THE IDEA BOOK

NORTH CAROLINA
RESILIENT COMMUNITIES PLANNING GUIDE

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NCORR
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EQUAL HOUSING OPPORTUNITY

Table of Contents

Finding Your Way Around the *Idea Book*

The *Idea Book* is Volume 2 of the *North Carolina Resilient Communities Planning Guide* and is organized into **14 resilience topics** listed alphabetically. Each topic contains an overview, a description of the topic's importance to resilience, key players, informational resources, featured strategies and a real-world case study. Depending on your community and the climate and natural hazard challenges you face, some of these topics may be more relevant than others. Likewise, your unique community may be faced with a climate or natural hazard challenge not addressed here. Either way, this document can serve as a resource guide and inspiration for understanding how to address climate change and natural hazard threats, whatever they may be.

The Resilience Topics include:

- Business and Local Economy
- Coastal Management
- Collaboration
- Communication and Education
- Ecosystem Protection, Restoration and Enhancement
- Energy and Utilities (electric, gas, broadband, potable water, wastewater, etc.)
- Equity and Justice
- Funding and Technical Assistance Mechanisms
- Housing
- Infrastructure and Capital Investments
- Land Use and Development
- Planning and Decision-Making Frameworks
- Public Health
- Stormwater Management and Flooding

Organization – Each resilience topic has three main sections: overview, strategies and a case study.

Overview – The overview provides a short explanation of the resilience topic and explains its role in resilience. This section also lists potential project leads, stakeholders and experts.

Strategies Chart – Each of the resilience topics contains strategies for all stages in the planning process, including the initial assessment, plan creation and implementation. The strategies chart contains a brief description of each strategy, how it supports resilience and a more tailored set of resources for further learning and inspiration. These resources are organized by information, examples and case studies.

Case Study – Each resilience topic contains a case study to illustrate a real-world solution. Each case study includes the project basics (cost, funding mechanisms and key players), information on making it happen, and how the project addressed, or could have addressed, equity and outcomes. Each case study also provides the name and contact information of a person who can tell you more about the project in case you want to replicate it in your hometown.

TOPIC | 01

BUSINESS AND LOCAL ECONOMY

Overview

Natural hazards can be detrimental to businesses and the local economy. Floods and heavy winds can destroy a business's facilities, financial records, and products, especially if that business is in a vulnerable area. Loss of utilities and displaced employees can also impact a business's operations and bottom line. Even when a hurricane hits another part of the state or country, a business may experience supply chain and transportation disruptions (FEMA, 2020).

Local businesses, chambers of commerce and other economic development stakeholders can build resilience by preparing for disruptions. Communities with businesses that are adequately prepared will bounce back more quickly from hazards. These communities can also rely on their businesses to provide sustainable income for their residents and tax revenue to support local needs.

Role in Resilience

Because businesses, organizations and other economic stakeholders contribute to a community's wellbeing, it is important for local leaders to engage them throughout the cycle of climate resilience planning. Locally produced goods and services fulfill day-to-day needs, provide employment opportunities for residents, and generate tax revenue supporting a range of public investments. Local businesses also attract people from other communities, provide recreation and entertainment, and help keep money in the community. Local North Carolina economies may be highly reliant on one industry sector or employer, like seasonal tourist communities and college towns, or they may be highly diversified, with a wide range of businesses representing many different economic sectors. Regardless of a town's economic structure, local leaders can work with businesses and economic development organizations to mobilize actions and networks that support climate resilience.

Communities can reduce or help protect themselves against short-term and long-term economic stressors from hurricanes, heat waves, droughts, wildfires and other extreme weather and natural disasters. Local businesses can reduce the costs of recovery by incorporating climate resilience into existing planning efforts and budgets, and the local economy can begin to pursue new opportunities that might arise as the climate changes. This section lists several strategies communities can use to support local businesses' climate change preparedness efforts.

Potential Project Leads, Experts and Stakeholders

- Local government departments and commissions focused on economic development, sustainability, floodplain management, and emergency management
- Chambers of commerce

- North Carolina's councils of governments (COGs) and regional economic development partnerships
- Workforce development organizations, such as the North Carolina Business Committee for Education
- Local businesses
- Higher education institutions, especially community college small business centers
- State government agencies, such as NC Department of Commerce
- Federal government agencies, such as US Economic Development Administration
- Nonprofits and academic entities focused on climate and economy, such as the NC State University Tourism Extension
- Consultants
- Seasonal and year-round employees
- Residents

FOR MORE INFORMATION

**To note: some resources below and within the strategy chart are related to business resilience in the wake of the COVID-19 pandemic. While this was not a climate-related event, there are lessons learned applicable to climate change resilience.*

The Disaster Resilience Toolkit Supporting America's Southern Rural Communities **provides an introduction to workforce disaster resilience and outlines ways local economies can prepare for, stabilize during, and recover from natural disasters. The resource, which was created by Bloomberg Philanthropies and Jobs for the Future, includes a checklist for local leaders who want to build a disaster-resilient workforce.**

Leadership in Times of Crisis: A Toolkit for Economic Recovery and Resiliency **is designed for a wide range of public and private sector officials working with businesses and industries in the economic recovery process, including but not limited to climate hazards. This resource was created by the International Economic Development Council.**

Triangle Farms for Food: Strategy + Action Plan **presents methods for protecting agricultural land to "keep farmland in farming, support current and beginning farmers, advance agricultural awareness and build a strong local food economy."**

BUSINESS AND LOCAL ECONOMY | 01

STRATEGIES

Actively engage businesses in resilience planning and implementation

This strategy supports participation by local businesses and other key economic players during community resilience planning processes, such as a resilience section in a comprehensive plan. Local businesses can often provide people power, support relationship building, and contribute resources supporting resilience building initiatives. Working directly with businesses and economic development organizations also provides greater insights into their resilience-related challenges and needs and ensures the community's resilience efforts include programs and projects directly supporting the local economy.

FOR MORE INFORMATION

Building Resilient Futures **(Enterprise Community Partners) This site provides guidance on how to help affordable housing owners write business continuity plans and more. Refer to the Business Continuity Toolkit.**

Planning Framework for a Climate-Resilient Economy (US Environmental Protection Agency) **This document outlines a framework to help "the business community prepare for and adapt to projected changes and think creatively about ways to prosper in a changing climate."**

EXAMPLE

Roadmap to Recovery and Resilience (Downtown Austin Alliance, TX)

Provide local business with support services for building resilience

This strategy helps businesses determine whether they are in locations vulnerable to hazards and implement hazard migration strategies. It also promotes preparedness measures like business continuity planning, which includes backing up important business and financial records, protecting inventory, and establishing redundant supply chains for goods and materials. Trainings could include asking businesses to consider how to utilize their skills, resources and networks during storm events to develop alternative revenue streams or branding opportunities.

Providing support services like risk and vulnerability assessments, guidebooks, technical assistance and one-stop-shops for resources and information builds resilience by ensuring businesses know what to do before, during and following climate and other disasters.

FOR MORE INFORMATION

Establishing A Business Recovery Center (Restore Your Economy) **This resource outlines the steps to developing a business recovery center: a "one-stop-shop set up to provide local, state and federal resources and services for businesses after a catastrophic event."**

EXAMPLES

Community Economic Recovery and Resiliency Initiative (NC Department of Commerce)

Disaster Planning/Business Interruption Consulting Services (Pennsylvania Small Business Development Center)

Homegrown Leaders training (North Carolina Rural Center)

Providence Resilience Partnership

Resiliency Innovations for a Stronger Economy (New York City Economic Development Corporation)

CASE STUDY

Polk County, FL, facilitates business recovery after disasters

Promote and support diversification of the local economy

This strategy supports resilience by supporting the economy's ability to react to and recover from climate hazards.

Supporting economic development strategies such as attracting business incubators and new or small businesses provides a diverse economy that spreads the impact of climate-related hazards.

FOR MORE INFORMATION

EXAMPLES

Accelerate Rural NC (Eastern Carolina University)

Bethesda Green Innovation Lab Incubator (Bethesda, MD)

Rhode Island Infrastructure Bank

CASE STUDY

*See the **Business and Economy** case study on the following pages.

Protect and enhance redundancy of supply chains and critical resource availability

Building flexibility and redundancy into sourcing, distribution and transport systems builds resilience by accommodating and adapting to uncertainty rather than relying on single-source production pathways. This ensures that businesses, manufacturers and consumers experience the least amount of disruption possible and helps the overall economy quickly bounce back following an event.

FOR MORE INFORMATION

Achieving Supply Chain Resilience in a Volatile World (BCG) **This set of slides provides an overview of supply chain challenges to expect and how to withstand them.**

Supply Chain Resilience Guide (FEMA) **This guide is designed to help emergency managers think through the challenges and opportunities presented by supply chain resilience.**

EXAMPLE

Supply Chain Resilience Initiative (Los Angeles, CA)

CASE STUDY

Puget Sound, WA, responds to pandemic with private-public collaborations to facilitate supply chain resilience

BUSINESS AND LOCAL ECONOMY | 01

CASE STUDY

CASE STUDY Oyster Trail protects oyster habitat and grows economy

Project Purpose

Oyster harvest levels are decreasing. This decrease is the result of poor water quality, disease and predation, habitat loss, increased harvest pressures and natural disasters (North Carolina Division of Marine Fisheries, 2017). Severe storms can cause water quality impairments that force oyster harvesting to stop until the NC Department of Environmental Quality confirms that shellfish are safe to eat (North Carolina Coastal Federation, 2023). The North Carolina Coastal Federation, North Carolina Sea Grant and North Carolina Shellfish Growers Association launched the NC Oyster Trail in 2020 to diversify and expand the local oyster economy through tourism experiences.

What is an oyster trail?

The North Carolina Oyster Trail is a collection of oyster-related tourism experiences. The trail features shellfish farm tours, tasting events and educational opportunities. These events aim to help oyster farmers, harvesters and restaurants diversify their revenue streams. Diversified revenue streams help the industry withstand climate and non-climate stressors.

Key Players: North Carolina Coastal Federation; North Carolina Sea Grant; North Carolina Shellfish Growers Association; and oyster farmers, sellers, and educators

Quick Facts

1. As of 2022, oyster harvest levels have decreased an estimated 80-85% from historic harvest levels.
2. Hurricane Florence caused an estimated $10 million in damages to North Carolina's shellfish aquaculture industry in 2018 (North Carolina Coastal Federation, 2021)
3. In 2020, the North Carolina Coastal Federation, North Carolina Sea Grant and North Carolina Shellfish Growers Association launched the NC Oyster Trail.
4. In 2021, the statewide Oyster Steering Committee released the 2021-2025 Oyster Restoration and Protection Plan for North Carolina: A Blueprint for Action. This Oyster Blueprint names the trail as an opportunity to improve the marketing, promotion and distribution of shellfish products.
5. The **NC Oyster Trail** and other Oyster Blueprint initiatives increased the amount of attention and funding for North Carolina oysters. This funding helped restore 450 acres of oyster habitat (North Carolina Coastal Federation, 2021).

Making It Happen

- In 2014, community members started discussing the idea of a North Carolina oyster trail after Virginia launched its trail.
- Trail partners worked with graduate students and professors at the UNC Kenan-Flagler Business School. The academic partners recommended a structure and estimated the economic impact of the trail. (See the report.) In 2018, trail partners presented this information to the North Carolina General Assembly. The state Senate included funding for the Oyster Trail in its 2017-2018 appropriations bill (General Assembly of North Carolina, 2017, p. 249). However, that funding was not included in the final state budget.
- The North Carolina Sea Grant funded a survey of tourists to understand their preferences for oyster tourism (Kozak, 2020).
- In 2019, the North Carolina Coastal Federation, North Carolina Sea Grant and North Carolina Shellfish Growers Association hosted stakeholder focus groups. They conducted these focus groups over a year-long planning period. They used stakeholder input to structure the NC Oyster Trail to meet the needs of potential members.
- Trail partners hired a private firm to design the trail's webpage.
- They recruited an initial 10 NC Oyster Trail members from focus groups and by contacting oyster-related businesses and organizations. To become a member, trail participants must offer a "memorable, participatory element that engages tourists with NC oysters." Members must pay a $50 registration fee and an annual $100 membership fee (North Carolina Coastal Federation and North Carolina Sea Grant, 2023).
- The North Carolina Sea Grant promotes Oyster Trail members. The organization uses an interactive online map, social media, brochures, news releases, local visitor bureaus and the annual NC Oyster Week.
- In 2020, the North Carolina Coastal Federation, North Carolina Sea Grant and North Carolina Shellfish Growers Association launched the NC Oyster Trail.

Spotlight on Equity

One core goal of the NC Oyster Trail is to seek economic development opportunities for less-economically-developed coastal communities (UNC Kenan-Flagler Business School and NC Policy Collaboratory, 2018). In addition, trail administrators ensure a diverse group of stakeholders work together to build and support the trail. To increase the trail's commitment to equity, trail administrators can ensure restaurants and farms owned by people of color are included in the trail's tourism experiences, and that trail events are planned in partnership with diverse community representatives.

Advice from the project manager

Trail members are the backbone of the NC Oyster Trail. Communities seeking to replicate this project should devote significant time and resources toward building and sustaining stakeholder relationships during the planning and implementation phases.

Forming a focus group composed of diverse stakeholders and at least one member from each type of trail organization or business is a great starting point. The focus group can ensure that the project meets their needs.

Outcomes

- The NC Oyster Trail helps sustain and grow the local oyster industry by connecting seafood producers, sellers and consumers through shellfish farm tours; seafood restaurants, raw bars and markets; and educational opportunities with ecotourism, aquariums, coastal museums and special events.
- The trail helps build a state-specific brand that leads consumers to choose and pay more for North Carolina oysters, adding value to the shellfish product.
- The trail supports the coastal ecosystem with volunteer opportunities to protect and restore oyster habitats.
- The trail advances the business success of wild harvesters and oyster farmers.
- Increased attention on oyster programs builds the case for increased funding for oyster-related programs, including from the NC Division of Marine Fisheries Oyster Sanctuary Program.
- Overwhelming interest from stakeholders along the coast and inland grew the number of Oyster Trail members to over 75 participants as of December 2022.
- Increased attention on North Carolina oyster populations, along with the support of other Oyster Blueprint initiatives, has increased funding for oyster-related programs by a factor of 10, and led to the restoration of 450 acres of oyster habitat, supporting half a billion oysters.

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Additional Resources

Coastal Review News Article on the Environmental and Economic Benefits of Shellfish

Island Free Press News Article on the N.C. Shellfish Industry and a New State Bill That Would Support the Industry

N.C. Policy Collaboratory's 2030 Strategic Plan for Shellfish Mariculture Report to the General Assembly

Virginia Oyster Trail website

Related Case Studies

- See **Energy and Utilities**: Electric Cooperatives install microgrid on Ocracoke Island.
- See **Infrastructure and Capital Investments:** Raleigh includes nature-based stormwater solutions in its roadway widening project.

Costs and Funding

- The NOAA National Sea Grant provided the trail's first major grant ($119,784) to fund the survey of tourists.
- Trail partners obtained additional grant funding to hire a private firm to design the trail's webpage.
- State and regional tourism departments dedicate staff time and volunteer hours to support trail operations.
- Annual trail membership fees contribute to trail operations.
- The North Carolina Sea Grant and the North Carolina Coastal Federation continue to support the trail financially.

References

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TOPIC | 02
COASTAL MANAGEMENT

Overview

Sea level rise and extreme weather are increasing risk in vulnerable coastal areas in North Carolina. The effects of these hazards on natural and human-made environments include acute loss of life and property as well as longer-term impacts like erosion; heavier and more frequent flooding, including greater king tides and sunny-day flooding; and the accumulation of marine debris (Kunkel, et al., 2020). Local governments and organizations can build resilience for estuarine and oceanfront shorelines with plans, policies and infrastructure. Such efforts can help people, property and habitats by protecting the natural environment against the long-term impacts of climate change and uncoordinated development.

Role in Resilience

Policy- and program-based coastal management strategies build resilience by limiting or prohibiting development in hazardous and sensitive coastal zones and by protecting or restoring vulnerable coastal areas in North Carolina. Examples include regulations requiring nature-based solutions like living shorelines or wetlands restoration to absorb or slow water; prohibiting new residential development in flood-prone coastal areas; building ordinances requiring elevation of homes to mitigate the impacts of storm surge and flooding; and, in extreme cases, programs to purchase privately owned properties in hazardous locations to avoid damages and convert the land to a more appropriate use.

Coastal management strategies can also focus on providing information and tools to educate the public about the importance of protecting our coastal environments and about risk exposure along the oceanfront and across the coast's broad network of brackish waterways.

Infrastructure is another strategy used to protect oceanfront shorelines and estuaries from climate hazards. Gray and green infrastructure build resilience by forming physical barriers between the sea and land.

Gray, or hard, infrastructure along the coast includes human-built physical barriers like sea walls, jetties or groins, and flood and tidal gates that mitigate the impacts of sea level rise, storm surge, king tides and the accumulation of marine debris. Constructing these structures is also called "shoreline armoring" or "coastal hardening." Such strategies have benefits but they also tend to be expensive, permanent and sometimes generate negative impacts in adjacent or downstream areas. Armoring the shoreline can also alter erosion and accretion (the graduation accumulation of sand and sediment) patterns: groins and seawalls tend to exacerbate erosion on one side of the wall.

Green infrastructure, also called soft infrastructure or nature-based solutions, mimics natural coastal features by using materials like sand,

rocks, vegetation, or living organisms such as oyster reefs to buffer the transition between land and water. Examples of green infrastructure strategies include building artificial reefs to buffer tidal energy, replanting dune grasses to prevent erosion and stabilizing shorelines with constructed oyster beds. Green infrastructure is less disruptive to ecosystems and sensitive habitats. In some cases, it can even strengthen these systems and the services they provide to communities in North Carolina. These natural strategies often cost less than hard infrastructure, as well (EPA, 2023). This section lists several strategies local governments and partners can use to embrace climate-resilient coastal management.

Potential Project Leads, Experts and Stakeholders

- Local government departments and commissions focused on public infrastructure, planning, sustainability, water and wastewater
- Nonprofits and academic entities focused on coastal issues, such as the North Carolina Coastal Federation, North Carolina Sea Grant, The Nature Conservancy and the NCSU Coastal Dynamics Design Lab
- Design and construction professionals (e.g., landscape architects, water resource professionals, and civil engineers) in the private, nonprofit, government and academic sectors
- State government agencies focused on coastal issues, such as NC DEQ Albemarle-Pamlico National Estuary Partnership, Division of Coastal Management and Division of Marine Fisheries; NC DNCR; and Wildlife Resources Commission
- Federal government agencies, such as NOAA and US EPA
- Consultants
- Residents

FOR MORE INFORMATION

Digital Coast aggregates resources for coastal managers. The site, hosted by NOAA, provides coastal data and the tools, training and information needed to make the data useful. Datasets range from economic data to satellite imagery. The site contains visualization tools, predictive tools, and tools that make data easier to find and use. Training courses are available online or can be brought to the user's location. Information is also organized by focus area and topic.

The National Coastal Zone Management Program is a voluntary partnership between the federal government and coastal states. Authorized by the Coastal Zone Management Act of 1972, this NOAA program provides the basis for protecting, restoring, and responsibly developing diverse coastal communities and resources. The page provides links to supporting legislation, data, tools, performance metrics and training resources for coastal managers.

Sea Level Rise Viewer (NOAA) Decision-makers can "use this web mapping tool to visualize community-level impacts from coastal flooding or sea level rise (up to 10 feet above average high tides)." The resource includes photo simulations and "data related to water depth, connectivity, flood frequency, socio-economic vulnerability, wetland loss and migration and mapping confidence." This tool does not include dates by which sea levels will reach specific levels.

COASTAL MANAGEMENT | 02 STRATEGIES

Monitor emerging conditions

Rapidly changing coastal conditions mean past trends are not enough to predict future changes. More frequently assessing vulnerabilities and monitoring conditions, such as sea level rise and changing coastlines, helps communities understand environmental changes and plan appropriately for expected changes.

Monitoring emerging conditions can be used to improve land management. For example, non-dynamic zoning systems may become outdated as climate change continues. Static approaches are less flexible and can slow municipal responses to emerging needs. Instituting review cycles for zoning updates may better suit emerging needs.

FOR MORE INFORMATION

Interactive Maps and Data (NC DEQ Division of Coastal Management) **This site hosts GIS data on coastal erosion rates and coastal wetlands, interactive maps on waterfront access and field representatives, and more.**

EXAMPLE

Flood Vulnerability Assessment (Beaufort, SC)

Monitoring and Adaptive Management Plan (Swan Island, MD)

Risk and Vulnerability Assessment (Sunset Beach, NC)

Risk and Vulnerability Assessment (Town of Leland, NC)

CASE STUDY

Southwest Florida Assesses Salt Marsh Vulnerability to Sea Level Rise

Develop plans for coastal zones

Plans might focus on protecting, managing and restoring coastal areas to support a natural ecosystem's ability to manage rising sea levels and storm surge.

FOR MORE INFORMATION

CAMA Land-Use Planning Guide (NC DEQ) **This manual is designed to help local governments prepare Coastal Area Management Act (CAMA) land use plans.**

EXAMPLES

Comprehensive and Land Use Plan and Infrastructure Vulnerability Assessment (Duck, NC)

Lower Cape Fear River Blueprint (NC Coastal Federation)

North Carolina Oyster Blueprint (NC Coastal Federation)

Planning for Sea Level Rise (Nags Head, NC)

Adopt land use and development policies and ordinances that manage coastal hazards

Zoning and development management regulations help coastal communities regulate and direct growth. An ordinance is an adopted law. These types of policies and ordinances contribute to resilience by directing development to safer locations, regulating characteristics of development and structures to reduce vulnerabilities, and prohibiting certain activities in hazardous locations.

FOR MORE INFORMATION

Uniform Floodplain Management Policy for State Property (North Carolina) The state has recently updated its requirements for construction on state lands that are at risk for flooding. The updated Uniform Floodplain Management Policy (January 2024) includes requirements for locating state construction outside the floodplain, elevating structures that must be constructed in areas at risk for flooding, and incorporating nature-based solutions to reduce flooding.

Managed Retreat Toolkit (Georgetown Climate Center) This online resource "combines legal and policy tools, best and emerging practices and case studies to support peer learning and decision-making around managed retreat and climate adaptation," specifically in vulnerable coastal areas.

(See **Land Use and Development** for additional resources)

Mitigate coastal hazards using green infrastructure or nature-based solutions

Green infrastructure and nature-based solutions build resilience by slowing and absorbing water, wind and wave action in the same way as natural features like wetlands and reefs. They can be alternatives to hard or grey infrastructure and are designed to mimic natural systems. Sometimes these systems are entirely introduced into the landscape. Other times, they are restorations or enhancements to existing natural features. Either way, the benefits of green infrastructure are wide-ranging, including stormwater management, air-cooling benefits from plants, the promotion of community identity and more.

*Note: North Carolina's Coastal Area Management Act (CAMA) does not permit the construction of hardened erosion control structures along ocean shorelines, with the exception of terminal groins in specific locations.

FOR MORE INFORMATION

Living Shoreline Resources (US EPA) **This page describes how to build and maintain living shorelines.**

Restoration and Management of Coastal Dune Vegetation (NCSU Extension) **This page describes the importance of coastal dunes as well as strategies for their protection and management.**

North Carolina Coastal Resilience (The Nature Conservancy) **This page describes nature-based solutions that protect coastal communities from the impacts of severe storms, flooding and rapid shoreline change.**

EXAMPLES

Dune planting and stabilization (Carteret County, NC)

Green and gray stormwater infrastructure (Smithsonian Magazine)

Moor Shore Road living shoreline (North Carolina Coastal Federation)

North River wetlands restoration (North Carolina Coastal Federation)

CASE STUDY

*See the following **Coastal Management** case study.

COASTAL MANAGEMENT | 02

CASE STUDY

CASE STUDY Sunset Beach installs a living shoreline

Project Purpose

The North Carolina town of Sunset Beach experiences repetitive flooding, sound side erosion, wind damage from hurricanes and rising sea levels, including more recently from Hurricanes Florence and Dorian. To manage these impacts, town officials and residents decided to install a living shoreline.

What are living shorelines?

Living shorelines are designed to protect and stabilize coastal edges. They are made of natural materials such as plants, sand and rock. Unlike a concrete seawall or other hard structures, which impede the growth of plants and animals, living shorelines grow over time. They assist in erosion control, restore coastal habitat, mitigate coastal flooding, improve water quality and serve as an education tool (National Oceanic and Atmospheric Administration, 2022). Living shorelines also experience less damage during storms than hardened shorelines because they reduce the intensity of waves (National Oceanic and Atmospheric Administration, 2016).

Key Players: Town of Sunset Beach, North Carolina Coastal Federation, East Coast Engineering and Surveying, Inc. (permit consultant), volunteers

Quick Facts

1. Sunset Beach, a small coastal town with a population of 4,000 residents, is split by an intercoastal waterway and the Atlantic Ocean—a location that exposes the town to flooding and severe storms.
2. The town partnered with the North Carolina Coastal Federation and volunteers to construct a 200-foot **living shoreline** in its Town Park, which borders the Atlantic Intercoastal Waterway.
3. The living shoreline is made of oyster domes and a marsh sill with native marsh grasses planted directly behind it. The structure helps manage nearby flooding and protect the town's coast from erosion.
4. The site's informational kiosk describes the benefits of nature-based adaptation strategies.

Making It Happen

- Staff attended a North Carolina Coastal Federation workshop at an existing living shoreline at Veterans Park on Oak Island. Workshop attendees learned how the living shoreline was constructed.
- In 2017, the town government secured funding from multiple sources and established a partnership with the North Carolina Coastal Federation to build the living shoreline. These partnerships helped them plan and construct the living shoreline within its Town Park.
- The scoping and design process took place in the latter half of 2017. In 2018, Sunset Beach hired a local consulting firm to finalize the plans and apply for permits. At the time, North Carolina project owners were required to apply to the North Carolina Department of Environmental Quality Division of Coastal Management (DCM) and the Army Corps of Engineers (USACE) for a permit. In 2019, DCM and USACE released a more streamlined regulatory process. Through the new process, living shoreline projects under 500 linear feet only need to obtain a permit from DCM. Projects over 500 linear feet still require a permit from USACE. As of June 2023, the new permit approval process only takes a few weeks and costs $200.
- During the permitting process, project managers moved the project forward in other ways. They obtained construction material and used an outreach campaign to promote the project and recruit volunteers.
- During the first two volunteer events, an estimated 150 individuals filled 3,000 bags with recycled oyster shells and gravel granite for the oyster reef sill (North Carolina Coastal Federation, 2019). During the third event, approximately 150 volunteers used the oyster and gravel bags to construct the 60-by-6-foot oyster reef-marsh sill structure. The town then constructed two 50-by-8-foot oyster reef-marsh sill structures using the oyster domes with guidance from the Coastal Federation. During the final event, 30 volunteers planted native ***Spartina alterniflora*** and ***Spartina patens*** marsh grasses and other vegetation. The town government completed the living shoreline in summer 2019.
- As the recipient of the project permit, the town is responsible for monitoring the impacts of the living shoreline and making living shoreline repairs, as needed. However, the NC Coastal Federation assists with shoreline monitoring and repairs. Volunteers run transects through the marsh to measure density and diversity of the marsh plant species. They also test different aspects of water quality, measure new oyster growth and examine the different species inhabiting the reef.

The town complemented the living shoreline project with stormwater run-off reduction measures nearby. The Town Park captures stormwater runoff and enables it to soak into the ground instead of contaminating the adjacent living shoreline.

Spotlight on Equity

Toward More Equitable Nature-based Coastal Adaptation in California *features recommendations on how to incorporate equity and justice into a living shoreline project. This report suggests defining equity goals with local partners. Another recommendation is to incorporate education and workforce development into projects.*

Advice from the project manager

Seek input from as many community members as possible. Because of community outreach, project managers in Sunset Beach learned of another project underway. The newly discovered project sought to install rip rap along the shoreline of the park and dredge an adjacent creek. Seeking input from community members also enabled a project design that fits within residents' vision for the property.

Current and future land uses are important factors to consider when implementing a living shoreline. The surrounding built environment can have a significant impact on the performance and durability of restored coastal area.

