

Surviving and Thriving in the Face of Rising Seas

Building Resilience in Communities on the Front Lines of Climate Change

HIGHLIGHTS

With sea level rise accelerating along the East and Gulf Coasts of the United States, coastal flooding is projected to intensify, and is likely to have a disproportionate impact on low-income and minority communities. Our nation's investments in climate resilience must anticipate and prioritize the needs of frontline communities who bear the brunt of these climate impacts. We present a screening tool to help identify coastal "climate equity hotspots" that face heightened exposure to climate impacts because of a combination of climate and socioeconomic risk factors. Policy makers and agencies should use this type of approach to target resources to communities most at risk.

Coastal communities across the United States are facing worsening risks of flooding during routine high tides and damaging storm surges. With sea level rise accelerating along the East and Gulf Coasts, these problems are projected to intensify in the coming years, and they are likely to have a disproportionate impact on low-income and minority communities. This report is an attempt to guide improvements in policy making around disaster aid and preparedness, to ensure that communities receive the support they need before and in the aftermath of climate-related disasters. It also makes the case for better long-term planning and sufficient resources to anticipate and prioritize the needs of frontline communities who bear the brunt of the climate impacts our nation is experiencing.

Our research reflects, in part, rich discussions at a climate equity convening in Baltimore, MD, in November 2014, co-sponsored by the National Association for the Advancement of Colored People (NAACP) and the Union of Concerned Scientists (UCS). These discussions served as a starting point for our study, which brings together recent research on socioeconomic disparities and coastal climate risks.

We present an analytical framework—a screening tool—to identify coastal "climate equity hotspots" that face heightened exposure to climate impacts because of a combination of climate and socioeconomic risk factors, and where



Tanisha Belvin (left) holds the hand of neighbor and friend "Mama Nita" LaGarde (right), while they are evacuated from the New Orleans Morial Convention Center to the Reliant Center in Houston in the wake of Hurricane Katrina.

additional attention and resources are required. We applied our screening tool using county-level data to assess the overlap of climate and socioeconomic risk factors for 35 coastal counties spread across nine East and Gulf Coast states—Connecticut, New Jersey, Pennsylvania, Maryland, Virginia, South Carolina, Florida, Mississippi, and Louisiana (see Figure ES-1). The report also includes five case studies of people and places on the front lines of worsening coastal climate risks in order to highlight some of the specific and common challenges communities face and the ways in which they are responding (see Figure ES-3, p. 8).

Finally, we identify opportunities for ensuring that our nation’s investments in climate resilience are better targeted and more equitably shared. We describe actions that can be taken by policy makers and local, state, and federal agencies

engaged in disaster aid and preparedness to help ensure the safety and increase the resilience of communities most at risk.

How Current Disaster Aid and Recovery Policies Fall Short

A growing body of evidence, including from the Intergovernmental Panel on Climate Change and the U.S. Global Change Research Program, suggests that exposure, vulnerability, and resilience to climate impacts are closely intertwined concepts and vary with respect to communities’ socioeconomic situations, including variables such as age, income, and health. Communities with high numbers of elderly, very young, or low-income residents, or residents with ill health,

FIGURE ES-1. East and Gulf Coast Counties Analyzed



The 35 coastal counties where we applied our climate equity screening tool are spread across the East and Gulf Coasts of the United States, from Connecticut to Louisiana.

may have fewer resources to prepare for disasters, a limited ability to evacuate, or a limited ability to bounce back. They may have less economic or political clout to ensure they get the attention needed from disaster relief agencies and may be more likely to have their employment and living conditions devastated by extreme events. In the event of a storm that brings flooding, for example, low-income families and individuals may lack transportation to get out of harm's way, may live in places that are more prone to flooding, or may live in older, less safe housing. Low- and fixed-income households also may not be able to afford to pay for insurance that could help cover their losses.

Our nation's disaster aid, recovery efforts, and investments need to better correspond to individual communities' risk and current level of preparedness, and meet the needs of those most at risk. Many programs are targeted at homeowners or businesses, leaving those who rent or live in public housing at a disadvantage. Evacuation plans are primarily geared toward individuals who own cars or can afford to pay for transportation and may not always factor in the needs of those with health or mobility challenges. State and federal agencies sometimes lack familiarity with the specific concerns of communities, or their disaster aid processes may suffer from bureaucratic hurdles that can also make aid less accessible to residents in a time of crisis. Overall, current aid and recovery programs are not administered with an eye to building climate resilience in places most at risk.

Extreme disasters tend to bring communities' vulnerabilities into sharp relief. For example, many coastal towns and cities on the eastern seaboard faced significant storm surge flooding from Superstorm Sandy, which destroyed homes, washed out bridges and roads, and caused extended power loss. Some residents in poor health who were unable to use stairways remained trapped in high-rise public housing buildings in New York City for days. Many residents in nursing homes in Gulf Coast states were unable to evacuate ahead of Hurricane Katrina and faced harm and even death in some cases.



Master Sgt. Mark C. Olsen/New Jersey National Guard

Families with young children, the elderly, low income residents, and people with health problems are among those who may find it especially difficult to evacuate ahead of a disaster or cope with its aftermath. Pictured here, members of the New Jersey Army National Guard mobilized for Superstorm Sandy provide assistance to displaced residents at an emergency shelter in Piscataway Township, NJ.

This report focuses primarily on minority and low-income communities who, the research shows, face a disproportionate burden from disaster risks and environmental hazards. Studies conducted in the aftermath of Superstorm Sandy show that low-income families in the New York-New Jersey area, many of whom also belong to minority communities, were among the worst affected. Three years later, they continue to face significant challenges in recovering from that storm, especially challenges related to housing. In areas of New Orleans flooded in the aftermath of Hurricane Katrina, African American residents outnumbered white residents by a ratio of more than two to one, and many were stranded for days in deplorable conditions. A study of the African American community of

Communities with high numbers of elderly, very young, or low-income residents, or residents with ill health, may have fewer resources to prepare for disasters, a limited ability to evacuate, or a limited ability to bounce back.

Crisfield, on Maryland’s Eastern Shore, in the wake of Superstorm Sandy found that residents there experienced flooding in their streets for days longer than on other streets and had great difficulty accessing food and safe housing.

Creating the conditions for frontline communities to prosper and thrive in the face of growing climate threats requires advocating for solutions that address their risks on multiple fronts. Above all, people need to have a direct voice in shaping their future. Policy solutions, human and financial resources, and further research need to be equitably focused and directed to the most critical gaps.

An Analytic Framework to Identify Climate Equity Hotspots

In this report we present a methodology that can be a starting point for the discussion of how to target resources in a balanced way to protect those most at risk. The screening tool helps identify “climate equity hotspots,” places where there is a confluence of climate and socioeconomic risk factors. We applied this tool to 35 coastal counties that cover a wide swath of the East and Gulf Coasts of the United States, focusing on a subset of places where climate equity concerns are especially relevant. Our study sample, while not random, has broad coverage, including counties with varying average incomes, sizes, and population densities, and including many places where communities of color make up a significant share of the population.

Our screening tool uses two broad measures of risk for the 35 counties: **a climate risk indicator** constructed using data on sea level rise and tidal flooding projections through 2045, and **a socioeconomic risk indicator** built from data on county-level per-capita income, poverty rates, race/ethnicity, and education. These indicators are proxies for risk factors that contribute to a county’s overall exposure to harm; we want to be clear that they are not to be interpreted as *determinants* of specific outcomes. Our methodology ranks each county’s risk *relative to the rest of our sample* of 35 counties. Expanding the sample size and data set to every coastal county in the country would provide a nationwide ranking and would be a useful extension of this framework.

We have constructed these indicators at the county level, where a consistent set of data was available and where many policies get implemented. The data we have used are readily available at the county level. The tool is designed to be flexible, transparent, and easy to use. However, it is important to recognize that there can be significant variation within counties in the risk factors we have identified, and further investigation into exposure risks for specific communities

within a county may be warranted. Where more localized data are available, they can be incorporated into the tool. The methodology can also be expanded with additional risk factors, extended to other parts of the country, and adapted to different types of climate impacts.

