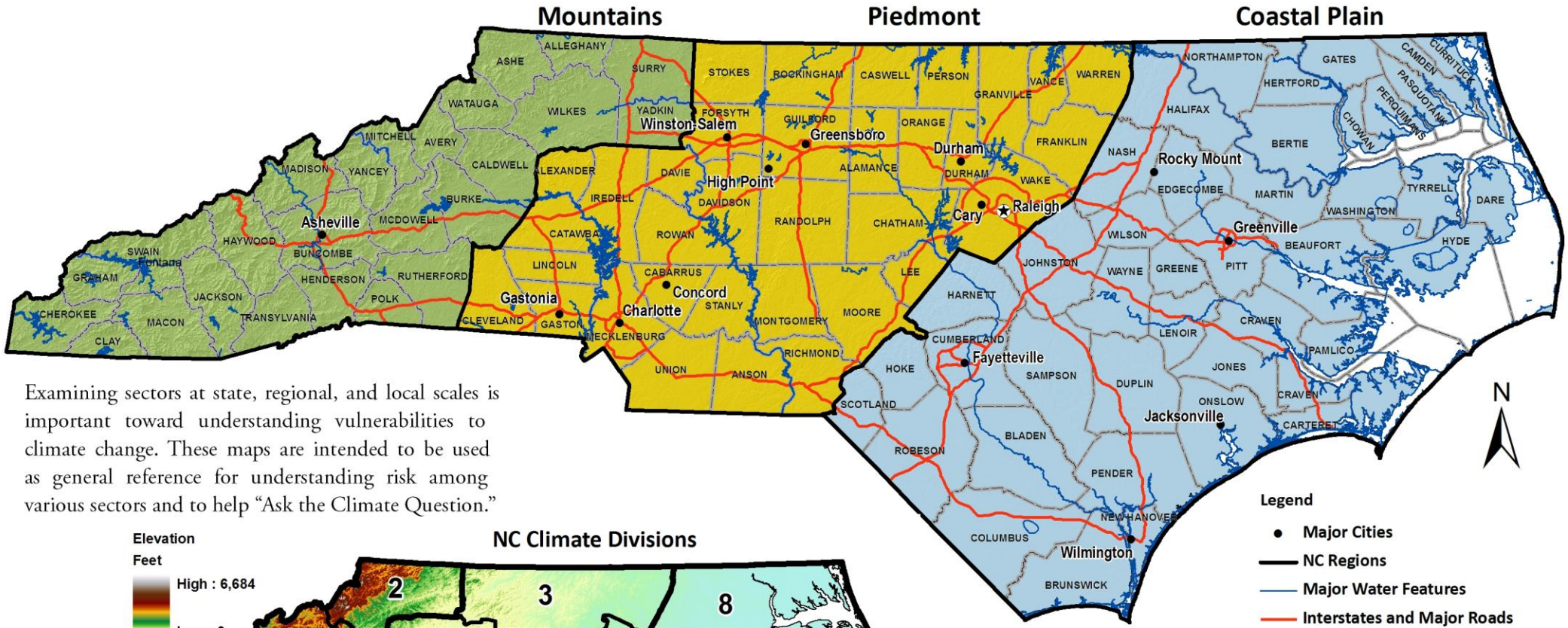
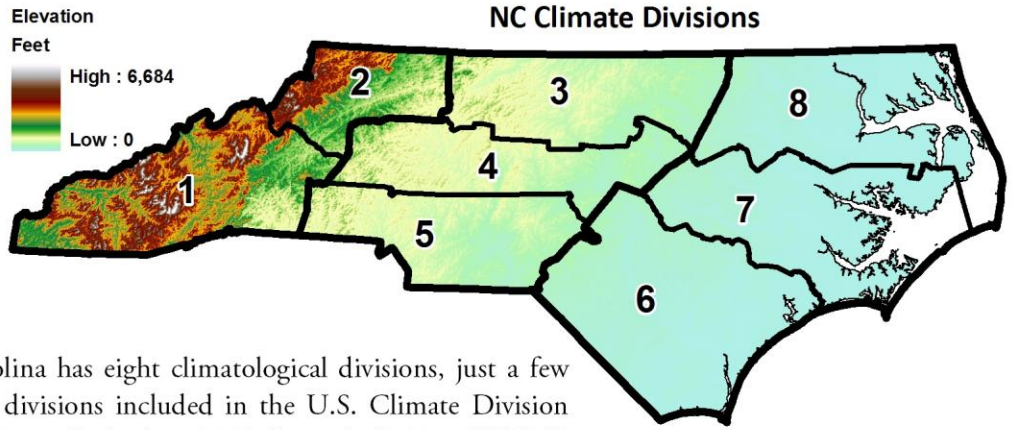
A Regional Perspective of North Carolina



Examining sectors at state, regional, and local scales is important toward understanding vulnerabilities to climate change. These maps are intended to be used as general reference for understanding risk among various sectors and to help "Ask the Climate Question."



1: Southern Mountains
2: Northern Mountains
3: Northern Piedmont
4: Central Piedmont
5: Southern Piedmont
6: Southern Coastal Plain
7: Central Coastal Plain
8: Northern Coastal Plain

Legend

- Major Cities
- NC Regions
- Major Water Features
- Interstates and Major Roads
- County Boundaries

NC Regions

- Coastal
- Mountains
- Piedmont

0 25 50 100 Miles

North Carolina has eight climatological divisions, just a few of the 344 divisions included in the U.S. Climate Division Dataset dating as far back as 1895. For each division, NOAA's National Climatic Data Center (NCDC) provides monthly climate and weather data, such as mean temperature, precipitation, and drought indices. These datasets are also available through the State Climate Office of North Carolina where they are continuously updated. For the purposes of this set of maps, the three North Carolina regions – the Mountains, Piedmont, and Coastal Plain – are defined by the grouping of climate divisions.

North Carolina is diverse in its topographic features, and one of the few states with three distinct regions: the Mountains, Piedmont, and Coastal Plain. These three regions are different in their climates, natural resources, and societal needs. Therefore, the vulnerabilities to climate change will be different for each of these regions, as will the challenges for planning and adapting to climate change.