Outcomes

- The 200 feet of living shoreline restored coastline along the Atlantic Intercoastal Waterway (North Carolina Coastal Federation, 2020).
- The living shoreline's components—oyster domes, a marsh sill and native marsh grasses—control erosion by buffering waves and wakes. The oyster domes are made of nearly 3,000 bags of recycled oyster shells.
- The shoreline enables salt marsh and oyster reefs to thrive while providing aquatic plants and animals with an enhanced habitat.
- Restoring oyster and saltwater marsh habitat improves local water quality. An adult oyster can filter up to 50 gallons of water per day.
- The artificial reef and saltwater marsh provide the town with flood management benefits. The natural structure slows and disperses coastal floodwaters across the shoreline.
- An informational kiosk describes the benefits of nature-based adaptation strategies.
- In 2022, the town installed an additional 60-foot-long oyster dome and shell bag oyster reef-marsh sill, bringing the total project length to 260 feet.
- With promotion and volunteer events, the project increased community awareness of nature-based adaptation and resilience tools.

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Additional Resources

NC Division of Coastal Management description of a living shoreline permitting process

Sunset Beach Living Shoreline YouTube Video

Living Shoreline Academy: A resource for living shoreline construction

Related Case Studies

- **See Ecosystem Protection, Restoration and Enhancement**: New Bern project grows natural stormwater resilience while improving native ecosystems

Costs and Funding

- The Town of Sunset Beach received a $35,000 grant from Duke Energy's Water Resource Fund for staff time and construction material. Sunset Beach supported the project with additional funds from its annual operating budget.
- The NC Coastal Federation used funding from a National Coastal Resilience grant. The National Oceanic and Atmospheric Administration awarded this grant so the NC Coastal Federation could support several living shorelines in North Carolina.
- Sunset Vision, a local community group, provided funding for an informational kiosk (Sunset Vision, 2020).

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TOPIC | 03
COLLABORATION

Overview

Building resilience in North Carolina's communities requires a systems-level approach to planning and problem-solving, and collaboration is a critical ingredient. Collaboration brings people out of their siloes to diversify perspectives and improve problem-solving. It also helps organizations to share knowledge and avoid duplication of efforts.

Role in Resilience

Much like a forest of trees connected by a network of roots that strengthens the entire ecosystem, a community that fosters collaboration is more likely to be resilient to the effects of hazards. For local governments, collaboration may mean looking internally to work across departments, or it may mean collaboration with the community, academia, or the private sector. For example, nonprofit organizations are often good partners for identifying systemic failures or emerging problems. Successful collaborations in resilience work can take many forms, including working with key stakeholders or subject matter experts through partnerships, joining or establishing pathways to provide and receive mutual aid or support, creating formal or informal opportunities for peer learning, and supporting cooperation across and within departments or offices at the leadership level. This section lists several strategies for harnessing a variety of perspectives, disciplines, and resources to address complex hazards like sea level rise, hurricanes, and other climate impacts.

Potential Project Leads, Experts and Stakeholders

- Local government departments and commissions focused on the issues to be addressed
- Nonprofits and other community organizations (e.g., neighborhood associations, advocacy groups, community foundations, tribal governments and faith communities), especially those that can help convene individuals from often overlooked communities (e.g., Association of Mexicans in North Carolina (AMEXCAN), Hispanic Federation, NC Black Alliance, NC Environmental Justice Network and NC Commission on Indian Affairs)

More North Carolina community-based organizations:

- NC Conservation Network Affiliates
- NC Environmental Justice Network member organizations
- NC Justice Center
- NC NAACP
- NC Rural Center
- NC Tribal Communities

- State government agencies focused on the issues to be addressed
- Regional organizations, such as North Carolina's councils of governments (COGs) and area agencies on aging
- Local businesses
- Higher education institutions
- Residents

FOR MORE INFORMATION

View a recording of Unlocking Resources for Climate Resilience Through Private Sector Partnerships, an event hosted by Devex and RTI International that reviewed "how partnerships with actors from both local and global private sectors can unlock urgently needed funds and resources for climate resilience and how the various parties can best work together to build a sustainable and resilient future."

COLLABORATION | 03

STRATEGIES

Establish partnerships

Partnerships, or collaborations among two or more people, organizations, agencies or departments, support resilience by connecting people and organizations with common goals to assess, plan and implement resilience-building strategies. Partnerships between universities, local businesses, and nonprofits, and between government departments and agencies can reduce duplication of effort and identify opportunities for knowledge sharing. Civil society groups are also highly effective at identifying emerging problems. They often help local communities monitor conditions.

Local governments can help collaborators identify statewide or federal sources of funding to support community-based resilience efforts or offer in-kind resources such as public meeting spaces, use of equipment, or access to public databases that can store or map information.

FOR MORE INFORMATION

Building Resilience Together: Military and Local Government Collaboration for Climate Adaptation (RAND Corporation) **This report reviews strategies for collaboration "between military services and local government to improve collective capacity to address climate change."**

North Carolina Inclusive Disaster Recovery Network **This "collaborative of public, private, nonprofit, and faith organizations" facilitates cross-sector support for disaster recovery. Its website hosts resources for marginalized communities, among others.**

Resilience Hubs (USDN) **This page provides guidance on the development of resilience hubs, which are partnership-based, community-serving facilities that aid and educate residents and coordinate resource distribution.**

EXAMPLES

Green Heart Project (Louisville, KY)

Lumberton Loop wetland restoration and greenway (Lumberton, NC)

Studying and monitoring sunny day flooding (Beaufort, NC)

CASE STUDIES

Southeast Florida counties and municipalities partner to develop a comprehensive sea level rise assessment

*See the case studies from the **Collaboration, Community and Education** and **Equity and Justice** sections.

Establish mutual support agreements

Mutual aid is the two-way exchange of support and resources between entities or within an organization. Mutual aid conserves and extends resources, building resilience by sharing people, equipment, and expertise instead of each entity investing on their own. Mutual aid agreements and organizations also strengthen relationships and create new networks of supporters, bringing unique insight and perspectives to the process.

FOR MORE INFORMATION

North Carolina Mutual Aid System **Participation in this program "enables your city or town to receive or provide assistance to another community."**

EXAMPLE

Interlocal Agreement for Emergency Management Coordination Service (State of NC, Pasquotank County)

Foster peer-to-peer knowledge exchange

Peer-to-peer learning opportunities leverage the experiences and expertise of other people and organizations with similar goals. Peer-to-peer knowledge exchange can take many forms, including email listservs, webinars, seminars, social media groups, workshops, or even informal gatherings like social activities outside of work hours. Peer-to-peer knowledge exchange builds resilience by establishing platforms for posing questions to a group; discussing challenges, opportunities, and best practices; and learning through the practical experiences of other practitioners knowledgeable in resilience topics.

FOR MORE INFORMATION

EXAMPLES

List of National Climate Resilience Networks
North Carolina Association of Floodplain Managers Conference
North Carolina Rural Center's Annual Rural Summit
North Carolina Rural Water Association Events
Triangle Area Water Supply Monitoring Project

Join resilience professional development networks

Local government elected officials and staff can join regional and national networks or form state or local climate collaboratives to share best practices and research, learn from peers, and brainstorm solutions to resilience problems.

FOR MORE INFORMATION

American Society of Adaptation Professionals **This group is a professional networking home for people working on climate change adaptation.**

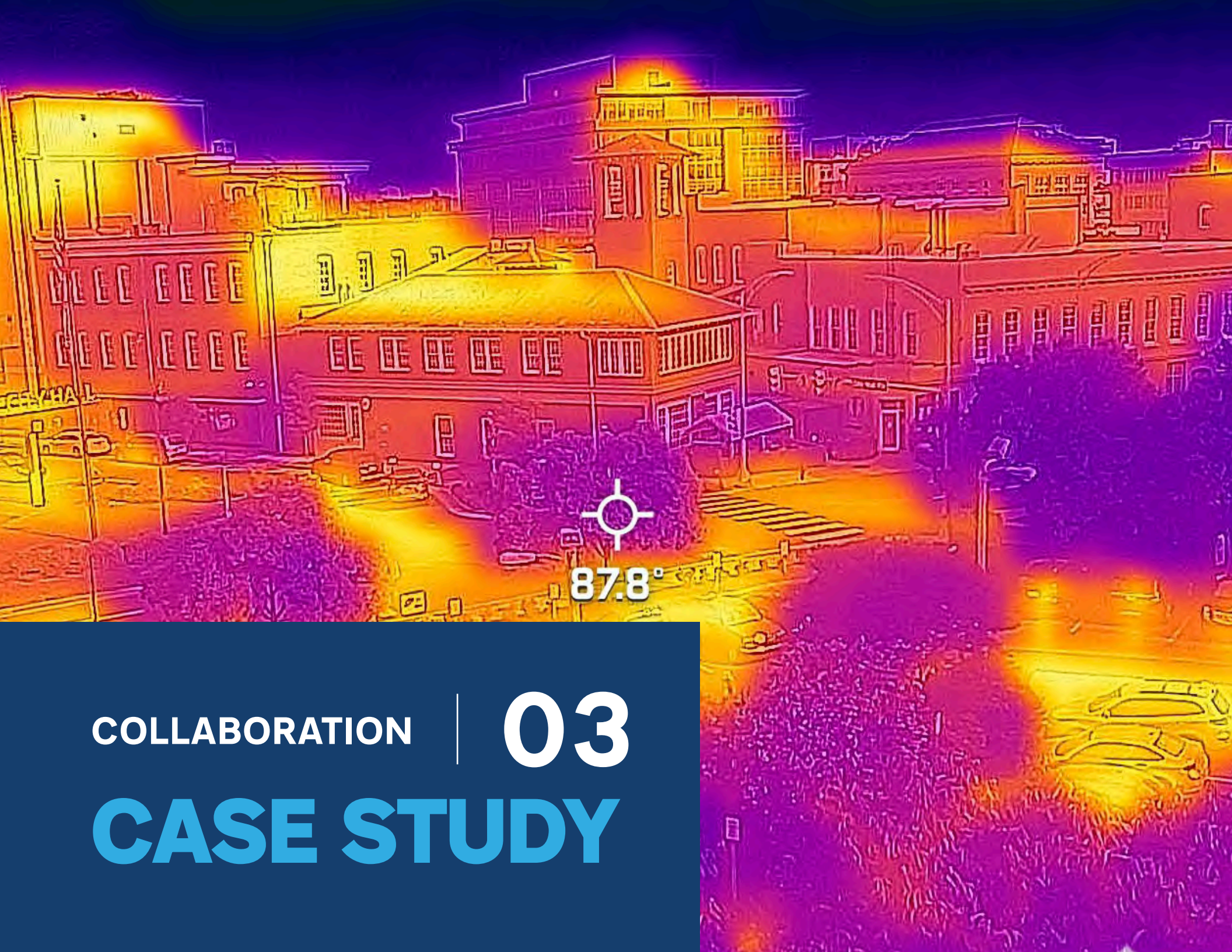
NC Association of Floodplain Managers **This group of local, state, and private sector professionals shares knowledge and disseminates information about the National Flood Insurance Program and state specific guidance on floodplain development.**

Regional Climate Collaboratives **This site lists local and regional resilience networks that exist across the country, all of which can serve as examples for forming a network in North Carolina.**

Urban Sustainability Directors Network **This professional development network brings staff together that work in local government sustainability. A partner network of USDN, the Southeast Sustainability Directors Network, provides a networking home for local government sustainability professionals from across the southeast.**

EXAMPLE

Puget Sound Climate Preparedness Collaborative



COLLABORATION | 03

CASE STUDY

CASE STUDY Raleigh and Durham map neighborhood temperatures

Project Purpose

Unusually high daytime and nighttime temperatures are occurring more often across Raleigh and Durham, NC. These high temperatures affect residents' health and the communities' infrastructure. The cities worked with several partners to measure temperature and related metrics in different areas on a hot day. They used the data to understand how summer temperatures vary across neighborhoods. They wanted to understand how landscape features affect temperature and humidity, and to identify appropriate heat management strategies.

Key Players: Durham County, City of Raleigh, NC Museum of Life and Science, NC Museum of Natural Sciences, North Carolina State Climate Office, National Weather Service Raleigh Office, Activate Good, NIHHIS, NOAA and CAPA Strategies

Quick Facts

1. Several entities in Raleigh and Durham partnered with federal agencies and Climate Adaptation Planning and Analytics (CAPA) Strategies to measure and map temperatures through CAPA Strategies' Heat Watch Campaign.
2. Residents volunteered to measure temperature and other data using sensors provided by CAPA Strategies.
3. Raleigh and Durham used the data to identify areas in need of cooling solutions such as planting trees and installing reflective pavement.

Making It Happen

The National Integrated Heat Health Information System (NIHHIS), the National Oceanic and Atmospheric Administration (NOAA) and CAPA Strategies administer the Heat Watch Campaign each year, if funds are available. The program guides a cohort of communities through an urban heat island mapping project. The NC Museum of Life and Science successfully applied to the program in November 2020 with several partners.

- Once accepted, Durham County and the City of Raleigh, in partnership with the NC Museum of Life and Science, the NC Museum of Natural Sciences and the State Climate Office formed a steering committee. The committee talked with neighborhoods and community groups to better understand what was important to them.
- The steering committee identified the study areas, prioritizing diverse land uses and neighborhoods. CAPA Strategies selected the best data collection routes.
- Activate Good helped recruit 165 volunteers for the Raleigh and Durham campaign, the most recruited by all campaigns nationally in 2021. Activate Good is an organization that connects volunteers to community service projects.
- The project team worked with the National Weather Service to select an appropriate weather day to collect the data.
- In advance of the campaign day, the NC Museum of Life and Science trained volunteers. CAPA Strategies sent the sensor equipment to the project team. The museum provided handheld sensors and infrared cameras.
- On the campaign day, held in July 2021, project managers set up control hubs in Raleigh and Durham. The hubs functioned as central organizing spots for distributing and collecting equipment. Volunteers walked, biked or drove during three times slots—morning, afternoon and evening—on pre-determined routes, collecting data from the provided sensors. They measured ambient temperature, humidity, geographic location and speed.
- Project managers sent the collected data to CAPA Strategies. CAPA returned cleaned data, maps and other analysis in a final report in January 2022.
- The State Climate Office **made campaign maps and data publicly available**.
- Partners offered webinars to review the results of the campaign with the public. Partners continue to engage with local agencies, neighborhoods and interested parties to educate about extreme heat and urban heat island using local data.

Spotlight on Equity

The Raleigh and Durham Heat Watch Campaign prioritized measuring temperatures in neighborhoods experiencing environmental and social injustices and inequities. Low-income, Black communities tend to have less tree cover and fewer air conditioners. Families in these areas often have a smaller budget to pay for growing energy costs. In addition, low-income families are less likely to have good health insurance, which makes it hard for them to access treatment if they experience a heat-related illness (EPA, 2022). For these reasons, project managers included neighborhoods with a high number of Black residents and with affordable housing in the campaign's study area. Learn more at the NIHHIS Heat Equity webpage.

Advice from the project manager

Test the campaign day routes in advance to ensure they are easy to follow. Also have backup equipment and batteries in case of equipment failure.

Collaborate with local volunteer organizations to drive volunteerism and ensure a single voice for communicating with volunteers. Using different volunteers during each collection period—morning, daytime and evening—is helpful in engaging participants but can lead to inconsistent results.

Conduct webinars before and after the campaign to raise awareness and educate community members.

Outcomes

- Results: Durham and Raleigh identified several areas with excessively high temperatures. They found that temperatures in these locations were higher even in the evening and early morning. These locations tended to have more impervious surface. Project partners also found that disadvantaged areas have higher average temperatures throughout the day than other areas.
- The NC Museum of Life and Science hosted several public programs and developed two exhibits based on these data. One program was in collaboration with the Hayti Heritage Cultural Center about how heat and other environmental hazards affect residents.
- The NC Museum of Life and Science worked with Durham Public Schools and the University of North Carolina at Chapel Hill to use these data in public school classrooms. Partners continue to monitor heat with public school students.
- Durham plans to build off the campaign by implementing heat management projects such as green infrastructure in heat island areas.

Continued on next page

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Additional Resources

NIHHIS Heat Island Mapping Campaigns
A map of participating communities since 2017

What you can do to reduce heat islands
A webpage from EPA

Planning for Urban Heat Resilience
A report from the American Planning Association

Related Case Studies

- See **Business and Economy**: Oyster Trail protects oyster habitat and grows economy.
- See **Coastal Management**: Sunset Beach installs a living shoreline.
- See **Communications and Education**: Local partners empower youth action for climate resilience.
- See **Ecosystem Protection and Restoration**: New Bern project grows natural stormwater resilience while improving native ecosystems.
- See **Equity and Justice**: Princeville, public universities and partners facilitate resilience planning that honors town history.

Outcomes *(cont'd)*

- The City of Raleigh Department of Transportation secured $150,000 in supplemental funding in 2022 to apply a coating to streets in areas with high urban heat. The coating increases the roads' reflectivity, which means that the road surface will not absorb as much heat and the air above the road does not get as hot. The coating also extends the life of pavements, absorbs some emissions and reduces pollutants. Treated roads in Raleigh showed a 37% reduction in a common roadway pollutant. Raleigh plans to continue applying the coating to roadways in high heat areas.
- Raleigh's Stormwater Management Division invested $750,000 of the City's American Rescue Plan Act funds toward the installation of green stormwater infrastructure and street trees. In addition, Raleigh's Urban Forestry Group received approval from Raleigh City Council to plant 1,000 trees in the right of way with $750,000. Both projects will address the inequality in the distribution of street trees in racially or ethnically concentrated areas of poverty.
- Raleigh **merged the campaign's urban heat data with a 3D map of the city** to use as a storytelling tool and to visualize neighborhood-level tree cover and urban heat impacts.
- Durham County Emergency Management updated its hazard mitigation plan with a section on heat informed by the campaign.

Costs and Funding

- If federal funding is available, NOAA pays the Heat Watch fee for participating jurisdictions (National Integrated Heat Health Information System, n.d.).
- The NC Museum of Life and Science provided handheld heat sensors and cameras that took infrared images.
- Local businesses provided food and beverages during the volunteer campaign day.

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EPA. (2022, September 02). Heat Islands and Equity. Retrieved from **https://www.epa.gov/heatislands/heat-islands-and-equity**

National Integrated Heat Health Information System. (n.d.). Urban Heat Island Mapping Campaign Application. Retrieved from Heat.gov: **https://www.heat.gov/pages/nihhis-capa-urban-heat-island-mapping-campaign-application**

TOPIC | 04
COMMUNICATION AND EDUCATION

Overview

Improving communication and education supports a resilient community by ensuring all community members have access to the information and resources they need to prepare and protect themselves against potential hazards. Communication and education efforts build resilience by establishing a two-way exchange of information, empowering community members through information and resources and building a strong foundation of community support for resilience initiatives.

Role in Resilience

Communication and education are key elements of every resilience topic in this guide. These strategies support community leaders' efforts to:

- Share and receive information and feedback.
- Raise awareness of resources, information, opportunities and events.
- Train and educate people and organizations.
- Build support and find champions for plans, projects and initiatives.
- Strengthen existing relationships with residents and key stakeholders.
- Establish new relationships with those who have historically been excluded from public processes.
- Make all the above more accessible and user friendly.

North Carolina's communities can build resilience with campaigns that raise awareness of hazards as well as preparedness efforts. Campaigns can take the form of direct outreach and engagement, distributing educational materials, implementing emergency notification and communication systems, and providing training to staff and residents. Making information, resources and opportunities more accessible to residents through varying formats and languages is also a critical element of building resilience. This section highlights strategies local leaders can use to effectively inform residents about the challenges of climate change and how to address them.

Potential Project Leads, Experts and Stakeholders

- Local government departments focused on communications, community development, emergency management, planning and sustainability
- Nonprofits and other community organizations (e.g., neighborhood associations, advocacy groups, community foundations, tribal governments and faith communities), especially those that can help convene individuals from often overlooked communities (e.g., Association of Mexicans in North Carolina (AMEXCAN), Hispanic Federation, NC Black Alliance, NC Environmental Justice Network and NC Commission on Indian Affairs)

  More North Carolina community-based organizations:

  - NC Conservation Network Affiliates
  - NC Environmental Justice Network member organizations
  - NC Justice Center
  - NC NAACP
  - NC Rural Center
  - NC Tribal Communities
- State government agencies, such as NCORR, NC DEQ Division of Environmental Education and Public Affairs and NCEM
- Federal government agencies, such as the CDC, US EPA, and NOAA
- K-12 schools and higher education institutions
- Regional organizations, such as North Carolina's councils of governments (COGs) and area agencies on aging
- Media outlets
- Residents

FOR MORE INFORMATION

Enhanced Engagement and Risk Communication for Underserved Communities is a compilation of best practices and lessons learned to help local leaders communicate with underserved communities about coastal hazards in a more effective way. This NOAA resource includes related stories and trainings.

Translation Tips: A Guide for Emergency Managers and Public Information Officers details specific tips about preparing materials for translation and working with translators. The document was created by the government of King County, WA.

COMMUNICATION AND EDUCATION | 04 STRATEGIES

Use public outreach and awareness campaigns to educate and inform the community about climate hazards and building resilience

Public outreach and awareness strategies describe one-way exchanges of information using methods like informational posters, notices, exhibits and special signage. These methods build resilience by educating the public and calling attention to issues and opportunities. For example, signs indicating the highwater mark of a past flood help the community visualize the potential level of flood inundation, raising awareness of flood risk.

FOR MORE INFORMATION

Drought Communication Toolkit (CDC) **This site provides materials to educate the public on health effects of drought.**

Communication materials for natural disasters and severe weather (CDC) **This site contains PDF educational materials in multiple languages on returning home after a disaster, heat-related illnesses and more.**

EXAMPLES

Green infrastructure and low impact development educational signage project (Weston & Sampson)

Special flood hazard area notification letter (Orange County, NC)

Flood risk outreach campaign (Dare County, NC)

Engage the community in building resilience

Activity- or event-based engagement methods build resilience by facilitating a two-way exchange of knowledge, information, and resources and by recognizing community efforts to build resilience. Examples might include tree planting days; volunteer-based living shoreline construction; interactive strategies for conducting collaborative, community-based problem-solving; discussing and learning about hazards; and providing feedback.

FOR MORE INFORMATION

Climate Resilience for Frontline Clinics Toolkit (Harvard University School of Public Health) **This guidance is for community health centers and clinics providing free or low-cost healthcare to protect patients from climate risks.**

***Incluye Recursos en Español**

EXAMPLES

Adopt-A-Drain (Durham, NC)

Living shoreline maintenance and clean-up (Carolina Beach, NC)

Public Participation Plan (NC DEQ)

Stormwater community outreach (Carrboro, NC)

Provide tools and resources to help build resilience

Providing tools, guides and other resources can help individuals and businesses build resilience by enhancing the community's capacity to proactively prepare for and respond to hazards. These resources can also encourage the community to implement hazard mitigation strategies.

FOR MORE INFORMATION

EXAMPLES

Climate-Resilient Personal Action Guide (Asheville, NC)

Be Flood Ready handout (King County, WA)

Prepárate NC: Una guía informativa y de recursos para la temporada de huracanes

Only available in Spanish

Implement accessible emergency notification and communication systems

Communities can build resilience by implementing a community warning system or public notification system for climate-related hazards like extreme weather, extreme heat or cold, floods and more. It is critical that communications are provided in multiple languages and formats to ensure equitable access for all community members. For example, consider mechanisms to alert the vision-impaired community when king tides flooding is expected.

FOR MORE INFORMATION

Establishing and Maintaining Inclusive Emergency Management with Immigrant and Refugee Populations (Welcoming America)

This checklist is "designed to help strengthen existing emergency preparedness plan by ensuring immigrants and refugees are part of any emergency response."

EXAMPLES

CodeRED Emergency Notification System (Robeson County, NC)

Community Alert System (Catawba County, NC)

CASE STUDY

How Arcata, CA, is Creating an Inclusive and Equitable Culture of Preparedness

Offer resilience education and training opportunities for staff, businesses and residents

This strategy focuses on providing targeted, formal education and training for local government staff and community members. These efforts enhance community resilience by giving staff and residents the tools to assess, understand and communicate climate-related hazards and opportunities to build resilience.

FOR MORE INFORMATION

Local Government Climate Adaptation Training (US EPA) **Local governments can use this series of videos to train staff on the basics of climate change and the risks climate change poses to government operations and services.**

Preparedness Training for Community Based Organizations (FEMA) **This resource contains a "web-based, self-guided training and a downloadable instructor kit that will guide participants on how to identify risks, locate resources and take preparedness actions" to keep local businesses and organizations open during disasters.**

EXAMPLES

Raleigh Watershed Learning Network (National League of Cities)

CASE STUDY

*See the following **Communication and Education** case study.

Ensure emergency management staff have response protocols for climate hazards

Many local governments have standard operating procedures to ensure the community is adequately preparing for incoming extreme weather such as hurricanes and ice storms. Heat wave protocols are less common and can help reduce morbidity and mortality from high daytime and nighttime temperatures.

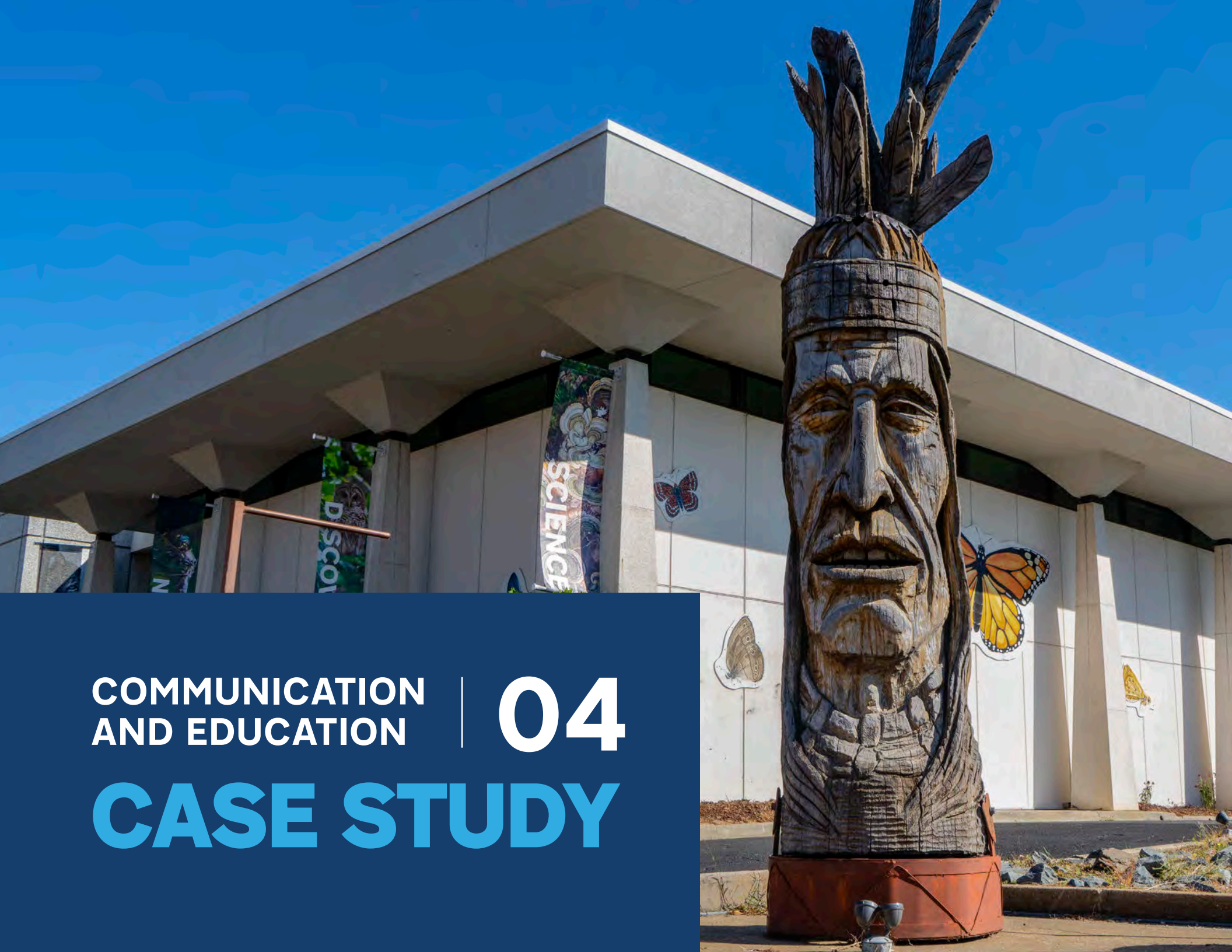
FOR MORE INFORMATION

A guide for building a heat response plan (CDC)
This document describes how to build, implement and monitor a heat response plan.