The use of this type of tool can help raise communities’ and policy makers’ awareness of challenges, inform stakeholder dialogues about choices for the future, and help build consensus around local and national priorities for targeting resources. It can also be used over time to examine whether the relative risk profile of a community has improved with increased investments in resilience.

Key Findings

We examined the risks from sea level rise and tidal flooding for the counties in our sample, using a methodology developed by Spanger-Siegfried, Fitzpatrick, and Dahl, and find that:

- All of the counties in our analysis will experience more than 4 inches of sea level rise by 2030 and more than 10 inches by 2045, given a mid-range sea level rise projection. One-third of these counties are projected to experience sea level rise of 6 to 10 inches by 2030, and about half are projected to experience 12 to 20 inches of sea level rise by 2045. Coastal communities in Louisiana and Virginia will be particularly affected.
- Nearly all of the 25 counties in the sample for which we had tidal flooding data and projections will experience at least a three-fold increase in tidal flooding events between now and 2030, and most will have at least a 10-fold increase between now and 2045.

Further, our analysis shows that:

- The counties’ climate risk indicator scores, combining sea level rise and tidal flooding risks, are highest for most of the Gulf Coast counties in our sample—including Harrison County, MS, and those in Louisiana—and are also high for most of the counties in the mid-Atlantic coast, from Virginia to New Jersey.
- A ranking of the counties’ joint climate and socioeconomic risk profiles shows Orleans Parish, LA, as the most vulnerable hotspot among the counties we analyzed, closely followed by neighboring St. Bernard, Jefferson, and Plaquemines parishes, and Harrison County, MS (see Figure ES-2). From this joint risk perspective, other counties showing substantial risks encompass three large urban centers—Miami, Philadelphia, and Baltimore;

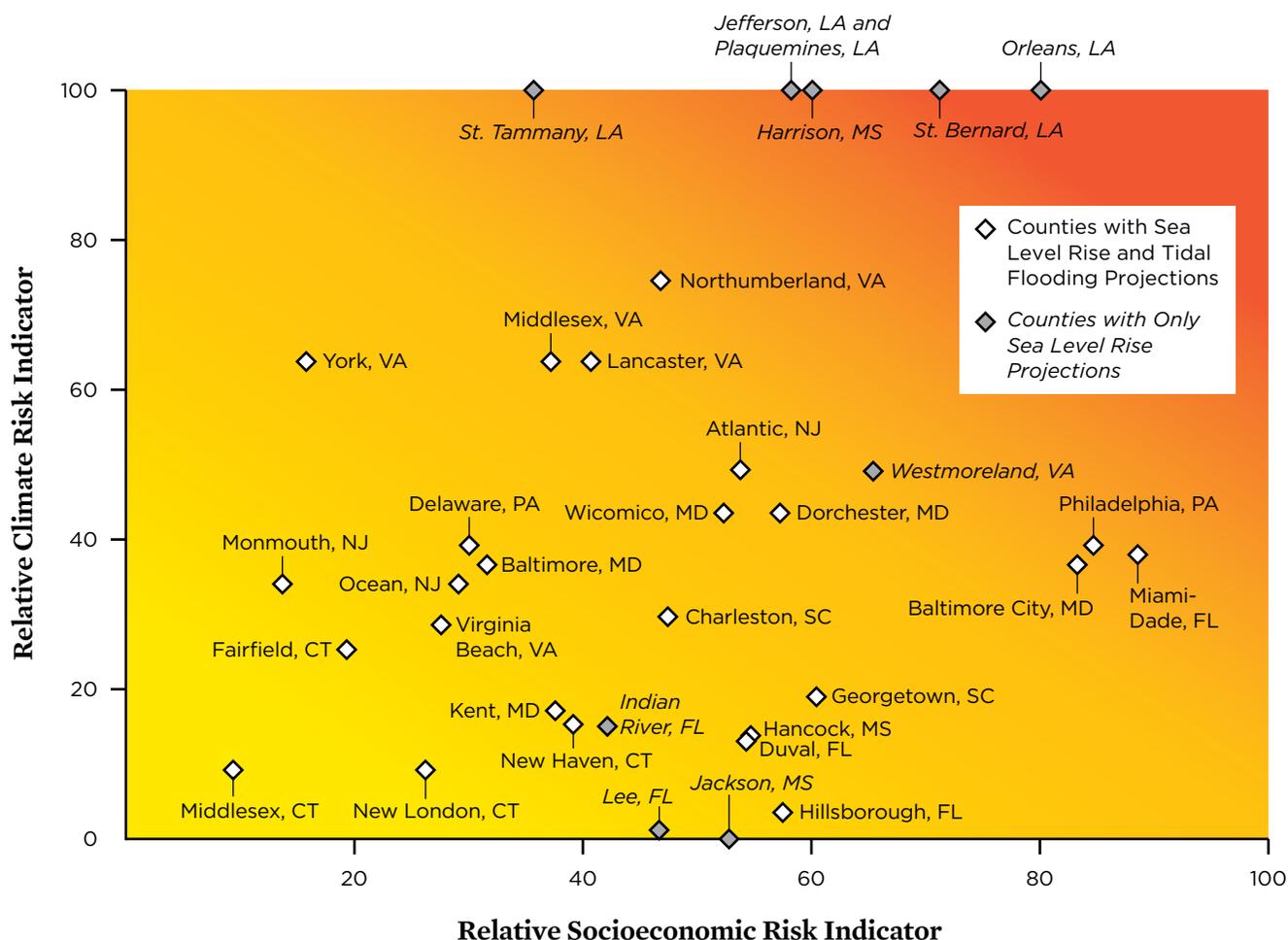
Northumberland and Westmoreland counties in Virginia (followed by Lancaster and Middlesex); and Atlantic County in New Jersey.

- Repeated storm damage in the same location can also create a cumulative burden on exposed communities. Using data from the Spatial Hazard Events and Losses Database for the United States (SHELDUS), we found that over a 30-year period (1985–2014), damage costs from past storms in the 35 coastal counties analyzed

are highly concentrated in location and years of occurrence. The overwhelming majority of the damages occurred among the counties in Louisiana, Mississippi, New Jersey, and Florida. Some of the counties hardest hit also have high poverty rates and a high proportion of minorities.

Figure ES-2 shows the relative climate and socioeconomic risk indicators for the counties in our sample, and identifies climate equity hotspots where both risk indicators

FIGURE ES-2. County-level Relative Joint Climate and Socioeconomic Risks



Counties that are climate equity hotspots can be identified by analyzing their joint climate and socioeconomic risks, and warrant further investigation into potential exposure risks for specific communities within them. The five Louisiana counties and Harrison, MS, rank relatively high in joint climate and socioeconomic risk at the county level. Several counties in Virginia, as well as the counties encompassing the major urban centers of Philadelphia, Miami, and Baltimore, also show relatively high joint risks. Even counties that rank relatively low will still experience some risk. Additionally, within counties there may be significant variation in risks which may be captured by future research using sub-county-level data.

are high. The risk indicator for each county is in relation to the 35-county sample we analyzed, not to a nationwide average of county risk. A low relative ranking for a county does not mean that it is exempt from climate concerns. Every coastal county will need to plan and prepare for sea level rise and the damaging impacts that accompany it.

There can be substantial variation within a county for both climate risks and socioeconomic risks. To explore this, we analyzed the data for Fairfield, CT. At the county level, Fairfield compares favorably to the other counties in our sample with low county-level climate and socioeconomic risk indicators. However, in a sub-county-level analysis, we found significant variation in the risk profile of towns within Fairfield: places like Bridgeport, Danbury, and Stamford face more risks from a socioeconomic perspective than places like Greenwich, Darien, and Weston, while Stratford and Norwalk show the greatest risk of tidal flooding. Bridgeport shows high overlapping risks from rising seas and socioeconomic factors. As this example shows, more sophisticated, comprehensive, and localized data and modeling of climate and socioeconomic risk factors could provide additional insights.

