Strategic Statewide Resilience and Risk Reduction Plan

EXECUTIVE SUMMARY

PURPOSE

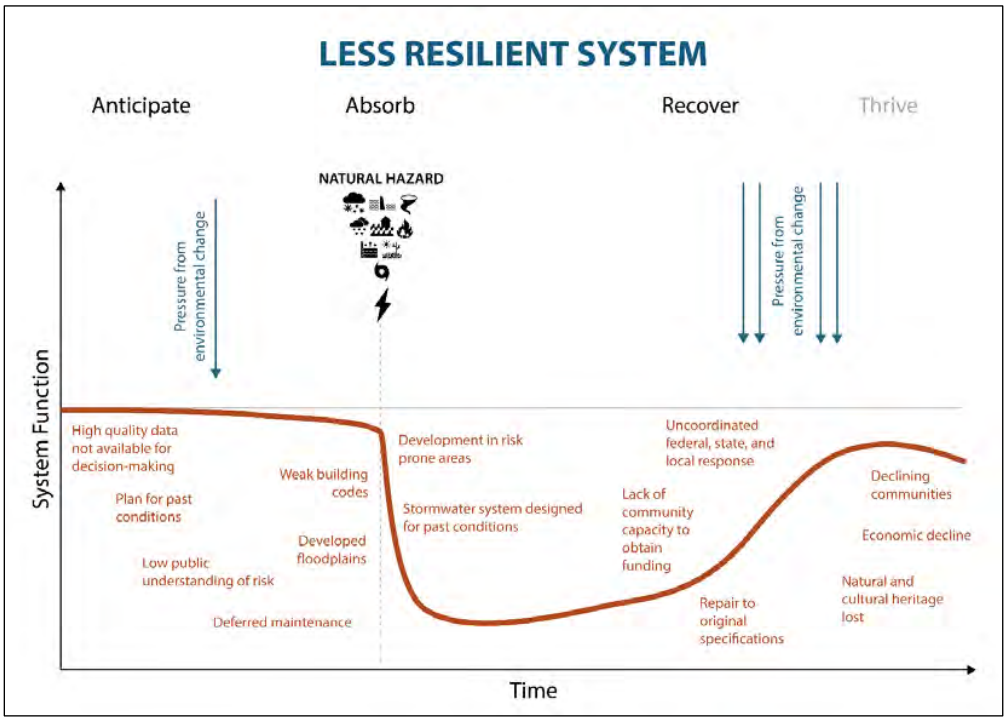
Impacts from three presidentially declared disasters in less than four years led, in part, to the creation of the South Carolina Office of Resilience. The South Carolina Office of Resilience (SCOR) exists to increase resilience to disasters and reduce or eliminate the long-term risk of loss of life, damage to and loss of property, and suffering and hardship, by lessening the impact of future disasters. The Disaster Relief and Resilience Act directs SCOR to develop, implement and maintain the Strategic Statewide Resilience and Risk Reduction Plan (Resilience Plan). The Resilience Plan is intended to serve as a framework to guide state investment in flood mitigation projects and the adoption of programs and policies to protect the people and property of South Carolina from the damage and destruction of extreme weather events (S.C. Code Ann. § 48-62-30 et seq.).