EXAMPLES

Heat Management Plan and Response Protocol (Richmond, IN)

Regional Inclusive Emergency Communications Plan (King County, WA)



COMMUNICATION AND EDUCATION | 04

CASE STUDY

CASE STUDY Local partners empower youth action for climate resilience

Project Purpose

This science, technology, engineering and math (STEM) enrichment program aims to engage a diverse group of students in developing solutions to health-related climate impacts in their communities. Program organizers designed the curriculum so it could be used by other organizations.

Key Players: University of North Carolina at Chapel Hill Center for Public Engagement with Science, North Carolina Museum of Natural Sciences

Quick Facts

1. The Center for Public Engagement with Science in the UNC Institute for the Environment and the Raleigh and Whiteville branches of the North Carolina Museum of Natural Sciences established **Youth Engaging in the Science of Resilience** (YES-Resilience).
2. Organizers ran a 10-month program during the 2020-2021 pilot year.
3. Through the program, 37 high school students from Whiteville, a rural community, and Raleigh, an urban community, learned about health-related climate impacts in their hometowns.
4. Program organizers facilitated personalized and place-based investigations of climate hazards. Participants explored the role of climate and health justice in building community resilience.

Making It Happen

- Program planning, which included curriculum development, took approximately eight months. Sessions during the pilot program ran from August 2020 until June 2021.
- Program partners obtained a grant to hire youth education specialists, design the STEM curriculum and run the program. The intention was to implement in-person programming in two locations: Raleigh, NC, and Whiteville, NC. However, in response to COVID-19 pandemic restrictions, program partners held one virtual program for most of the year.
- Staff held online training sessions for students once or twice per month over a 10-month period. The program included half-day academies, leadership sessions and a youth action forum, all of which were virtual.
- Each session engaged youth participants in active learning on a range of climate science topics, from wildfires and flooding to extreme precipitation and heat (University of North Carolina at Chapel Hill, 2023).
- Youth participants developed and practiced leadership and communication skills. They worked with one another, with peers outside the program and with a range of professionals addressing climate resilience in the state.
- In each academy session, professionals from a variety of the climate-related fields shared their knowledge and offered insights into their work.
- For the concluding summer event, program organizers hosted in-person sessions at the Raleigh and Whiteville Museum of Natural Sciences locations. Both three-day summer institutes included a variety of indoor and outdoor activities, guest speakers and participant presentations.
- Program staff coached youth participants to complete resilience-focused community action projects. Either individually or in small groups, students worked on their projects using the knowledge and skills they developed during the program.

Spotlight on Equity

Equity and justice are points of emphasis in the YES-Resilience program. To recruit a diverse group of participants, program staff reached out to parent groups, teachers and prospective youth. They used social media, direct email, classroom presentations and webinars. Program staff invited guest speakers whose identities are underrepresented in STEM fields to take part in all sessions. These guests described their educational and career paths. Academy sessions also incorporated discussions about vulnerable populations in participants' own communities. They brainstormed potential solutions that could help those populations become more resilient to climate hazards. Furthermore, students designed strategies to bring their voices into climate resilience conversations.

Advice from the project manager

Most challenges noted by the YES-Resilience program manager had to do with pandemic restrictions. While online sessions allowed the program to operate, access to reliable internet varied among participants. To increase engagement in virtual sessions and reduce "Zoom fatigue," program staff recommend including offline activities that encourage students to go outdoors. Breaks were important online and during the in-person summer institute. Participants recommended having more breaks to allow youth to build connections with one another.

In addition, transportation for rural participants to attend the in-person summer institute was an issue. This challenge could have been much bigger had the program operated fully in-person as originally planned. Program organizers offered a transportation stipend to offset travel expenses.

Outcomes

- Many participants completed action projects. Students coordinated public education efforts, displayed sustainable art at the North Carolina Museum of Natural Sciences, and designed tree planting and ecosystem restoration projects.
- Program evaluation found that participants preferred in-person sessions and hands-on activities. They enjoyed having opportunities to build community with each other and with content experts.
- Staff designed program materials so that interested organizations can choose to modify the sequence of activities to suit their available resources, including personnel. *Youth Engaging in the Science of Resilience: An Activity Guide for Museum and Science Center Educators* is available upon request on the YES-Resilience website.

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Additional Resources

National Science Foundation's Advancing Informal STEM Learning Pilot and Feasibility Grant

National Science Foundation's Advancing Informal STEM Learning Innovations in Development Grant

Related Case Studies

- See **Coastal Management**: Sunset Beach installs a living shoreline
- See **Collaboration:** Raleigh and Durham map neighborhood temperatures
- See **Planning and Decision-making Frameworks:** Norfolk, VA, updates zoning regulations to address flooding and sea level rise
- See **Public Health:** Preventing heat-related illness in the Sandhills Region

Costs and Funding

- Program partners received $356,000 from the National Science Foundation (NSF) Advancing Informal STEM Learning Program. They used this funding to develop and pilot the curriculum for the project. Funds covered personnel time, materials, youth stipends, travel and evaluation.
- Following the pilot program, the team received an additional $2,358,000 from the NSF. This funding allowed program staff to further adapt curriculum materials for community-based organizations serving diverse youth in North Carolina and Washington state. In the updated program, Latino and Indigenous youth look at climate data and maps to understand how climate change is impacting their communities. Students can also collect weather and air quality data using personal devices (UNC Institute for the Environment, 2022).

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TOPIC | 05

ECOSYSTEM PROTECTION, RESTORATION AND ENHANCEMENT

Overview

Ecosystems, which are the foundation of the natural world, help protect humans and the built environment from harm and are at risk of impacts from climate change. Ecosystems, including rivers and streams, lakes and ponds, wetlands, forests, grasslands, and oceans, among others, perform critical environmental services like filtering stormwater, forming natural shoreline protection, preventing erosion, and removing excess carbon dioxide from the atmosphere. They protect communities through benefits like wind and flood protection and heat mitigation. And they provide habitat for wildlife and native plants. Furthermore, intact ecosystems can offer economic benefits such as productive farmland, tourism and healthy fisheries.

But climate change and human activity often disrupt natural spaces, damaging and degrading ecosystems in North Carolina. Even seemingly small disruptions to an ecosystem can have a ripple effect resulting in harmful outcomes to both the natural and built environments. Sensitive ecosystems are easily disrupted by development, uncontrolled stormwater runoff, air and water pollution, and resource depletion like fishing and harvesting timber. Hazards resulting from climate change like wildfires, flooding and sea level rise also impact these natural networks. Protecting, restoring, and enhancing ecosystems enables these spaces to support and protect life in North Carolina, building resilience in our state.

Role in Resilience

Ecosystem protection, restoration and management build resilience by ensuring ecosystems are healthy enough to carry out critical functions for both the natural and human environments. North Carolina's communities can build resilience by implementing strategies to protect and restore ecosystems, helping these natural systems perform their important roles without disruption. Developing community plans at the watershed or habitat scale takes a comprehensive approach to protecting and restoring ecosystems. Land use policies can help people coexist with the natural environment in ways that prevent degradation and destruction, particularly in areas sensitive to human impacts. Restoration projects like living shorelines and dune reconstruction provide protection in coastal areas, and tree planting can provide much needed heat reduction in urban spaces. In addition, many ecosystem projects have water and air quality benefits. This section lists strategies that provide habitat for wildlife while improving the quality of life for the people of North Carolina.

Potential Project Leads, Experts and Stakeholders

- Local government departments and commissions focused on parks, sustainability, public infrastructure, planning, economic development, water and wastewater
- Design and construction professionals (e.g., landscape architects, water resource engineers, environmental scientists) in the private, nonprofit, governmental and academic sectors
- Environmental nonprofits, such as the North Carolina Coastal Federation, North Carolina Sea Grant, The Nature Conservancy, Conservation Trust for North Carolina and Carolina Wetlands Association
- State government agencies, such as NC DEQ, NC DNCR, Wildlife Resources Commission, NCORR and NC DOT
- Federal government agencies, such as US EPA
- Builders and developers
- Residents

FOR MORE INFORMATION

The Green Growth Toolbox, developed by the North Carolina Wildlife Resources Commission, provides tools to help the state's local governments plan for growth in a way that conserves natural habitats and other assets. The guidance provides information to support the strategies listed in the table below.

Ecosystem Protection Strategies for Climate Change, part of the US EPA's Climate Change Adaptation Resource Center (ARC-X), links to adaptation strategies for protecting wetlands, shorelines, habitats, water quality and more.

The Natural and Cultural Resources Natural Heritage Program provides information for communities to weigh the ecological significance of natural areas and to evaluate potential ecological impacts of conservation and development projects.

Natural and Working Lands Action Plan, outlines specific projects for North Carolina's natural and working lands to increase carbon sequestration, build ecosystem and community resilience, provide ecosystem benefits and enhance the economy.

ECOSYSTEM PROTECTION, RESTORATION AND ENHANCEMENT

05 STRATEGIES

Develop plans that take habitat and watershed impacts into consideration

This strategy supports resilience by conducting planning efforts at the habitat or ecosystem level. Planning at this level allows for a more proactive approach to preserving and protecting environmental systems.

FOR MORE INFORMATION

EXAMPLES

Eno River and New Hope Creek Watershed Landscape Plan for Wildlife Habitat Connectivity

Community Floodprint: A landscape planning approach to address flooding, recovery and equity (Lumberton, NC)

Comprehensive and Land Use Plan and Infrastructure Vulnerability Assessment (Duck, NC)

North Carolina Coastal Habitat Protection Plan

Urban Open Space Plan (Durham, NC)

(See **Stormwater Management and Flooding** for additional resources)

Adopt land use and development regulations that support ecosystems

Adopting ecosystem-friendly regulations helps people coexist with the natural environment in ways that prevent degradation and destruction by prohibiting activity and development in places that are too sensitive to bear human impacts.

FOR MORE INFORMATION

Conservation Subdivision Handbook for North Carolina Communities (NCSU) **This resource describes the benefits of conservation subdivisions, "a design strategy that attempts to preserve undivided, buildable tracts of land as communal open space for residents," as well as a model ordinance and case study examples.**

*See the **Green Growth Toolbox** linked in the previous For More Information section on V2-56.

EXAMPLE

Resource Conservation District (Chapel Hill, NC)

Plan and implement ecosystem and habitat restoration projects

Communities with damaged or degraded ecosystems and habitats can consider strategies to restore and strengthen sensitive locations.

FOR MORE INFORMATION

EXAMPLES

Tree Canopy Action Plan (Charlotte, NC)

Grandfather Restoration Project (Pisgah National Forest, NC)

Habitat restoration project for the Muskie fish in (French Broad River, NC)

Rocky Branch Urban Stream Restoration (NC)

(See **Coastal Management** and **Stormwater Management and Flooding** for additional resources)

CASE STUDIES

*See the case studies from the **Coastal Management** and **Ecosystem Protection, Restoration and Enhancement** sections.

Protect existing waterways, green spaces, and sensitive ecosystems

Protecting sensitive habitat and the quality of water and land-based ecosystems preserves native species and spaces along with the benefits they provide.

Strategies can include increasing land and water protection activities, eradicating invasive species, protecting natural infrastructure that provides cooling and flood mitigation services, encouraging continuous blocks of forests to avoid fragmentation, and managing land and aquatic environments for specific climate change impacts.

FOR MORE INFORMATION

North Carolina Conservation Planning Tool (NC DNCR)
This resource provides data and maps that can inform local, regional and statewide conservation and land use planning efforts, including "aquatic and terrestrial habitat and lands preserved for conservation, agriculture and forestry."

EXAMPLE

Lands Legacy Program (Orange County, NC)

ECOSYSTEM PROTECTION, RESTORATION AND ENHANCEMENT

05

CASE STUDY

CASE STUDY

New Bern project grows natural stormwater resilience while improving native ecosystems

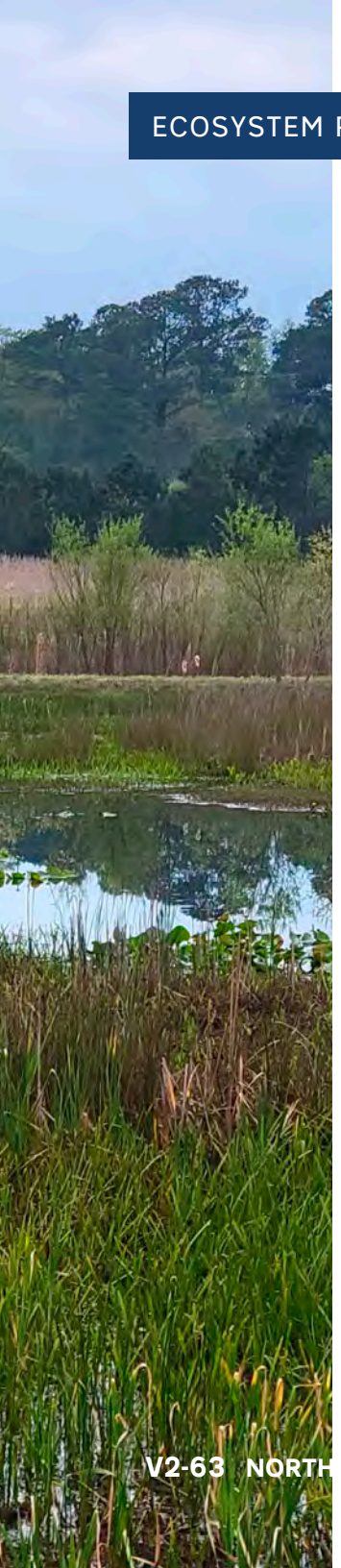
Project Purpose

The City of New Bern wanted to reduce the impact of larger rainfalls that had caused major flood damage. In partnership with the State of North Carolina and NC State University, New Bern completed the Jack Smith Creek Stormwater Wetlands. The project aimed to improve the quality of the water that flows from nearby land into Jack Smith Creek, reduce the impact of nuisance flooding, and protect and preserve existing wetlands along the waterway.

Key Players: City of New Bern, NC DEQ Ecosystem Enhancement Program, NCSU Department of Biological and Agriculture Engineering Stormwater Group

Quick Facts

1. The Jack Smith Creek Stormwater Wetlands project is a multi-use park that helps manage flooding and protect water quality.
2. The project features more than 38 acres of wetland, including 25 acres of planted stormwater wetlands, 10 acres of preserved wetlands, more than two acres of enhanced wetlands and one acre of newly created wetland.
3. The City of New Bern used a conservation easement to gain access to the land.
4. At the time of project completion, the Jack Smith Creek Stormwater Wetlands was the largest artificial wetlands site in North Carolina.
5. The wetlands are designed to capture and treat runoff from over 1,000 acres of commercial and residential land.



Making It Happen

- The City of New Bern contacted the NC Department of Environmental Quality (NC DEQ) about water quality and stormwater issues.
- In 2004, the city and the NC DEQ Division of Mitigation Services, then called the Ecosystem Enhancement Program, began searching for land that experienced frequent flooding to place a project. They found a location with no residents and few structures.
- They used a conservation easement process to access the land.
- In 2007, New Bern engaged other partners, including the Stormwater Engineering Group from the NC State University (NCSU) Department of Biological and Agricultural Engineering. The academic partners informed the design of the 51-acre site by collecting and analyzing wetlands and stormwater data.
- New Bern hired a contractor to construct the stormwater wetland. The contractor began construction in 2009 and completed their work in 2012.
- In 2013, project partners finished the final plantings, marking the project's completion.
- The city kept the public apprised of the project through local media and press releases throughout construction.
- The city assumed all management, monitoring and stewardship functions following project completion.
- In 2018, the regulatory monitoring period closed.

The design applies numerous innovations to maximize capacity. For instance, the wetlands use a "multi-cell, labyrinth approach" that directs stormwater runoff by using small dams, called "weirs," and culverts to maximize water quality improvements that promote biodiversity. A pump moves roughly 1,000 gallons of water per minute (GPM), with emergency activation up to 40,000 GPM. The pumps allow New Bern to use the stormwater wetlands for flood control. In addition, the project was part of the NC DEQ Division of Mitigation Services' Nutrient Offset Program. The site's 140,000 native wetland plants filter excess nutrients from the water before it reaches the Neuse River. Ultimately, the elevation of the wetlands plays a key role in how much river surge the project can control.

Spotlight on Equity

The Jack Smith Creek Stormwater Wetlands is near vulnerable populations. Nearby neighborhoods are home to many Black or African American residents, residents who do not speak English well, families and elders in deep poverty, and households without cars (US Department of Commerce, 2013). The project reduces the risk of street flooding and property flooding for these residents, restores natural habitat in their neighborhood, and provides access to green space.

Advice from the project manager

Project managers mentioned that new regulations require "full delivery" for wetland enhancement projects funded by the NC DEQ Division of Mitigation Services. This means that NC DEQ now requires similar projects to be managed and delivered via a bidding process, so NC DEQ is no longer able to provide project management as the agency did in this case.

Outcomes

- Upon completion, the Jack Smith Creek Stormwater Wetlands were the largest artificial wetlands in North Carolina.
- The site captures stormwater from more than 1,000 acres of residential and commercial properties. The project features more than 38 acres of wetland, including 25 acres of planted stormwater wetlands, 10 acres of preserved wetlands, more than two acres of enhanced wetlands and one acre of newly created wetland.
- Monitoring showed that the project managed water quality and stormwater as intended.
- The site is now a popular park and public recreation area.
- PBS's "AquaKids" show featured the project when discussing the importance of wetlands and the benefits they provide.

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Additional Resources

Jack Smith Creek Stormwater Wetlands Site Map **and** Video

Related Case Studies

- See **Coastal Management:** Sunset Beach installs a living shoreline

Costs and Funding

- The total project cost was $2.6 million (2012 dollars), including $1.4 million for wetland restoration work and $300,000 for the easement.
- The City of New Bern dedicated at least half of one employee's time for project management, ongoing monitoring and maintenance costs.
- The North Carolina Land and Water Fund, then known as the NC Clean Water Management Trust Fund, supported the project financially.

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US Department of Commerce. (2019). *Neighborhoods At Risk: New Bern, NC.* Retrieved from Headwaters Economics: https://nar.headwaterseconomics.org/

TOPIC | 06
ENERGY AND UTILITIES

Overview

Access to power and utilities like electricity, gas, drinking water, wastewater removal and treatment, and broadband is foundational to a functional community. Utilities supply the services that keep people comfortable, healthy, connected and moving. Electricity generation and distribution networks provide the energy needed to power medical devices in hospitals, illuminate buildings and streets, warm and cool people and food, and power vehicles. Other utility systems supply clean drinking water, pipe away and treat wastewater, and keep people connected through internet and phone services. North Carolina's communities can build resilience by making buildings more energy efficient, protecting energy and utility infrastructure from harm, and supplying backup options, also known as system redundancy, in the event of a system disruption or damage.

Role in Resilience

Utility networks are very vulnerable to disruption due to their size and complexity. More frequent and severe climate hazards and extreme weather events are increasing this vulnerability (International Energy Agency, 2021). To build resilience, communities must ensure critical systems like utilities are protected and that there are alternative options in place when system disruptions do occur.

Strategies that increase the efficiency of utility systems and reduce wasteful use of valuable resources like water and electricity build resilience. Efficient buildings more easily maintain temperatures during outages and require less energy day to day from the grid or another local source.

Additional strategies that enhance the resilience of utility delivery and availability may include retrofitting or moving vulnerable distribution networks and critical facilities to ensure they work during extreme weather events. Communities can also build resilience by building alternatives for generating critical resources like water and electricity to create redundancy, or duplication, in the system so that if one part fails, other options are available. Examples of this type of redundancy include distributed networks of microgrids for generating electricity, using renewable sources of energy like solar, and increasing the onsite capture and treatment of water. Lastly, it is important that residents receive up-to-date information and emergency communications during times of crisis. North Carolina's communities can support resilience with strategies that supply comprehensive, equitable access to communication networks like broadband internet. This section lists several strategies local leaders can use to build and support resilient utility service delivery.

Potential Project Leads, Experts and Stakeholders

- Local government departments and commissions focused on building inspections, weatherization, public works, planning, sustainability, emergency management, water, wastewater and other utilities
- State government agencies, such as the Department of Information Technology Division of Broadband and Digital Equity; NCEM; and the NC DEQ State Energy Office, Division of Water Infrastructure, Division of Waste Management and Division of Energy, Mineral and Land Resources
- Federal government agencies, such as US EPA and US DOE

- Energy and utility professionals (e.g., architects, electricians, solar installers, weatherization staff)
- Utility companies and commissions, such as the North Carolina Rural Electric Authority, ElectriCities of North Carolina and the North Carolina Utility Commission
- Higher education institutions, such as the NCSU Clean Energy Technology Center
- Nonprofits and other community organizations (e.g., neighborhood associations, advocacy groups, community foundations, tribal governments and faith communities), especially those that can help convene individuals from often overlooked communities (e.g., Association of Mexicans in North Carolina (AMEXCAN), Hispanic Federation, NC Black Alliance, NC Environmental Justice Network and NC Commission on Indian Affairs)

  More North Carolina community-based organizations:

  - NC Conservation Network Affiliates
  - NC Environmental Justice Network member organizations
  - NC Justice Center
  - NC NAACP
  - NC Rural Center
  - NC Tribal Communities
- Consultants
- Solar and wind energy companies
- Builders and developers
- Residents

FOR MORE INFORMATION

The EPA's Creating Resilient Water Utilities initiative "provides drinking water, wastewater and stormwater utilities with tools, training, and technical assistance to increase resilience to climate change." Utilities and other stakeholders in the early stages of understanding climate risks can start by using the Resilient Strategies Guide, advanced users can employ the Climate Resilience Evaluation and Awareness Tool "to assess risk to utility assets and operations," and all users can review the database of case studies on water sector utilities that are building climate resilience.

The Guide to Expanding Mitigation: Making the Connection to Electric Power, released by FEMA, "shows how community officials can work with the public and private actors in the electric power sector to support hazard mitigation, especially in the planning process and project development."

The Important Role of Energy Codes in Achieving Resilience, released by the International Code Council, details the influence of energy codes on energy efficiency as well as pre- and post-disaster resilience.

The US Climate Resilience Toolkit's energy page describes how climate change threatens energy systems and contains links to tools and additional information on energy resilience.

ENERGY AND UTILITIES | 06 STRATEGIES

Assess and protect utilities and distribution networks

Ensuring utility infrastructure systems are in good working condition and well protected is a critical element of building resilience, particularly given the increasing likelihood of extreme weather. This strategy includes inspecting and monitoring for function and integrity and repairing or relocating damaged or vulnerable utility networks, including backup resources.

FOR MORE INFORMATION

EXAMPLE

Northeast Wastewater Treatment Facility disaster protection (Hickory, NC)

CASE STUDY

Blue Plains Wastewater Facility in Washington, DC Reinforces Against Floods

(See **Infrastructure and Capital Investment** and **Land Use and Development** for additional resources)

Develop clear contingency plans for power outages

Having a clear, set procedure and an established emergency manager are helpful measures to decrease the amount of time without power. These operational directives can be very helpful in the event of a large disaster when help may not arrive immediately.

FOR MORE INFORMATION

Incident Action Checklist Power Outages (EPA)
This document provides activities that drinking water and wastewater utilities can take to prepare for, respond to and recover from power outages.

Diversify utility sources to increase redundancy

Utility disruptions can be limited by diversifying utility networks. For example, a well-maintained emergency generator can automatically supply power to life-saving machines if power goes out at a hospital, but a microgrid with renewable sources might offer more co-benefits. In addition, diverse supplies of clean water, electricity, and broadband build resilience by making it less likely that all networks and services will be disrupted, allowing communities to meet their daily needs.

FOR MORE INFORMATION

Microgrids (NC Electric Cooperatives) **This webpage describes microgrids, energy systems that help diversify energy supply, and gives a brief overview of existing microgrid locations in North Carolina.**

CASE STUDIES

Duke Energy announces McAlpine and Mount Holly, NC, microgrids

Tampa Bay, FL, diversifies water supply sources

*See **Energy and Utilities** case study, below.

Manage demand and reduce use of water, electricity and other resources

Managing the demand and use of utilities like energy and water helps conserve scarce resources.

Managing utility use patterns builds reliance by ensuring the resources are available when needed most and that alternative sources are available if necessary. This strategy primarily includes methods for monitoring and reducing usage through education, awareness, behavior modification, and supportive interventions.

Many utilities, agencies, and organizations across North Carolina offer energy audits, energy efficiency upgrades, and emergency housing rehabilitation services. These services can help make residential structures more energy resilient.

FOR MORE INFORMATION

Benefits of Smart Meters (Advanced Energy) **This page describes the energy efficiency and resilience benefits of smart meters and provides examples of their use.**

Energy Savings Performance Contracting Toolkit (US DOE) **This website is a collection of resources on the best practices and innovative approaches states and cities have used to implement performance contracting for energy efficient buildings.**

"WaterSense" products (EPA) **This website lists products that have been third-party certified for their water efficiency and performance.**

Weatherization Assistance Program (NC DEQ) **This program provides funding for local organizations to offer free energy efficiency and weatherization services to low-income households.**

EXAMPLE

Long Range Water Resources Plan Update (Cary, Morrisville and Apex and Wake County, NC)

CASE STUDIES

Advanced Energy builds Heron's Nest Community in Shallotte, NC, as energy smart neighborhood

Brunswick Electric Membership Corporation in NC uses advanced metering infrastructure to provide better electric service

ENERGY
AND UTILITIES

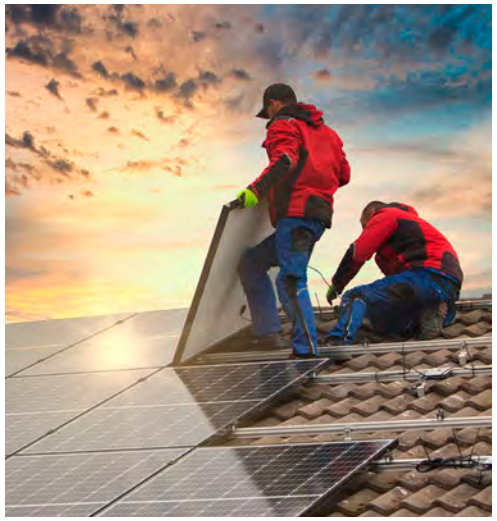
06

CASE STUDY

CASE STUDY

Electric Cooperatives installs microgrid on Ocracoke Island

Project Purpose



NC Electric Cooperatives—an organization that supports North Carolina's 26 nonprofit electric cooperatives—and Tideland EMC—one of those 26 rural electric cooperatives—wanted to increase the reliability of energy on Ocracoke Island. Ocracoke relies on underwater power lines connected to the mainland for electricity. On the island, overhead power lines connect homes and businesses to the grid. Just like any other location, the power can go out on the island on a blue-sky day or when a storm or high winds occur. The two energy utilities installed a microgrid, which allows the cooperatives to provide power to residents and visitors before the main grid can be reconnected.

What is a microgrid?

A microgrid is a small electric system that combines local energy resources and control technologies to provide power to a defined area. Usually, a microgrid is connected to a larger system, but it can function independently when needed. The area served by a microgrid is typically much smaller than what would be served by a utility company (NC Electric Cooperatives, 2024).

Key Players: NC Electric Cooperatives, Tideland EMC

Quick Facts

1. NC Electric Cooperatives and Tideland EMC installed a **microgrid** and in-home energy conservation controls on Ocracoke Island in 2017.
2. Ocracoke's microgrid project features a solar array, diesel power generation and a utility-scale battery storage system. These items supply energy resources year-round to support grid resilience. The system contributes electricity during periods of high demand and can provide power when the main grid is disconnected.
3. The cooperatives also installed over 230 smart thermostats and 40 water heater controls in the homes of Tideland EMC consumer-members on the island. The cooperatives can activate the thermostats and water-heater controls to reduce total load when electricity use is high (NC Electric Cooperatives, n.d.).
4. The **microgrid** and the conservation tools improve Ocracoke Island's resilience to power outages when the mainland grid connection fails. The project also increases the capacity of the island's electrical distribution during peak tourism season when demand is abnormally high.