Engaging Frontline Communities in Solutions

Communities most exposed to climate risks show a high degree of awareness of these risks and strong support for climate action. Recent polls of Latino and African American populations confirm that a majority view climate change as an important issue and that they are already experiencing,

or expect to experience, climate impacts personally. More than half of the nation's Latinos live in California, Florida, and Texas—states that are already experiencing climate impacts and face serious future risks.

A robust, inclusive stakeholder engagement process is a prerequisite to creating solutions that work for communities and address their specific needs and concerns. This is all the more important for communities that have been historically marginalized for socioeconomic, political, racial, or ethnic reasons, and where extra effort must be made by policy makers and implementing agencies to build collaborations based on trust. For example, many groups in communities affected by Hurricane Katrina marked the 10th anniversary of the storm by committing to protect and revitalize their communities and to gain more decision-making power over development and restoration plans for the future.

Investing adequate resources in preparing communities before the next disaster is critical: investments in preparedness are a more cost-effective way to use limited taxpayer dollars. At the NAACP-UCS Climate Equity Convening, participants clearly highlighted the need to address housing, transportation, and healthcare concerns as a way to build community resilience. For example, special attention should be given to evacuation plans for communities where many residents may lack access to reliable transportation with which to flee to safety. Some communities may also require more specific help in navigating administrative procedures to access disaster aid. This highlights the need for disaster response agencies to reach out to communities *before* a disaster hits and establish a relationship of trust so that recovery and preparedness efforts are more effective and more in line with what a community needs.

Making Resilience Policies More Effective and Equitable

All frontline communities need to be prepared for future disasters and ongoing challenges from coastal flooding. Screening tools, such as the climate equity hotspot tool we have developed, can help identify people and places particularly at risk that require extra attention and resources. The federal government should work closely with state, local, and tribal authorities to help ensure that these frontline communities are better prepared and protected and that taxpayer dollars are spent wisely. UCS recommends that:

- **Federal, state, and local agencies should target funding for preparedness and disaster recovery to communities most at risk.** Funds and technical expertise from federal aid programs should be specifically allocated



Plaquemines Parish residents speak with a FEMA representative about their concerns for their communities' future as they recover from Hurricane Katrina.



Volunteers, such as the AmeriCorp volunteer pictured here, are often crucial to rebuilding efforts following disasters.

to meet the needs of frontline communities, using socioeconomic and climate risk factors such as those identified in our screening tool to prioritize communities most at risk. These programs include the Federal Emergency Management Agency's (FEMA's) Hazard Mitigation Grant Program, Pre-Disaster Mitigation Grant Program and disaster aid programs, the Department of Housing and Urban Development's (HUD) Community Development Block Grant Program, and the Department of Transportation's Public Transportation Emergency Relief Program. Rebuilding in the wake of extreme weather events, and investments in long-lived infrastructure, should be done with an eye to enhanced climate resilience. The grant application process should be made more streamlined and more easily navigable, allowing disadvantaged communities to access funds more easily and in a more timely way.

- **Policy makers should direct investments in transportation, energy, health, and shelter to meet the needs of populations at heightened risk.** Meeting basic needs can be challenging in the aftermath of a disaster. Federal and state agencies should plan ahead and make smart investments that can help ensure that people are able to get out of harm's way or able to shelter in place safely and that critical infrastructure and services are restored quickly. HUD and FEMA can play an important role by

increasing investments in climate-safe, affordable housing and resilient communities. Where possible, agencies should look for synergies in programs, such as worker training assistance programs, community development programs, clean energy retrofit programs, and community health programs, that can be leveraged to ramp up local resilience. These steps can limit disruptions and dislocations in frontline communities and reduce the need for longer-term taxpayer-funded assistance.

- **The federal government should mandate and enable the use of the best-available actionable science, data, mapping, and tools.** Federal, state, and local adaptation planning should be informed by the best-available, actionable climate science and must be developed in consultation with local stakeholders. A national commitment and funding will be required to scale up these efforts, link them where useful, localize the information as much as possible, make the data and tools widely accessible to communities, and build local capacity to use them. When communities have better information about their risks, they can make informed choices about prioritizing the risk mitigation measures they wish to undertake.
- **Congress should increase funding for climate resilience.** Congress should help prepare and protect at-risk communities by increasing funding for pre- and

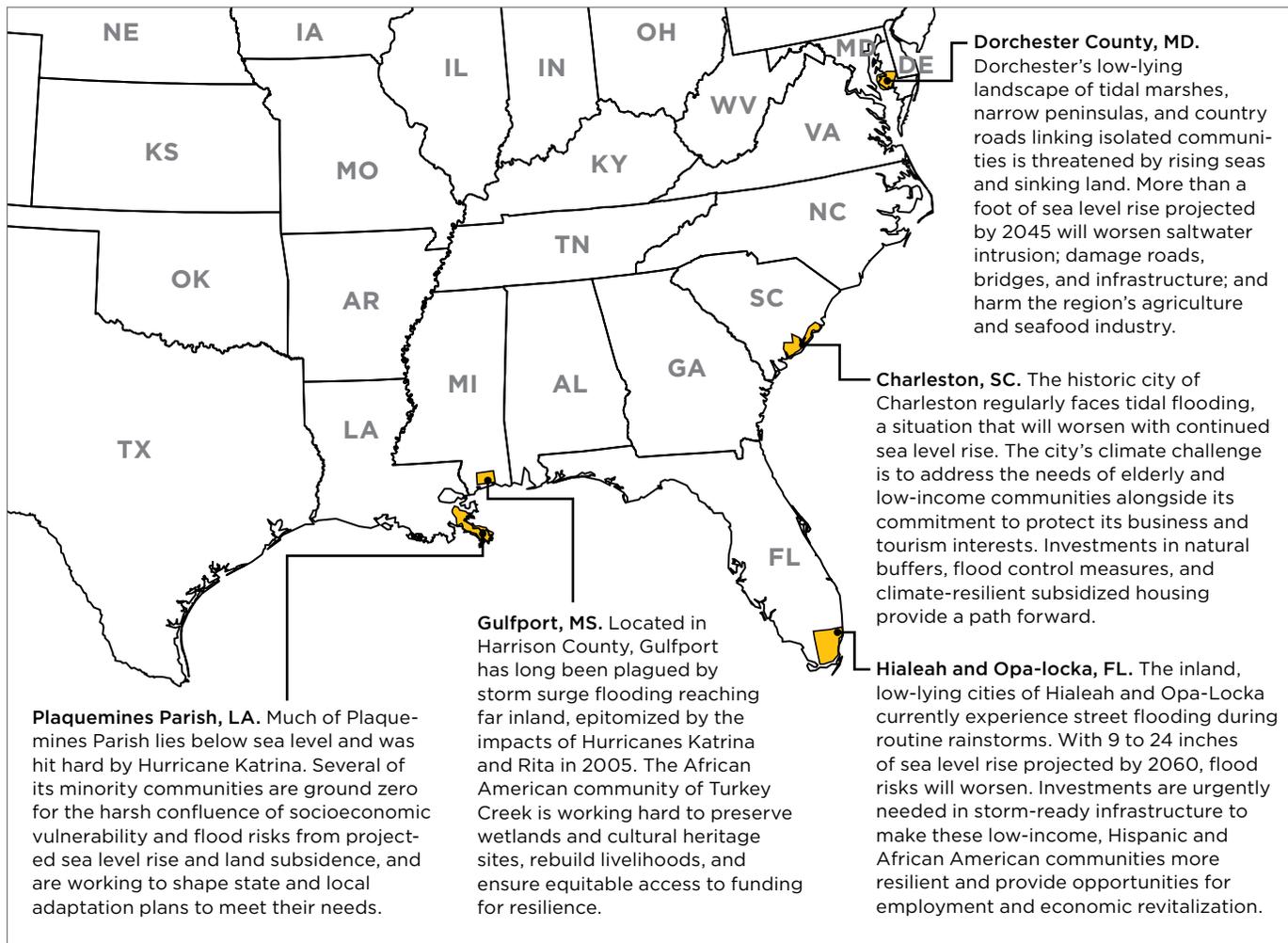
post-disaster mitigation or by creating a well-financed national resilience fund, coupled with long-term climate planning criteria. Funding for frontline communities needs to be prioritized.