Sources: NCDOT; NCCGIA; State Climate Office of North Carolina

Note: These maps are for general reference purposes only and contain no legal representation

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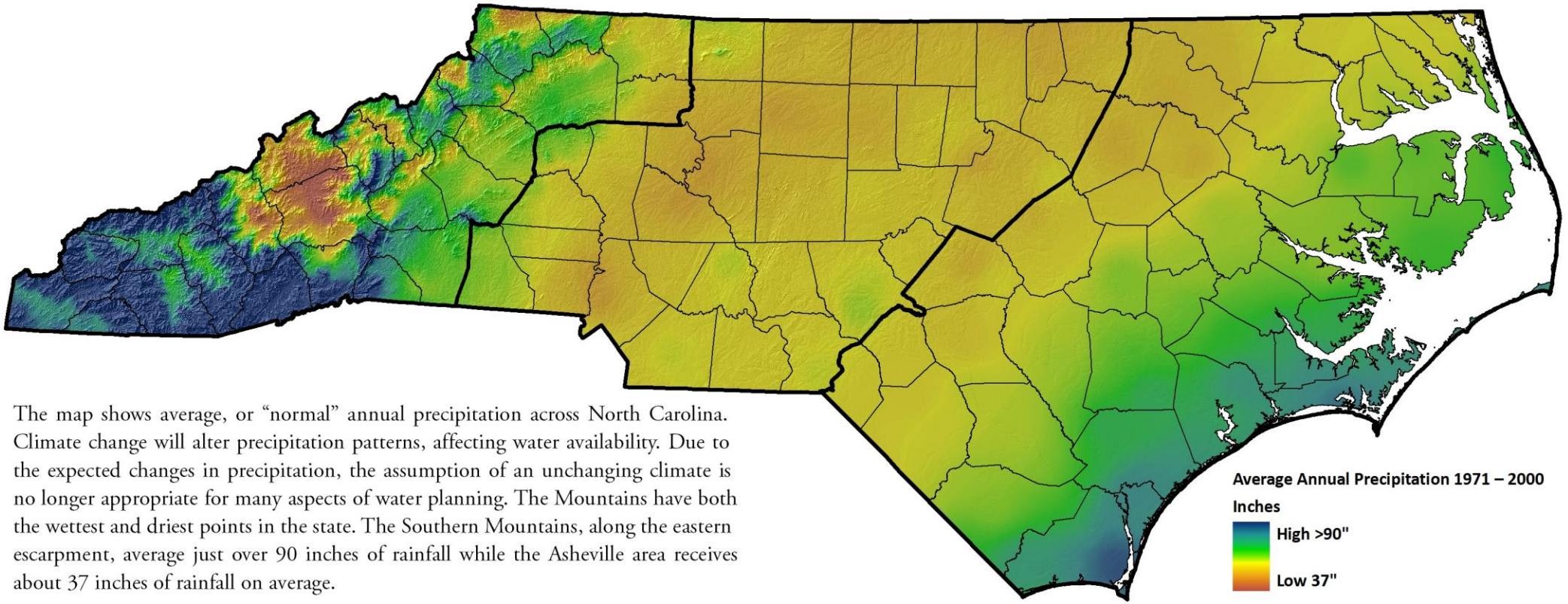
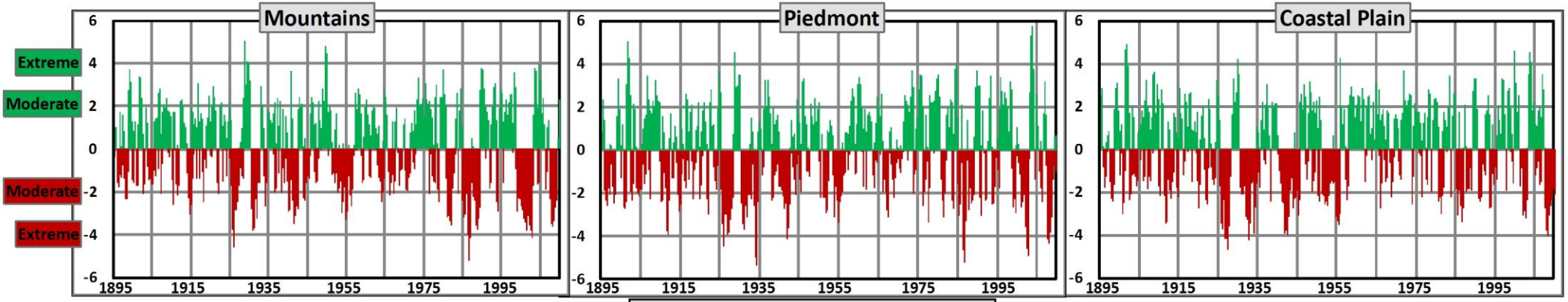
Climate

Average Precipitation



The map shows average, or "normal" annual precipitation across North Carolina. Climate change will alter precipitation patterns, affecting water availability. Due to the expected changes in precipitation, the assumption of an unchanging climate is no longer appropriate for many aspects of water planning. The Mountains have both the wettest and driest points in the state. The Southern Mountains, along the eastern escarpment, average just over 90 inches of rainfall while the Asheville area receives about 37 inches of rainfall on average.



Palmer Hydrological Drought Index
(Monthly 1895-2009)

Sources: State Climate Office of North Carolina; Oregon State University, PRISM Group

The graphs above show an index indicating long-term impacts to water resources, such as reservoirs and groundwater levels. On the graphs above, red indicates dry conditions whereas green indicates wet conditions. Any value above 2 or below -2 indicates moderate wet/dry conditions, respectively, while any value above 4 or below -4 indicates extreme wet/dry. The graphs reflect historical wet and dry periods, showing that precipitation variability is a major component of the climate in North Carolina. The frequency and severity of wet and dry periods are likely to change; therefore, understanding how this variability changes and impacts water resources will be important in adapting to climate change.

Climate

Average Temperature

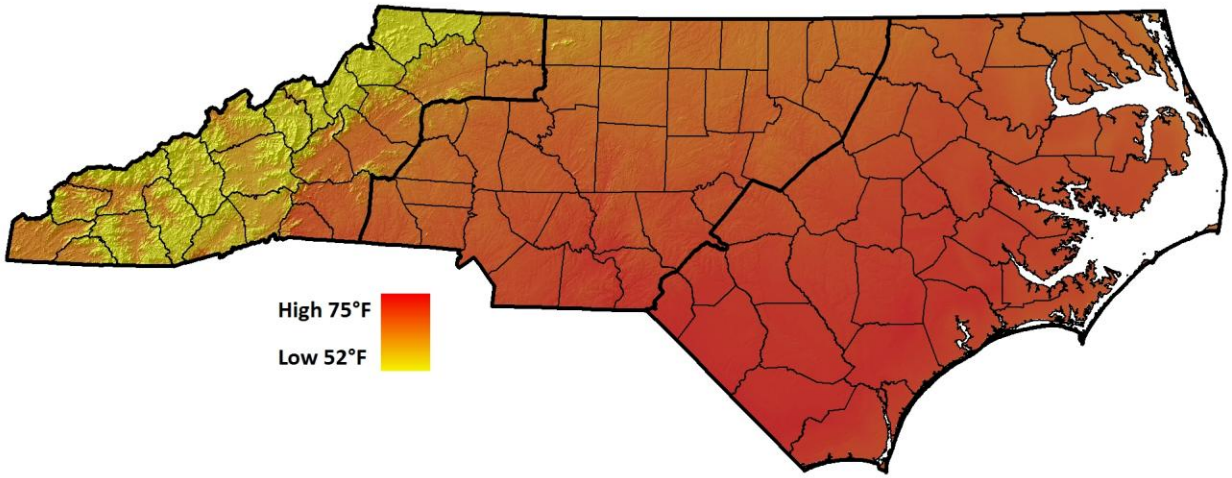
The diverse terrain of North Carolina creates a range of average temperatures, which generally decrease with increases in elevation. On any given day, temperatures can range more than 20°F from the Mountains to the Coast. The cool temperatures in the high elevations result in short growing seasons for crops, high energy demand in the winter, and, ecologically, serve as refuges for rare forest types and species. Temperatures in the central and eastern part of the state provide long growing seasons for agricultural production.