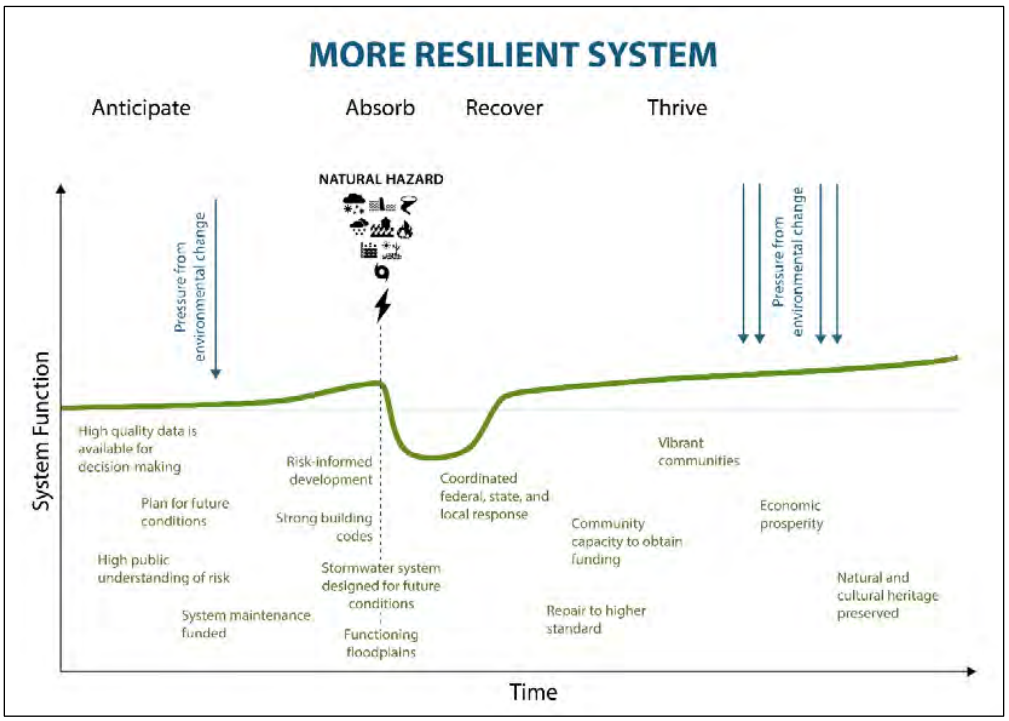
DEFINING RESILIENCE

Resilience is a complex term, capturing multiple theories and concepts depending on who is giving the definition. Working with the Advisory Committee, SCOR has adopted the following definition of resilience, guiding our work on this plan:

The ability of communities, economies, and ecosystems within South Carolina to anticipate, absorb, recover, and thrive when presented with environmental change and natural hazards.

The figures on the following page compare the difference in system function over time for a more resilient system and a less resilient system when faced with environmental changes and natural hazards.


LESS RESILIENT SYSTEM
Anticipate
Absorb
Recover
Thrive
NATURAL HAZARD
Pressure from environmental change
Pressure from environmental change
System Function
High quality data not available for decision-making
Plan for past conditions
Weak building codes
Developed floodplains
Low public understanding of risk
Deferred maintenance
Development in risk prone areas
Stormwater system designed for past conditions
Uncoordinated federal, state, and local response
Lack of community capacity to obtain funding
Repair to original specifications
Declining communities
Economic decline
Natural and cultural heritage lost
Time


MORE RESILIENT SYSTEM
Anticipate
Absorb
Recover
Thrive
NATURAL HAZARD
Pressure from environmental change
Pressure from environmental change
System Function
High quality data is available for decision-making
Plan for future conditions
Strong building codes
High public understanding of risk
System maintenance funded
Risk-informed development
Stormwater system designed for future conditions
Functioning floodplains
Coordinated federal, state, and local response
Community capacity to obtain funding
Repair to higher standard
Vibrant communities
Economic prosperity
Natural and cultural heritage preserved
Time

KEY FINDINGS

NATURAL SYSTEM

- South Carolina's hydrological footprint consist of eight major river basins: Broad, Catawba, Edisto, Pee Dee, Salkehatchie, Saluda, Santee, and Savannah. The hydrologic footprint extends beyond state boundaries, and includes those basins shared with neighboring states.