- **The United States should work with other nations to cut carbon emissions.** Deep cuts in global carbon emissions are needed to help slow the pace and limit the magnitude of sea level rise and other climate impacts over the long term. Our nation’s efforts to build coastal resilience—in socioeconomically at-risk communities as well as more affluent ones—will be quickly overwhelmed if climate change and sea level rise continue unchecked.

Conclusion

The efforts of local environmental and climate justice groups in the face of accelerating climate risks attest to the strength and endurance of frontline communities. They are also a reminder that **if we fail to take action to protect frontline communities, the devastation and hardships they face today will be a reality for many more communities tomorrow.** Building climate resilience requires marshaling resources and know-how so that communities can make well-thought-out choices about their future that help them survive and thrive. As a nation, we have to ensure that fairness and equity are an integral part of our climate solutions.

FIGURE ES-3. Case Studies in Coastal Climate Equity Challenges



The five case studies included in this report highlight communities along the East and Gulf Coasts that face growing threats from sea level rise and storm surge and require a more equitable policy response.

Dorchester County, MD: Historic, Isolated Communities at Risk

Dorchester County, MD, faces serious threats from rising seas and sinking land, with its low-lying landscape of tidal marshes, narrow peninsulas, and country roads linking small, isolated communities. More than 55 percent of the county lies in the 100-year floodplain, much of it in the tidal floodplain; even minor storms and routine high-tide events can flood vast portions of the county. When Hurricane Isabel hit the region in 2003, it caused record-breaking storm surge, reaching up to eight feet and resulting in immense damage to homes and livelihoods. Superstorm Sandy in



H. Seymour Squyer

Dorchester County, the birthplace of Harriet Tubman, the famous abolitionist who led hundreds of enslaved people to freedom along the Underground Railroad, faces serious threats from rising seas and sinking land. Already, the waters of the Chesapeake Bay near the Tubman memorial have risen more than 10 inches over the past 70 years and may rise another 15 inches by 2050.

2012 brought heavy rain and flooding to communities on the Eastern Shore, including some near Dorchester. With rising seas, sea water is encroaching farther inland, converting more areas from freshwater marshes to salt marshes and eventually to open water. These types of changes to marshes can disturb ecosystems necessary for fish and shellfish and can lessen their ability to function as buffers to storms and water filtration systems.

Sea level in Dorchester County is projected to increase by more than a foot by 2045. A 2014 report from the Union of Concerned Scientists found that, under a mid-range scenario of sea level rise, tidal flooding in Cambridge, MD (the county seat), would increase from 10 events in 2015 to more than 240 in 2045. Sea level rise along the mid-Atlantic coast is occurring faster than along other parts of the Atlantic coastline due to local and global factors, such as land subsidence, changes in the Gulf Stream and climate change. A 2013 report from the Maryland Climate Change Commission recommended that the state plan for a relative sea level rise of 2.1 feet by 2050 and 3.7 to 5.7 feet by the end of the century.

Dorchester County is the birthplace of Harriet Tubman, the famous abolitionist who led hundreds of enslaved people to freedom along the Underground Railroad. The area was settled by freedmen and women after the Civil War. Since the land was low-lying and swampy, it was considered less desirable and was therefore one of the few places that African Americans could afford to own property after slavery ended. Today, the county is nearly 30 percent African American, and 18.4 percent of residents live below the poverty line.

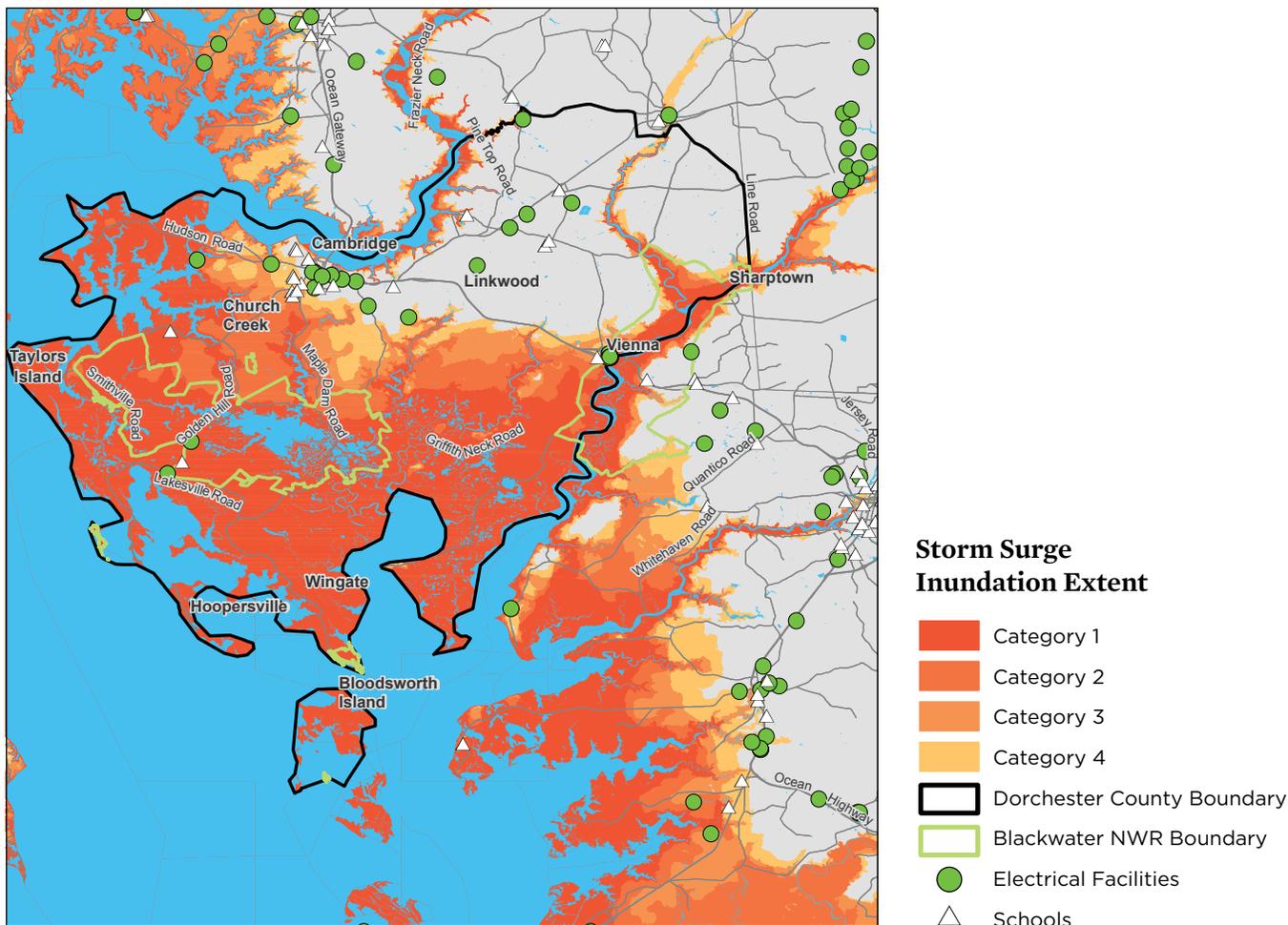
Dorchester's African American residents are particularly at risk from flooding. Christine Miller Hesed, a researcher at the University of Maryland Department of Anthropology, explains:

The vulnerability of African American communities on the Eastern Shore is exacerbated by their longtime social and political isolation. In the past these communities have been largely self-sufficient in responding to periodic flooding; however, the increased frequency and magnitude of flooding events along with the outmigration and aging within these communities means that they must now look for assistance from the techno-bureaucratic world of policymaking and regulation with which they have little experience in navigating.