The maps to the right show the average maximum and average minimum temperatures (°F) across the state over a 30-year period. The normal monthly temperatures in the table below show normal maximum and minimum temperatures for January and July at specific weather stations over a 30-year period.

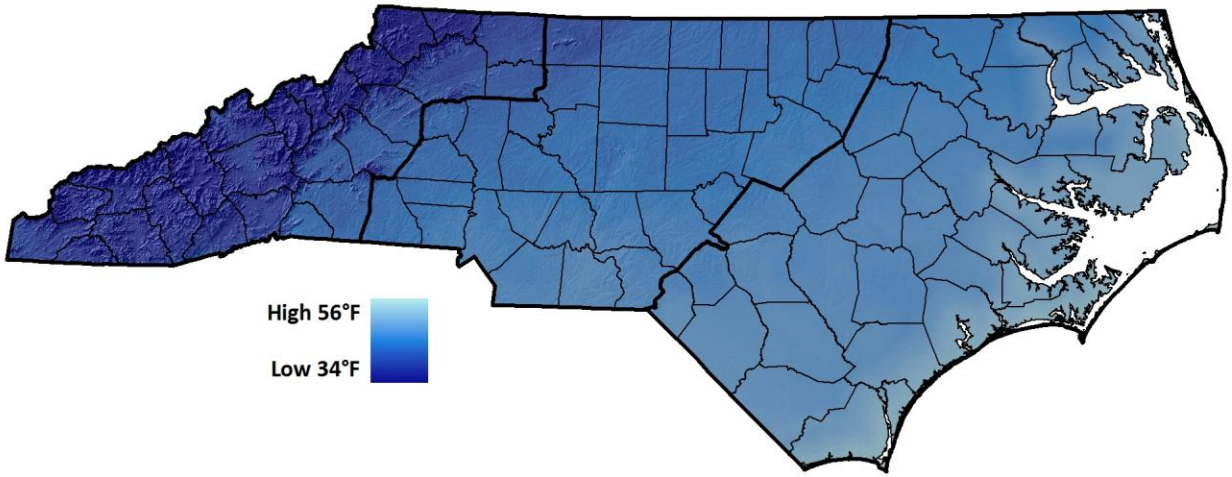
Monthly Normal Temperatures (1971-2000)

	January		July	
Weather Station, County	Normal Max. Temp.	Normal Min. Temp.	Normal Max. Temp.	Normal Min. Temp.
Mountains Mt. Mitchell, Yancey Co.	34	17	68	53
Asheville, Buncombe Co.	46	27	84	64
Piedmont Charlotte, Mecklenburg Co.	51	32	90	71
Burlington, Alamance Co.	50	28	91	68
Coastal Plain Wilmington, New Hanover Co.	56	36	90	72
Greenville, Pitt Co.	52	31	89	70

Average Maximum Temperature 1971–2000



Average Minimum Temperature 1971–2000

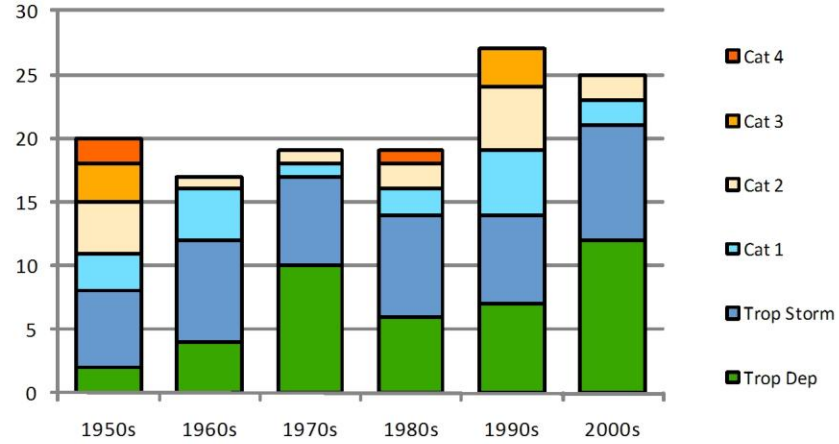


Sources: State Climate Office of North Carolina; Oregon State University, PRISM Group

Extreme Weather Events

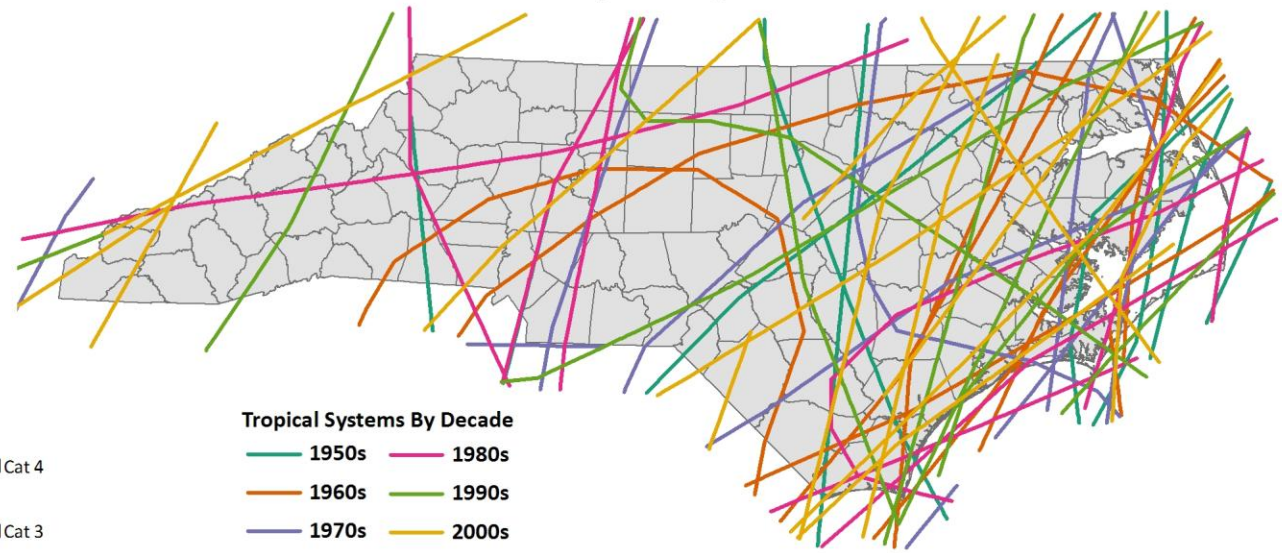
Climate is not only the measure of average conditions, but also the characteristic range of weather variability. This variability can be defined by the frequency and severity of events such as heavy rains, drought, heat waves, hurricanes, and tropical storms. Changes in the frequency and severity of extreme weather events often cause more damage and are more difficult to adapt to than gradual change.