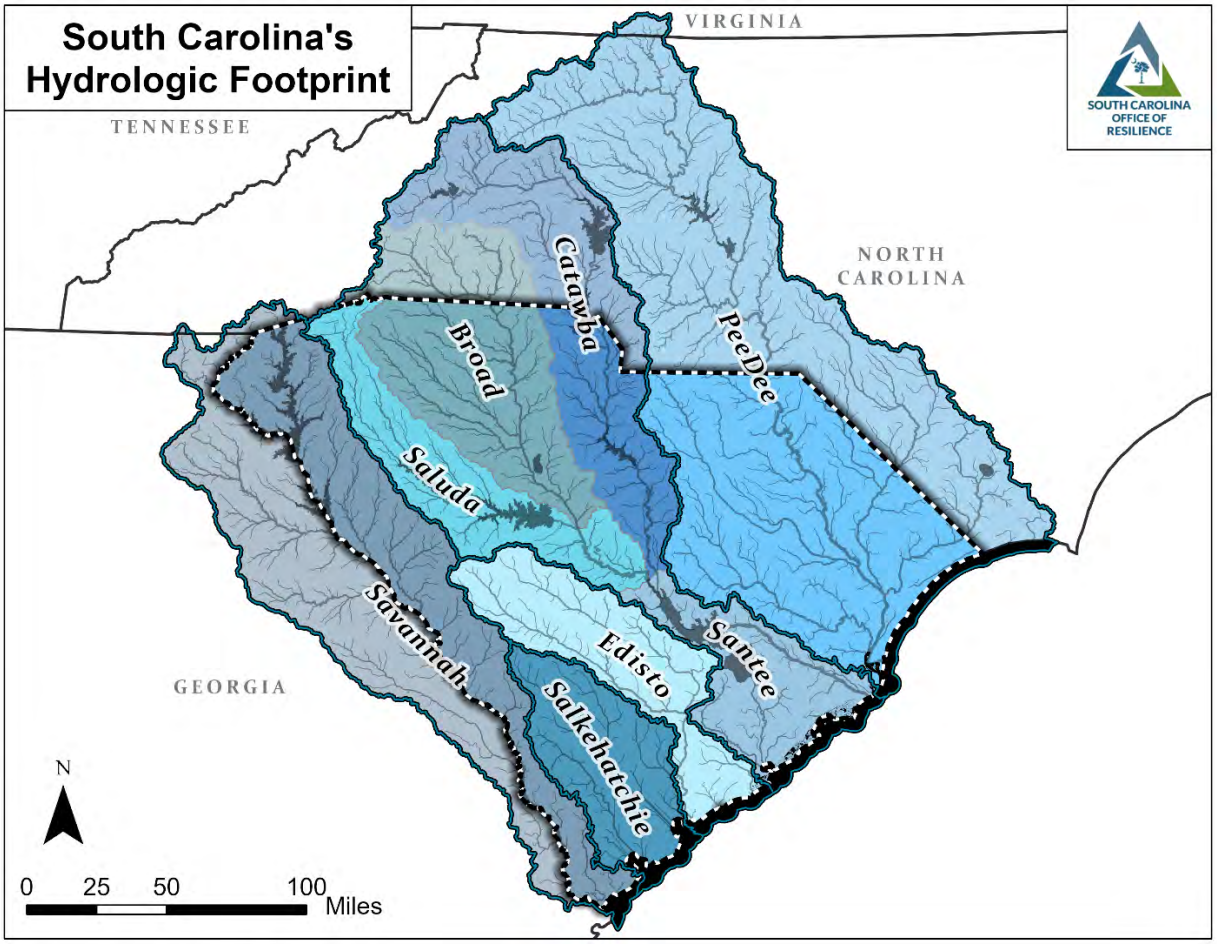
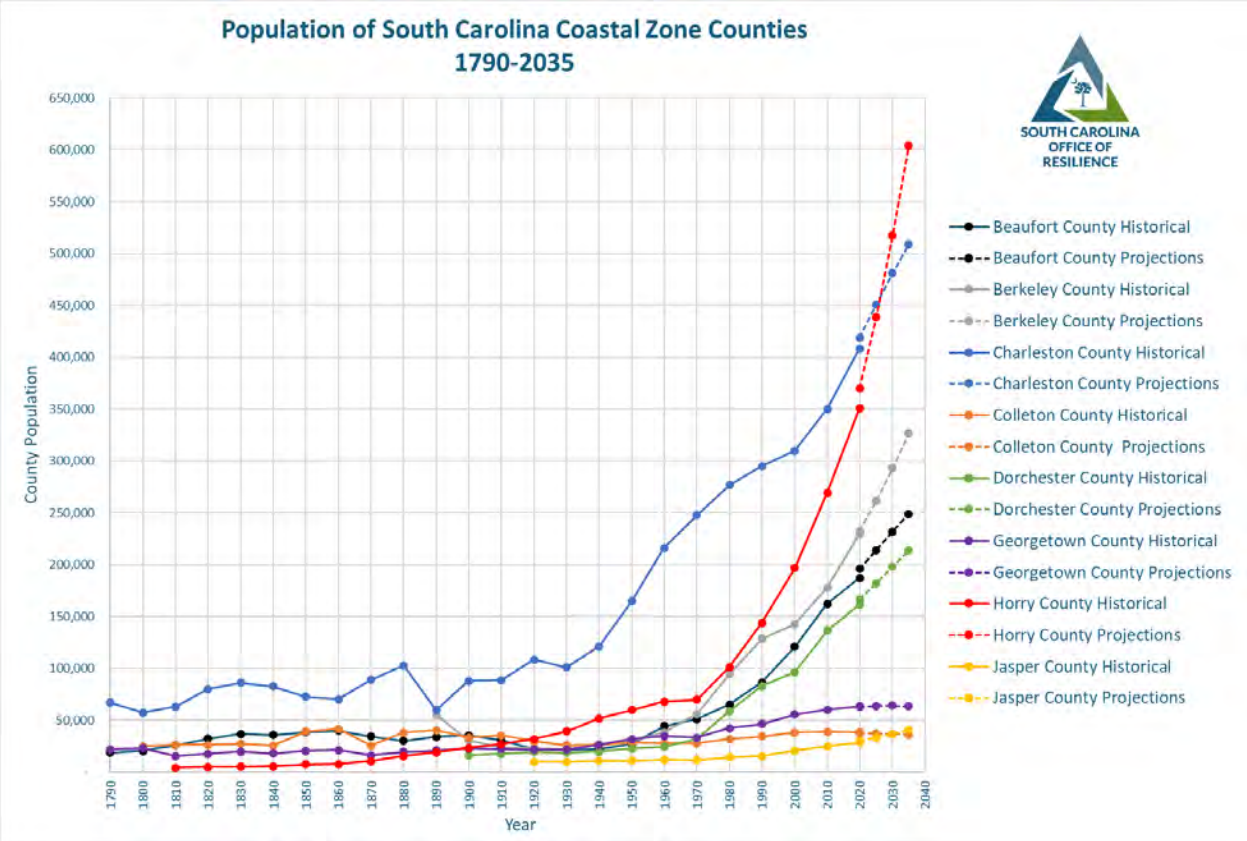