Making It Happen

- Planning and construction began in 2015. Project managers at NC Electric Cooperatives and Tideland EMC requested bids from vendors.
- The microgrid is connected to a cooperative-owned 3-megawatt diesel generator. An independent contractor installed the roof-mounted 15-kilowatt solar array. Engineers designed the array to withstand winds of up to 140 mph. Another independent contractor conducted the engineering, procurement and construction of the 1-megawatt hour battery bank, transformer and recloser systems. They installed the batteries on a 4-foot concrete base for protection against flooding.
- While the microgrid was being installed, the electric cooperatives developed the behind-the-meter demand response component. Tideland EMC marketed this component to cooperative members on the island. The program offered Ocracoke residents internet-connected thermostats and water heater control devices at discounted prices. Program marketing highlighted the potential for energy and cost savings and the convenience of controlling thermostat settings remotely. The cooperatives gave residents with smart thermostats or water heater controls an annual credit towards their electricity bills. Tideland EMC can use the internet-connected thermostats and water heater controls when electricity is in high demand, i.e., "demand response."
- Project managers installed communications equipment that allows for 24/7 remote monitoring and operation of the site. They also conducted several systems tests before completing the project (NC Electric Cooperatives, n.d.).
- The cooperatives considered the project operational in 2017.

NC Electric Cooperatives and Tideland EMC each have an office on the island, and the NC Electric Cooperatives' plant manager oversees the microgrid's operations. Tideland EMC and NC Electric Cooperatives conduct regular testing. A local electric and solar servicing business conducts quarterly maintenance on the microgrid.

Spotlight on Equity

Energy bills often strain low-income families. These residents spend a higher portion of their income on energy bills than the average household (Drehobl, Ross, & Ayala, 2020). Residents who were able to install smart thermostats and water heater controls received an annual credit that goes towards their electric bill, lessening the burden of utility costs.

Advice from the project manager

A microgrid project's success depends upon committed partners with aligned goals and needs from the project.

Outcomes

- The cooperatives deploy the microgrid's energy resources year-round to support grid resilience. The system contributes electricity during periods of high demand and can provide power when the main grid is disconnected.
- Hurricane Dorian in 2019 was the microgrid's first major test. Both the main grid and microgrid were forced to shut down due to severe wind and significant floodwaters. However, once the floodwaters subsided, the microgrid's diesel generator restored power one day before the main grid was reconnected.
- The microgrid increases the capacity of the island's ability to meet peak electrical demand during tourism season.

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Related Resources

- Ocracoke Island Microgrid Fact Sheet (PDF)
- Ocracoke Island Microgrid Use Cases and Testing Results (PDF)
- NCEMC Ocracoke Island Microgrid Project Implementation Report (PDF)

Costs and Funding

- NC Electric Cooperatives and Tideland EMC funded the project. Total project costs are not available.
- NC Electric Cooperatives noted that communication and control technologies for microgrid projects can cost up to $500,000 (2023 estimate) depending on the size and complexity of the project.

References

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TOPIC | 07
EQUITY AND JUSTICE

Overview

Climate change impacts do not affect all of North Carolina's communities in the same way. People of color, including Black and Indigenous people, and low-income communities are more likely to experience hazards from climate change and are more likely to suffer severe and cumulative impacts (Berberian, Gonzalez, & Cushing, 2022; EPA, 2021). These disproportionate impacts often occur because past and present inequitable policies and systems create higher risks for residents. For example, governments used to release maps outlining areas with high percentages of Black residents, and mortgage companies discriminatorily interpreted these areas as risky investments. Today, residents in these same areas, which were known as "redlined" districts, are often challenged by increased health impacts and decreased access to healthcare, healthy food and economic opportunity, in addition to other struggles (Egede, et al., 2023). People living in low-income, sometimes previously redlined neighborhoods, experience more severe health impacts from extreme heat because they are less likely to have street trees and more likely to be found near major automobile transportation corridors, which contribute to poor air quality (Constantine, 2020; Hoffman, Shandas, & Pendelton, 2020). Underserved and under-resourced residents are also more likely to have underlying health conditions like asthma that make the impacts of these hazards even worse (American Public Health Association, 2023; EPA, 2022). For these reasons and others, people of color, including Black and Indigenous people, and low-income individuals are often on the frontlines of climate change, experiencing its effects first and more severely than better served and more economically advantaged communities.

Moreover, current and historic systems and policies for disaster response and recovery have not equally benefitted all population groups (Sledge & Thomas, 2019). To move towards equitable and just practices in disaster response, recovery and resilience, local decision-makers and leaders can actively look to repair the harms done to people and places by centering and prioritizing the needs and experiences of underserved and under-resourced residents. Equity and justice in resilience also requires recognizing that political, economic, and social institutions have contributed to increased climate-related vulnerabilities and risks for low-income households and individuals, people of color, people with limited English proficiency, seniors, young children, and people with health conditions or impairments.

Role in Resilience

Acknowledging the risks to community members who are already disadvantaged and prioritizing investments that increase their resilience leads to a more just and equitable approach to building community resilience. Often these population groups are also less likely to be engaged in public processes due to decades of mistrust in government. Developing relationships with groups and community leaders who are already trusted by people of color, including Black and Indigenous people, can aid resilience-building efforts. Local leaders can also prioritize projects based on social vulnerability and hazard exposure, strengthen community networks, provide opportunities for participatory governance and commit to an "equity in all policies" framework for public investments and decision-making. This section lists strategies local governments and partners can use to build resilience in a just and equitable manner.

Potential Project Leads, Experts and Stakeholders

- Local government departments and commissions focused on community development, planning, social services, health and sustainability
- Federal government agencies, such as FEMA, NOAA, EPA and US DOT
- Nonprofits and other community organizations (e.g., neighborhood associations, advocacy groups, community foundations, tribal governments and faith communities), especially those that can help convene individuals from often overlooked communities (e.g., Association of Mexicans in North Carolina (AMEXCAN), Hispanic Federation, NC Black Alliance, NC Environmental Justice Network and NC Commission on Indian Affairs)

  More North Carolina community-based organizations:

  - NC Conservation Network Affiliates
  - NC Environmental Justice Network member organizations
  - NC Justice Center
  - NC NAACP
  - NC Rural Center
  - NC Tribal Communities
- Translators, both written and verbal and for those that are hearing or visually impaired
- Healthcare institutions
- Higher education institutions
- Residents, especially Black, Indigenous, and people of color, and low-income communities

FOR MORE INFORMATION

The Adaptation Equity Portal of the Adaptation Clearinghouse provides links to a variety of equity-focused adaptation resources.

Building Alliances for Equitable Resilience is a report developed by FEMA, NOAA and the Resilient Nation Partnership Network to deliver insights, guidance, perspectives, personal stories and resources for advancing equitable climate resilience through partnerships and diverse voices.

In the Eye of the Storm: A People's Guide to Transforming Crisis and Advancing Equity in the Disaster Continuum is a toolkit designed to guide users "through the process of building equity into the four phases of emergency management: prevent and mitigation, preparedness and resilience building, response and relief, and recovery and redevelopment."

Making Equity Real in Climate Adaptation and Community Resilience Policies and Programs is a guidebook developed by the Greenlining Institute to give "policymakers a blueprint on how to operationalize equity in policies and grant programs to prioritize equitable climate adaptation and community resilience needs of frontline communities and address the historical neglect they have experienced." While this report focuses on California, most recommendations are applicable in a diversity of policy contexts and geographies.

EQUITY AND JUSTICE | 07

STRATEGIES

Strengthen social resilience through community networks

Residents who are vulnerable because of historic inequities rely heavily on social networks and assets. Local governments can support frontline communities by acknowledging and strengthening the social ties that bind communities together.

FOR MORE INFORMATION

Resiliency Organizing Hubs (NC Climate Justice Collective) **This page describes Resiliency Organizing Hubs and how they can support community connections.**

EXAMPLES

Climate Change and Social Resilience: Findings from Community Listening Sessions (State of Oregon Health Authority)

Researchers and Robeson County, NC, residents unite on Project BRIDGE **to inform decisions about recovery with voices of residents**

CASE STUDY

Durham, NC, Equitable Community Engagement Blueprint encourages active participation in neighborhood redevelopment and public policy

(See **Communication and Education, Collaboration and Public Health** for additional resources)

Ensure the equitable implementation of resilience projects and policies

The benefits of public investments in resilience are not always equitably distributed across all community members. This strategy builds resilience by establishing processes for understanding where vulnerable community members are located, prioritizing investments in historically marginalized communities, and monitoring public investments to ensure a more equitable distribution of resilience resources.

FOR MORE INFORMATION

Conversations with Communities: Considerations for Equitable Flooding and Disaster Recovery Policy (American Flood Coalition and Institute for Diversity and Inclusion in Emergency Management) **This report shares takeaways from a 2020 conversation with community-based organizations on how to ensure equitable flood policy.**

Climate and Environmental Justice Screening Tool (White House Council on Environmental Quality) **This map shows information about census tracts that are overburdened and underserved.**

Tree Equity Score (American Forests and EarthDefine) **This site provides scores for places with at least 50,000 residents. "Scores indicate whether there are enough trees in specific neighborhoods or municipalities for everyone to experience the health, economic and climate benefits that trees provide."**

EJ SCREEN (EPA) **This resource maps population demographics, environmental hazards (e.g., toxic waste, ozone), environmental justice indices, climate change data and more. Users can select any geographic area in the country.**

Environmental Justice Transportation Disadvantage Index Tool (NC DOT) **These maps and interactive dashboards help users understand and visualize transportation disadvantage and the disproportionate impact of transportation barriers on communities of color. The tool can also help inform policies, planning, and project development decision-making.**

Continued on next page >

Equity Guide for Green Stormwater Infrastructure Practitioners (Green Infrastructure Leadership Exchange and Greenprint Partners) This guide offers best practices and sample metrics to track progress toward long-term equity goals.

Neighborhoods at Risk (Headwaters Economics) This website offers "interactive maps, charts, and resources to help communities identify neighborhoods that may be more impacted by climate change. It shows where people may experience unequal impacts from hurricanes, flooding, and extreme heat."

North Carolina Community Mapping System (NC DEQ) This tool provides a dashboard of community information, including permitting and incident tracking, flood zones, managed conservation areas and more. The tool also features an environmental justice tool that allows all users to understand the sociodemographic and health characteristics of communities across North Carolina.

North Carolina Environmental Public Health Tracking Program (NC DHHS) This resource allows users to view interactive maps and environmental health data visualizations at the state and county levels by year. The tool will soon include monitoring data and track environmental and climate hazards that can affect human health throughout the state.

Populations at Risk (Headwaters Economics) This tool can be used to "generate reports with socioeconomic information about populations more likely to experience adverse social, health or economic outcomes due to their race, age, gender, poverty status, or other factors."

Social Vulnerability Index Map (CDC) This tool shows how population characteristics relevant to vulnerability to climate change vary by census tract. Users can select North Carolina, zoom into specific communities, and download information.

EXAMPLES

Climate Equity Index (Richmond, VA)

Community-Centered Climate Resilience in Connecticut

Community Reparations Commission (Asheville, NC)

Green and equitable infrastructure in historically Black neighborhoods (Durham, NC)

Santa Ana, CA, and Menominee Nation, WI, *encuentro* (community exchange)

CASE STUDY

Upper Snake River Tribes partner to complete climate change vulnerability assessment

*See **Equity and Justice** case study, below.

Strengthen resilience for vulnerable and marginalized groups (e.g., older populations, people of color, people with limited English proficiency)

Given the disproportionate impacts of climate hazards across population groups, targeted planning efforts help to build resilience by increasing an awareness of unique needs during the planning process. Planners can use this information to tailor desirable outcomes.

(See **Communication and Education**, **Collaboration**, and **Public Health** Resilience Topics for additional strategies designed to support equity for vulnerable populations)

FOR MORE INFORMATION

Cleveland Climate Action Plan: Racial Equity Tool (City of Cleveland, OH) This tool guides decision-makers through the process of recognizing and addressing inequities in climate resilience planning and proposed solutions.

Disaster Resilience Tool Kit (AARP) This guide shows how local leaders can reduce the risks of climate change for older adults.
*Disponible en Español

Establishing and Maintaining Inclusive Emergency Management with Immigrant and Refugee Populations (Welcoming America) This checklist is "designed to help strengthen existing emergency preparedness plans by ensuring immigrants and refugees are part of any emergency response."

Prepárate NC: Una guía informativa y de recursos para la temporada de huracanes Esta guía contiene recursos para las familias hispanas de Carolina del Norte para afrontar la temporada de huracanes.
*Only available in Spanish

EXAMPLE
City of Miami Resolution on Climate Gentrification (Miami, FL)


OLDEST TOWN CHARTERED
1885
TOWN OF
PRINCEVILLE
NORTH
CAROLINA
BY BLACKS IN AMERICA
PRINCEVILLE
TOWN HALL
WELCOME TO OUR
TOWN!
STEWARTSIGNS.COM

EQUITY
AND JUSTICE | 07

CASE STUDY

CASE STUDY

Princeville, public universities and partners facilitate resilience planning that honors town history

Project Purpose

Princeville, NC, the first town chartered by formerly enslaved African Americans in the United States, has weathered multiple floods since the community's founding. The town was founded in the Tar River floodplain after the Civil War, surrounded by swampy land undesirable to white landowners. A levee completed in 1965 protected the town from flooding for several decades until Hurricane Floyd in 1999, when upwards of 15 feet of floodwater sat in Princeville's town center. Damage to the town's infrastructure was devastating. The community rejected proposals to relocate the entire town and its residents to higher ground. However, the community flooded again after Hurricane Matthew. Princeville partnered with academia and nonprofits to develop a plan to adapt to the reality of flood risk and honor the community's long history of Black self-determination.

What is a floodprinting?

Floodprinting is a form of resilience planning created by the NCSU Coastal Dynamics Design Lab. Floodprinting allows flood-vulnerable communities to explore the relationship between land and water, with a focus on equity and recovery (Cohen, 2022).

Key Players: Workshop: NCSU Coastal Dynamics Design Lab and College of Design, North Carolina Collaboratory, Town of Princeville, Edgecombe County, NCEM, Governor's Recovery Office; Princeville's Homeplace publication: NCSU Coastal Dynamics Design Lab, NCSU College of Design, UNC Chapel Hill Coastal Resilience Center, North Carolina Collaboratory, Design Concepts CLA, Inc., Greenways, Inc.; Floodprint: NCSU Coastal Dynamics Design Lab, Conservation Trust for North Carolina, Town of Princeville, Upper Coastal Plain Council of Governments

Quick Facts

1. Since formerly enslaved African Americans founded Princeville after the Civil War, the town has faced eight devastating floods. In 2016, water from Hurricane Matthew circumvented the levee and left 80% of the town flooded. The water destroyed about 450 homes (NCSU Coastal Dynamics Design Lab, 2020).
2. NC State University (NCSU) and its partners developed a conversation guide for Princeville called "Homeplace," which helps flood survivors navigate community discussions about recovery and resilience efforts.
3. NCSU, along with the Town of Princeville and several interdisciplinary partners, crafted the Princeville Community **Floodprint.** Responding to Princeville residents' desires to adapt in place, the floodprint plan responds to the reality of living with flood risk while honoring the town's Black history and character. The document outlines initiatives to manage stormwater, increase public access to the Tar River and convert previously flooded properties to agricultural land.

Making It Happen

- In 2017, the Town of Princeville, Edgecombe County, universities and state agencies co-sponsored a multi-day community workshop. The workshop aimed to explore designs for a more flood-resilient Princeville. Designers and planners at the community workshop included NCSU Coastal Dynamics Design Lab faculty, staff and students.
- The NCSU Coastal Dynamics Design Lab, in partnership with the University of North Carolina at Chapel Hill, led a team of faculty and students to develop a guide on resilient housing designs for Princeville. NCSU titled Princeville's guide **Homeplace: A Conversation Guide for the Princeville Community, Rebuilding After Hurricane Matthew**. "Homeplace" starts by defining key urban planning and resilience concepts and strategies in plain language. The document also describes Princeville's vulnerabilities and its need for resilience planning. The reader can follow different tracks within the guide for different homeowner decisions, for example, if they chose to relocate or elevate. NCSU also published "Homeplace" guides for Fair Bluff, Kinston, Lumberton, Seven Springs and Windsor, NC.
- The NCSU Coastal Dynamics Design Lab worked with community partners to produce the 2020 **Princeville Community Floodprint**. The document responds to the community's desire to stay in place. It recommends land use strategies that reduce flood risk in addition to acknowledging staffing needs and public safety concerns. The floodprint also aims to improve the long-term function of ecosystems in areas that routinely flood.

Spotlight on Equity

Princeville is a community with a long and important history. It is the oldest town founded by formerly enslaved people. Today, most town residents are Black. Both the floodprint and the Homeplace guide aimed to provide a variety of long-term recovery planning options for the Princeville community to consider and select. Because of its rich history of Black leadership, Princeville sought options from which the town could choose, as opposed to recommendations from outsiders for a particular path forward. Academic and nonprofit partners respected this and deferred to the community's own expertise in developing the Homeplace guide and floodprint.

In partnership with community members, the floodprint process and final document acknowledge and build upon the place-based history. By improving the material safety of the community and offering new channels for economic growth and recreational space, the plans also strive to improve the day-to-day lives of the residents.

Advice from the project manager

When rebuilding in the floodplain is desired by some residents, flood risk minimization is still possible using smart design practices and community-based planning processes.

Community leaders hold essential expertise that technical experts and outsiders do not. Outside groups can partner with communities in a way that advances equity by respecting this expertise and integrating it in plans, committing to the community over several years and helping with the nuts and bolts of project implementation once a plan has been adopted.

Planning efforts that are cross-disciplinary rather than only technically focused help build community capacity and result in quality planning outcomes.

Outcomes

- As of spring 2023, Princeville has generated more than $600,000 in grants for implementing projects in the floodprint.
- Guided by the floodprint, the Town of Princeville, Princeville Elementary and their partners constructed a section of the Heritage Walking Trail, installed rain gardens and other stormwater management features to address water runoff from the school building, built an outdoor classroom for teachers and students to incorporate conservation into their lesson plans, and placed a Resilience Corps NC environmental educator to provide additional capacity to the school staff (Conservation Trust for North Carolina, 2022).

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Additional Resources

- Princeville Community Floodprint video
- UNC Coastal Resilience Center's summary of the initial community design workshop in 2017
- Conservation Trust for North Carolina project summary – Includes video

Related Case Studies

- See **Collaboration**: Raleigh and Durham map neighborhood temperatures.
- See **Housing**: Wilson Housing Authority constructs new affordable housing outside the floodplain.
- See **Public Health**: Preventing heat-related illness in the Sandhills Region.

Costs and Funding

- NC Emergency Management (NCEM) funded the initial community design workshop in Princeville. Funds covered all aspects of preparation and delivery. Leading Black planners, designers and architects from across the state and nation donated tens of thousands of dollars of time.
- The North Carolina Collaboratory funded the Homeplace effort, including all six community documents, with funds upwards of $900,000.
- The $50,000 floodprint project was funded by the Z. Smith Reynolds Foundation of North Carolina through the Common Ground Collaboration, a project of the Conservation Trust for North Carolina, and The Conservation Fund.

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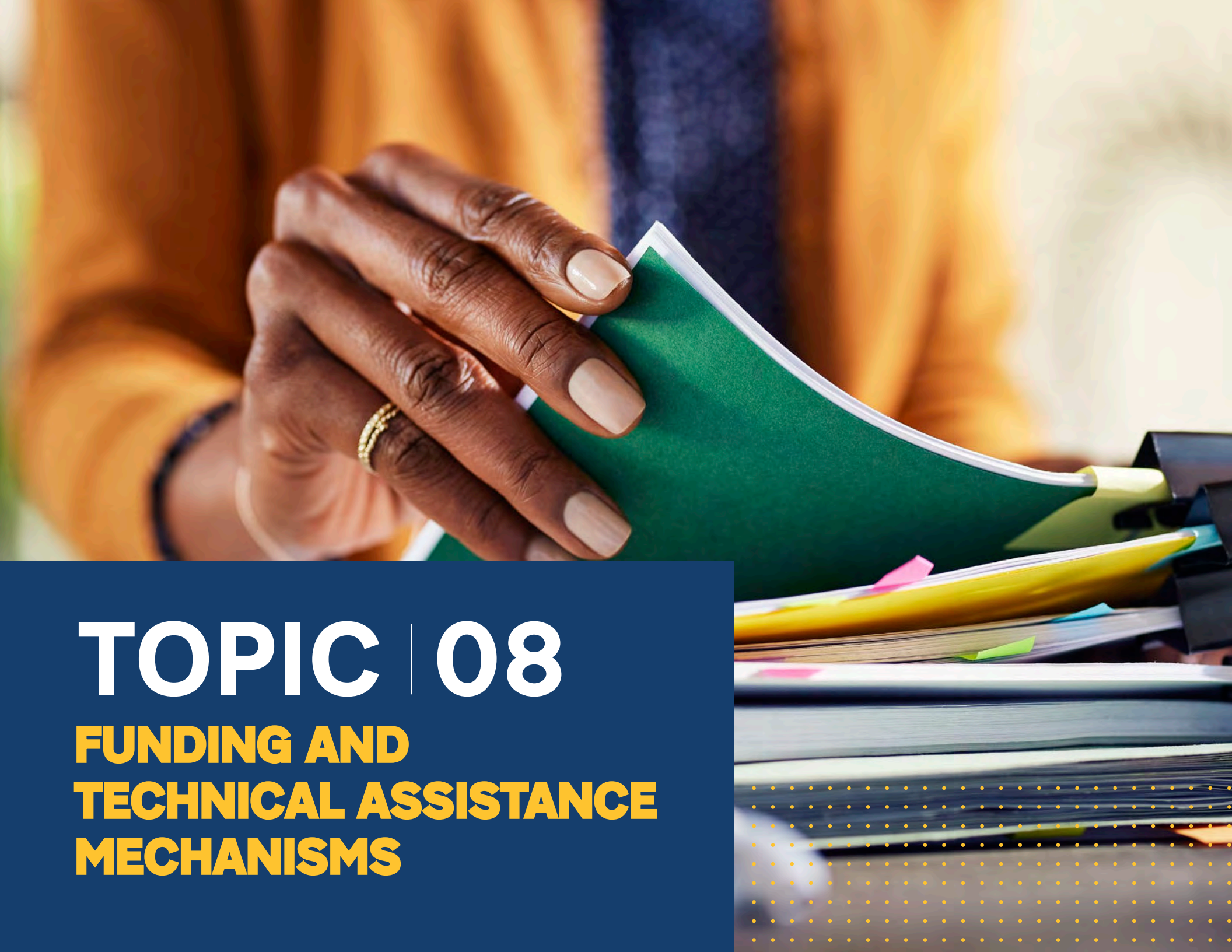


TOPIC | 08

FUNDING AND TECHNICAL ASSISTANCE MECHANISMS

Overview

Many projects and programs that build community resilience require significant funding and subject matter expertise. There are now many sources of technical assistance and funding through federal, state, private-sector and nonprofit entities to implement resilience-building strategies. The challenge for local leaders can be finding the right expertise as well as the right funding source for a project, the staff time to apply, and the capacity to track and complete grant reporting requirements.

Role in Resilience

Identifying appropriate funding streams and technical assistance opportunities early in the planning process are essential elements in successful resilience planning and project implementation. Traditional public funding mechanisms include municipal tax revenues (both general and enterprise funds), user fees, capital improvement budgets, municipal bonds, and grant funding (formula and discretionary). These methods continue to be used, but they can also be supplemented by innovative approaches to raising revenue, including special taxing structures; public-private partnerships; impact bonds including climate, green, social, and environmental; and self-sustaining or revolving loan funds like wetland and land banking schemes. Thinking creatively about funding sources can help forge new opportunities. Prospects for technical assistance also extend beyond hiring consultants. For example, universities are often willing to help, as are nonprofits and state government agencies. This section describes funding and technical assistance strategies and lists resources that can help local leaders take advantage of new opportunities.

Potential Project Leads, Experts and Stakeholders

- Local government departments and commissions focused on budget management, sustainability and planning (e.g., financial advisors, accountants, grant writers and managers)
- Nonprofits and other community organizations (e.g., neighborhood associations, community foundations)
- State government agencies, such as NCORR and NC DEQ
- Federal government agencies, such as EPA and FEMA, among others
- Higher education institutions, such as the UNC Environmental Finance Center

FOR MORE INFORMATION

The funding section of the NC Resilience Exchange offers a climate-resilience-focused funding database and lists of resources to help North Carolina communities write their own grant application or find someone else to write it for them.

The Federal Funding and Technical Assistance page of the EPA's Climate Change Adaptation Resource Center lists funding strategies, resources and opportunities from the EPA and other federal agencies.

How Cities are Paying for Climate Resilience, a report published by the Innovation Network for Communities, "identifies eight distinct strategies cities are using to pay for large-scale climate resilience projects, mostly to address sea level rise and flooding."

Ready-to-Fund Resilience Toolkit, released by the American Society of Adaptation Professionals, describes how small and mid-sized local governments can "more effectively operate within the resilience funding and finance system," "ensure projects are ready to receive funding" and "create equity through resilience funding and finance." The resource also provides "tips for overcoming challenges such as lack of resources, funding or political will."

The Recovery and Resilience Resource Library, hosted by FEMA, "helps users to find and research federal disaster recovery resources that would be beneficial in pre-disaster recovery planning or in the wake of a disaster." The library contains grants, technical assistance, capacity-adding opportunities, and more.

FUNDING AND TECHNICAL ASSISTANCE MECHANISMS

08 STRATEGIES

Integrate hazard mitigation and resilience in all public projects

In addition to the climate adaptation benefits, integrating resilience and hazard mitigation into ongoing projects can increase financial efficiencies and the lifespan of capital and social investments.

FOR MORE INFORMATION

(See **Infrastructure and Capital Investment** for additional resources)

Take advantage of disaster declaration funds

When a community receives a Presidential Disaster Declaration, funds become available for recovery. Many of those funds can be used to increase resilience to future disasters during reconstruction so the community will experience fewer impacts the next time the disaster strikes.

FOR MORE INFORMATION

Hazard Mitigation Assistance Program and Policy Guide

This Guide "provides helpful information for prospective applicants and subapplicants from state, local, tribal and territorial governments on the application and grant processes for four hazard mitigation grant programs." These four include the Hazard Mitigation Grant Program, Building Resilient Infrastructure and Communities program, the Flood Mitigation Assistance program, and the Hazard Mitigation Grant Program Post Fire.

Use taxes

Taxes offer many avenues for generating revenue for resilience-building initiatives. Strategies include property tax rate increases, special assessments, dedicated occupancy or tourism taxes, real estate transfer tax, and project development financing (more commonly known as tax increment financing, or TIF).

Land transfer taxes assess a fee on the transfer of real property. The State of North Carolina collects this tax for most routine property transfers and can authorize local counties to assess an additional tax of the same type for their own use. In the seven counties already authorized to collect the tax, revenues from the land transfer tax primarily fund capital improvement projects, which could include resilience efforts.

FOR MORE INFORMATION

EXAMPLES

Land transfer tax (Dare County, NC)

Municipal service district funds beach nourishment (Nags Head, NC)

Regional parcel tax for restoration (San Francisco)

Two percent room occupancy and tourism development tax for beach nourishment (Dare County, NC)

Voter-approved climate action tax (Ann Arbor, MI)

CASE STUDY

Woodfin, NC, funds water and sewer extensions, pedestrian walkways and bike trails with Tax Increment Financing

Institute a voluntary surcharge

Voluntary surcharges on retail-, occupancy-, or tourism-related purchases are like nonprofit fundraising campaigns that solicit donations at the supermarket checkout. However, a voluntary surcharge requires the customer to opt out of the fee rather than opting in when making a qualifying purchase. For example, land trusts are using this strategy to fund the purchase and preservation of land.

FOR MORE INFORMATION

EXAMPLES

1% for Open Space funds land protection projects (Gunnison County, CO)

Pennies for Preservation program supports land protection (St. Simons Island, GA)

Implement fees to support specific services

Local governments can raise revenues by adding a fee on top of regular rates, charges or costs of service. Generated revenues can be used to fund improvements and other projects. For example, stormwater service fees are performance- or impact-based, meaning the fee amount is based on the individual's relative use of the service. Regardless of the fee design, communities can use these funds to implement resilience-related projects.

*See note in the next strategy box.

FOR MORE INFORMATION

EXAMPLE

Stormwater services fees (Charlotte, NC)

Support resilience projects through development regulations or compensatory mitigation

Land use regulations can require or incentivize low-impact development approaches. One approach is requiring developers to pay an impact fee, including "fee-in-lieu," to mitigate potential impacts of their project on the community.