Tropical Systems Affecting North Carolina by Decade Since 1950

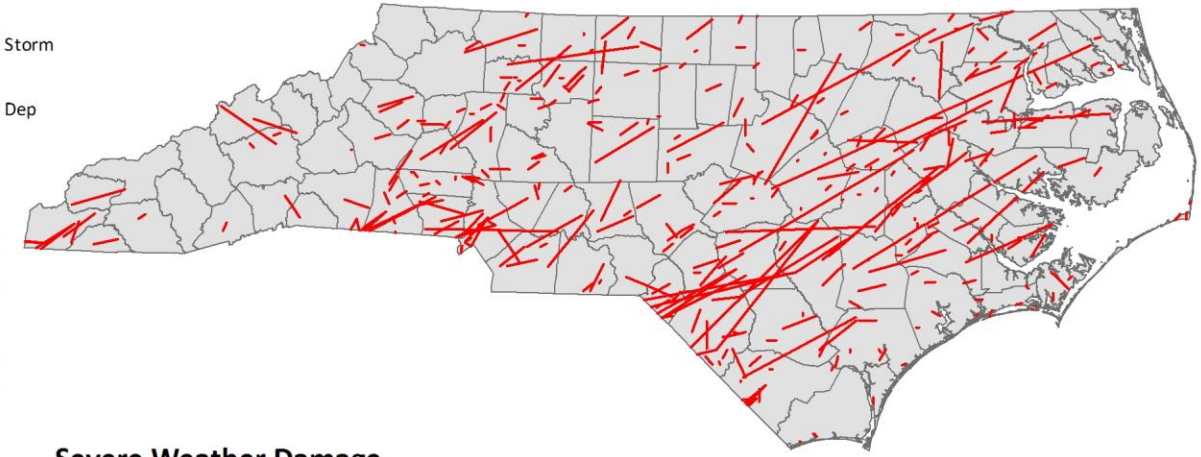


The graph above shows the number of hurricanes and tropical systems that have affected North Carolina by making direct landfall on the coast or by passing through the state. Hurricanes affect the state at an average of twice a year, although other types of tropical systems, such as tropical depressions, also impact the state with large amounts of rain. The top right map shows the paths of tropical systems since 1950; each line shows where the center of an individual storm passed through, but not necessarily the extent of each storm's impact. Impacts of tropical systems are not isolated to the Coast; tropical systems and storm remnants often impact the central and western part of the state. In fact, the greatest danger associated with storms is inland freshwater flooding due to heavy amounts of rainfall. Climate change and increasing sea-surface temperatures will possibly lead to increased storm intensity, resulting in greater impacts to the state.

Tropical Systems Since 1950



Tornado Paths Since 1950

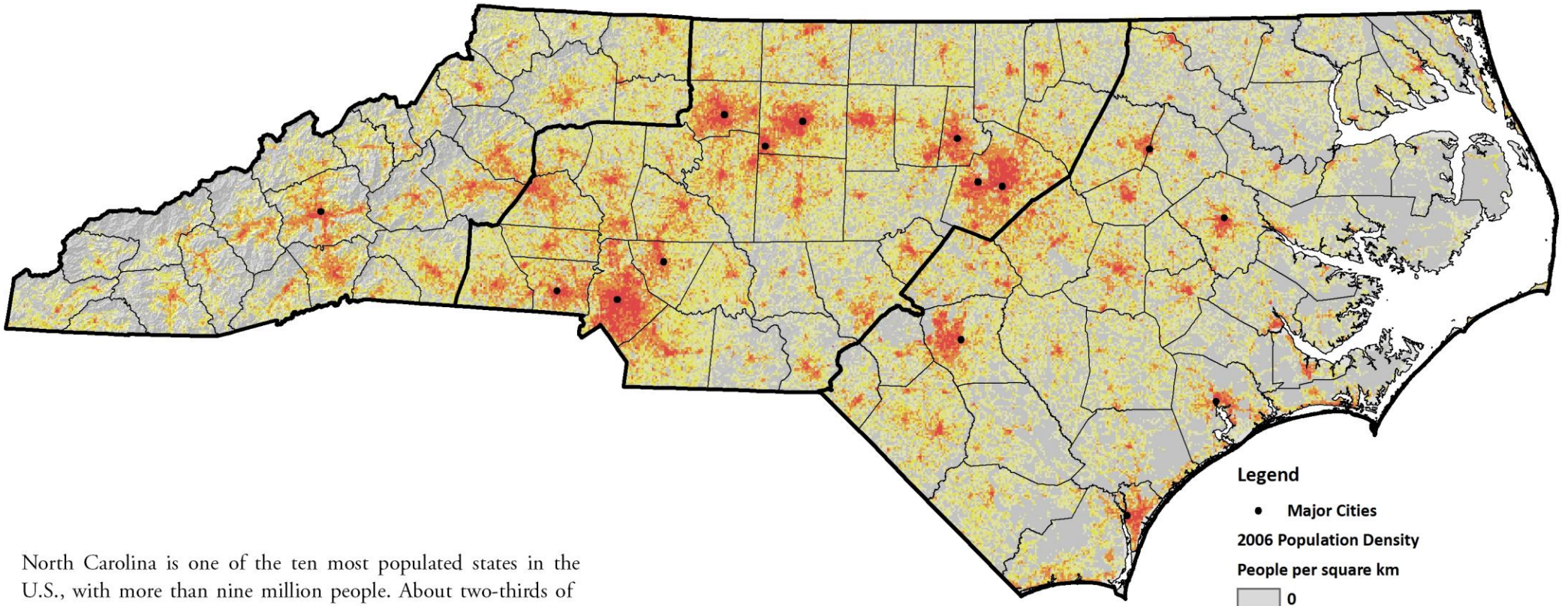


Severe Weather Damage

North Carolina ranks among the top five states in billion dollar weather disasters since 1980 (more than 30 separate events), ranging from hard freezes to blizzards and hurricanes. In North Carolina, severe weather includes tropical storms, hurricanes, tornadoes, heavy rains, ice storms, drought, and flooding. The map directly above shows tornado paths since 1950. Tornadoes usually impact the Piedmont and Coastal Plain.