Figure 3: South Carolina's Hydrological Footprint

- There are eight major aquifers that are recharged by surface water that falls on permeable surfaces like the Sandhill region of South Carolina. The deeper aquifers are used for larger withdrawers, while the surficial aquifer is mostly used for minor withdrawers like private drinking water supply and smaller irrigation operations.
- Septic systems can be impacted by changes in the water table elevation caused by increased precipitation and/or sea level rise.

POPULATION & LAND USE

- South Carolina's population has increased to over 5.1 million people from an estimated 2.5 million people in 1970.
- Population growth is expected to continue with the population reaching 6.2 million people by 2035.
- Changing land uses can put new development areas and existing areas at an increased risk for natural hazards. Developed areas can experience flooding as natural systems are changed into developed areas with non-permeable surfaces. Developed settings decrease the storage capacity to the system and discharge water faster into the waterways. Meanwhile, changes in land uses at the wildland-urban interface can increase wildfire risk.
- The explosive population growth in South Carolina is regionally disproportionate. Population growth has centered around coastal counties and urban areas. Many rural areas, especially along the I-95 corridor, are experiencing population decline.



TEMPERATURE TRENDS

- Since 1895, average annual temperature has increased by approximately 1°F, lower than the average global increase of approximately 2°F. However, the rise during the past 60 years has matched or exceeded global increases, and the past 30 years have been warmer than any other consecutive 30-year period.

- The instrumental temperature record includes considerable year-to-year and decade-to-decade variability.
- Most stations exhibit statistically significant increases in a) maximum temperature in winter, spring, and summer, and b) minimum temperature in summer. While the state has had temperature increases in the past sixty years, few stations exhibit maximum temperature trends during fall, or minimum temperature trends during winter, spring, or fall when considering records from the beginning of the early 20th century.
- Climate models project South Carolina temperature increases of 5° to 10°F by the year 2100, depending on future greenhouse gas emissions.

PRECIPITATION TRENDS

- Precipitation has varied greatly on a yearly and decadal basis.
- Summer precipitation has decreased and the number of precipitation days in fall has increased; overall, few other statistically significant trends are found for seasonal or annual total precipitation.
- There are relatively few statistically significant long-term trends in heavy precipitation. However, recent heavy precipitation events affecting the coastal regions and the Pee Dee River Basin (2015, 2016, 2018) match expectations of a warmer world with higher evaporation rates and atmospheric moisture.
- Drought has periodically affected all parts of the state. The historical record reveals interannual and interdecadal variability, but no statistical trend. Rising temperatures in the 21st century will likely exacerbate agricultural and hydrologic drought.

STORM EVENTS

- South Carolina's geographic position makes it vulnerable to tropical cyclones. The impact of tropical storms and hurricanes affecting the state have fluctuated greatly across years and decades. Their frequency and intensity have been influenced by large-scale conditions including sea-surface temperature and wind shear.
- Future scenarios are mixed with respect to the frequency of storms, but more consistently project greater intensity of wind and precipitation for those storms that do occur.