In the aftermath of Superstorm Sandy, residents of Crisfield in next-door Somerset County experienced multi-day flooding and found that aid and rebuilding dollars were slower to come to them than nearby affluent areas.

Roads in Dorchester County already flood regularly during high tide. Residents cope by using alternate routes

FIGURE ES-4. Dorchester County, MD: Present-day Exposure to Storm Surge from Different Categories of Hurricanes



While hurricanes more commonly make landfall along the Gulf and southeastern coasts of the United States, those that do make their way farther north can have devastating consequences. A Category 1 hurricane in Dorchester County, MD, for example, has the potential to inundate large swaths of the county, including the towns of Hoopersville and Wingate as well as the majority of the Blackwater National Wildlife Refuge (areas colored deep orange). Stronger storms—Categories 2, 3, and 4—would inundate even larger areas (colored in lighter shades of orange and yellow) and pose greater flood risks to critical infrastructure such as schools, electrical facilities, and roads. With rising seas, future storm surges will reach farther inland. In addition, warming oceans are expected to contribute to more intense hurricanes.

SOURCE: UCS ANALYSIS USING NOAA'S STORM SURGE MODEL (SLOSH, AT WWW.NHC.NOAA.GOV/SURGE/SLOSH.PHP)

{ “The vulnerability of African American communities on the Eastern Shore is exacerbated by their longtime social and political isolation.”

— Christine Miller Hesed, researcher, University of Maryland Department of Anthropology }

and, if necessary, by temporarily relocating. In some cases, people have elevated their homes as a protective measure. However, even one foot of sea level rise will significantly worsen impacts already being felt. In addition to flooding, the future will likely bring further saltwater intrusion, failure of septic systems in rural communities, and damage to roads, bridges, and other infrastructure. Changes to the coastal ecosystem will also affect the primary local sources of livelihood: agriculture, forestry, and the seafood industry. For example, large areas of farmland are being lost to marsh. Added to this is the social and cultural loss that will be painfully felt by these historic communities that may have to disperse and relocate.

The state of Maryland has developed an ambitious climate adaptation plan. The Living Shoreline Protection Act, the Chesapeake and Coastal Bays Critical Area Act, and the Climate Change and Coast Smart Construction Executive Order are intended to help restore natural buffers to coastal flooding, limit development in high-risk areas, and ensure that state agencies include sea level rise risks in their planning and activities. State planners indicate that roads will likely be maintained and raised over time, in some cases functioning as dikes, but this is costly and may not be possible everywhere over the long term. The Maryland State Highway Administration is developing a methodology to evaluate the vulnerability of the state's roads and bridges to climate-related risks. This can help guide decisions about how to meet infrastructure investment needs.

For Dorchester County, the reality is that large areas may be lost to sea level rise or cut off from interior areas within the next few decades, forcing difficult decisions for residents. Given that more isolated areas in Dorchester County are facing declining employment prospects and a falling population, it seems unlikely that they will see significant public investments in shoreline protection—protective measures will likely be targeted toward larger population centers such as Cambridge. Frontline communities in Dorchester and neighboring Eastern Shore counties, many with strong historical and cultural ties to the locale, will need sufficient resources to help plan for the future and make choices about how best to protect themselves from tidal flooding, encroachment of saltwater, and coastal disasters of the coming years.

For Dorchester County, large areas may be lost to sea level rise.

Charleston, SC: Historic City at Risk of Flooding

Charleston, SC, sitting at the confluence of three rivers, is extremely vulnerable to hurricanes, sea level rise, and accompanying increases in tidal flooding. The last major hurricane to hit Charleston—Hurricane Hugo in 1989—devastated the city. However, it may not take another Category 4 hurricane to wreak similar destruction. The city is projected to experience 5.2 inches of sea level rise by 2030 and 11.5 inches by 2045 under a mid-range sea level rise scenario. Tidal flooding, which currently happens an average of 24 times per year, is projected to increase to nearly 80 times per year by 2030 under a mid-range scenario and to more than 180 times per year by 2045.

The city of Charleston has a long, complex history. It is the oldest city in South Carolina, founded by English colonists in 1670. Built with the labor of enslaved Africans, it grew as a seaport and agricultural center with rice, cotton, and indigo plantations. During the Civil War, Charleston sustained significant damage and only slowly recovered, repairing its buildings rather than replacing them—thus beginning a tradition of historic preservation of antebellum buildings.

In contrast to its success in architectural preservation, Charleston struggles with gentrification and segregation. After the Civil War, the city was relatively integrated; freedmen stayed on in the areas that were once plantations. However, integration did not last. Following national trends, starting in the mid-twentieth century, “white flight” resulted in 30 years of steady out-migration by European American residents, creating a majority African American city in the 1980s. More recently, that trend reversed. Downtown neighborhoods have been revitalized, and college students increasingly vie for limited housing. Many African American Charleston natives describe being forced out because of prohibitive costs and the incentive to sell their homes as prices rose, resulting in a 55 percent drop in the African American population over 30 years. In contrast, northern parts of Charleston, where industrial, port, and rail activity fill the air with pollution, have remained predominantly African American.

STORM SURGE FLOODING

The climate story in Charleston reflects not only its past, but also ongoing efforts to keep flooding at bay. Downtown Charleston and the adjacent city of North Charleston sit on a peninsula, which was widened artificially by filling in creeks and draining marshes. Many natural flood-control features were filled in with trash or diverted through pipes, reducing

the peninsula's resilience to sea level rise and flooding. When category 4 Hurricane Hugo hit in 1989, winds of up to 130 miles per hour and storm surge caused a record-breaking \$7 billion in damage. In an act of resilience, Charleston rebuilt after the storm, repairing and restoring historic homes. In fact, the city saw a boom in tourism from the revitalization efforts and today is one of the top travel destinations in the United States.

Despite this, flooding during routine high tides is now a common occurrence. A recent study looking at increases in nuisance flooding in U.S. cities ranked Charleston as the city seeing the seventh largest increases over the last half century. One in six homes in the city of Charleston lie less than four feet above the high-tide line, constituting a flood-damage risk of more than \$4 billion. Charleston has made some infrastructure improvements to protect against flooding and inundation, including improvements to some drainage systems and existing stormwater pumps and the installation of new ones, but more needs to be done.

UNEVEN IMPACTS

Ultimately, the entire peninsula will be affected by coastal climate impacts, but the impacts likely will not be felt evenly