Sources: State Climate Office of North Carolina; NOAA's NCDC

Population and Public Health



North Carolina is one of the ten most populated states in the U.S., with more than nine million people. About two-thirds of North Carolina's population is concentrated to the middle part of the state, where there are three major Metropolitan Statistical Areas with populations exceeding one million, including the Charlotte-Gastonia-Rock Hill, Raleigh-Durham-Chapel Hill, and Greensboro-Winston Salem-High Point metropolitan areas (U.S. Census Bureau 2008 estimates).

Direct climate impacts to public health include extreme temperatures (heat and cold), severe storms, flooding, and climate sensitive diseases. Any warming in the future will also make it more challenging to meet air quality standards necessary to protect public health. Specific groups of people, including children, the elderly, and the poor, are disproportionally affected by climate-related health effects. Extreme weather events can also undermine public health infrastructure, cause stress to environmental resources, and impact economies.

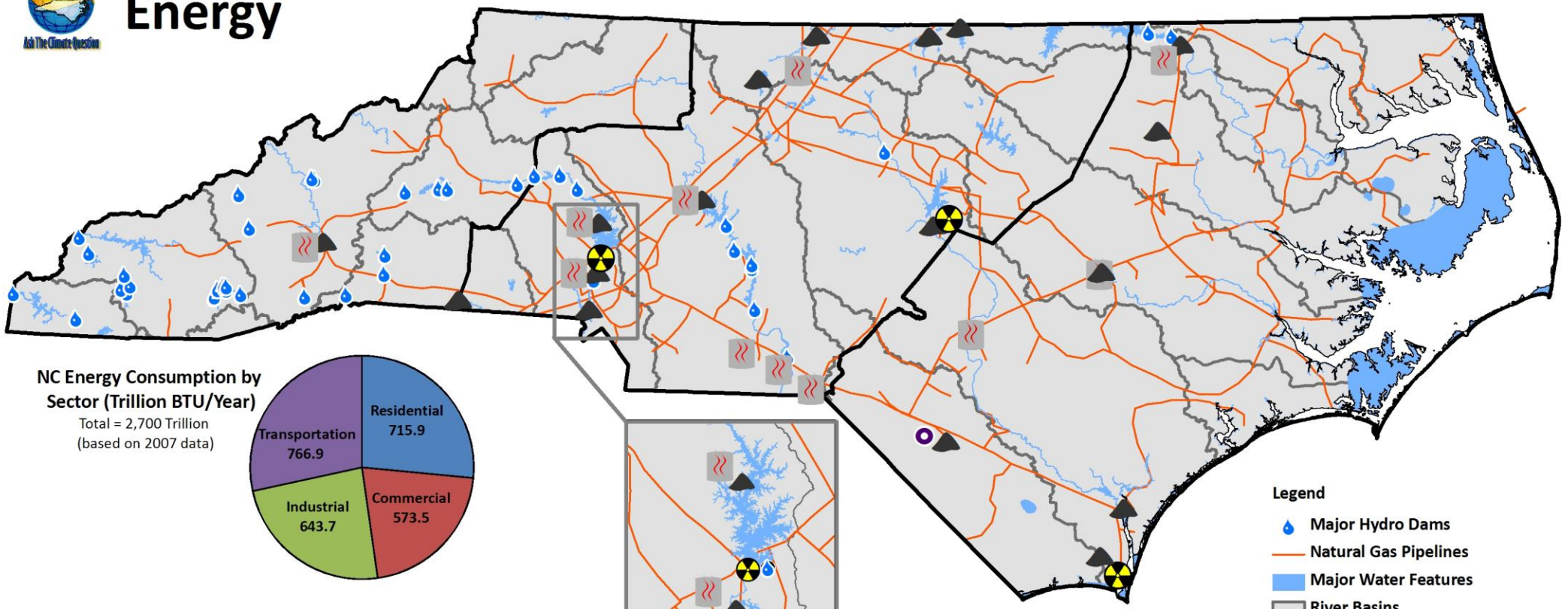
Average Number of Days with Temperatures >= 90°F

	Jun	Jul	Aug	Yearly Average	# Years
Asheville, Buncombe Co.	1	4	2	8	41
Charlotte, Mecklenburg Co.	8	14	11	38	45
Wilmington, New Hanover Co.	8	16	12	43	42

Much of the state already experiences heat-related impacts to public health. The table above shows the average number of days that temperatures reach 90°F or greater at three weather stations across the state. The number of days with extreme heat and the risk to public health are likely to increase in the future.

Sources: LandScan™ Global Population Database, Oak Ridge, TN: Oak Ridge National Laboratory. Available at http://www.ornl.gov/landscan/; NCCGIA; NC DENR; NOAA's NWS

Energy



In the Catawba River Basin, energy production and water resources are tied closely together with several power plants along a 30-mile stretch of the Catawba River and Lake Norman.

North Carolina has among the highest electricity production and consumption rates in the U.S. More than one-half of North Carolina households use electricity as their main heating energy source and are becoming more dependent on electricity for heating, relying less on wood for heat. Coal makes up about 60% of the total energy source, with nuclear at 30% and hydroelectric/natural gas making up most of the remaining 10%. Both industrial and residential energy demands are expected to increase into the near future. Residential energy demands will be driven by increasing population. Also, greater cooling requirements in summer will increase electricity use and higher peak demand. The energy sector is the largest consumer of water, while nuclear, coal, and natural gas power plants require large amounts of water for cooling. Higher average temperatures with climate change will increase the need for cooling water for electrical generating stations. Energy production and delivery systems will also be exposed to sea-level rise and extreme weather events and some renewable energy sources such as hydropower are subject to changing patterns of precipitation.

Mountains

Changing precipitation patterns have significant implications for hydroelectricity in the Mountains. The Mountains also rely heavily on transportation energy for transporting goods to the region. Energy demands are greatest in the Mountains during the cold winter months.