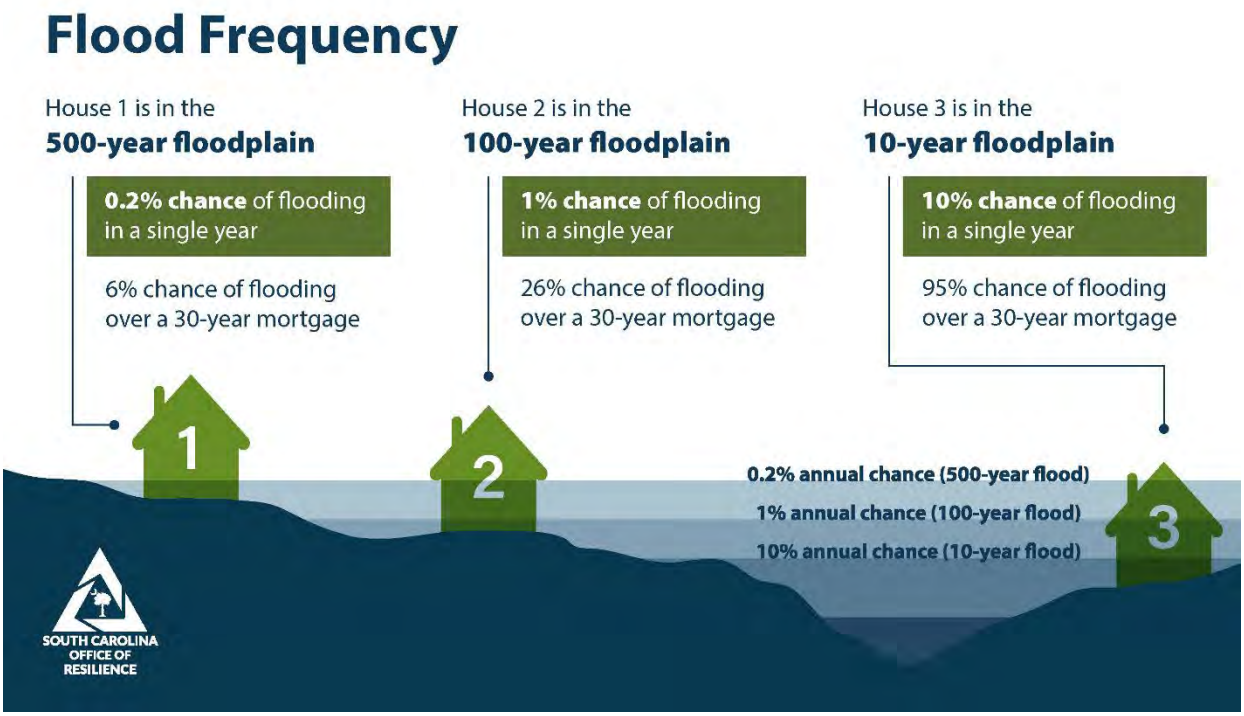
COASTAL IMPACTS

- South Carolina's coast is low-lying and vulnerable to sea level rise. Sea levels have already risen by approximately 1 foot from 1899 levels and will further rise by approximately 1 foot by 2050. Projections for sea level rise range from 2 to 16 feet by 2150.
- Sea surface temperature increases off the Carolinas are statistically significant, and projected increases of 7 to 9 °F by 2100 would be among the highest nationally.
- Ocean acidification is currently stressing marine organisms and is projected to accelerate.

- Beyond sea level rise, South Carolina is likely to experience compound changes (a combination of impacts that could be larger than each individually) in our coastal and marine waters including sea surface temperature, ocean acidification, salinity, deoxygenation, and potential disruptions to the Gulf Stream.
- Physical and chemical changes may combine to create harmful impacts for marine ecosystems and coastal economies in South Carolina.

FLOOD RISK & VULNERABILITY

- Flooding in South Carolina is caused by prolonged rain events, short intense rain, overflowing rivers, dam or levee failure, storm surge, and tidal process. Flooding can be broken into three types: river flooding (fluvial), overland flooding (pluvial), and coastal flooding.
- Estimates of flood frequency are based on historical record and do not account for changes in climate and landscape conditions.



- Existing rainfall intensity, duration, and frequency (IDF) curves from NOAA Atlas 14 are based on the concept of stationarity, the idea that past conditions are predictive of the future. Changing rainfall patterns and failure to use the most up-to-date data could lead to underestimating the likelihood of damaging rain events.
- SCOR determined that the intermediate to intermediate-high sea level rise scenario should be considered in the development of South Carolina's Statewide Resilience Plan.
- Projected sea level rise will lead to increased coastal flooding in low lying areas.