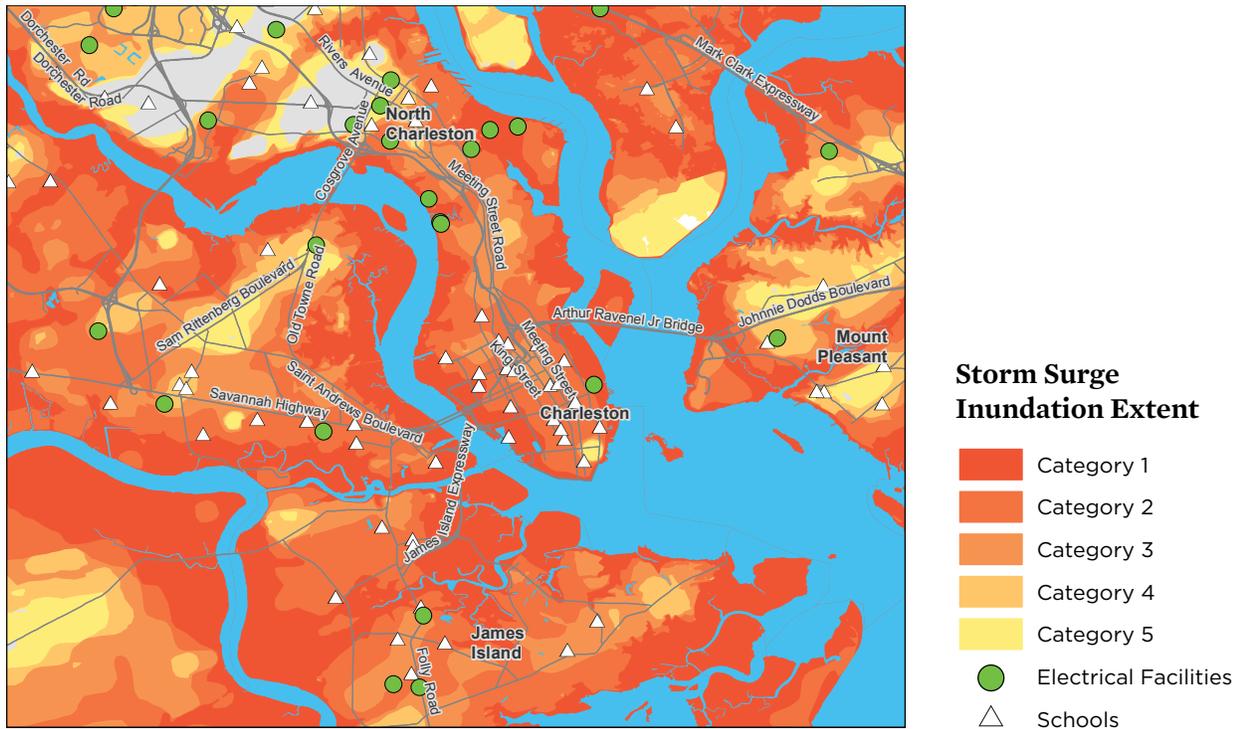
by all residents. In a recent interview, Katie Zimmerman of the South Carolina Coastal Conservation League explained that the eastern half of the peninsula experiences more tidal flooding that inundates homes and causes damage. She attributed this to decision makers' failure to prioritize climate adaptation, but commented that "[poorer] residents are less important to decision makers."

Elderly African American residents are among those most vulnerable in a major storm. Increasingly, the elderly residents in low-income, majority African American neighborhoods are the only remaining long-standing community members because their children are moving farther away as they are priced out. When a storm hits, these older residents may be isolated from their families. Community leaders speak of the need to preserve diversity in the peninsula and to protect communities from displacement, but protecting vulnerable residents from climate impacts has not yet become a priority for policy makers. Additionally, business interests, with their promises of economic benefits, seem to hold sway in local politics. In the WestEdge district and in North Charleston, for example, buildings are going up in former wetlands. The developers have failed to see wetlands as a natural ecological feature that could provide a buffer against storm surge and tidal flooding, and instead hope to control



Charleston is at risk from hurricanes, sea level rise, and accompanying increases in tidal flooding. The city's historic Battery, a defensive sea wall and promenade, is vulnerable to major storms. Tidal flooding is routine today and projected to worsen as sea levels rise.

FIGURE ES-5. Charleston, SC: Present-day Exposure to Storm Surge from Different Categories of Hurricanes



In the past 35 years, four hurricanes have made landfall along the South Carolina coast. These storms have ranged from relatively moderate Category 1 storms—such as Hurricane Gaston in 2004—to more severe storms, such as Hurricane Hugo, which struck the state as a Category 4 hurricane in 1989. Our analysis shows that even Category 1 storms have the potential to inundate broad swaths of the Charleston County coastline, particularly in low lying areas such as James Island. As was the case with Hurricane Hugo, the surge from Category 4 (or 5) storms can cause extensive damage to the city of Charleston, where the county’s schools are most concentrated. With rising seas, future storm surges will reach farther inland. In addition, warming oceans are expected to contribute to more intense hurricanes.

SOURCE: UCS ANALYSIS USING NOAA’S STORM SURGE MODEL (SLOSH, AT WWW.NHC.NOAA.GOV/SURGE/SLOSH.PHP)

flooding through landfill. And as Charleston builds new roads and renovates flood-prone highways, in some cases communities have been displaced.

State Senator Marlon Kimpson and State Representative Wendell Gilliard explained in an interview that there have not been material efforts to address climate change in the State General Assembly. Gilliard also argued that a more cohesive city- or county-wide effort to address the impacts of climate change on communities of color is needed. But despite the lack of political salience of these topics, there are ways to move forward. South Carolina already has laws protecting marsh land, which can provide a natural buffer and flood control. While Charleston’s peninsula has none of its original salt marshes left, these laws could be more effectively

used to leverage natural systems for flood control. Subsidized housing and other community development projects could also integrate initiatives aimed at natural flood control.

Charleston has rebounded before, and it may be able to rebound again. But it will need to do more to protect its residents from future storms. If Charleston faces another Hugo, there is a high potential that the Battery, an iconic defensive seawall, will be breached by floodwaters, causing major damage. Even without a hurricane, Charleston’s residents are experiencing an increase in tidal flooding due to sea level rise, and Charleston needs to prioritize the needs of its most at-risk residents. Otherwise, the coming damage will only compound existing inequalities.

Opa-locka and Hialeah: Two Florida Communities Grappling with Decades of Storm Impacts

The neighboring cities of Opa-locka and Hialeah, located in the western corner of Miami-Dade County, FL, are low-lying with an average elevation of approximately six feet. Like most of southeast Florida, Hialeah and Opa-locka sit on a very porous limestone. This limestone holds fresh water (the Biscayne aquifer) and is the source of potable water for most of the region. As sea levels rise, the water table also rises, bringing the potential to contaminate wells and contribute to inland flooding. Projected sea level rise for southeast Florida by 2060 is 9 to 24 inches. The eight inches of sea level rise that has occurred over the last 100 years in Florida is already causing sunny-day flooding during seasonal high tides, and higher sea levels will continue to amplify the storm surges of hurricanes and tropical storms.

Both Opa-locka and Hialeah are low-income communities: though Hialeah has an active and productive business sector, the median household income is only \$29,961 (compared to the U.S. median of \$53,046), while the median household income in Opa-locka is \$20,338. Both cities have majority minority populations. Opa-locka's population of 15,967 is 66 percent African American and 35 percent Hispanic, while Hialeah's population of 233,394 is approximately 95 percent Hispanic and 3 percent African American. A 2010 report referred to Opa-locka as a "thriving food desert," an environment "that supports substandard nutritional outposts." Hialeah's high unemployment rate, coupled with the fact that most adults lack health insurance, contributes to the ongoing economic struggle of its residents. These issues complicate and increase the need for resiliency efforts.

Current climatic changes add a greater sense of urgency to the on-going efforts to address poverty. A 2012 report from the Opa-locka Community Development Corporation identified key strategies for strengthening the city's economy such as more workforce development initiatives and the designation and preservation of historic buildings and homes. These recommendations both allow for economic development and, if implemented thoughtfully, could make the city significantly more resilient through green jobs and projects, and storm-ready infrastructure upgrades.

The critical need for resilience in Miami-Dade's low-income communities was most evident during Hurricane Wilma in 2005, which amplified the destruction caused by Hurricane Katrina just weeks before. Katrina hit south Florida as a category 1 storm before making landfall in the



© Keren Bolter and Nicole Hernandez Hammer

Much of southeast Florida is low-lying, with bedrock of porous limestone. As sea levels rise, tides are now riding on elevated water levels and the water table also rises, contributing to inland flooding.