*Note – North Carolina's local governments need to be careful about imposing impact fees or fees-in-lieu. Impact fees are only allowed where explicitly authorized by the General Assembly. Encouraging some projects to provide additional funds may be permissible, but most requirements to pay for impacts or resilience programs will be outside of North Carolina local government authority. See this article for additional information.

FOR MORE INFORMATION

Stream and Wetland Mitigation Program Guidance (NC Department of Environmental Quality) **This website provides guidance on the types of compensatory mitigation programs available and permissible in North Carolina.**

EXAMPLES

Compensatory Mitigation (Wilmington, NC)

CASE STUDY

Charlotte-based utility runs a stream and wetland mitigation bank

Pursue public-private partnerships

Local governments can use public-private partnerships to purchase and manage land and to construct, operate, and maintain infrastructure to support climate resilience. Even with limited funding, local governments can pursue public-private partnerships by limiting development fees or offering in-kind support such as volunteer time and topical expertise.

FOR MORE INFORMATION

EXAMPLES

Public-private partnership for stormwater management (Prince George's County, MD)

Watershed Protection Program (Raleigh, NC)

Issue bonds

With the permission of residents, local governments can borrow money to pay for most capital projects demonstrating a public benefit. Residents must demonstrate their permission through a "bond referendum," a question on a ballot asking community members to vote "yes" or "no." If the vote passes, the local government can issue a bond to pay for the project.

Municipal bonds, climate or green bonds, and social and environmental impact bonds can be used to build community resilience. Governments can lower the costs of debt service for bonds funding projects that improve social or environmental circumstances by seeking a "green" or "ESG" (environmental, sustainability goal) certification (see Green Bonds case study on page V2-103).

FOR MORE INFORMATION

EXAMPLES

Green bonds protect water resources (Asheville, NC)

DC Water green bonds finance river clean up (Washington, DC)

CASE STUDIES

Atlanta uses environmental impact bond to manage stormwater in environmentally and economically distressed neighborhoods

Hampton, VA, finances flood management with environmental impact bond

*See the **Funding and Technical Assistance Mechanisms** case study, below.

Establish self-sustaining funds and banks

Revolving loan funds and banks are mechanisms for both creating and allocating revenue and resources. These self-replenishing financial mechanisms can be used to purchase land that is banked or held in trust (for use or conservation); as microloan programs for site-level hazard mitigation, energy efficiency and stormwater management; and for investing in green infrastructure. As loans are repaid, new funding can be loaned out.

FOR MORE INFORMATION

How Can Revolving Loan Funds Make Our Coasts More Resilient? (Environmental and Energy Study Institute) This fact sheet explains how revolving loan funds operate and describes existing programs.

EXAMPLES

NC Clean Water State Revolving Fund funds wastewater treatment facilities and projects associated with estuary and nonpoint source programs.

Southern California Renewable Energy Network Revolving Savings Fund supports energy efficiency upgrades of public agency facilities.

Pursue grant funding

Formula and competitive grant funding at both the state and federal levels is available to help communities implement resilience and hazard mitigation projects. Communities can also try to integrate resilience into projects funded through other programs not specifically focused on climate or resilience, like transportation infrastructure grant programs.

FOR MORE INFORMATION

Climate Resilience Toolkit: Funding Opportunities This resource contains a library of grants from government entities and private foundations, as well as links to other climate resilience-focused funding databases.

Nature-based Solutions Funding Database (National Wildlife Federation) This resource is designed for communities interested in pursuing federal funding and technical assistance for nature-based solutions.

Grants Page (NC DEQ) This webpage "provides information on all NC DEQ funding programs in one place, along with a searchable list of currently open applications for grant opportunities." The Division of Water Resources also lists water-related funding opportunities on its website.

EXAMPLE

FY2020 Building Resilience Infrastructure and Communities (BRIC) resilience projects in North Carolina

Pursue technical assistance programs

Many technical assistance programs guide local governments through grant applications and project implementation.

FOR MORE INFORMATION

EXAMPLES

BRIC Direct Technical Assistance

North Carolina Resilient Communities Program

Offer grants to incentivize resilience

Local governments can secure funds from the budget or other sources to offer grants to incentivize resilience-building projects.

FOR MORE INFORMATION

EXAMPLES

Percent for Green grants program funds large-scale green infrastructure projects (Portland, OR)

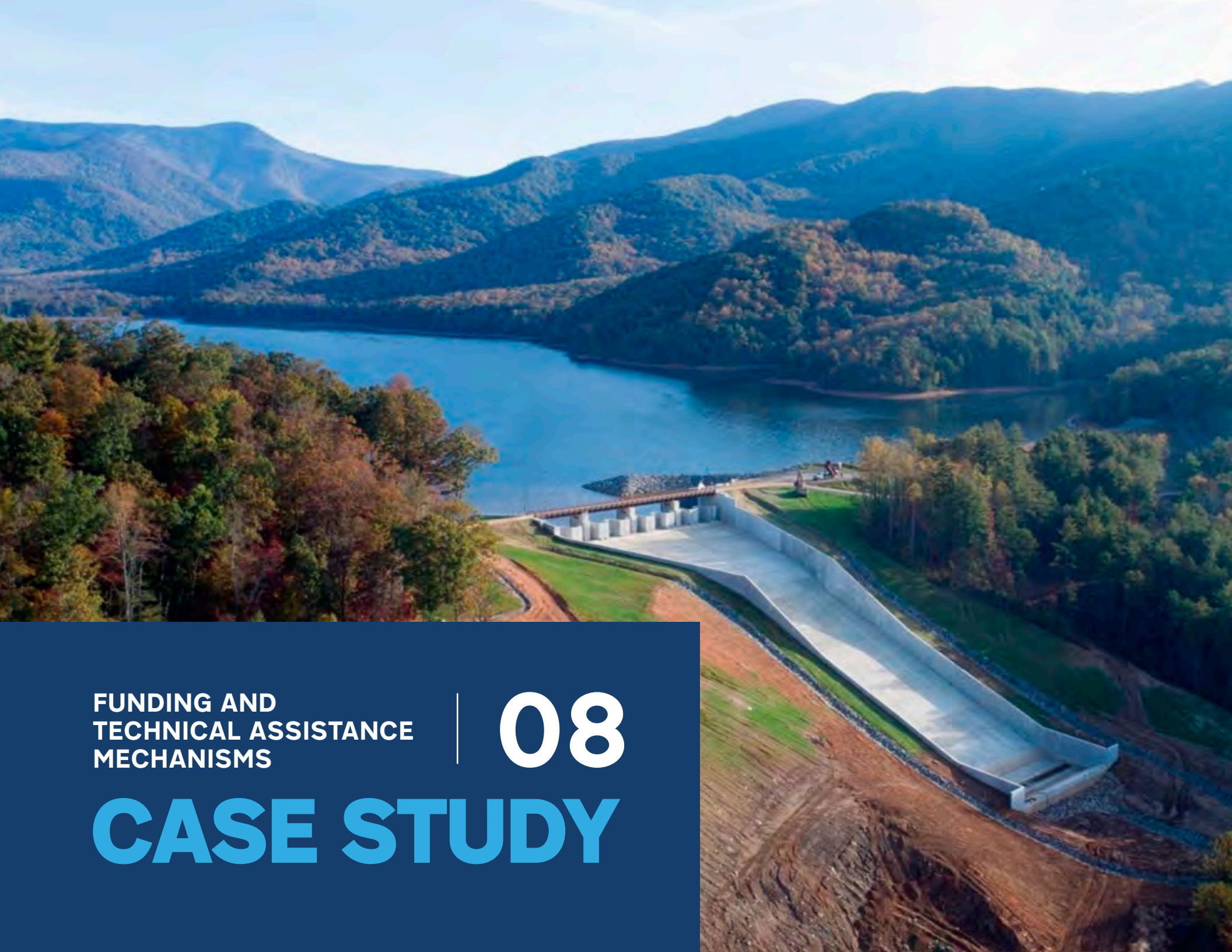
Take advantage of low-interest loans

Some programs offer low-interest loans directly to communities.

FOR MORE INFORMATION

Water Infrastructure Finance and Innovation Act

This program provides low-interest-rate loans for eligible water and wastewater infrastructure projects.



FUNDING AND TECHNICAL ASSISTANCE MECHANISMS

08 CASE STUDY

CASE STUDY

Asheville uses green bonds to improve drinking water infrastructure

Project Purpose

Asheville's mountainous topography makes water pressure higher than in other areas. This pressure stresses water lines, making them more prone to leaks (McDaniel, 2015).

In 2007, when interest rates were high, the City of Asheville Water Resources Department issued a routine water revenue bond to make system upgrades. The upgrades reduced water leaks by replacing failing water lines, enhancing water tanks, and replacing valves. The city also added emergency generators to keep the pump stations online when the power goes out.

When interest rates were lower in 2015, Asheville investigated refinancing options. The city found they could cancel their existing debt and obtain a lower interest rate using a green bond, even though the project had already been constructed.

Green Bonds

Green bonds are like traditional municipal bonds, except they fund projects that meet certain standards for environmental or climate benefits. In 2007, a market began emerging for bonds self-labeled as "green." Within a few years, market- and government-led efforts standardized a set of principles and guidelines to define what projects can and cannot identify as "green." Interest rates for green bonds are lower because the market for green bonds is stronger than for traditional bonds (OECD, 2015). Green bonds can lower the cost of project financing, making projects more affordable.

Debt Ratings

A debt rating is the result of an assessment of the city's ability to meet one or more financial commitments. Credit rating agencies use ratings to issue an opinion on an individual obligation (e.g., a bond) or of an entity's general creditworthiness (Moody's, n.d.). There are three leading agencies that issue debt ratings: Moody's, Standard & Poor's (S&P) and Fitch. Only Moody's and S&P issue ratings to local governments. Moody's highest rating is an Aaa, followed by Aa1, Aa2, Aa3 and lower. Standard and Poor's top rating is an AAA, and continue down with AA+, AA, AA- and down (Finney, Mansa, & Rohrs Schmitt, 2023). Having a high rating from both Moody's and S&P gives a city access to strong financial markets, ultimately lowering borrowing costs and saving the city money (City of Asheville, 2021).

Key Players: City of Asheville Water Resources Department, financial advisors, North Carolina Utilities Commission

Quick Facts

1. The City of Asheville used a **green bond** to refinance water service projects at a lower interest rate.
2. Satisfied with its first green bond issuance, the City of Asheville sought another green bond to fund improvements to the North Fork Dam.
3. In 2021, a second green bond was issued for improvements to the North Fork Dam.
4. Following this second issuance, Moody's and Standard & Poor awarded Asheville with strong **debt ratings** of Aa1 and AA+, respectively.

Making It Happen

- In 2015, the City of Asheville prepared the refinancing of the 2007 bond under the Green Bond standards. To obtain the green bond, Asheville had to demonstrate the environmental benefits of the 2007 project. In North Carolina, the state Utilities Commission must certify municipal green bond instruments by reviewing documentation on the project's environmental benefit. Asheville's first green bond was issued in June 2015.
- The City of Asheville was happy with the interest rate savings associated with the first green bond issuance. In 2020, Asheville decided to pursue another green bond opportunity. The new project would fund $40 million in improvements to the North Fork Dam (Bechel, 2021). The interest rate for this water revenue bond was just under 2.1%. In September 2021, Asheville was issued its second green bond.

Spotlight on Equity

Local governments can use green bonds to finance projects that help residents who experience the worst effects of climate change.

Advice from the project manager

Any time you are issuing a bond or borrowing money, talk to your financial advisors to see if the projects for which you are issuing the debt would allow for a green bond.

Outcomes

- The green bonds issued to the City of Asheville lowered the cost to deliver environmentally friendly projects by lowering the interest rate.
- As of 2015, the City of Asheville had issued $55 million in green bonds to finance both water infrastructure projects (McDaniel, 2015).
- Following the 2021 green bond issuance, Moody's awarded an Aa1 debt rating and Standard & Poor affirmed a debt rating of AA+ for the City of Asheville's water revenue bonds. These high ratings lowered borrowing costs for the city, saving taxpayer dollars (City of Asheville, 2021).

Project Contact

City of Asheville Finance and Management Services Department

Additional Resources

- Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bonds includes list of eligible project categories, including flood mitigation and climate adaptation

Related Case Studies

- See **Stormwater Management and Flooding:** Charlotte-Mecklenburg region runs local floodplain buyouts program.

Costs and Funding

- The only costs for issuing a green bond are staff salaries and financial advisor fees. Local governments in North Carolina use financial advisors to handle all bond applications. Asheville did not experience a difference in cost between a green bond application and a regular bond application.

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TOPIC | 09
HOUSING

Overview

Safe and adequate housing is an essential component of a resilient community. Housing that is structurally unsound, poorly maintained, or unhealthy (moldy, lacking adequate heating and cooling, or having contaminated water) and housing located in vulnerable places puts people and property at risk. People are also at extreme risk when they do not have access to housing at all. These factors, as well as growth pressures, contribute to the housing challenges in North Carolina communities, which makes planning and implementing strategies for housing resilience particularly complex.

Role in Resilience

Building housing resilience requires strategies that protect new and existing residents from more frequent and severe impacts of climate hazards. Local leaders can incentivize housing development in safer locations; promote or require more sustainable housing construction and development; and repair or retrofit the most vulnerable housing. In extreme cases, when housing cannot be retrofitted or strengthened, local governments can purchase residential properties and relocate residents to remove them from risk of harm. This section provides resources and examples of these strategies and more.

Potential Project Leads, Experts and Stakeholders

- Local government departments and commissions focused on community development, planning, emergency management, building inspections and public health
- Housing authorities
- Design and construction professionals (e.g., architects, landscape architects, civil engineers) in the private, nonprofit, governmental and academic sectors
- Nonprofits and other community organizations (e.g., neighborhood associations, advocacy groups, community foundations, tribal governments and faith communities), especially those that can help convene individuals from often overlooked communities (e.g., Association of Mexicans in North Carolina (AMEXCAN), Hispanic Federation, NC Black Alliance, NC Environmental Justice Network and NC Commission on Indian Affairs)

More North Carolina community-based organizations:

- NC Conservation Network Affiliates
- NC Environmental Justice Network member organizations
- NC Justice Center
- NC NAACP
- NC Rural Center
- NC Tribal Communities

- Builders and developers
- State government agencies, such as NCORR and NCEM, which support post-storm recovery, housing resiliency and affordability options; and the NC DHHS, which promotes healthy indoor air quality
- Federal government agencies, such as HUD and FEMA
- Regional organizations, such as North Carolina's councils of governments (COGs) and area agencies on aging
- Higher education institutions
- Residents

FOR MORE INFORMATION

The Community Resilience Toolkit, developed by the Department of Housing and Urban Development (HUD), helps recipients of its Community Planning and Development funds identify opportunities to mitigate the impacts of natural hazards on housing. In addition to its six sections on specific natural hazards, this resource describes what a resilient community can look like, actions a local government can pursue and additional financing opportunities.

**Disponible en Español*

HOUSING | 09 STRATEGIES

Encourage housing growth in safer locations

Communities should assess all residential areas for current and future climate-related vulnerabilities and identify safe areas to accommodate future growth and development. This strategy enhances resilience by protecting people and property from climate hazards like sea-level rise and flooding.

FOR MORE INFORMATION

National Risk Index Mapper (FEMA) **Allows users to identify areas for housing development in their communities that are at lower risk for natural hazards.**

EXAMPLE

Analyzing future urban growth and flood risk (Pender County, NC)

(See **Land Use and Development** and **Infrastructure and Capital Investment** for additional resources)

Adopt zoning codes, development regulations, building codes, and ordinances to support climate-resilient housing

Development regulations such as zoning codes control development and land use activities. Building codes provide a baseline standard for quality and safety, and additional ordinance requirements can build resilience to specific threats. These strategies can build resilience by incentivizing development in safe locations, prohibiting development in dangerous or vulnerable locations, and requiring structures to use strong, context-appropriate materials. For example, local governments can ensure that newly constructed and renovated houses meet the standards set by the NC DOI for wind load, which varies by county.

FOR MORE INFORMATION

EXAMPLES

Flood damage prevention ordinance Chapter 5, Article 4 (Chapel Hill, NC)

Floodplain Development Regulations (Gaston County, NC)
Requires a minimum of three feet of freeboard (i.e., height added to the Base Flood Elevation for lowest construction elevation).

(See **Energy and Utilities** and **Land Use and Development** for additional resources)

Acceptable Building Code Ordinances in North Carolina
Unless state law specifically prohibits the intent of the ordinance, local governments can adopt ordinances that are more stringent than the North Carolina Building Code. Local governments may need to go through the Building Code Council for a review of the ordinance and should speak with their legal counsel when considering this option. All fire code ordinances must be reviewed by the Building Code Council. See NC General Statutes § 143-138(e) *for more information.*

Retrofit existing housing to be more resilient to current and anticipated climate impacts

A home's location, design, materials, construction techniques and age contribute to its ability to withstand climate impacts. Older, poorly maintained, and poorly constructed housing is more vulnerable than newer housing. Additionally, residents living in manufactured and mobile homes are more vulnerable to impacts, especially if the home was constructed prior to the passage of safety regulations for manufactured homes in 1973. Although local governments cannot directly regulate the age of manufactured homes, they can require that homes comply with the standards set by HUD. Communities can also build resilience by retrofitting existing vulnerable homes to protect them from the impacts of climate hazards and ensure that inhabitants can afford them.

FOR MORE INFORMATION

Appendix G: Flood-resistant construction **The part of the North Carolina Building Code designed "to minimize public and private losses due to flood conditions in specific flood hazard areas."**

EXAMPLES

Home elevations (Currituck County, NC)

Permit requirements for manufactured homes to ensure compliance with wind, flood and other safety standards (Beaufort County, NC)

(See **Land Use and Development** and **Energy and Utilities** for additional resources)

Acquire extremely vulnerable residential properties that cannot be retrofitted

In some situations, it may not be possible to safely retrofit a home to protect people and property against potential hazards. Instead, the community might choose to acquire the properties and demolish structures in high-risk areas. Residential buyout programs build resilience by providing resources to residents in hazardous areas, helping them relocate, and converting the property to open space to accommodate flooding.

FOR MORE INFORMATION

Managed Retreat Toolkit (Georgetown Climate Center)
This resource "combines legal and policy tools, best and emerging practices, and case studies to support peer learning and decision-making around managed retreat and climate adaptation."

Strategic Buyout Program (NCORR) **This program "offers eligible property owners located in flood-prone areas the chance to sell their home and relocate to a safer area." Local governments can contact the program to discuss properties of concern.**

EXAMPLES

Voluntary floodplain buyout program (Charlotte, NC)

Residential property acquisitions (Pender County, NC)

> ***Managed retreat*** *is the purposeful, coordinated movement of people and infrastructure away from places of high and growing risk like extremely vulnerable, eroding beachfront.*

Ensure safe and healthy shelter for all

There are residents in North Carolina without homes. And among those with homes, some buildings are structurally unsound, poorly maintained, or unhealthy (e.g., contain mold or contaminated water, lack adequate heating and cooling). Some homes are in vulnerable places, such as the flood zone, putting people and property at risk. Resilient communities actively support and help provide permanent, short-term, and emergency housing opportunities for residents.

FOR MORE INFORMATION

EXAMPLES

Front porch initiative for under-resourced rural communities (Rural Studio)

(See **Public Health** for additional resources)

CASE STUDY

*See **Housing** case study, below.

HOUSING | 09
CASE STUDY

CASE STUDY

Wilson Housing Authority replaces vulnerable public housing in safer location nearby

Project Purpose

Hurricane Matthew caused flooding that rendered 40 public housing units in two Wilson Housing Authority communities uninhabitable. The impacted homes were in the floodway and had experienced multiple damaging floods in the past. As a more resilient solution, Wilson Housing Authority and the City of Wilson constructed Eatmon Townhomes, an affordable housing project that included 32 new units outside of the floodplain.

Key Players: Wilson Housing Authority, City of Wilson, FEMA, HUD, NCORR, NC Department of Commerce, Stogner Architecture and DanCo Builders

Quick Facts

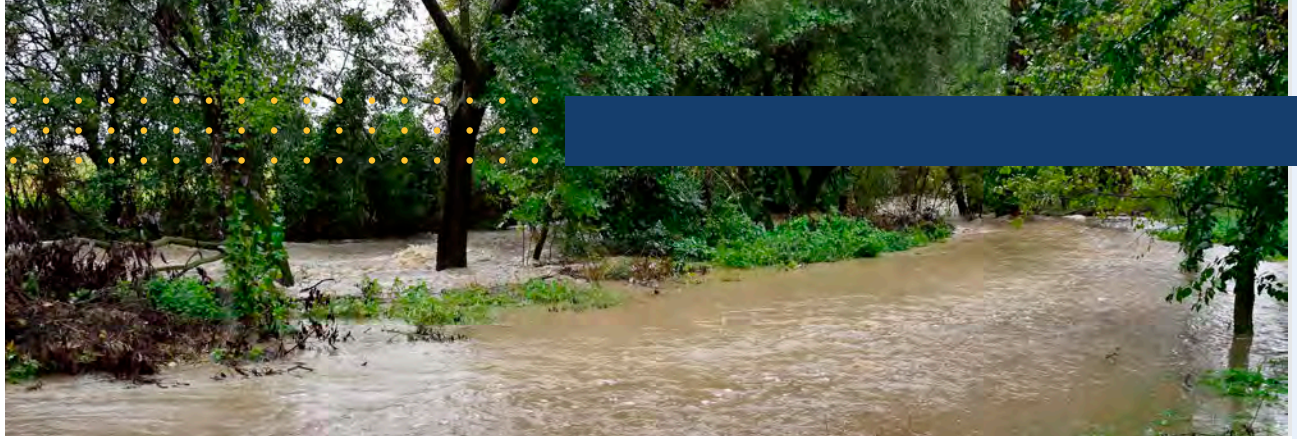
1. The area affected by flooding had a median household income of $16,051 in 2015, the year before Hurricane Matthew. Fifty-seven percent of the families in the census tract were living in poverty. The unemployment rate in the area was 27.5%. The availability of housing affordable to residents at all income levels is a critical element of resiliency.
2. Project managers funded the project through direct allocations instead of loans. They acquired $5.1 million through a mix of federal, state and local sources (Retana, 2022).
3. As of early 2024, Wilson Housing Authority is working with NC Emergency Management to use Federal Emergency Management Agency (FEMA) funds to demolish the damaged, uninhabitable homes. Future plans include a greenway trail and flood retention ponds.

Making It Happen

- In 2017, Wilson County's Hurricane Matthew Resilient Redevelopment Plan listed the Eatmon Townhomes project as high priority.
- In 2018, the Wilson Housing Authority and the City of Wilson secured a Rental Assistance Demonstration Grant from HUD to convert the public housing units into Section 8 affordable housing and construct them outside the floodplain.
- Construction of the new housing units began in 2021.
- In 2023, the first residents moved into the new housing units.

Spotlight on Equity

Preserving affordable housing near its original location is important to support the day-to-day in-person connections in low-income communities where information and support like childcare are often exchanged among neighbors. The Wilson Housing Authority's 32 new housing units are available to applicants with incomes at 80% or below the area median income. Tenants pay no more than 30% of their monthly incomes in rent with a minimum of $50 per month. The Wilson Housing Authority chose its first applicants from an existing waitlist. They prioritized homeless individuals, families and veterans. In addition, the Wilson Housing Authority installed green energy appliances in each unit to increase the energy efficiency of the homes and lower utility costs.



Advice from the project manager

Project managers emphasized the importance of providing quality affordable homes to Wilson residents. Wilson Housing Authority Director of Public Relations Timothy Rogers shared a few tips:

- *Attention to detail when assuring quality construction caused minor delays, but it was worth it to ensure new tenants moved into homes that the Housing Authority was proud of.*
- *When replicating this project, acknowledge that low-income residents have historically been limited to the most flood-exposed areas. Affordable housing projects can provide residents with new, safe and high-quality homes while addressing flood risk in the community.*
- *Consider nature-based solutions during site design to help with flood management.*

Outcomes

- Project partners intentionally located the new housing units outside the floodplain but in the existing community, within the City of Wilson's redevelopment area. The location provides residents with access to urban amenities.
- The 32 new, two-bedroom units include 28 two-story townhomes and four additional one-story homes. Partners designed the one-story homes to be accessible for residents with disabilities.
- Project partners designed and constructed units with the intent of providing quality homes that residents would find comfortable.
- The Wilson Housing Authority deeded the land with the damaged homes to the City of Wilson. As of early 2024, the City of Wilson is working with NC Emergency Management to explore the use of FEMA hazard mitigation funds to demolish the damaged, uninhabitable homes and preserve the land as open space in perpetuity. Future plans include a greenway trail and flood retention ponds.

Project Contact

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Additional Resources

- NC Department of Public Safety Eatmon Townhomes Press Release
- NCORR's Community Development Program

Related Case Study

- See **Stormwater Management and Flooding:** Charlotte-Mecklenburg region runs local floodplain buyouts program.

Costs and Funding

Instead of using loans, project partners funded the $5.1 million project with direct allocations:

- $750,000 – Community Development Block Grant (CBDG) – Neighborhood Grant
- $2,712,905 – Public Housing Restoration Fund administered by the NC Office of Recovery and Resiliency (NCORR) and supported through state CDBG Disaster Recovery funding
- $1,637,095 – HUD Public Housing Operating Reserves and Capital Funds and Public Housing Demolition and Disposition Transitional Funding
- Insurance proceeds from the damaged homes
- A grant from the City of Wilson's Chamber of Commerce
- Funding from the Wilson Housing Authority and the NC Department of Commerce

TOPIC | 10

INFRASTRUCTURE AND CAPITAL INVESTMENT

Overview

Damage or interruptions to infrastructure and public facilities can seriously threaten public safety. For example, if a community or neighborhood has only one road or bridge providing access and it is washed out in a storm, emergency medical services cannot get to that location and residents cannot get in or out. And there is a great deal of aging infrastructure in the state that extreme heat, storms, and precipitation can render unfunctional. Communities can enhance their resilience by investing in flexible and redundant systems, prioritizing public investments in safe locations, and prohibiting public investments in vulnerable locations.

In this section, infrastructure refers to the networks and facilities that allow people to meet daily needs, like traveling between home and work, getting children to school or to the doctor, and accessing safe and healthy natural spaces. Infrastructure includes roadways, bridges, public transportation, parks, recreation facilities and more. Utilities, a type of infrastructure, are covered separately in Topic 6: **Energy and Utilities**.

Capital investment means using public money to build or buy the facilities and networks just described, as well as other public property like town halls, police stations, and the vehicles and equipment needed for a properly functioning public entity.

Role in Resilience

Protecting existing infrastructure and being thoughtful about how and where public money is invested limits interruptions to critical systems. To limit system interruptions, local leaders can assess the likelihood of current and future hazards and use that information to identify appropriate infrastructure solutions. For example, North Carolina's communities can require their budgets and capital improvement plans to account for existing and future hazards and vulnerabilities. This strategy can be expanded to require reassessment of hazards and vulnerabilities at set points over the useful life of the facility and determine if protective measures need to be adopted. Additionally, municipalities can build resilience incrementally when repairing, maintaining, or upgrading infrastructure and facilities. For example, a community could integrate nature-based stormwater strategies when updating sidewalks for Americans with Disabilities Act compliance. Regular coordination across departments and agencies is key to integrating resilience strategies into ongoing maintenance and upkeep of public infrastructure and facilities.

Strategies for increasing the resilience of infrastructure and **capital investments** should address how the various elements of infrastructure networks and public facilities are planned and constructed, when the investments will be made, and where these facilities will be built. This section outlines these strategies and provides resources and examples to help local leaders integrate climate vulnerability and hazards into infrastructure and capital investments.

*Electricity and other service utilities like drinking water, wastewater and internet are discussed in Topic 6: **Energy and Utilities**.

Potential Project Leads, Experts and Stakeholders

- Local government departments and commissions focused on public infrastructure, planning, finance, water and wastewater, emergency management, economic development, parks and recreation, and building inspections
- Design and construction professionals (e.g., architects, landscape architects, civil and water resource engineers) in the private, nonprofit, governmental and academic sectors
- State government agencies, such as NC DOT, NCEM, NCORR, NC DNCR and the NC DEQ Division of Water Infrastructure and Division of Energy, Mineral and Land Resources
- Federal government agencies, such as HUD and FEMA
- Builders and developers
- Local businesses
- Residents

For More Information

The Future Precipitation for Resilient Design project, a partnership between NC DOT and NCSU, aims to update Intensity Duration Frequency (IDF) curves to help transportation planners and engineers design roads, bridges and ditches for the most intense precipitation events expected in North Carolina in the future. This page describes the project and how those IDF curves are calculated. The anticipated project completion date is December 2024.