- Land subsidence is likely contributing to relative sea level rise in many coastal areas.
- Since 2015, all 652 high and significant hazard dams in the state have been assessed, and the state has invested significant resources in the State's dam safety program.
- Dam failure can lead to flooding downstream. Additionally, there is the potential for mobilization of contaminated sediments that may be trapped behind the dam.
- FEMA flood mapping does not currently capture the full risk of flooding. Supplemental tools such as the First Street Foundation Flood Hazard Layers should be utilized for a more complete understanding of flood risk under both current and future conditions.
- Using the First Street Foundation Flood Hazard Layers and other publicly available datasets, SCOR assessed and mapped the vulnerability of various facilities.

WILDFIRE

- Wildfires are common occurrences in South Carolina and are defined by the South Carolina Forestry Commission as any forest fire, brush fire, grassfire, or any outdoor fire that is not controlled or supervised.
- On average, approximately 1,400 wildfires burn nearly 11,000 acres in South Carolina each year (SC Forestry Commission (SCFC), 2021).

DROUGHT

- In the last 21 years, South Carolina has experienced three major droughts.
- The State Water Plan under development at SCDNR aims to understand water supply versus water demand, including the impacts of drought on the water resources in the State.

HEAT

- Heat is the most dangerous of the weather related hazards in recent decades (National Weather Service, 2022).
- Historic analysis documents maximum summer temperature increases across the State.
- Portions of the state are projected to experience up to 50 more days a year with temperatures above 95 °F by the end of the century.
- Future temperature increases and more frequent and intense heat waves will likely cause the Southeast to experience a disproportionate health burden.

SEVERE THUNDERSTORMS

- Thunderstorms occur frequently in South Carolina, and severe storms have the potential to produce damage-causing hail, lightning, and high winds.
- Tornadoes are a facet of severe thunderstorms as well.
- In South Carolina, extreme winds are the most reported hazard to the National Centers for Environmental Information (NCEI).

TROPICAL SYSTEMS AND HURRICANES

- While hurricanes are considered low frequency but high consequence events.
- South Carolina ranks 5th (fifth) among states that experience hurricanes, behind Florida, Texas, Louisiana, and North Carolina.

TORNADOES

- There is no significant trend in tornadoes occurring in the State.
- Current climate projections predict that tornado alleys are shifting east.

WINTER WEATHER

- Damage from winter weather events has increased in the last few decades.
- These events can disrupt communications and power by trees or branches falling on suspended lines, disrupt travel plans by impairing roadways, and damage plants both for residential and agricultural purposes.

SEISMIC EVENTS

- According to the USGS, South Carolina has experienced 229 earthquakes since 2001, with 46 events larger than a magnitude 2.5. The largest event since 2001 reached a magnitude 4.1 in Parksville, SC, on November 11, 2014.
- The largest earthquake recorded in the State was the Charleston Earthquake of 1886 with an estimated magnitude of 7 to 7.6.
- Tsunamis are rare on the east coast of the U.S. and there is insufficient data to make reasonable decisions or recommendations to mitigate or plan for the impacts of a tsunami.

RECOMMENDATIONS SUMMARY

Improve Data Collection and Coordination

Establish a data coordination office to coordinate, catalog, document, and make accessible the wide range of data produced by and for the State.

Increase the density of weather stations to provide higher quality data for developing weather models, hydrologic models, drought assessments, flood forecasting and other decision-making processes.

Increase the density of permanent river gage locations to provide higher quality data for the development of better hydrologic models and to inform and improve water planning, drought assessments, flood forecasting, and flood frequency estimates.

Increase the density of tidal gauges to enable better monitoring and modeling of conditions.

Develop a statewide network to monitor surficial groundwater to better understand the impacts of sea level rise and changes in rainfall infiltration on shallow systems including septic fields.

Install extensometers along the coast to monitor vertical land movement to develop a better understanding of relative versus absolute sea level rise and improved understanding of the causes of subsidence.

Update NOAA Atlas 14 IDF curves for rainfall and incorporate into infrastructure design. Adopt NOAA Atlas 15 IDF curves when released and design based on future conditions.

Establish a group to evaluate climate information will inform decision makers on how future climate trends will likely impact the State.

Fund the collection and processing of updated LiDAR data to allow decision makers to use the most up-to-date elevation to use in computational models and in decision making.

Create a roadway elevations inventory that may be used for transportation network vulnerability analyses.