Piedmont

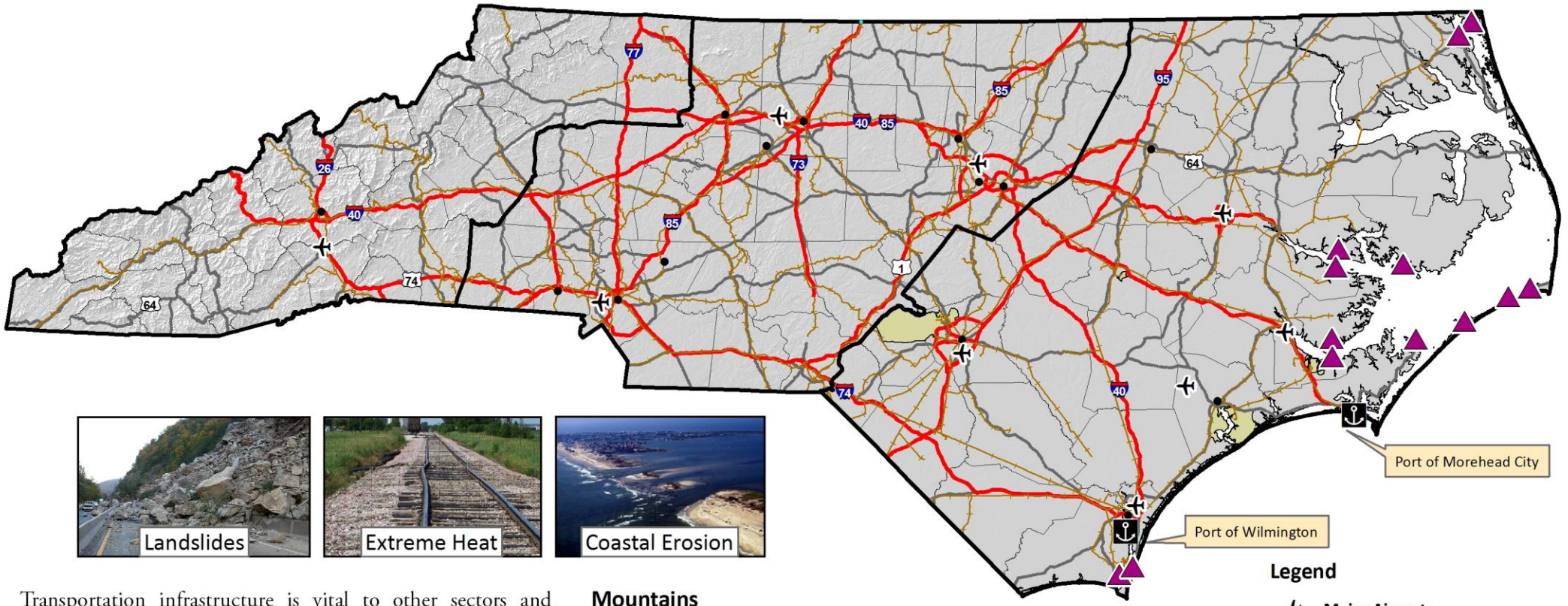
The central part of the state is experiencing increased energy demands due to population growth. Also, the availability of water resources will have implications for energy development.

Coastal Plain

Several areas off the Coast of North Carolina have been identified as potentially well-suited for wind energy production, making North Carolina one of the top ten states in wind power capacity.

Sources: U.S. Energy Information Administration; U.S. Army Corps of Engineers; NCCGIA; NID

Transportation



Landslides

Extreme Heat

Coastal Erosion

Transportation infrastructure is vital to other sectors and municipalities throughout the state, ensuring safe and reliable connectivity. In North Carolina, this connectivity is achieved through an intricate multi-modal network of rail lines, road systems, ports, and ferries. Transportation facilities play major roles in the connectivity of supplies and goods not only within North Carolina, but also throughout the Southeast.

Impacts from climate change pose significant risk to transportation infrastructure and present challenges to ensuring transportation connectivity. Impacts such as severe storms, extreme heat, and coastal erosion/flooding threaten to cause increased disruptions and damage to transportation infrastructure in North Carolina.

Mountains

Landslides are a major risk in the Mountains due to the terrain and many steep slopes. Landslides are often triggered by repeated freeze-thaw and heavy precipitation events. In the Fall of 2004, 130 landslides were triggered by the storm remnants of Hurricanes Frances and Ivan.

Piedmont

The Piedmont region contains the major population and economic centers in the state and has by far the greatest amount of traffic use and congestion. Transportation infrastructure in this region is vulnerable to impacts from extreme heat, such as rail buckling.

Coastal Plain

The Coast contains two major port facilities, the Port of Wilmington and the Port of Morehead City (one of the deepest ports on the East Coast). Both of the major ports, 13 major ferries, and the transportation networks to and from these facilities are vulnerable to sea-level rise, flooding, and coastal erosion.

Legend

- Major Airports
- Major Cities
- Rail Lines
- Interstates and Major Roads
- Other Roads
- Major Military Bases
- NC Ports
- Major Ferries

Sources: NCDOT; NC Port Authority; NCCGIA; North Carolina Geologic Survey

Photo Credits: NCDOT; NC Dept. of Cultural Resources; Globe Gazette

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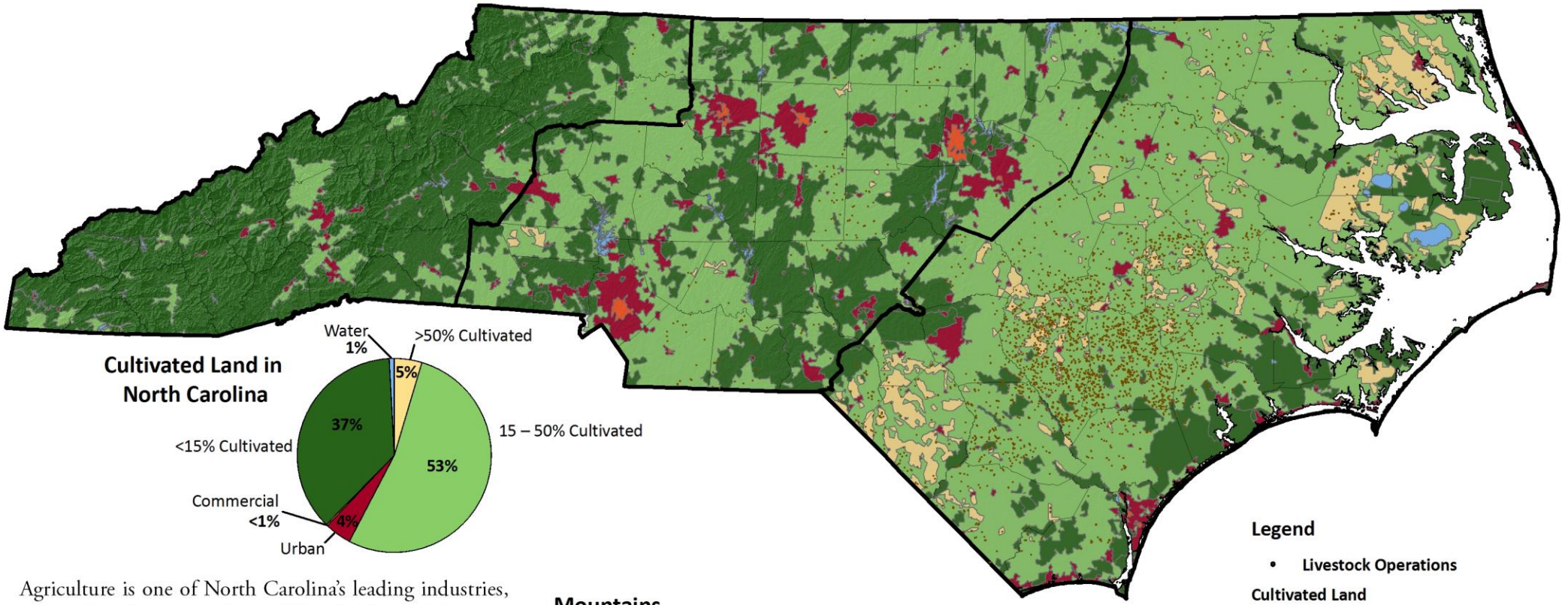
Agriculture