INFRASTRUCTURE AND CAPITAL INVENTMENT | 10 STRATEGIES

Assess climate vulnerabilities of existing and proposed capital improvement projects

Understanding how climate change will impact the built environment of a community is the first step to improving local resilience. Vulnerability assessments outline a process to achieve that understanding. Local governments can complete these assessments for an individual structure, a neighborhood, or an entire community.

Refer to Phase 2 of the *Playbook* for more information on performing climate vulnerability assessments.

FOR MORE INFORMATION

Guide to Community Climate Vulnerability Assessments (National Resources Defense Council) **This resource is a "primer for communities and community partners on how to complete a climate vulnerability assessment."**

EXAMPLES

Risk and Resilience Analysis Procedure (Colorado Department of Transportation)

Coastal Hazard Infrastructure Vulnerability Assessment (Duck, NC)

US 17/US 258 Compendium to the I-40/I-95 Flood Resilience Feasibility Study (NC DOT)

CASE STUDY

Fort Collins, CO, assesses regional resilience of buildings and physical infrastructure

Plan for and install protected, adaptive and redundant infrastructure

Capital improvement planning and implementation are a key element of a community's growth and development trajectory. The capital improvement planning process can assess the risk of current and future climate hazards on proposed investments. Resilient decision-making processes prohibit infrastructure and other public facilities in vulnerable locations or areas reserved for open space.

FOR MORE INFORMATION

Building Resilience: New Strategies for Strengthening Infrastructure Resilience and Maintenance (Organisation for Economic Cooperation and Development) This document, which includes examples and case studies, provides a framework for governments to "address short-term infrastructure challenges through maintenance spending while building resilient and sustainable infrastructure for the future."

Community Resilience Planning Guide (US Department of Commerce) This resource offers a "six-step process that helps communities think through and plan for their social and economic needs, their particular hazard risks, and recovery of the built environment."

Incorporating Resilience into Transportation Planning and Assessment (RAND Corporation) This publication details how to "increase the resilience of [a community's] entire transportation system." The guide, which also addresses how transportation planners can measure resilience and consider equity in their decision-making, is designed for state transportation departments and metropolitan planning organizations.

A Guide to Assessing Green Infrastructure Costs and Benefits for Flood Reduction (NOAA) This document provides "a process that communities can use to assess the costs and benefits of green infrastructure to reduce flooding."

Nature-Based Solutions for Coastal Highway Resilience: An Implementation Guide (US DOT) This document "is designed to help transportation practitioners understand how and where nature-based and hybrid solutions can be used to improve the resilience of coastal roads and bridges."

Continued on next page >

FOR MORE INFORMATION (CONTINUED)

EXAMPLES

Cool pavement program (Phoenix, AZ)

Marc Basnight Bridge (Bodie Island and Hatteras Island, NC)

NC 12 elevation project (Duck, NC)

SR 17 shaded fuel break project (San Jose, CA)

CASE STUDIES

Fayetteville, NC, installs stormwater greenscape downtown

Hillsborough, NC, partnership builds street-side bioswales to manage stormwater runnoff

*See **Infrastructure and Capital Investment** case study, below.

Include resilience criteria as part of capital improvement scoring processes for decision-making and investments

Most communities use a scoring or evaluation process to prioritize their projects. Adding resilience-based criteria to this process ensures selected projects will contribute to reducing community vulnerabilities and mitigating risk. Some communities choose to add weight to resilience criteria, prioritizing projects that strengthen and protect the community's public investments.

FOR MORE INFORMATION

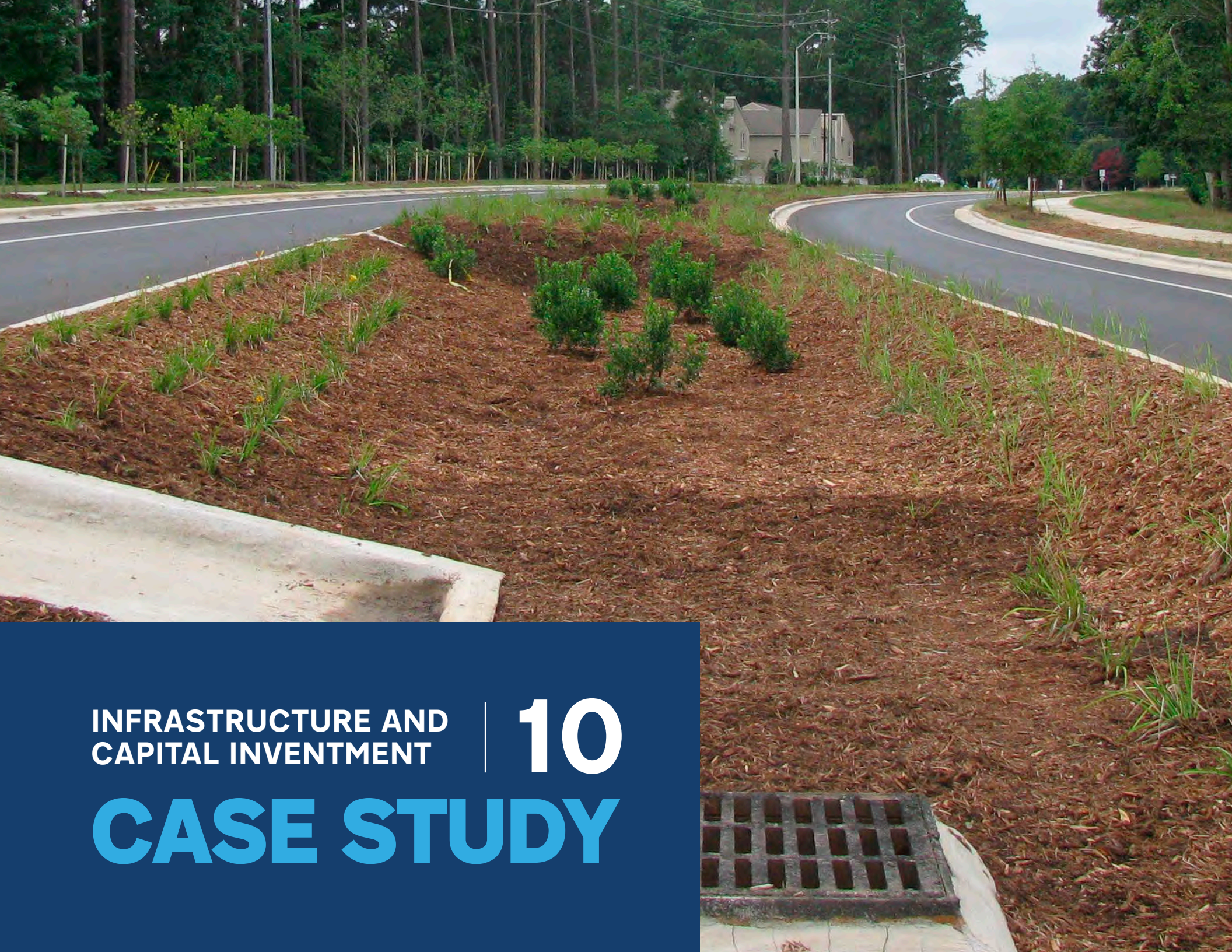
Integrating Resilience into Local Capital Improvement Programs (University of Maryland Environmental Finance Center) This publication "presents best practices for embedding climate risk assessments into capital improvement planning processes at the municipal and county level."

EXAMPLES

Capital Improvement Program Evaluation Criteria and Scoring Guide (Baltimore, MD)

Flood hazard mitigation project prioritization (Maricopa County, AZ)

Required resilience score metric for capital projects (New York, NY)



INFRASTRUCTURE AND CAPITAL INVENTMENT | 10

CASE STUDY

CASE STUDY

Raleigh includes nature-based stormwater solutions in its roadway widening project

Project Purpose

Sandy Forks Road in Raleigh, NC, was a busy, two-lane road showing signs of aging. The road was considered one of the worst in Raleigh due to congestion, roadway disrepair, lack of sidewalks and bike lanes, and environmental degradation from people walking alongside the road and destroying vegetation. Climate hazards like flooding blocked travel along this important route during emergencies, while runoff from the roadway surface affected water quality. The City of Raleigh began the Sandy Forks Road widening project to repair the aging roadway, increase the road's capacity, incorporate sidewalks and bike lanes, reduce water pollution, and improve the road's resilience to flooding and other climate hazards.

> ***Bioretention cells** are depressions in the landscape that capture stormwater and filter it through engineered layers of soil and vegetation, including native plants. As the stormwater passes through the bioretention cell and infiltrates into the earth, pollutants are naturally filtered out rather than running off directly into an engineered stormwater system or other waterbody. (The City of Raleigh, 2023)*

Key Players: City of Raleigh

Quick Facts

1. The project widened the roadway from two lanes to four or six lanes in some areas, resulting in substantial tree removal.
2. The Sandy Forks Road widening is the first, and, as of December 2023, only, road project in Raleigh that applied for Greenroads Certification. The city used the certification requirements as a way to gain knowledge and skills on applying nature-based solutions, including **bioretention cells** and native-planted medians, which can help reduce stormwater run-off from the street and thus reduce erosion, water pollution and flooding. The completed project was awarded silver certification.

Making It Happen

- The City of Raleigh held public meetings to discuss the repair of Sandy Forks Road in 2012 and 2013.
- In 2014, the city held project design meetings. The city selected a 3.4-mile stretch of road between Six Forks Road and Falls of Neuse Road to implement the project.
- The city awarded a project contract in 2015. The initial construction phase finished in fall 2016. The project included a vegetated median that spanned a maximum width of 16.5 feet.
- Final touches on the project wrapped up in 2017, including the installation of public art and educational signage related to water treatment and environmental resilience.
- In 2018, Sandy Forks Road was awarded a Silver Greenroads Certification. A certification signifies that the project successfully incorporated road sustainability features.

Spotlight on Equity

The community where this project was constructed was not considered disadvantaged or socially vulnerable. Instead, this project served as a pilot project for the City of Raleigh in incorporating environmental sustainability into road design. The inclusion of vegetated areas and bioretention cells helps protect residents from flooding. This vegetation, along with newly planted trees, improves water quality and helps cool the area. The city is now considering these types of solutions for other projects in areas with high percentages of disadvantaged and socially vulnerable residents.

Advice from the project manager

City Communications Analyst Tiffanie Mazanek noted that this project would have been an excellent opportunity to consider grant options. "For more and more of our projects, we are finding federal and state funding that can offset some of the costs. There are a lot more opportunities for grant funding when we include sustainably or environmental actions."

She also mentioned that the extra paperwork that goes into the Greenroads Certification can be a challenge for small communities. But overall, it helped the City of Raleigh think about alternatives and find environmentally friendly solutions that they have begun implementing in other road projects.

Mazanek also remarked that bike transportation was a large talking point during the project design phase. The community has been vocal in asking for bike lanes that are separated from the roadway with delineators. While communities love the new lanes, they would prefer a clear separation between lanes and vehicles to make them even safer.

Outcomes

- Sandy Forks Road became a divided two-lane road with a median and extra turning lanes in some places.
- The roadway was repaired to aid traffic flow and increase its lifespan. Road lifespan is generally about 40 years; however, the City of Raleigh added extra pavement that should add an extra ten years.
- The city included nature-based stormwater solutions in the project. The median vegetation and three bioretention cells support flood prevention and water quality improvement. In addition, the city used a more eco-friendly asphalt mixture to minimize the road's impacts to water quality.

Continued on next page

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Additional Resources

- Raleigh Receives Greenroads Silver Certification for Sandy Forks Road Video
- Sandy Forks Road Improvements Corridor Public Meeting Presentation, December 2013

Related Case Studies

- See **Ecosystem Protection, Restoration, and Enhancement:** New Bern project grows natural stormwater resilience while improving native ecosystem.
- See **Energy and Utilities:** Electric Cooperatives install microgrid on Ocracoke Island.
- See **Funding and Technical Assistance Mechanisms:** Asheville uses green bonds to improve drinking water infrastructure.
- See **Stormwater Management and Flooding:** Charlotte-Mecklenburg region runs local floodplain buyouts program.

Outcomes *(cont'd)*

- The project included removing invasive species and planting native species, which has helped support a more natural ecosystem. Educational signage about the sustainable initiatives of the Sandy Forks Road project is helping to keep residents informed.
- Sandy Forks Road was chosen in part for its ability to test the value of bioretention cells. The city placed one of these cells along the road's median. Bioretention cells require infrastructure underneath the roadway. The bioretention cells along Sandy Forks Road were constructed as a pilot project. Raleigh now has many roads with bioretention cells running along the roadside.
- Other improvements in the project included the construction of new sidewalks and bike lanes and the use of energy-saving light fixtures.
- Recycled and reused materials were important aspects of the project. The city recycled trees removed for the project into lumber and stumps into wood chips. The city also crushed asphalt from the previous roadway and used it in the new surface.
- This project featured one of Raleigh's first public art installations as part of a road project. The city now includes art in most of its development initiatives.
- The project earned the highest score globally awarded at the time to achieve its Greenroads Certification. A silver certification was still the highest award given by the global transportation nonprofit, Sustainable Transport Council, as of December 2023.

Costs and Funding

- The total cost of this project was approximately $9.9 million.
- The City of Raleigh used Capital Improvement Plan funds and other city-initiated funding.

References

The City of Raleigh. (2023, November 3). *Roadway Bioretention Areas.* Retrieved from https://raleighnc.gov/stormwater/services/green-stormwater-infrastructure/roadway-bioretention-areas

TOPIC 11

LAND USE AND DEVELOPMENT

Overview

Land use and development strategies help communities build resilience by directing growth away from vulnerable and toward safe locations. Along the coast, for example, rapidly changing coastal conditions mean past trends are not enough to predict future changes. Local governments can use land use and development methods that support construction and design that safeguards future inhabitants, ensures that development does not increase risk to nearby properties, and protects natural lands that buffer communities from sea level rise, flood and other risks.

Land use describes the ways humans impact land, including building a house, roads, office park or factory; farming; forestry; setting aside land for a park or open space; and more. Common categories of land use include residential, agricultural and commercial. When more than one land use is combined it's called "mixed use." Communities assign uses to organize their growth and future development, with the goal of ensuring that future development responds to community needs and values.

Role in Resilience

Managing land use and development is one of the most effective ways communities can build resilience. Communities can adopt policies and laws that limit or prohibit new housing or other development in dangerous locations like floodplains. Programs and ordinances can direct or incentivize growth to more suitable locations that are less vulnerable. Communities can also adopt planning codes that require lower impact design features and reduce a project's potential negative effects on the surrounding community. Some examples of planning code requirements would be to require minimizing a project's stormwater run-off to reduce flooding and build resilience or to require a buffer zone around a stream or river. Zoning laws might also require additional construction elements. For example, in vulnerable coastal areas, local zoning ordinances might require elevating structures. These strategies work to protect people, buildings, and the natural environment from unnecessary risk.

Implementing land use and development strategies promoting "smart growth" can also build resilience. Smart growth strategies promote more sustainable development by mixing land uses, providing multimodal transportation options, requiring higher density development in already-developed areas, reducing sprawl, and protecting undeveloped open space (EPA, 2023). These strategies can reduce off-site impacts of a project. This section provides more information on land use and development strategies local governments can use to manage flooding and other risks.

Potential Project Leads, Experts and Stakeholders

- Local government departments and commissions focused on planning, sustainability, economic development, public works, and parks and recreation
- North Carolina's councils of governments (COGs), which host municipal and regional planning organizations

Development regulations like zoning codes control how properties can be used (meaning what activities are allowed), what can be built, and where structures may be located on a property. Development regulations can include height and size of buildings; parking requirements; minimum or maximum lot sizes; open space requirements; limits on impervious surface; and more. Zoning also controls the density of development, which is the number of houses or apartments that are allowed in an area, often measured in acres.

- Land use planning professionals (e.g., landscape architects, water resource and civil engineers, transportation planners, bike and pedestrian planners, environmental scientists) in the private, nonprofit, governmental and academic sectors, including the North Carolina chapter of the American Planning Association and the North Carolina Association of Floodplain Managers
- Land conservancies and trusts, such as the Tar River Land Conservancy, Carolina Mountain Land Conservancy, Triangle Land Conservancy and North Carolina Coastal Land Trust
- Environmental nonprofits, such as The Nature Conservancy, Conservation Trust for North Carolina, Carolina Wetlands Association, the North Carolina Coastal Federation and North Carolina Sea Grant
- Nonprofits and other community organizations (e.g., neighborhood associations, advocacy groups, community foundations, tribal governments and faith communities), especially those that can help convene individuals from often overlooked communities (e.g., Association of Mexicans in North Carolina (AMEXCAN), Hispanic Federation, NC Black Alliance, NC Environmental Justice Network and NC Commission on Indian Affairs)

  More North Carolina community-based organizations:
  - NC Conservation Network Affiliates
  - NC Environmental Justice Network member organizations
  - NC Justice Center
  - NC NAACP
  - NC Rural Center
  - NC Tribal Communities
- Higher education institutions, such as the NCSU Coastal Dynamics Design Lab and the Duke University Ecosystem Services Program
- State government agencies, such as the NC DEQ Division of Coastal Management, Division of Mitigation Services, Division of Water Infrastructure, and Division of Water Resources; NC DNCR; Wildlife Resources Commission; and NCORR
- Federal government agencies, such as FEMA
- Local utilities
- Builders and developers
- Local businesses
- Residents

For More Information

Climate Resilient Land Use Strategies, a webpage hosted by the Greater Boston Metropolitan Area Planning Council, highlights "regulatory language and policy examples" that communities can replicate to address climate resilience.

Green Growth Toolbox, developed by the North Carolina Wildlife Resources Commission, provides tools to help the state's local governments plan for growth in a way that conserves natural habitats and other assets. The guidance provides information to support the strategies listed in the table below.

In the Guide to Expanding Mitigation: Making the Connection to Codes and Standards, FEMA explains how communities can "benefit from diverse codes and standards, communicate the hidden costs of failing to act and work with departments to adopt and enforce codes that increase community resilience." The resource includes case studies and is targeted toward emergency management officials.

The Planning and Land Use page of the US Climate Resilience Toolkit provides a primer on how land use planning and zoning can be used to manage and prevent climate impacts. The page also includes links to tools and case studies.

In Planning for Community Resilience, Dr. Philip Berke explains how "effective land use planning can reduce vulnerabilities and strengthen community resilience." This 28-minute video is hosted by FEMA.

The Sustainable Development Code "offers best practices for community development." The website contains a database of development code recommendations, case studies, policy briefs, and best practices to "remove obstacles," "create incentives," and "fill regulatory gaps."

LAND USE AND DEVELOPMENT | 11

STRATEGIES

Adopt zoning codes to support resilience

Zoning codes or ordinances can build resilience by directing development to safer locations and regulating new and modified structures to reduce vulnerabilities. Zoning codes can even prohibit certain activities in hazardous locations. Variations of zoning include base zoning districts, special coastal or hazard zones, and overlay zones.

FOR MORE INFORMATION

Model Flood Damage Prevention Ordinance (NCEM) **NCEM designed this model ordinance to help local governments comply with the minimum criteria of the National Flood Insurance Program.** See the instructions for using the model ordinance.

EXAMPLES

Building restrictions for new development in the floodplain (Raleigh, NC)

Coastal resilience overlay district, Section 3.9.18 (Norfolk, VA)

Floodway fringe overlay district (Cedar Falls, IA)

Waterfront mixed use overlay district, Article XVIII (Saugus, MA)

Oceanfront setback lines (NC)

Watershed Protection Districts Overlay (Section 5.5, Durham County, NC)

Wildfire hazard zones (Portland, OR)

CASE STUDY

*See the case study from the **Planning and Decision-Making Frameworks** section.

Adopt or update development regulations to support resilience

Development regulations can build resilience by planning for growth and development away from hazards, incentivizing development in safe locations, and prohibiting development in dangerous or vulnerable locations. One example is increasing oceanfront development setback requirements, either at the state level by working with the NC Coastal Resources Commission or at the local level through zoning codes and ordinances that go beyond the state standard. Another example is reviewing existing municipal codes to ensure that no prior rule was based on historic data and fails to account for changing future conditions.

*See the call out boxes in this topic/section for information about acceptable building code ordinances in North Carolina.

FOR MORE INFORMATION

Coastal Flood Damage Prevention Model Ordinance (NCEM)
This model ordinance was written for North Carolina communities.

Non-Coastal Flood Damage Prevention Model Ordinance (NCEM)
This model ordinance was written for North Carolina communities.

EXAMPLES

Expedited permit review (Santa Rosa, CA)

Incentivize development in smart/safe locations (Atlanta Regional Commission, Livable Cities Initiative)

Resilience or climate change element in Section 5 of Comprehensive Plan (Raleigh, NC)

Rural buffer and urban growth boundary in Comprehensive Plan (Orange County, NC)

Unified Development Ordinance > Subdivision regulations > Ocean frontage lots (Nags Head, NC)

Unified development ordinance that prevents new subdivisions in the floodplain (Section 12.2.4, Tarboro, NC)

CASE STUDY

*See the **Housing** and **Planning and Decision-Making Frameworks** case studies.

Adopt resilient building codes and regulations

In addition to where buildings are located, construction materials and practices are an important component of building resilience. Building codes provide a baseline standard for quality and safety, and additional building code requirements can build resilience to specific threats.

Helpful strategies include elevating homes in flood hazard areas, mitigating extreme temperatures and urban heat islands by requiring building materials that absorb less heat and "Firewise" strategies like promoting the use of non-combustible building materials.

In North Carolina, unless state law specifically prohibits the intent of the ordinance, local governments can adopt ordinances that are more stringent than the North Carolina Building Code. Local governments may need to go through the Building Code Council for a review of the ordinance and should speak with their legal counsel when considering this option. All fire code ordinances must be reviewed by the Building Code Council. See NC General Statutes § 143-138 for more information.

FOR MORE INFORMATION

2021 International Building Code: A Compilation of Wind Resistant Provisions (FEMA) **This document contains "the wind resistant provisions of the 2021 International Building Code."**

Building Community Resilience Through Modern Model Building Codes (International Code Council, Alliance for National and Community Resilience) **This publication details the importance of building codes in the defense against hurricanes, flooding and other natural disasters. The document also contains case studies and a literature review.**

Green Communities Certification **(Enterprise Community Partners) This certification program for green affordable housing techniques offers guides, reports, case studies and recorded trainings on green housing practices.**

CodeMaster for Flood Resistant Design (FEMA) **This guide provides "preliminary considerations and design process, key flood terminology, a 12-step process to incorporate flood resistance in the design of a building, an example showing the 12-step process being executed, and information on additional FEMA mitigation resources related to flood-resistant design." (Purchase is required to access this resource.)**

Continued on next page >

FOR MORE INFORMATION (CONTINUED)

Comparing National Flood Insurance Program Requirements to 2021 International Codes (FEMA) This "checklist guides floodplain managers, building officials, and designers as they compare the requirements."

FORTIFIED resilient construction standard (Insurance Institute for Business and Home Safety) Homeowners and developers can choose to use this "voluntary construction and re-roofing program designed to strengthen homes and commercial buildings against specific types of severe weather such as high winds, hail, hurricanes and even tornados."

International Green Construction Code (International Code Council) This code details construction standards for people-friendly buildings that conserve natural resources and reduce pollution and emissions. The code is drafted to align with the LEED standard.

International Wildland Urban Interface Code (International Code Council) This page provides a model supplemental code that "establishes a set of minimum standards to reduce the loss of property from wildfire. The purpose of these standards is to prevent wildfire spreading from vegetation to a building." Additional North Carolina resources are available via the North Carolina Forest Service.

No Adverse Impact Legal Guide for Flood Risk Management (Association of State Floodplain Managers) This guidebook "provides legal resources to inform the decisions of community representatives and municipal attorneys who design, implement, and defend NAI programs. It includes detailed resources for legal professionals and legal essentials for floodplain managers and community officials."

EXAMPLES

Coastal Flood Resilience Design Guidelines (Boston, MA)

CASE STUDIES

*See the case studies from the **Land Use and Development** and **Planning and Decision-Making Frameworks** sections.

> Some strategies implemented in other states may be outside the scope of authority for North Carolina's local governments. Please consult with your local legal counsel if you have questions about a project you are envisioning.

LAND USE AND DEVELOPMENT | 11

CASE STUDY

CASE STUDY

Brevard manages flood risk with a "No Adverse Impact" development standard

Project Purpose

In 2004, hurricanes Frances and Ivan dropped 33 inches of rain in the Brevard region. The French Broad River flooded, causing immense devastation in the area. Following this disaster, Brevard's City Council decided to update the Flood Damage Prevention Ordinance. The updates aimed to ensure that future development would not worsen the community's flood vulnerability.

What is No Adverse Impact?

No Adverse Impact (NAI) floodplain management requires developers review their proposals for adverse impacts to other property or the natural environment. Example adverse impacts include increased erosion or changes in floodwater speed or volume. Under NAI, developments must include measures to reduce or eliminate those negative effects.

Key Players: Brevard Planning Department, Brevard Public Works, Brevard City Council

Quick Facts

1. Directly east of Brevard is the French Broad River, which is fed by multiple local creeks that run through parts of the city.
2. In 2009, the City Council updated the Flood Damage Prevention Ordinance to include a **No Adverse Impact** (NAI) determination requirement. NAI is a longstanding floodplain management strategy that "ensures the action of any community or property owner, public or private, does not adversely impact the property and rights of others" (ASFPM, 2003). To get approval, builders must demonstrate that their projects will not increase the flood risk faced by downstream property owners and communities (The Pew Charitable Trusts, 2019; City of Brevard, 2023).
3. The ordinance reduces flood risk downstream by limiting new impervious surfaces and structures upstream and within Brevard.
4. The city places the burden of proof on development applicants, so NAI certification requirements have a low cost for the city.

Making It Happen

- In 2009, the City of Brevard updated its Flood Damage Prevention Ordinance to protect residents and educate them about specific risks to their properties. The adopted ordinance also aims to minimize the need for future public spending on flood control and maintain a consistent tax base. The new ordinance includes a No Adverse Impact determination requirement, which mandates that proposed developments not increase danger to residents or other properties in the floodplain. The standards of the NAI regulations are beyond federal minimums.
- The ordinance defines development as "any man-made change to improved or unimproved real estate, including, but not limited to, buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations, or storage of equipment or materials" (City of Brevard, 2023).
- The ordinance lists alterations to the floodplain that must not occur. These include no creation of increased sediments or debris from construction; no increase in the base flood elevation; and no reduction in the size of the floodway. A floodway is the river or stream itself and any land that regularly floods during a 100- or 500-year flood event.
- The ordinance requires that developers address comments from any nearby property owners or tenants who may face potential flooding from the proposed development.
- Developers must provide documentation from professional engineers that determine NAI. Only then can the developer receive project approval.
- The city has continued to update the ordinance since its adoption.

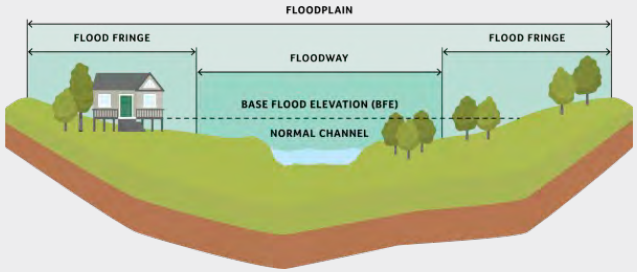
Spotlight on Equity

The policy implemented in Brevard protects those who already live in a floodplain. Land prices are often lower in the floodplain because of flood risk, and lower-income households are often concentrated in these more vulnerable lands. Therefore, NAI requirements may protect socially vulnerable populations that already reside in a community. This policy could help those currently living in floodplains by minimizing increased stormwater impacts.

How is a No Adverse Impact policy different from a No-Rise requirement?

In most cases, communities must prohibit development in the floodway that would increase flood levels during a base flood. In other words, a project must have a "no-rise" or "zero-rise" certification from a qualified professional engineer (FEMA, 2019).

Under a No Adverse Impact policy, developers cannot change the water-carrying capacity of the entire floodplain. When a developer proposes a project that would decrease the amount of water the floodplain can handle, the developer must add a measure to the project that would manage the additional water on-site.



Advice from the project manager

Adopting an NAI ordinance can enhance safety for future development without high ongoing administrative costs. In addition, new regulations should always evaluate the potential to disproportionately affect minority or disadvantaged community members.