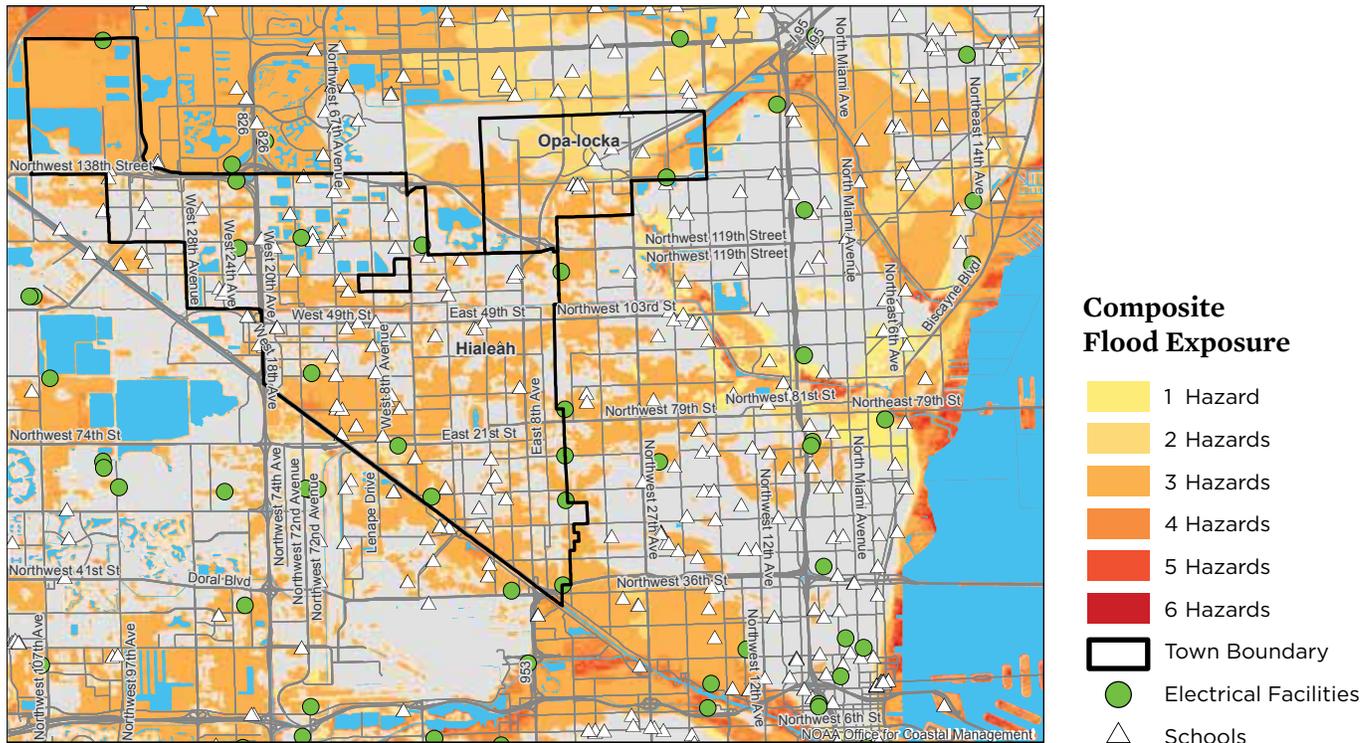
Gulf Coast as a category 3 storm. Hurricane Wilma reached south Florida as a category 3 storm with winds of 125 miles per hour and a storm surge of seven feet.

Local resident Christie Diaz was a teenager living with her parents in Hialeah when Hurricane Wilma hit her neighborhood. She remembers her apartment building being without power for two weeks, and government food trucks made deliveries to the community. Her parents were unable to get to work for several weeks, and she was out of school for nearly a month; but, she noted, it was the elderly living in multi-family buildings who had the hardest time receiving assistance.

Diaz noted how streets now regularly flood during routine rainstorms, and this flooding lasts longer than it did 10 or 15 years ago. She says: "Everybody should know about how sea level rise is affecting our community, because it is affecting us now and will be even worse in the future. If we don't know, we can't take action."

Gilberto Turcios is a long-time resident of Opa-locka and was there during the relentless 2005 hurricane season. He recalls trees falling on homes, including his aunt's, and roots pulling up sewer pipes. He remembers long lines of residents waiting for water, food, and supplies from FEMA, the Red Cross, foreign embassies, and other organizations, but he feels that the local churches were most involved in giving aid to Opa-locka's residents. He says that although the information residents received about the coming storms was helpful, there was not enough transportation available to residents who wanted to evacuate.

FIGURE ES-6. Flood Risk in Miami-Dade County from Storm Surge and Other Factors



Hurricane-induced storm surge is only one of several types of flooding that can place communities at risk. Heavy rainfall, for example, is a common cause of flooding during hurricanes as well as weaker storms. South Florida is underlain by the Biscayne aquifer in which groundwater is very close to the surface. So when heavy rain falls, the ground is quickly saturated and the land readily floods. This is all the more true when rainfall and storm surge combine during a hurricane. This map shows Composite Flood Exposure, an index developed by the NOAA Office of Coastal Management to show how many flood hazard zones a given location falls within. The index factors in flood risk from shallow coastal flooding, high- and moderate-risk flooding determined by FEMA, Category 3 hurricane storm surge, and sea level rise of 3 feet. Darker colors indicate more flood hazard zones for that location. In Hialeah and Opa-locka, heavy rains present a greater flood risk than storm surge.

DATA SOURCES: NOAA OFFICE OF COASTAL MANAGEMENT

Turcios felt that government agencies failed low-income communities after the storm. Agency personnel promised to repair damaged roofs, but supplied temporary blue tarps and provided no follow-up services. In Turcios' view, "the government didn't do the right thing in poor communities; they just did a quick fix and forgot about it." He felt that because of climate change, preparing the community and having a plan for recovery is more important now than ever: "Over the last 20 years I've noticed flooding happening more often ... I'm

concerned because the more water tends to be around a home the more the water can crack the walls and weaken the base of the house. It's an economic loss, it hurts property values.... Raising a house is very expensive, and only three or so homes have been elevated in my neighborhood."

As local governments and federal agencies move forward with projects to revitalize Opa-locka's and Hialeah's economies, resilience should be a key driver behind these efforts in order to allow for progress even in the face climate change.

Gulfport, MS: A Struggle Against Flooding and Environmental Injustice

The sprawling city of Gulfport is located in Harrison County, MS, along the Gulf of Mexico. With scenic beaches, resorts, casinos, and golf courses, the area is a hub of tourism. Hurricanes, storm surge, and inland flooding have long plagued the Mississippi shoreline, but the devastation of Hurricanes Katrina and Rita in 2005 caused unprecedented, long-lasting damage, and uneven recovery. Between 1985 and 2014, Harrison County suffered nearly \$6 billion in property and crop damages from coastal storms, hurricanes, and flooding (in 2014 dollars). And with rising sea levels, the risks of coastal flooding and storm surge are worsening.

Other local factors, including land subsidence along the Gulf Coast combined with accelerating sea level rise due to climate change, will lead to a projected increase in local sea level of an additional 19 inches by 2050. Simultaneously, the rapid loss of coastal wetlands to growing development is reducing natural protections against flooding and worsening its impacts.

Hurricane Katrina devastated portions of the Mississippi coast with storm surge flooding of 25 to 28 feet above normal tide level and with flood waters reaching more than six miles inland. In the aftermath of the hurricane, disaster aid was slower to arrive in communities of color, such as North Gulfport and Turkey Creek, exacerbating existing stresses on these neighborhoods. Affordable housing units in Harrison County, in short supply prior to the storm, declined by 25 percent due to Katrina. Higher rents for the remaining

units and a greater emphasis on repairing single-family owner-occupied homes relative to multi-family rental units further reduced the affordable housing stock.

Explaining the situation in a 2007 interview, Melinda Harthcock of the Steps Coalition said, “We had an affordable housing crisis before the storm. Developers were filling in wetlands ... but few noticed the danger. Katrina dramatically accelerated everything.” Kathy Eglund of Gulfport, chair of the NAACP Environmental and Climate Justice Committee, warns that “people need to understand that when, not if, the next storm comes it will be even worse. Now when we have hard rain, we have flooding we hadn’t experienced before.”

IMPACTS ON THE TURKEY CREEK COMMUNITY

Settlement patterns in the Gulfport area reflect the area’s long history. In 1866, African American freedmen and -women settled there in swampland areas, such as Turkey Creek and North Gulfport, and were banned from beaches and areas along the coast where the white population lived. In 2001, the Turkey Creek community was recognized as one of the 10 most endangered historic places in Mississippi and was added to the National Register of Historic Places in 2007. Today, more than 36 percent of Gulfport’s population is African American, and nearly one-quarter of the overall population lives in poverty. Sprawling development to the north of the city has put pressure on wetlands as they get dredged and filled, and this has disproportionately increased the flooding risk borne by low-income African American communities.