Agriculture is one of North Carolina's leading industries, accounting for more than 20% of jobs and income for the state. The range of climate conditions in North Carolina produces a diversity of crops and livestock. Climate change will increase productivity in certain crops and regions and reduce productivity in others. Climate change will likely impact agriculture by challenging North Carolina's capacity to efficiently produce food, fuel, feed, and livestock products. Many weeds, diseases, and insect pests that affect crops and livestock will benefit from warming, thus increasing stress on crop plants, while increased heat, disease, and weather extremes are likely to reduce livestock productivity. For crops, adapting to climate change may be as simple as changing planting dates to take advantage of longer growing seasons or avoiding crop exposure to adverse conditions, but these adaptation measures will depend on the region and crop.

Mountains

Agricultural production is relatively limited in the Mountains due to the terrain and cooler climate. However, the unique climate in the Mountains supports specialized agriculture, such as apples and Christmas trees.

Piedmont

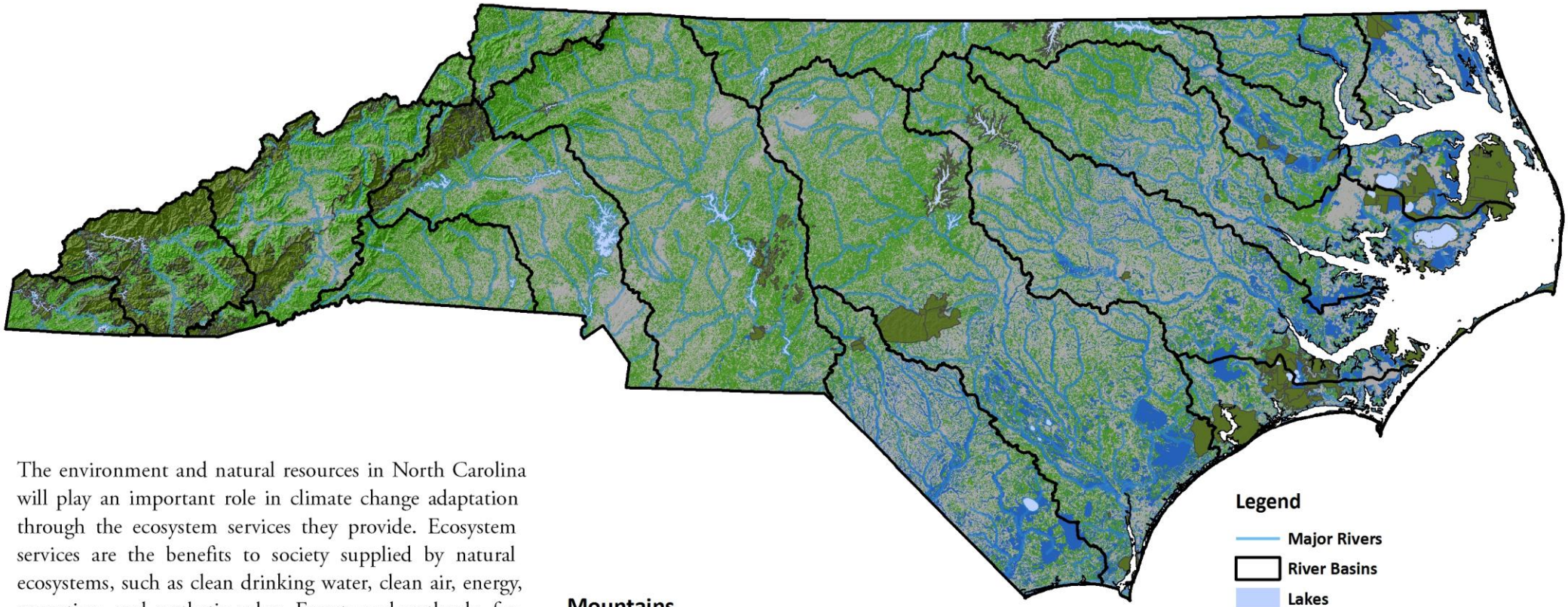
The central part of the state is a major area for hay and cattle production. The Piedmont also contains the largest population centers, and is therefore the region to which most agricultural products are transported.

Coastal Plain

The Coastal Plain – an area with deep soils and flat land – is the major region for agricultural crop production in North Carolina. Some of the most widely grown crops include soybeans, peanuts, potatoes, sweet potatoes, corn for seed, wheat, and several other small grains. The Coastal region is also where most of North Carolina's livestock operations are located. In most years, precipitation is sufficient for crop growth, but much of the area is irrigated.

Sources: US Department of Agriculture, National Statistics Service; State Climate Office of North Carolina; NCCGIA

Environment and Natural Resources



The environment and natural resources in North Carolina will play an important role in climate change adaptation through the ecosystem services they provide. Ecosystem services are the benefits to society supplied by natural ecosystems, such as clean drinking water, clean air, energy, recreation, and aesthetic value. Forests and wetlands, for example, protect water quality by preventing runoff and erosion. Through these ecosystem services, the natural environment is closely tied to the economy and to the preservation of cultural heritage. Unlike the "Built Environment," the natural environment does not have the same ability to adapt to a changing climate. While people can often plan and adapt behavior, natural systems often cannot because they are acclimated to certain areas and climate conditions. Climate change is not the only environmental threat; other pressures, such as land use, development, and the use of resources, are often greater stressors than climate change. Therefore, environmental sustainability and careful decision-making, taking into account the way in which we use our natural resources, will be important in planning for the future and adapting to climate change.

Mountains

The North Carolina Mountains make up part of the Southern Appalachians, which contain some of the greatest biodiversity in the U.S. This region also contains well over one million acres of Federal Land, including the Pisgah and Nantahala National Forests and Great Smoky Mountains National Park.