Partner with NOAA to develop a high resolution land cover dataset for the hydrological footprint of South Carolina. This allows for a more detailed catalog of the type and area coverage of various land cover types, allowing for better forecasting, planning, and modeling.

Complete a statewide sediment study to understanding of sediment budgets, including the impact of reservoirs and identify potential engineering and policy solutions to remobilize sediment in the system.

Complete the SCDNR Flood Inundation Modeling and Mapping Project to provide emergency responders and others with the information needed for evacuations, search and rescue, road closures, and other emergency response activities.

Establish a Modeling Technical Advisory Group to inventory existing models and technical capabilities, identify data gaps, make recommendations on modeling needs, and evaluate proposals for modeling improvements.

Establish a committee to examine the need for a contract with an imagery provider so that when a disaster occurs, images can be used to better assess the damage extent post-event. This can aid the ability of SCEMD, FEMA, and SCOR to identify where to focus response and recovery efforts.

Develop higher resolution population projections at the subcounty scale to inform local, county, municipality, and state planning processes.

Develop a statewide property level data standard to allow for cross jurisdictional data analysis and modeling.

Inventory and analyze zoning and land use policy statewide to understand how local jurisdictions implement zoning and the ways in which land use regulations shape a community's development and resilience.

Create and fund a cultural resources coordinator position to develop a cultural resources inventory. Such an inventory will allow for comprehensive planning that mitigates the loss of cultural resources across the State and efficient recovery.

Increase Education, Outreach, and Disclosure

Host a series of regional workshops to educate the public about the Statewide Resilience Plan.

Develop a SCOR Resilience Atlas to provide a centralized location for resilience related GIS data to aid in decision-making statewide.

Develop and maintain a resilience resource list for communities and other audiences to access information and resources that aid in decision making.

Maintain the S.C. Sea Grant Resilience Planning Archive. This archive catalogs the resilience planning efforts undertaken across the state to inform planning and project implementation and allow for cross jurisdictional coordination.

Develop a resilience training and certification program to build community capacity and aid in local implementation of statewide resilience principles.

Strengthen hazard disclosure in real estate transactions to increase the knowledge of risk and conditions by purchasers related to flooding and other natural hazards.

Develop a cultural resources training to help cultural institutions and caretakers increase the resilience of their resources and collections.

Reestablish a flood hazard signage program to increase public awareness of risk.

Coordinate Watershed-Based Resilience Planning and Projects

SCOR will coordinate with communities at the watershed level to identify risks and vulnerabilities, develop actionable flood mitigation and resilience solutions, and build community capacity by leveraging local, regional, and state partnerships.

Establish a Resilience Grant/Loan Program using the Disaster Relief and Resilience Reserve Fund to implement mitigation projects, programs and policies recommended by the Statewide Resilience Plan and watershed-based resilience planning. Recurring funds should be allocated to the Resilience Grant/Loan Program to ensure that projects, programs, and policies identified through watershed-based resilience planning are implemented in a timely manner.

Incorporate Resilience into Planning, Land Use and Other Regulatory Processes

Each state agency should conduct a resilience review based on the climate and flood risk and other hazard data presented in the vulnerability assessment and make recommendations on policy and regulatory changes that are needed to reduce vulnerabilities.

Utilizing best available data, counties and municipalities should adopt policies that restrict new development in flood prone areas whether or not they designated by FEMA as a special flood hazard area. Any new structures in flood prone areas should be designed to withstand a 1% annual flood event over the design life of the structure, considering future conditions.

Develop best management practices for communities to incorporate resilience into comprehensive plans to guide decision making regarding growth and development, public facility investments, regulation of land uses, siting of green space, and economic development initiatives.

SCOR will develop best management practices and provide principles that enable communities to develop local strategies to implement resilient policies, aligning with their comprehensive plans, through zoning and land use codes, subdivision regulations, overlay zones, floodplain management, and stormwater ordinances.

Water systems should conduct a resilience review of their water systems based on the climate and flood risk and other hazard data presented in vulnerability assessment.

New legislation should be established to regulate the alteration of isolated wetland systems to reduce the potential loss of flood mitigation and ecosystem services.

Maintain and Strengthen Building Codes

South Carolina should maintain the current update schedule for both the Residential and Commercial codes to keep up with reasonable standards of construction for public health, safety, and welfare.

The State should not make modifications to the International Residential and Commercial Codes that reduce resilience. Examples are the current reductions to the hurricane and seismic requirements in some areas.