Outcomes

- For the community, ongoing costs of limiting and mitigating unsafe development in the floodplain has positive safety and economic effects long-term because it protects life and property from new or increased flooding impacts.
- The ordinance also helps maintain a natural floodplain with minimal disturbance, which benefits waterways, fish habitat and other native ecosystems.
- The ordinance reduced the costs of flood insurance for residents, thanks to incentives in FEMA's National Flood Insurance Program (NFIP). The ordinance made the city eligible for a voluntary rating under the NFIP, "which insures property owners and renters at risk of flooding. The Community Rating System (CRS) discounts insurance premiums for communities that take measures to reduce flooding. To participate, a community's flood prevention ordinance must meet certain standards for mitigation, flood plain management and outreach activities, which Brevard's certification requirement exceeds" (The Pew Charitable Trusts, 2019).
- After more than 10 years since its adoption, city staff believe the regulation has been effective in protecting life and property and returning parts of the city to more sustainable environmental states. For example, the city had relatively few substantially damaged structures from Tropical Storm Fred in 2021. In addition, all structures elevated because of the flood ordinance survived without incident.

Project Contact

City of Brevard Planning and Zoning Department

Additional Resources

- City of Brevard webpage for the ordinance
- No Adverse Impact Floodplain Management resource page from the Association of State Floodplain Managers
- No Adverse Impact Legal Guide for Flood Risk Management
- Pew Charitable Trusts article on the floodplain ordinance

Related Case Studies

- See **Ecosystem Protection and Restoration**: New Bern project grows natural stormwater resilience while improving native ecosystems.
- See **Equity and Justice**: Princeville, public universities and partners facilitate resilience planning that honors town history.
- See **Housing**: Wilson Housing Authority constructs new affordable housing outside the floodplain.
- See **Infrastructure and Capital Investments**: Raleigh includes nature-based stormwater solutions in its roadway widening project.
- See **Planning and Decision-Making Frameworks**: Norfolk, VA, updates zoning regulations to address flooding and sea level rise.

Costs and Funding

- Costs, covered by the City of Brevard's budget, included staff time to draft the ordinance and carry it through adoption.
- Because the burden of proof of NAI lies upon the property developer and not the city, the cost of maintaining the ordinance is low. Brevard estimates costs at less than $5,000 annually.

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City of Brevard. (2023). Chapter 34. *Flood Damage Prevention.* Retrieved from Association of State Floodplain Managers: https://www.floods.org/resource-center/nai-no-adverse-impact-floodplain-management/

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The Pew Charitable Trusts. (2019, November). *North Carolina City Adopts Stringent Standard.* Retrieved from: https://www.pewtrusts.org/-/media/assets/2019/11/north_carolina_brevard_brief_final.pdf

TOPIC | 12

PLANNING AND DECISION-MAKING FRAMEWORKS

Overview

Planning and decision-making frameworks are the tools communities use to develop solutions based on identified needs, opportunities and challenges. To be more resilient, planning and decision-making frameworks must be forward-looking, proactive, flexible and adaptive. In addition, incorporating future projections and community input will contribute to the efforts' successes. By following the guidance in this section and the *Playbook*, plans and policies can be created with the flexibility needed to respond to changing conditions and circumstances.

Role in Resilience

Planning and decision-making frameworks describe the way communities approach preparing for the future. Historically, planning and decision-making processes have relied on the assumption that past trends will be accurate predictors of the future. Local leaders often adopt goals, objectives and policies based on this assumption. Now, the unpredictable and increasingly significant impacts of climate change mean that past trends no longer define future conditions, invalidating this formerly tried-and-true approach. Local leaders must integrate climate projections into planning and decision-making processes to understand how to prepare their community for the coming decades.

Communities can build resilience by recognizing uncertainty and improving coordination to react to anticipated and unanticipated challenges.

For example, local leaders and residents can develop flexible plans that reinforce one another. If multiple plans (e.g., comprehensive plan, economic development plan and/or transportation plan), address climate change within their existing area of focus, the community will become more resilient as the plans are implemented. Plans can also build in checkpoints to enable goal and priority changes as the impacts of climate change become better understood. This flexibility increases resilience.

By including uncertainty as part of the process, these approaches consider a range of potential outcomes, rather than closing out options in favor of a single course of action. When multiple plans come together to guide actions, the potential for haphazard or stalled implementation is replaced with self- and mutually supporting solutions. This section lists several strategies local governments and partners can use to facilitate forward-looking, proactive, flexible and adaptive planning and decision-making efforts.

Potential Project Leads, Experts and Stakeholders

- Local government departments and commissions focused on long-range and short-term planning, sustainability, economic development and public infrastructure
- North Carolina's councils of governments (COGs), which host municipal and regional planning organizations
- North Carolina State Climate Office
- State government agencies, such as NCORR and the NC DEQ Albemarle-Pamlico National Estuary Partnership, Division of Mitigation Services, Division of Water Resources and Division of Coastal Management
- Federal government agencies, such as FEMA
- Higher education institutions
- Environmental nonprofits, such as the North Carolina Coastal Federation, North Carolina Sea Grant, The Nature Conservancy and Conservation Trust for North Carolina
- Nonprofits and other community organizations (e.g., neighborhood associations, advocacy groups, community foundations, tribal governments and faith communities), especially those that can help convene individuals from often overlooked communities (e.g., Association of Mexicans in North Carolina (AMEXCAN), Hispanic Federation, NC Black Alliance, NC Environmental Justice Network and NC Commission on Indian Affairs)

  More North Carolina community-based organizations:
  - NC Conservation Network Affiliates
  - NC Environmental Justice Network member organizations
  - NC Justice Center
  - NC NAACP
  - NC Rural Center
  - NC Tribal Communities
- Residents

For More Information

The *Idea Book's* companion, the *North Carolina Resilient Communities Planning Guide – Volume 1: Playbook*, provides step-by-step guidance on the process of building a resilience plan and implementing it.

For a landscape design perspective and focus on rural communities, the North Carolina State University's Coastal Dynamics Design Lab offers the Rural Resilience Framework: Disaster Adaptation Strategies for Building Rural Resilience. The second half of this report provides a time-tested framework for design and planning professionals to help rural communities with disaster recovery and resilience.

From federal partners, the Practitioner's Guidance for Implementing the Steps to Resilience provides additional detail on procedures to plan and implement resilience using the US Climate Resilience Toolkit.

PLANNING AND DECISION-MAKING FRAMEWORKS

12 STRATEGIES

Use historical data and projections to inform decisions and plans

In addition to looking at historical data, local governments can use science-based forecasting data and projections to guide planning and decision-making. Future-looking data can include projected population changes, projected changes in the number of high temperature days and nights, projected changes in extreme precipitation days and more.

Taking climate change into account will increase your community's chances at being prepared for increases in heavy rain, landslides, wildfires, daytime and nighttime temperatures, sea level rise and the many cascading effects.

FOR MORE INFORMATION

Defining Extreme Heat as a Hazard: A Review of Current State Hazard Mitigation Plans (Duke University) Among other topics, this report includes recommendations for how to incorporate climate change projections into heat-focused health plans.

Future Precipitation for Resilient Design (NC DOT, NCSU) This project will update Intensity Duration Frequency (IDF) curves to help transportation planners and engineers design roads, bridges, and ditches for the most intense precipitation events expected in North Carolina in the future. The anticipated project completion date is December 2024.

North Carolina Climate Science Report, released by the North Carolina Institute for Climate Studies' Climate Science Advisory Panel, provides observed and projected changes in statewide averages for North Carolina's temperature and precipitation averages and extremes, droughts, hurricanes, winter storms and other severe weather events. The document also includes regional changes in temperature, precipitation and storms for the Coastal Plain, Piedmont and Western Mountains regions; past and future sea level rise and coastal water level; and information on compound events such as inland flooding, wildfire, urban heat islands and more. Local planners can use this document to inform planning efforts.

Continued on next page >

FOR MORE INFORMATION (CONTINUED)

Sea Level Rise Viewer (NOAA) Decision-makers can "use this web mapping tool to visualize community-level impacts from coastal flooding or sea level rise (up to 10 feet above average high tides)." The resource includes photo simulations and "data related to water depth, connectivity, flood frequency, socio-economic vulnerability, wetland loss, and migration and mapping confidence."

EXAMPLES

Floodplain Management Plan (Morehead City, NC)

Planning for Rising Waters: Final Report of the City of Kingston Tidal Waterfront Flooding Task Force (Kingston, NY)

Use scenario planning and metrics tracking to prepare for various outcomes

Incorporating future-looking data into decision-making may require scenario planning, a way of acknowledging that a community needs to plan for alternative paths to be prepared for various outcomes. Furthermore, establishing and tracking metrics and identifying benchmarks for achieving defined goals can help you adjust policy and planning directions once the goals are met or if they are delayed or cannot be met after all.

FOR MORE INFORMATION

Climate Adaptation Through a "Pathways" Approach (ICF) **This webpage provides a detailed overview of using flexible adaptation pathways in planning for climate resilience.**

Climate Change Scenario Planning Showcase (US National Park Service) **This resource contains a "framework for working with uncertainty and preparing for a wide range of plausible future conditions." The page links to additional guidance documents.**

Next Generation Scenario Planning: A Transportation Practitioner's Guide (FHA) **This guide outlines a six-phase basic scenario planning process and "profiles recent examples of scenario planning in action."**

EXAMPLES

Flexible Adaptation Pathway for the Los Angeles Metro (LA Metro)

East Coast Climate Change Scenario Planning (Mid-Atlantic Fishery Management Council)

Develop processes to respond to needs as they arise

Building out a government that can quickly respond to emerging needs and adapt to new information enables communities to adapt to changing climate conditions and to understandings of impacts on residents. Features of a nimble institution include decentralized decision-making, increased participation from residents, and regular periods of procedural review to understand where and how existing policies are failing. For example, governments that intentionally solicit community feedback on emerging climate-related needs or problems are much better at reacting to emerging or foreseeable problems.

FOR MORE INFORMATION

EXAMPLES

Adaptive Governance Initiative (Louisiana)

Climate Change Element (Broward County, FL)
See Policy CC3.2.

CASE STUDY

South Bend, IN, uses Smart Sewer Technology to Monitor and Manage Increased Water Levels

Develop mutually supporting plans

This strategy speaks to the importance of adopting plans, codes and policies that work well together and build on each other. Alignment and integration of plans and policies builds resilience by reducing conflicting policies and goals and identifying opportunities to build efficiencies. For example, communities can identify opportunities to integrate green infrastructure into roadway upgrades or maintenance projects.

FOR MORE INFORMATION

Climate Action Planning Vertical Integration Guide (C40)
This guide explains the principles of enabling climate action by aligning local, state, and national plans (i.e., "vertical integration"). The document provides examples from around the world as well as tools and resources to help city governments.

Integrate Climate Adaptation: A toolkit for urban planners and adaptation practitioners (C40) **This toolkit "is designed to help planners build a case for including adaptation measures when developing projects and engaging decision-makers."**

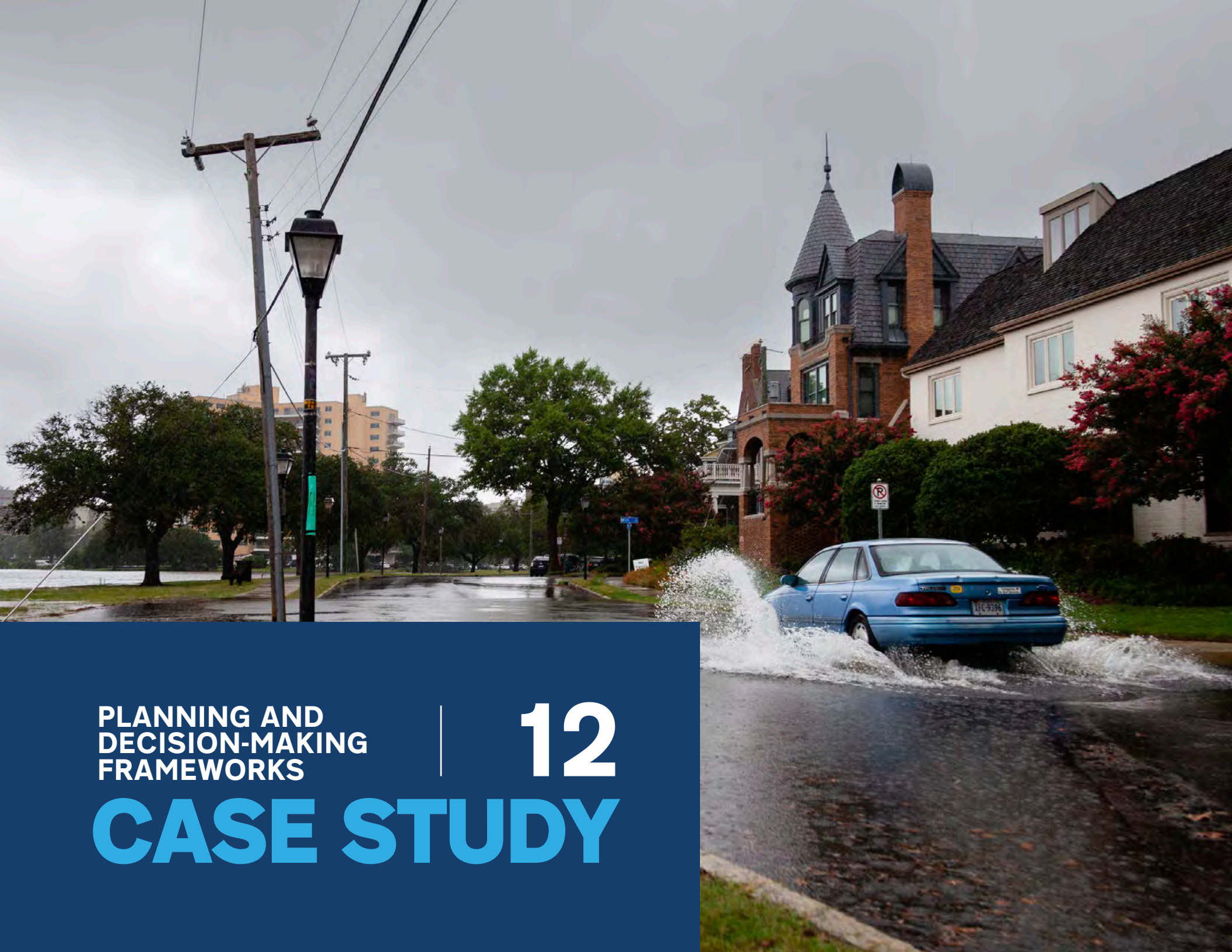
Plan Integration: Linking Local Planning Efforts (FEMA)
This tool is "developed to help your community analyze local plans to document existing integration and further integrate hazard mitigation principles into local planning mechanisms and vice versa."

Plan Integration for Resilience Scorecard V2.0 (Texas A&M University) **This guidebook helps communities "understand and discuss inconsistencies across their networks of plans by spatially evaluating their plan documents and existing vulnerabilities."**

EXAMPLE
Coastal Hazard Resilience Plan Alignment in California (multiple partners)

CASE STUDY

*See **Planning and Decision-Making Frameworks** case study, below.



PLANNING AND DECISION-MAKING FRAMEWORKS

12 CASE STUDY

CASE STUDY

Norfolk, VA, updates zoning regulations to address flooding and sea level rise

Project Purpose

Between 1930 and 2010, relative sea level in Norfolk rose more than one foot. Half of that amount was from sinking land. This change in sea level combined with more frequent heavy precipitation causes recurrent coastal flooding. In response, the City of Norfolk updated its zoning ordinance to manage flooding and promote safer development (The Pew Charitable Trusts, 2019).

What are Dutch Dialogues?

Dutch Dialogues are a partnership between the Netherlands and the United States to offer workshops on addressing water issues in flood-prone coastal cities. The workshops combine Dutch approaches to water management with American expertise on water problems in US cities. Water problems addressed through the Norfolk process included flooding, poor water quality, sea level rise and sinking land (The City of Norfolk, n.d.). Many flood-prone coastal places in the US have used the Dutch Dialogues approach.

Key Players: Norfolk Planning Department, Rockefeller Foundation, Old Dominion University, Norfolk City Council

Quick Facts

1. The City of Norfolk used the **"Dutch Dialogues"** approach to educate and engage residents in envisioning what the region could be if it adapted to flooding.
2. The Dutch Dialogues prompted the community to include flood management goals in its short-range and long-range plans. Residents called for an overhaul of the zoning ordinances to try to avoid impacts from more frequent heavy rainfall events, sea level rise, and sinking land (The City of Norfolk, n.d.).
3. The newly adopted zoning ordinance:
   - Requires landscaping to be exclusively salt-tolerant and native species (The Pew Charitable Trusts, 2019);
   - Implements a Coastal Resilience Overlay Zone and an Upland Resilience Overlay, the latter of which encourages new development to locate on higher ground while supporting preservation of low-ground areas (The Pew Charitable Trusts, 2019;
   - Uses a scoring system for approving projects that evaluates the project's vulnerability to flood and impact on nearby flooding; and
   - Requires development in the 1% annual chance flood zone (referred to as the 100-year flood zone) to be elevated three feet above the base flood elevation.

Making It Happen

- The Virginia Institute of Marine Sciences published a report in 2013 on state adaptation to recurring coastal flooding. After reading the report, the City of Norfolk began integrating flood management goals in its general plan, plaNorfolk2030. The plan called for a zoning ordinance overhaul to address flooding and sea level rise.
- To build public support for a new zoning ordinance, the city hosted Dutch Dialogues workshops. The process educated residents, the real estate community and developers on floodplain dangers and management opportunities. The Dialogues, which happened in 2015, also helped participants envision a flood resilient future (The City of Norfolk, n.d.).
- City staff involved developers and real estate agents in drafting the new zoning regulations. As a result, these community members understood the changes and considered them worthwhile.
- The Rockefeller Foundation provided additional technical assistance for community outreach.
- Old Dominion University, among others, helped with ordinance development by analyzing floodplain data.
- In 2016, Norfolk published Norfolk Vision 2100, a long-term strategy to address flooding challenges.
- In 2018, Norfolk adopted new zoning regulations. These new regulations implement part of Norfolk Vision 2100. They attempt to avoid impacts from more frequent heavy rainfall events, sea level rise and sinking land. The planning department advertised the new regulations by conducting outreach through postcards, virtual meetings and open houses.

More information on the new zoning regulations

The zoning ordinance creates an Upland Resilience Overlay Zone. The Upland Resilience Overlay encourages development on higher ground and preserving undeveloped, flood-prone properties. To do so, the overlay awards resilience quotient points to projects on high ground and to those that use a conservation easement or other legal instrument to preserve at-risk properties.

Resilience quotient points

The zoning scoring system requires new development and redevelopment applications to meet a minimum point threshold, or quotient, for approval. The system awards points for meeting standards for flood and energy resilience, as well as stormwater management. The ordinance includes pre-drafted resilient standards a developer can use to avoid going through the typical site plan review process. Developers may choose not to use the scoring system and instead meet a greater stormwater standard to obtain site plan approval (The Pew Charitable Trusts, 2019).

The new zoning ordinance also creates a Coastal Resilience Overlay Zone. Proposed developments in the Coastal Resilience Overlay Zone must be elevated three feet above the mapped base flood level (called a “freeboard” requirement). This requirement is a two-foot increase over the previous freeboard regulation.

Advice from the project manager

Make adhering to new standards easy. Dedicate resources to educating residents on the need for the standards and how they protect the community.

Outcomes

- The resilience quotient offers a flexible, points-based system. The system gives points to new development for techniques of their choosing, so long as they reduce flood risks, conserve energy and manage stormwater.
- About half of new developments are using the new scoring system, while the other half are still adhering to older, more standard approaches in the ordinance.

Spotlight on Equity

Regulations have the power to improve communities for generations to come. However, they must be tailored to ensure that the costs of redevelopment and new development do not overburden vulnerable members of the community. The same is true in Norfolk, a diverse city with more than 54% of the population made up of people of color (US Department of Commerce, 2013). The median income is below the national average and many low-income residents live in public housing. Norfolk's Dutch Dialogues discussed Tidewater Gardens, an impoverished Norfolk neighborhood with one of the highest rates of sea level rise in the country—six inches since 1992. The city's flood resilience strategy, **Norfolk Vision 2100** *(2016) identifies Tidewater Gardens as an area of dense development in need of protection. Residents are concerned, however, that the approach will lead to gentrification (Kusnetz, 2018).*

Project Contact

- **City of Norfolk Office of Resilience – norfolkrc@norfolk.gov**

Additional Resources

- Norfolk's Revised Zoning Ordinance Aims to Improve Flood Resilience
- Dutch Dialogues Virginia: Life at Sea Level

Related Case Studies

- See **Equity and Justice**: Princeville, public universities and partners facilitate resilience planning that acknowledges town history.
- See **Land Use and Development**: Brevard manages flood risk with a "No Adverse Impact" development standard.

Costs and Funding

- The Hampton Roads Planning District Commission sponsored the Dutch Dialogues process.
- The project received technical assistance from the Rockefeller Foundation, Old Dominion University and additional local environmental groups.

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TOPIC | 13
PUBLIC HEALTH

Overview

Protecting the health of residents is a vital goal of resilience initiatives. Public health programs provide mass vaccinations, health care screenings for chronic diseases, and many other individual-level benefits. However, the inequitable availability of public health resources has harmed historically under-resourced communities. These same communities often have the worst air and water pollution, as well, which directly contributes to chronic health issues (American Lung Association, 2023; Schaider, Swetschinski, Campbell, & Rubel, 2019). Local governments can work with their county health departments and local medical staff to ensure all residents have equitable access to reliable water, shelter, healthcare and other resources that protect them from the impacts of climate change.

Role in Resilience

Extreme weather events have both immediate and long-term impacts on the health of people and places. For example, extreme temperatures (both high and low) trigger a range of impacts on human health, which often disproportionately affects aging populations, young children, and people with underlying health conditions like asthma (American Public Health Association, 2023; EPA, 2022). Poor air quality caused by wildfires is harmful to people living with respiratory challenges, and hazards like drought impact the availability of fresh food, especially for people who already live with food insecurity. Furthermore, experiencing disasters and the long-term consequences of a changing climate can cause depression and anxiety, negatively impacting mental health (World Health Organization, 2022).

Communities can build resilience by investing in strategies that improve the physical and mental health of people and places. Healthier people have an easier time responding to stressors and unexpected events, and a healthier overall population needs less care, reducing the strain on the healthcare system and requiring less special intervention in times of crisis. Communities can implement strategies that provide access to public open space, fresh food, and safe options for active multimodal transportation, such as biking and walking, for all. They can also ensure all community members have safe and healthy places to live, a mix of job opportunities paying a living wage, access to education and workforce development, clean drinking water, functioning wastewater systems, and healthcare services. This section lists resources to help communities adopt resilience-building public health strategies.

Potential Project Leads, Experts and Stakeholders

- Local government departments and commissions focused on public health, community services, sustainability, and emergency management
- State government agencies, such as NC DHHS and NCEM
- Federal government agencies, such as HHS
- North Carolina State Climate Office
- Local and regional healthcare institutions
- Nonprofits and other community organizations (e.g., neighborhood associations, advocacy groups, community foundations, tribal governments and faith communities), especially those that can help convene individuals from often overlooked communities (e.g., Association of Mexicans in North Carolina (AMEXCAN), Hispanic Federation, NC Black Alliance, NC Environmental Justice Network and NC Commission on Indian Affairs)

  More North Carolina community-based organizations:
  - NC Conservation Network Affiliates
  - NC Environmental Justice Network member organizations
  - NC Justice Center
  - NC NAACP
  - NC Rural Center
  - NC Tribal Communities
  - Western North Carolina Health Network
- Housing authorities
- K-12 schools
- Residents

For More Information

North Carolina Community Mapping System, hosted by NC DEQ, provides a dashboard of community information and locations of potentially hazardous pollutant sites. The tool also features an environmental justice tool that allows all users to understand the sociodemographic and health characteristics of communities across North Carolina.

The Environmental Health Data Dashboard allows "users to view interactive maps and environmental health data visualizations at the state and county levels." NC DHHS monitors and reports "environmental and climate hazards that can affect human health throughout the state" on this page. Additional North Carolina public health data and resources related to climate change are also linked on the page.

The Environmental Justice Index, hosted by the CDC, uses data from the Census Bureau, the EPA, the US Mine Safety and Health Administration and the CDC "to rank the cumulative impacts of environmental injustice on health for every census tract."

Mental Health and Our Changing Climate: Impacts, Implications and Guidance, published by the American Psychological Association, Climate for Health and ecoAmerica, explains how climate change impacts mental health. "The report provides climate communicators, planners, policymakers, public health professionals, and other leaders the tools and tips needed to respond to these impacts and bolster public engagement on climate solutions."

Public Health Adaptation Strategies for Climate Change, part of the EPA's Climate Change Adaptation Resource Center (ARC-X), contains descriptions of public health adaptation strategies and relevant case studies.

The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment, hosted by the US Global Change Research Program, details findings that examine how climate change is already affecting human health globally and the changes that may occur in the future.

PUBLIC HEALTH | 13 STRATEGIES

Conduct community climate and health assessments

A community health assessment is a thorough examination of the health status for different population groups in a community. Assessing and monitoring community health builds resilience to the impacts of climate change by proactively providing people with the resources needed for improved physical and mental health during natural and climate disasters.

FOR MORE INFORMATION

EXAMPLES

Sandhills Community Readiness: Determining Pilot Groups for Heat Safety Programming (NC DHHS)

North Carolina Climate and Health Implementation and Monitoring Strategy for Heat-Related Illness (NC DHHS)

Measuring the Human Dimensions of Resilience, Health and Well-Being in the Gulf Coast (Gulf Research Program)

CASE STUDY

*See **Collaboration** case study.

Develop plans to achieve climate and health goals

Using climate projections to understand the future health needs of different communities within a jurisdiction can help public health departments set goals and identify appropriate interventions. Combining these goals and interventions into a planning document will assist local leaders in planning and prioritizing implementation.

FOR MORE INFORMATION

Heat Action Plan Toolkit (NCORR) This North Carolina resources provides a template heat action plan for communities, sample messaging and graphics, example community surveys and heat thresholds for specific regions across the state.
*Incluye Recursos en Español

Building Resilience Against Climate Effects (BRACE) (CDC) This framework "is a five-step process that allows health officials to develop strategies and programs to help communities prepare for the health effects of climate change." In particular, refer to the BRACE Resources page, which contains templates, data, and more.

Climate Change and Health Playbook: Adaptation Planning for Justice, Equity, Diversity and Inclusion (JEDI) (American Public Health Association) This resource, which serves as a supplement to BRACE, guides communities wanting to embed JEDI "into their climate and resilience initiatives, programs and operations."

Defining Extreme Heat as a Hazard: A Review of Current State Hazard Mitigation Plans (Duke University) This report "assesses the treatment and definition of heat as a hazard in each state's plan" and offers recommendations for states and local governments to understand and address the effects of extreme heat on their residents.

Use public awareness campaigns to educate the community about climate hazards and building resilience

Public awareness campaigns use methods like informational posters, notices, exhibits, radio announcements, social media and special signage. This strategy builds resilience by educating the public and calling attention to issues, hazards, or opportunities. For example, social media posts during heat waves can educate residents about how to avoid heat related illnesses.

FOR MORE INFORMATION

Heat Health Alert System (NC DHHS) **All NC residents can sign up to receive an alert when extreme heat conditions in their county are forecasted to reach levels that cause impacts to human health.**

***Se puede registrar en Español**

CASE STUDY

*See **Public Health** case study, below.

(See **Communication and Education** for additional resources)

Actively support safe and healthy shelter for all

Resilient communities actively support and help provide permanent, short-term, and emergency housing for residents. Safe and secure shelter means housing or other shelter structures are free of harmful environmental contaminants like lead, mold, and air pollution; free from pests and insects; heated and cooled; well-maintained and up-to-code; not located in hazardous areas; and appropriately sized for the number of residents. It also means residents have access to clean, healthy water for drinking, cooking, and bathing, and it means that sanitary systems are functioning and maintained. This strategy also ensures that all people, especially a community's most vulnerable residents, can access safe, healthy shelter during extreme weather and have the resources needed to repair and restore their homes following disasters.