Piedmont

Increasing population and development in the Piedmont region have altered the natural landscape and have placed stress on water resources. North Carolina's increasing population, particularly in the Piedmont region, will continue to drive increasing water demand.

Coastal Plain

The Coastal Plain is home to some of the most extensive wetlands in the Southeast, which support many rare species endemic to this area. While the wetlands have been greatly decreased from their original extent due to land practices, the wetlands provide natural flood mitigation from storm surge and prevent coastal erosion.

Sources: NCCGIA; NC DENR

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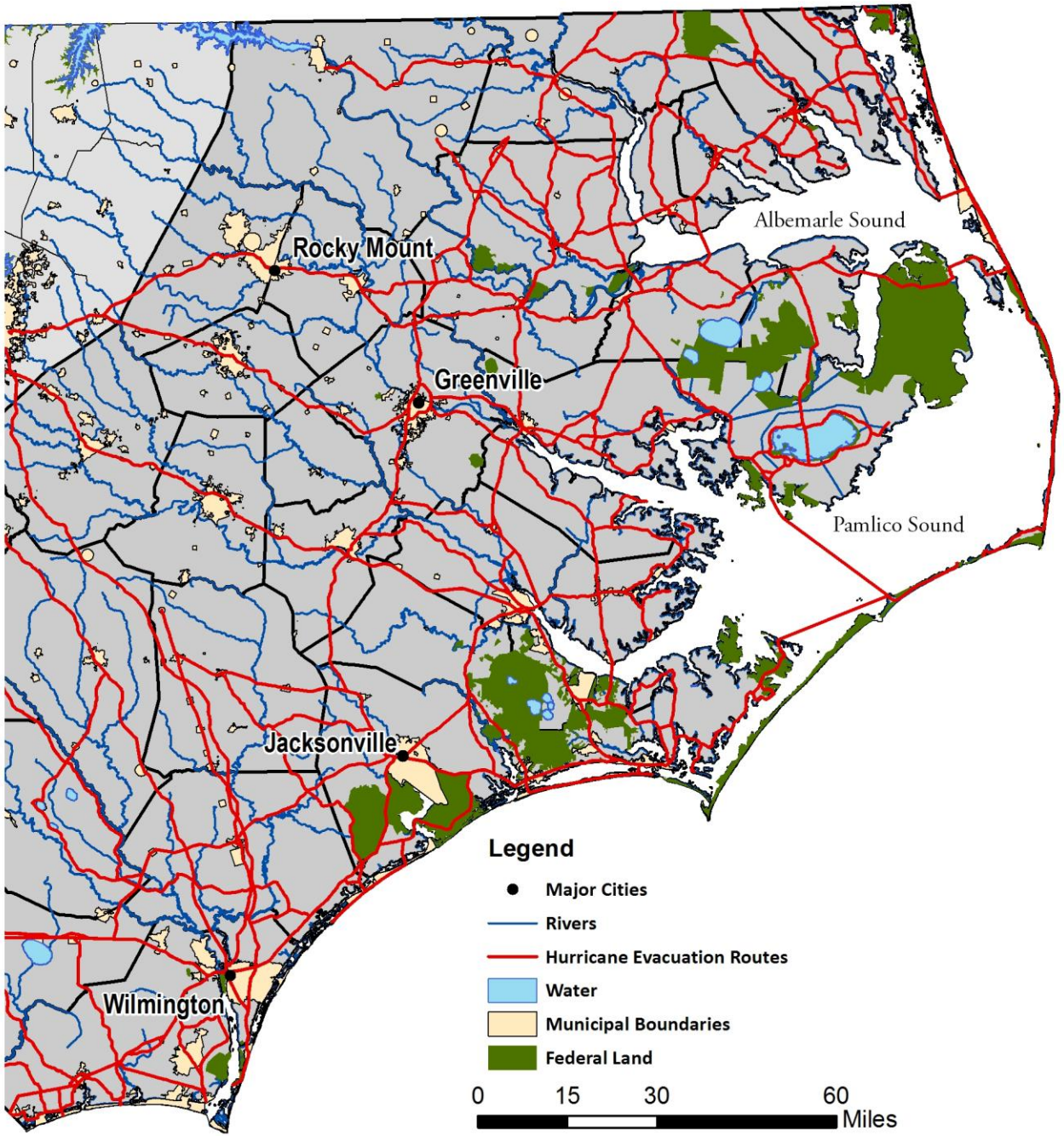
Coastal Resources



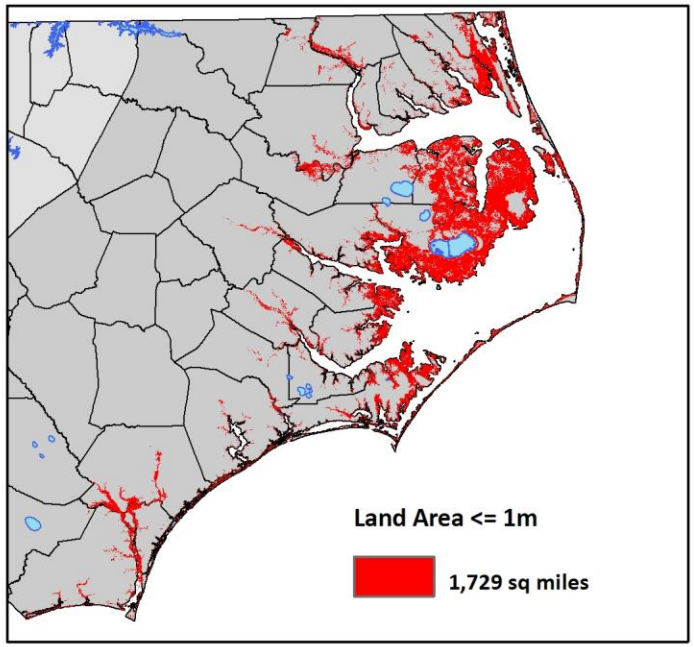
Sea-Level Rise

The North Carolina Coast has a significant vulnerability to sea-level rise, with more than 2,300 miles of coastline vulnerable to a one meter rise in sea-level. The loss of coastal wetlands due to sea-level rise will lead to further coastal erosion and loss of protection from wave action. This area also has significant natural resources and the largest estuarine system on the Atlantic coast.

Storm Surge Inundation

The Coast is also vulnerable to storm surge inundation. Storm surge is generated by the force of winds pushing water inland. Hurricane storm surge often combines with the normal tide to result in extensive coastal flooding. The projected increase in storm intensity will make the Coast more susceptible to hurricane damage, with more temporary and permanent flooding.

The map below shows land area equal to or less than one meter elevation, the land area especially vulnerable to sea-level rise, more temporary and permanent flooding from storm surge, and further coastal erosion.



Sources: NCCGIA; National Hurricane Center; NCDOT; NC Sea Level Rise Risk Management Study