Develop professional education programs about building codes for professions involved in construction such as contractors, architects, and engineers to ensure innovations and resilience best management practices are utilized.

Assess how an update to the 2009 Energy Code could impact the resilience of the power grid in the State. The assessment should consider both the costs of construction and operation of buildings as well as the impacts on public health, safety, and welfare.

Utilize the most conservative wind zone map when there is a question as to a property's location relative to the county level wind maps approved by the SC Building Codes Council.

Coordination is needed between Internal Organization for Standardization (ISO) and building code officials to ensure officials understand how they will be scored by the Building Code Effectiveness Grading Schedule and how to accurately complete their reports.

Incorporate Resilience into Infrastructure Design

Consider future conditions in the design of critical infrastructure. Critical infrastructure can be defined as those assets, systems, and facilities that communities rely upon for everyday health, safety and welfare and lifeline functions.

Review state and local stormwater infrastructure design standards to see if they should be modified to handle lower frequency storm events (i.e. a “50-year” storm vs “10-year” storm).

Identify and remove barriers to permitting nature-based solutions on the state and local level.

Funding sources for infrastructure maintenance should be identified prior to construction to ensure the infrastructure will function properly over the intended life of the project.

Consider the future conditions identified in the climate and vulnerability sections of this report when planning and investing in port infrastructure.

Maintain Natural Flood Protection Through Conservation

Develop a Priority Flood Mitigation Conservation Map. SCOR has used a combination of public and private datasets to better understand the landscape's role in flood mitigation across South Carolina. This data model identifies areas where floodwaters are expected, where wetlands can help absorb excess water, and those areas where water is most likely to infiltrate the ground. Protecting these areas may help attenuate the impact that future development has on flooding.

Develop a grant program for state and local governments and non-profits to complete land acquisitions that maximize flood reduction benefits, implementing the Priority Flood Mitigation Conservation Map. This program should partner with other conservation agencies such as SC Conservation Bank, South Carolina Department of Natural Resources (SCDNR), South Carolina Forestry Commission (SCFC), South Carolina Parks, Recreation, and Tourism (SCPRT), SC Department of Agriculture (SCDA), and South Carolina Department of Health and Environmental Control (DHEC).

Incorporate Resilience into Housing Recovery

Any future disaster recovery and mitigation action plans, policies and procedures developed for the State should refer to the principles of the Strategic Statewide Resilience and Risk Reduction Plan.

Manufactured housing units needing full replacement should be replaced with stick built or modular homes where possible.

Impact windows should be used when homes are repaired or replaced following a disaster, regardless of the wind zone the home is located in.

In areas that are prone to flooding, require replacement homes to have a first-floor elevation built to Base Flood Elevation (BFE) +3 feet. If this requirement would cause the home's first floor elevation to be elevated above 10ft above land surface, the home would become ineligible for replacement and would instead be offered a voluntary buyout.

Housing funds allocated to South Carolina should not be used to repair or construct homes if they are:

- A FEMA Repetitive Loss Property
- Properties in the FEMA Regulatory Floodway
- Properties Seaward of DHEC Setback Line

Establish a Voluntary Pre-Disaster Buyout Program

The Disaster Relief and Resilience Act required SCOR to develop an estimate of the current number and cost of residential properties within the State for which a buyout may be appropriate. Properties are identified and prioritized based on potential risk to flooding. The following criteria were used to develop this estimate and are proposed for the prioritization of the properties under a pre-disaster buyout program:

- Tier 1: Repetitive Loss Properties in the FEMA Regulatory Floodway & Repetitive Loss Properties Seaward of the DHEC Beachfront Setback Line
- Tier 2: Properties in the FEMA Regulatory Floodway & Properties Seaward of the DHEC Beachfront Baseline
- Tier 3: All Other Repetitive Loss Properties
- Tier 4: First Street 100 Year Event (Current) with 6+ feet of inundation
- Tier 5: First Street 100 Year Event (Future) with 6+ feet of inundation

Developing a voluntary buyout program would require a more detailed analysis and eligibility of individual properties and property owners and would be ultimately determined by the funding source and require collaboration with communities.

Identify and Maximize All Available Funding Sources For Resilience Activities

Develop a Resilience Funding Hub, a web-based portal, to collect, coordinate and disseminate information related to funding to enable coordination, collaboration and cooperation among state agencies, local and regional governments, and non-profits to obtain funding.

Develop best management practices on how communities should implement resilience practices into a range programs and projects, as required by many federal and non-federal funding sources.