FOR MORE INFORMATION

Plan. Prepare. Stay Informed. (ReadyNC) **NC residents can use this webpage to find open shelters during emergencies and apply for disaster recovery assistance.**

EXAMPLES

Equitable Weatherization Clinic in South Florida (Miami Law Environmental Justice Clinic)

Maycroft Apartments "resiliency room" (Washington, DC)

CASE STUDY

State Acquisition and Relocation Fund for buyout relocation assistance supports post-disaster community investments in Lumberton, NC

(See **Housing** for additional resources)

Provide and promote equitable and accessible physical and mental health resources and services

This strategy focuses on connecting all community members with the information and resources needed to protect and maintain their physical and mental health. This builds resilience by reducing the impacts of climate hazards intersecting with underlying health issues; supports the physical and mental stamina needed to prepare for, respond to, and recover from extreme events; and reduces strains on the community healthcare system.

FOR MORE INFORMATION

Healthy Places NC (Kate B. Reynolds Foundation) **This program works to improve the health of residents in some of NC's most rural and vibrant yet under-resourced counties.**

EXAMPLES

Community plants trees to reduce air pollution and health risks (Louisville, KY)

Healthy Opportunities Pilots (three NC areas)

Mobile Health Program (Forsyth County, NC)

Psychiatry access line for health care providers (NC)

Mobile dental unit for special needs populations (NC)

Trauma informed systems initiative (San Francisco, CA)

Local Motive Mobile Farmers' Market (Southeastern NC)

***Disponible en Español**

(See **Communication and Education** and **Equity and Justice** for additional resources)

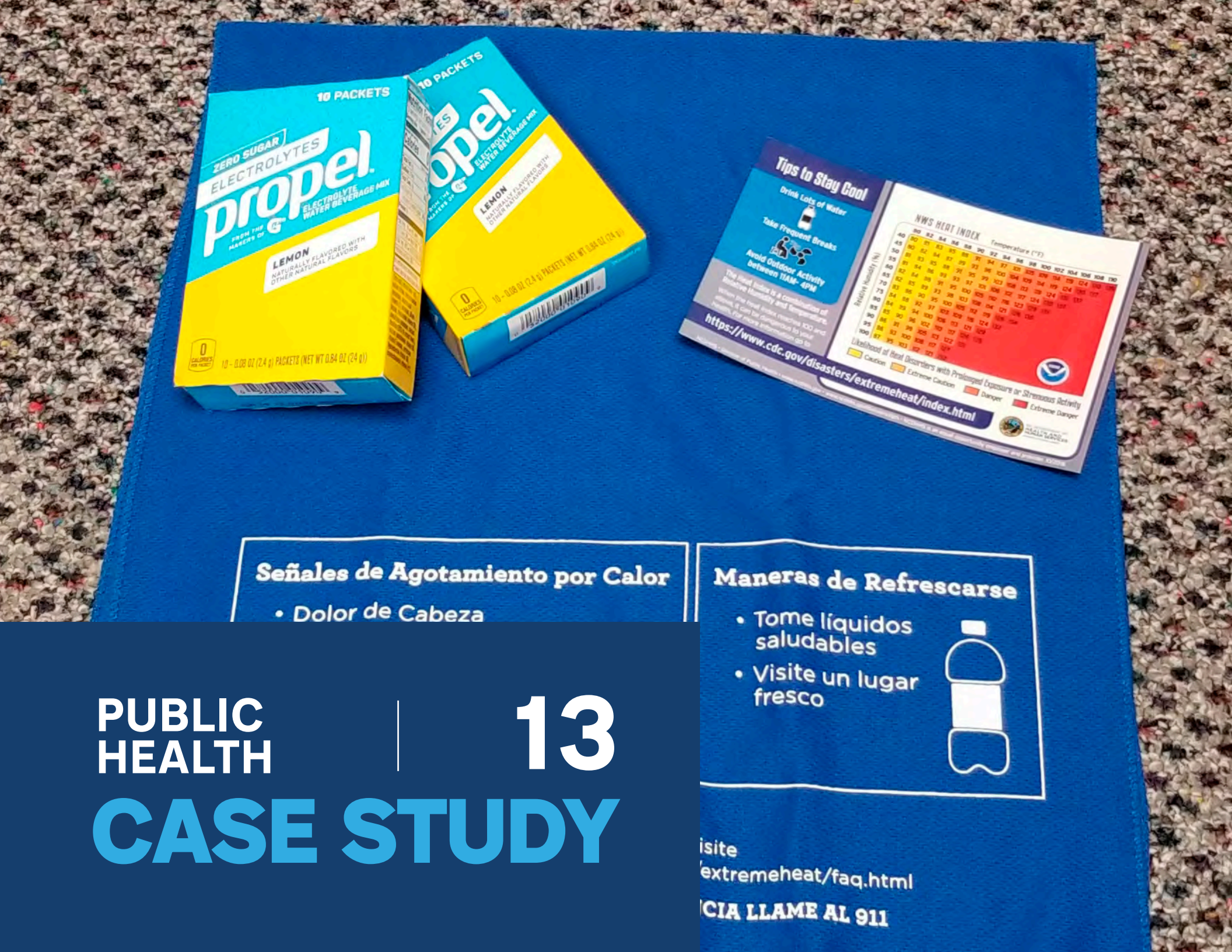
Support community networks

Social networks are many families' first points of outreach for assistance. Local governments can support these networks with outreach campaigns, funding and other resources.

FOR MORE INFORMATION

EXAMPLE

Neighborhood Buddy Initiative (Princeton, NJ)



PUBLIC HEALTH | 13

CASE STUDY

CASE STUDY

Preventing heat-related illness in the Sandhills Region

Project Purpose

Compared to the rest of the state, communities in North Carolina's Sandhills region—Bladen, Robeson, Hoke, Sampson and Scotland Counties—experience an elevated number of extreme heat days. Residents in the Sandhills region are particularly vulnerable to the impacts of rising temperatures due to high exposure and existing health vulnerabilities. To help prevent heat-related illness in the Sandhills, the NC Department of Health and Human Services (NC DHHS) Climate and Health Program worked with local heat-related illness prevention specialists in the region to implement a heat-health alert system and a summertime educational and informational campaign (NC DHHS, 2017).

Key Players: NC DHHS, Sustainable Sandhills, Scotland County Health Department, North Carolina Farmworkers' Project, Robeson County Health Department, Manos Unidas

Quick Facts

1. Most parts of North Carolina are projected to see at least two to three additional weeks of very hot days (maximum temperature of 95 degrees F or higher) for 2021-2040 (Kunkel, et al., 2020). On average since 2020, there are about 3,500 emergency department visits for heat-related illness each year during the heat season, which runs May 1 to Sept. 30 (NC DHHS, 2017).
2. Following interviews with community members, program partners developed a heat alert system and multilingual educational materials. As of spring 2023, partners used social media, multilingual trainings, heat stress kit distribution and heat messaging in farmworker health assessments to issue heat wave notifications and inform vulnerable residents about healthy heat management strategies.
3. The programming in the Sandhills helps build resilience against public health impacts of extreme heat by increasing awareness of heat risks, promoting positive health protective behaviors and increasing access to resources.

Making It Happen

- In 2017, NC DHHS conducted qualitative interviews with relevant stakeholders in Bladen, Robeson, Sampson and Scotland Counties to assess community readiness for heat health programming. NC DHHS reported interview results and intervention strategies in the Sandhills Heat Community Readiness Report.
- During interviews, local stakeholders reported concern about vulnerability to heat-related illness among farmworkers, individuals living in poverty, older adults, outdoor workers and children. Some of these groups are more exposed to extreme heat, such as outdoor workers and individuals who cannot afford air conditioning. Others are more sensitive to extreme heat, such as aging populations and individuals who have not yet acclimatized to the heat. Those who experience high exposure and high sensitivity are particularly vulnerable, such as farmworkers who have recently immigrated. Exposure to extreme heat during working hours is dangerous for populations that are traditionally underserved due to transportation and language barriers.
- In response to the interview results, NC DHHS outlined two prevention strategies—a heat alert system and multilingual educational materials—in the North Carolina Climate and Health Implementation and Monitoring Strategy for Heat-Related Illness, published in 2018. These programs and partnerships enable NC DHHS to reach the most heat-vulnerable populations in the region.
- To help implement these interventions, the NC DHHS Climate and Health Program established a Heat-Illness Prevention Specialists Task Force in 2018 (now known as the Sandhills Climate Resilience Task Force). The group is composed of representatives from local health departments and community-based organizations that can speak for the needs of their target populations: agricultural workers, low-income residents that cannot afford adequate cooling, older adults and youth athletes that practice outside during the summer.
- NC DHHS and Sustainable Sandhills developed heat wave announcements, designed educational messaging and trained the prevention specialists on the Task Force on how to interpret heat data.
- Each prevention specialist identified appropriate communication channels for heat alerts to reach the populations with which they have trusted relationships. For example, the NC Farmworkers' Project, which works with migrant and seasonal farmworkers to maintain and improve their health, conducted multilingual trainings and distributed heat stress kits, electrolytes, cooling towels, water bottles with heat health messaging and personal protective equipment such as hats. In another example, Manos Unidas incorporates heat messaging into their existing health assessments offered to farmworkers. They also do some specific heat health trainings and provide heat stress kits, educational materials and water bottles. As of spring 2023, Task Force members issued heat alerts via social media, but there was interest in expanding the approach to issue communications through more formal channels.
- The Task Force began issuing heat alerts in 2018 in Bladen, Robeson, Sampson and Scotland Counties. The group also distributed educational materials and health protective resources during heat season (May to September).
- In 2019, NC DHHS and the Task Force expanded heat health programming to Hoke County.

Advice from the project manager

Heat health interventions can be more effective if coordinators can build on current local efforts, utilize local expertise and work through existing channels of health and social service provision.

Gathering information, making it accessible to those that need it and developing systems that monitor impacts that affect vulnerable members of the community are necessary steps for addressing inequality and inequity.

Outcomes

- In the Sandhills region, vulnerable populations, including farm workers, now have increased access to resources they can understand to help them learn about and address impacts from heat.
- NC DHHS expects to see an increase in protective actions to prevent heat-related illness among vulnerable populations within target Sandhills counties, as well as reduced heat-related illnesses among vulnerable populations in the region.

Project Contact

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Related Resources

- View the interview results and intervention strategies in the Sandhills Heat Community Readiness Report.
- The 2018 North Carolina Climate and Health Implementation and Monitoring Strategy for Heat-Related Illness describes the Sandhills programming in detail.
- NC DHHS Climate and Health Program Summer Heat Data Emergency Data and Prevention Tips

Related Case Studies

- See **Collaboration**: Raleigh and Durham map neighborhood temperatures.

Costs and Funding

- NC DHHS allocates about $125,000 per year toward heat management programs. Funding comes from the Centers for Disease Control and Prevention Building Resilience Against Climate Effects (BRACE) cooperative agreement, a five-year agreement funded at $500,000 per year from 2021-2026, as of spring 2024.

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Spotlight on Equity

The impacts of rising temperatures are higher in underserved communities, especially those living in poorly insulated mobile homes, those with limited access to adequate cooling, and individuals who experience disparate asthma and cardiovascular disease. Several Sandhills counties have a high concentration of potentially underserved populations. Concentrating heat safety programming in the Sandhills region places a spotlight on equity by prioritizing the communities that face the highest exposure to heat with the lowest capacity to adapt. For example, as the number of extreme heat days is projected to increase, many households in the Sandhills region that already struggle with energy bills may not be able to adequately cool their homes.

Additionally, North Carolina's farmworkers, a heavily migrant population, are at a disadvantage when it comes to accessing health care. They often do not speak English or they speak English as a second language. Many farmworkers do not have easy access to transportation, typically have lower incomes, are unfamiliar with the local health care services available and are often scared to visit a doctor who might tell them they are unable to work. The Climate and Health Program has historically supported farmworker organizations by integrating heat health educational materials into farmworker outreach staff's existing health promotion activities. Moving forward, the program is coordinating with the NC DHHS Office of Rural Health's Farmworker Health Program to provide critical extreme heat education and health promotion resources to those who care for farmworkers, like migrant health clinic community health workers and clinicians.

TOPIC | 14

STORMWATER MANAGEMENT AND FLOODING

Overview

Precipitation and snowmelt generate stormwater and can cause flooding (Kunkel, et al., 2020). Communities use stormwater management techniques to control, collect and sometimes use excess water. These strategies build resilience by reducing or eliminating flooding hazards, improving water quality, and promoting options for recycling and reusing stormwater.

Role in Resilience

As North Carolina's communities grow and develop land that may have previously absorbed excess water, good stormwater management becomes increasingly important. If not effectively managed, excess stormwater, also called stormwater runoff, can overwhelm sewer and drainage systems causing flooding and pollution. Increased stormwater velocity and volume from **impervious surfaces** can also make soil erosion worse and lead to sedimentation of nearby water bodies, particularly in heavily developed areas (USGS, 2018). Stormwater runoff can also damage infrastructure by washing out roads, for example. If not slowed or retained, runoff directly flows into water bodies, carrying excess nutrients, bacteria, debris and other pollutants that can damage water quality, supplies, habitats and ecosystems (EPA, 2023).

Stormwater management reduces the amount and speed of water flowing into ditches, sewers and other drainage systems. Resilient stormwater management also promotes options for recycling stormwater for nonpotable uses such as crop and garden irrigation. Stormwater management solutions can also build resilience by promoting or requiring solutions that mimic nature, such as nature-based solutions or green infrastructure. **Nature-based and green infrastructure solutions** for stormwater management may also provide additional economic, public health and social benefits to communities, including recreational opportunities.

Impervious and pervious surfaces

Impervious surfaces, such as rooftops, roads and parking lots covered by impenetrable materials such as concrete and asphalt, cannot absorb stormwater. Instead, they cause water to run off at greater rate of flow than if the water were able to infiltrate the ground naturally. Pervious surfaces allow water to absorb into the ground naturally and include parks, forests, gardens and other vegetated areas.

Grey infrastructure

Grey infrastructure refers to human-engineered water sources such as stormwater drains, pipes and sea walls.

Natural-based solutions, green infrastructure and low-impact development

Green infrastructure, also called low-impact development, is a type of nature-based solution. It replicates natural processes by using vegetation or enhancement and restoration of natural land and water flow patterns to slow, retain and absorb runoff rather than channeling and piping it into a waterway. Many people use these terms interchangeably, while others interpret nature-based solutions to refer to the broader protection or restoration of ecosystems for the purpose of benefiting people and the environment. Examples of green infrastructure for stormwater management include rain gardens, wetlands, bioswales and green roofs.

Robust, resilient stormwater management systems can operate at different scales—from large-scale municipal sewer systems to small rain gardens that capture stormwater. Regional or watershed-scale activities require a comprehensive approach to stormwater management, necessitating cooperation between localities and aligning with the geography of how water flows. Local government strategies typically increase the capacity and redundancy of **hard, or grey, and nature-based, or green, stormwater infrastructure**. Both types of strategies can hold water on land where flooding will not carry pollutants and sediment into nearby streams and lakes or impact buildings or infrastructure. Grey and green approaches can be designed to divert water flow to other locations, remove impediments to flows (e.g., raising and widening bridges) and enhance stream channels to accommodate more flow. Another large-scale option is to use dams as dry detention facilities or to store additional water during heavy rain. Neighborhood- or site-level strategies

provide more targeted options for managing stormwater through approaches such as shared open space and personal rain gardens. A key component for all strategies is raising awareness through education and training to the community, including local leadership, on approaches and funding opportunities. This section provides more information to help local governments increase the resilience of stormwater management systems, no matter their size.

Potential Project Leads, Experts and Stakeholders

- Local government departments focused on stormwater, public infrastructure, planning and sustainability
- State government agencies, such as US DOT; NCEM; NCORR; and NC DEQ Albemarle-Pamlico National Estuary Partnership, Division of Water Infrastructure, Division of Mitigation Services, Division of Coastal Management and Division of Energy, Mineral, and Land Resources
- Federal government agencies, such as FEMA and the EPA
- Stormwater and floodplain professionals (e.g., landscape architects, water resource and civil engineers, and floodplain managers) in the private, nonprofit, governmental and academic sectors
- Environmental nonprofits, such as the North Carolina Coastal Federation, North Carolina Sea Grant, The Nature Conservancy, Conservation Trust for North Carolina, and Carolina Wetland Association
- Higher education institutions
- Builders and developers
- Local businesses
- Residents

For More Information

FEMA offers two guides focused on Building Community Resilience with Nature-Based Solutions: A Guide for Local Communities and Strategies for Success. The Guide for Local Communities "provides foundational information on the benefits associated with using nature-based solutions to advance natural hazard mitigation and climate adaptation." The second guide, Strategies for Success, "builds upon the first and highlights five key strategies for implementing successful nature-based solution projects."

The Green Growth Toolbox, developed by the North Carolina Wildlife Resources Commission, provides tools to help the state's local governments plan for growth in a way that conserves natural habitats and other assets. The guidance provides information to support the strategies listed in the table below.

The Green Streets Handbook, published by the EPA, "is intended to help state and local transportation agencies, municipal officials, designers, stakeholders, and others to select, design and implement site design strategies and green infrastructure practices for roads, alleys, and parking lots." The handbook includes a chapter on green street stormwater design practices.

The Nature-Based Stormwater Strategies webpage, hosted by the North Carolina Coastal Federation, focuses on an action plan report that discusses opportunities in North Carolina for nature-based stormwater strategies in new development, stormwater retrofits, roadways and working lands. The site also includes example projects, fact sheets and more.

The NC DEQ Division of Water Resources hosts a webpage that lists several resources on green infrastructure.

The Low Impact Development Barrier Buster Fact Sheet Series, released by the EPA, discusses the benefits of low impact development strategies, construction techniques on specific slopes, soils and small spaces, and how to use incentives, planning techniques and codes to facilitate low impact development projects. Low impact development is the use of natural processes to manage stormwater and protect water quality.

The Stormwater Management Practices at EPA Facilities webpage, hosted by the EPA, reviews green infrastructure and low impact development practices to reduce stormwater runoff and pollution.

STORMWATER MANAGEMENT AND FLOODING

14 STRATEGIES

Develop plans at the watershed or regional scale

Planning for flood and stormwater management at the watershed scale supports resilience by planning in a way that respects geography rather than political boundaries. This scale of planning involves coordination between local and regional governing entities. This more comprehensive approach to managing stormwater mitigates downstream impacts and protects the health of critical watersheds that provide invaluable ecosystem services.

FOR MORE INFORMATION

Flood Resiliency Blueprint (NC DEQ) **This statewide initiative will produce an online decision-support tool and river-basin-scale planning efforts to address flooding in North Carolina.**

Examples

North Carolina River Basin Restoration Priorities

Statewide Watershed Planning Initiative (Florida)

Watershed Master Plan (Fayetteville, NC)

Watershed Restoration and Stormwater Resilience Plan (Atlantic Beach, NC)

Watershed Restoration Plan (Central Asheville, NC)

Watershed Restoration Plan (Swansboro, NC)

Conduct a stormwater study and adopt a stormwater management plan and/or regulations

The first step in adopting a plan or pursuing stormwater management projects is to conduct a stormwater study to map and understand the current system. A stormwater plan or regulations can be based on this study. Effectively managing stormwater reduces potential flooding and erosion as well as pollution of waterways by slowing and filtering stormwater. Stormwater regulations like performance standards ensure that new development does not result in more stormwater runoff.

Strategies supporting the adequate operation of stormwater infrastructure include ensuring that stormwater plans include costs for system maintenance and for providing education, training, and other resources to private property owners on the importance of inspecting and maintaining stormwater infrastructure.

FOR MORE INFORMATION

Green Infrastructure Design and Implementation (EPA)
This webpage lists many states' green infrastructure design manuals, links to modeling tools and describes solutions to design challenges.

EXAMPLES

Stormwater Management Plan (Black Mountain, NC)

Stormwater Management Plan (Raleigh, NC)

Stormwater Drainage Manual (Harrisburg, NC)

Stormwater Ordinance (Fayetteville, NC)

CASE STUDIES

DC Utilizes Green Infrastructure to Manage Stormwater

Yancey County, NC, addresses nonpoint source pollution mitigation in the Bald Creek Watershed

Promote or require green infrastructure

Green infrastructure, also called low impact development, manages stormwater runoff by mimicking natural processes, e.g., retaining and absorbing stormwater runoff on-site rather than channeling it away. This development practice reduces the impact of stormwater on nearby properties. Local leaders can promote green infrastructure in their permitting process. They can also partner with organizations in North Carolina to provide project review and permitting education and training courses for city staff; assist with operation and maintenance; and compare costs of conventional gray stormwater infrastructure to green infrastructure.

FOR MORE INFORMATION

Bioretention Design Handbook (EPA) **This document contains the latest trends and approaches for bioretention design, construction, inspection, and maintenance. The handbook also features numerous photographs of bioretention facilities that showcase the diversity of design techniques.**

Equity Guide for Green Stormwater Infrastructure Practitioners (Green Infrastructure Leadership Exchange and Greenprint Partners) **This guide offers best practices and sample metrics to track progress toward long-term equity goals.**

Green Infrastructure Toolkit (Georgetown Climate Center) **This resource "is intended to aid local governments nationwide in comparing best practices across cities, drawing lessons from different approaches and crafting similar policies for their own jurisdictions."**

EXAMPLES

Developer incentives for low-impact development stormwater practices within planned unit developments (Charlottesville, VA)

Green Area Ratio (Washington, DC)

Green Infrastructure (Charleston, SC)

Green Infrastructure Planning and Design Handbook (Boston, MA)

Green Roof Tax Credit (Philadelphia, PA)

Green stormwater retrofits (Swansboro, NC)

Infographic: Green Stormwater Management Options for Various Land Uses (Raleigh, NC)

Low Impact Development Manual (Columbia, NC)

Model Green Streets Policy (New Jersey)

Residential Rain Catchers Program (Durham, NC)

Maintain and enlarge existing stormwater infrastructure

Inspecting and maintaining existing stormwater infrastructure ensures that facilities operate at their design capacity. Cleaning bridge openings, culverts, and ditches in advance of heavy rain can reduce flooding. Properly functioning stormwater infrastructure supports on-site and downstream stormwater management.

As existing stormwater infrastructure needs to be replaced and development prompts stormwater system expansions, local governments can size infrastructure to accommodate expected higher volumes of water.

FOR MORE INFORMATION

Bioretention Performance, Design, Construction and Maintenance (Urban Waterways) This document reviews research conducted by NCSU to examine the performance of bioretention cells in North Carolina.

Mosquito Control for Stormwater Facilities (Urban Waterways) Climate change is increasing the likelihood of disease-carrying mosquitoes. This webpage provides guidance on how to design stormwater infrastructure to limit their numbers.

Stormwater Design Manual (NC DEQ) This webpage links to design guidance for many types of small-scale stormwater management practices.

EXAMPLES

Culvert assistance program (St. Lucie County, FL)

Homeowner's Watershed and Stormwater Handbook (Carrboro, NC)

Report system for broken or clogged storm infrastructure, flooding issues and street sweeping (Black Mountain, NC)

Stormwater Education for Homeowners video (Hendersonville, TN)

Conserve open space for floodwater storage

Conserving open space makes or leaves room for stormwater retention within communities. This is accomplished by prohibiting or removing development in locations that accommodate floodwater or by ensuring complementary land uses in locations that collect and retain stormwater, like parks. Zoning can be used to require green space to absorb stormwater, provide respite from heat, and capture carbon.

FOR MORE INFORMATION

Conservation Subdivisions Handbook (NC Cooperative Extension Service) This document is a guide for North Carolina communities in the use of conservation design for land use planning.

EXAMPLES

Recreation Conservation District (p. 18, Stow, MA)

Residential Conservation District (p. 18, Fairfax County, VA)

South Ellerbe Restoration Project (Durham, NC)

Stormwater parks (Puget Sound Regional Council)

CASE STUDIES

*See the case studies from the **Stormwater and Flooding** and the **Ecosystem Protection, Restoration and Enhancement** sections.

Participate in the National Flood Insurance Program (NFIP) Community Rating System (CRS)

The CRS is a voluntary program that incentivizes flood risk reduction strategies that exceed minimum NFIP requirements. Participating communities earn credit for flood mitigation activities. These credits can generate flood insurance premium reductions for community members. Any community can apply to join the CRS if they are fully compliant with the NFIP floodplain management requirements. CRS classes are rated from Class 9 to Class 1, with Class 1 having the greatest reduction in flood insurance premiums.

FOR MORE INFORMATION

Community Rating System (FEMA) **The CRS homepage contains the CRS Coordinator's Manual, case studies, a list of participating communities and more.**

STORMWATER MANAGEMENT AND FLOODING

14

CASE STUDY

CASE STUDY

Charlotte-Mecklenburg region runs local floodplain buyouts program

Project Purpose

In the 1980s and 1990s, repetitive flooding in Mecklenburg County caused millions of dollars in damages to personal and public property. In 1997, Hurricane Danny killed two people in Charlotte and caused a large petroleum spill into a local creek. Furthermore, the consolidated city-county government lacked floodplain development restrictions. In response, local governments in the Charlotte region established a merged city-county stormwater utility. The merged utility reduced flood risk in the region using floodplain buyouts.

Key Players: Elected officials and municipal and county stormwater utilities from the City of Charlotte; Towns of Cornelius, Davidson, Huntersville, Matthews, Mint Hill and Pineville; and Mecklenburg County

Quick Facts

1. The floodplain buyout program "undevelops" floodplains.
2. The program is funded with stormwater fees and grant funds.
3. The program is voluntary for property owners.
4. In the first 23 years of the program, Charlotte-Mecklenburg Storm Water Services purchased more than 450 floodplain properties. The program created 185 acres of undeveloped public space.

Making It Happen

- In the early 1990s, the City of Charlotte; Towns of Cornelius, Davidson, Huntersville, Matthews, Mint Hill, and Pineville; and Mecklenburg County established the Charlotte-Mecklenburg Storm Water Services. The new utility became responsible for managing stormwater and restoring floodplains. The entity developed a more extensive approach to stormwater management.
- In 1999, the utility launched its Floodplain Buyout Program. The program purchases and removes buildings in the floodplain, returning the properties to open space.
- Program staff focus on a few neighborhoods each year, coordinating acquisitions and other flood management projects.
- The utility offers a grant program for retrofitting at-risk properties when buyouts are not feasible.
- The utility's "damages avoided" newsletter covers the successes of the buyout program. The newsletter illustrates what could have happened to local properties in a major flooding event if they were not bought out.

Spotlight on Equity

The utility noticed that the number of flooding complaints was lower in low-income neighborhoods. So, staff conducted special outreach to those areas. They helped make low-income residents aware of their reporting abilities, as well as their buyout and retrofit options.

Advice from the project manager

Program Manager Tim Trautman emphasizes the value of planning buyouts holistically. He suggests designing a buyout program in a way that respects public interests and benefits (Urban Land Institute, 2021). For example, converting purchased properties into well-maintained local parks is beneficial to the community.

One challenge with the program is agreeing to a fair price for the flood-prone businesses and housing. About 75% of participating property owners are relieved to walk away from high-risk properties, but each participant has a different perception of a fair price (Urban Land Institute, 2021). To help ease the transition for all sellers, staff try to complete the land's open space conversion quickly, so previous residents can enjoy the new open space.

Outcomes

- Between 1999 and 2022, Charlotte-Mecklenburg Storm Water Services purchased more than 450 floodplain properties. These purchases allowed for the transition of over 185 acres of developed properties to undeveloped public space. In addition, the program relocated more than 700 residents out of harm's way. Eligible residents received relocation assistance (Urban Land Institute, 2021).
- The utility estimates that buyouts have avoided $25 million in losses and will ultimately avoid over $300 million in future losses (Urban Land Institute, 2021).
- The buyout program and other flood reduction measures earned Mecklenburg County a Class 3 rating through the National Flood Insurance Program's Community Rating System. Class ratings range from 9 to 1, with 1 being best. The rating allows the program to provide a 35% discount on flood insurance, which saves residents $1 million each year.

Project Contact

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Additional Resource

- Property Buyouts Can be an Effective Solution for Flood-Prone Communities Report from the Pew Charitable Trusts

Related Case Studies

- See **Land Use and Development**: Brevard manages flood risk with a "No Adverse Impact" development standard.
- See **Planning and Decision-Making Frameworks:** Norfolk, VA, updates zoning regulations to address flooding and sea level rise.

Costs and Funding

- The Floodplain Buyout Program began with two full-time equivalent planners.
- Charlotte-Mecklenburg Storm Water Services funds buyouts with stormwater fees, hazard mitigation funds from the Federal Emergency Management Agency, stormwater mitigation funds from state government and local funds.

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