According to Derrick Evans of Turkey Creek, “Gulfport is a giant textbook of incompatible land use.” But, he says, “The Turkey Creek watershed is very important. ... [We need to] get the wetlands off the development table. We are working to get our fair share of RESTORE Act [Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act] dollars.” Howard Page of the Steps Coalition agrees: “A healthier wetland only adds to flood protection.”

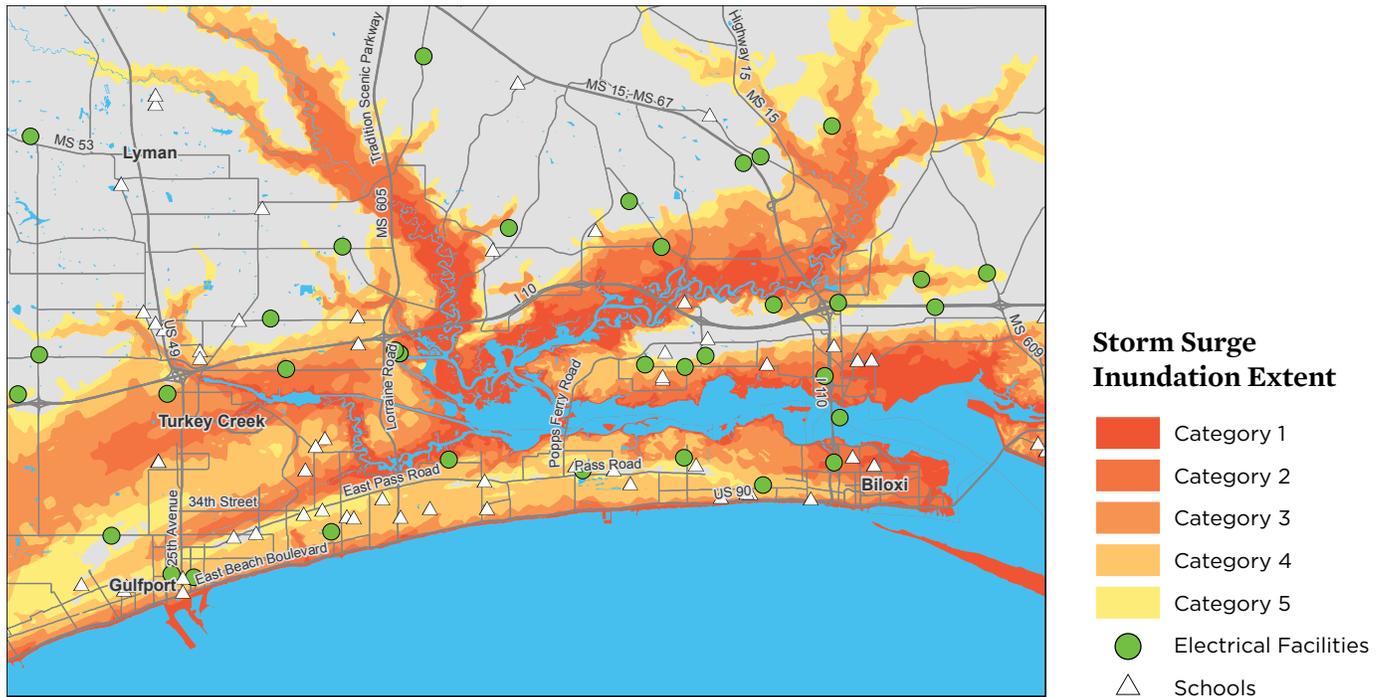
Gulf Coast residents have worked hard to protect and revitalize their communities in the wake of Hurricanes Katrina, Rita, and Isaac, and the BP Deepwater Horizon oil spill, working through organizations such as the North Gulfport Community Land Trust, the NAACP, the Steps Coalition, the Sierra Club, the Audubon Society, the Gulf Coast Fund, the Mississippi Coalition for Vietnamese-American Fisher Folks and Families, the Gulf Restoration Network, and the umbrella regional movement Gulf South Rising. Their efforts contributed to the decision by Southern Company to convert the nearby Jack Watson power plant from burning coal to burning natural gas. Fishing communities are trying



FEMA

An aerial shot of Gulfport, MS, after Hurricane Katrina, showing houses completely removed from their foundations and destroyed.

FIGURE ES-7. Gulfport, MS: Present-day Exposure to Storm Surge from Different Categories of Hurricanes



Owing to its Gulf Coast location, Harrison County, MS, has experienced hurricanes throughout its history, including Category 5 Camille in 1969 and Category 3 Katrina in 2005. While the area potentially affected by surge from Category 1 storms is relatively limited and includes few schools or electrical facilities, Category 3 storms, such as Hurricane Katrina, have the potential for widespread damage. Katrina, for example, brought more than ten feet of water to the streets of Gulfport and left more than one million Mississippians affected. With rising seas and land subsidence, future storm surges will reach farther inland. In addition, warming oceans are expected to contribute to more intense hurricanes.

SOURCE: UCS ANALYSIS USING NOAA'S STORM SURGE MODEL (SLOSH, AT WWW.NHC.NOAA.GOV/SURGE/SLOSH.PHP)

to rebuild livelihoods after impacts such as the steep drop in oyster dock landings over the last decade. The groups are also calling on state and local officials to include their perspectives in both planning and allocating funding awarded as a result of the Deepwater Horizon disaster.

Community engagement must account for diverse needs, for example, translation services. Thao Vu, executive director of Mississippi Coalition for Vietnamese-American Fisher Folks and Families, says, “When Hurricane Katrina

came, it didn’t just damage housing, but also fishing infrastructure. So, not just their homes, but also their livelihoods [were affected], and future disasters [will] only exacerbate [the] losses and impacts they’ve experienced. FEMA aid centers set up after Katrina did not have adequate translators or materials written in a manner people [could] understand. Title VI of the Civil Rights Act and executive order[s] should address diversity of language in the community, but we do not have a model of compliance here in Mississippi.”

In the aftermath, disaster aid was slower to arrive in communities of color, exacerbating existing stresses on these neighborhoods.

Plaquemines Parish, LA: Sinking Land and Rising Seas Mean Tough Choices

Plaquemines Parish, much of which lies below sea level, is located to the southeast of New Orleans where the Mississippi river flows into the Gulf of Mexico. Despite an extensive levee system surrounding portions of the parish and plans for more investments in flood control, coastal communities face a difficult future with growing threats from flooding and storm surge.

Louisiana is experiencing some of the highest rates of relative sea level rise in the world. Land subsidence—caused by upstream flood-control measures on the Mississippi River, oil and gas operations, and sediment compaction—is a major contributor. Wetlands that once helped shield the coast from being battered by storms are now being lost at a rate of 40 square miles per year, with 2,300 square miles of wetlands (an area larger than Delaware) having been lost since 1932. According to the state of Louisiana, its coasts could see 10.6 to 31.5 inches of sea level rise between 2010 and 2060,

which will result in significant coastal land loss, including in Plaquemines.

Several predominantly African American communities located in Plaquemines are ground zero for the harsh confluence of socioeconomic vulnerability and extreme risks from sea level rise. Formerly the sites of plantations, the communities of Ironton, St. Rosalie Plantation, Woodland, and many other towns were established by formerly enslaved people whose descendants live there today. Faced with segregation and discriminatory laws, the Plaquemines African American community engaged in a civil rights struggle that resonates to this day.

Today residents live with significant pollution from nearby oil refineries and coal export terminals. The 2010 Deepwater Horizon oil rig explosion occurred just 40 miles from the coast of Plaquemines Parish, and the consequent oil spill affected more than 3,000 acres of coastal wetlands in the parish and devastated the livelihoods of many people in the local African American fishing community.

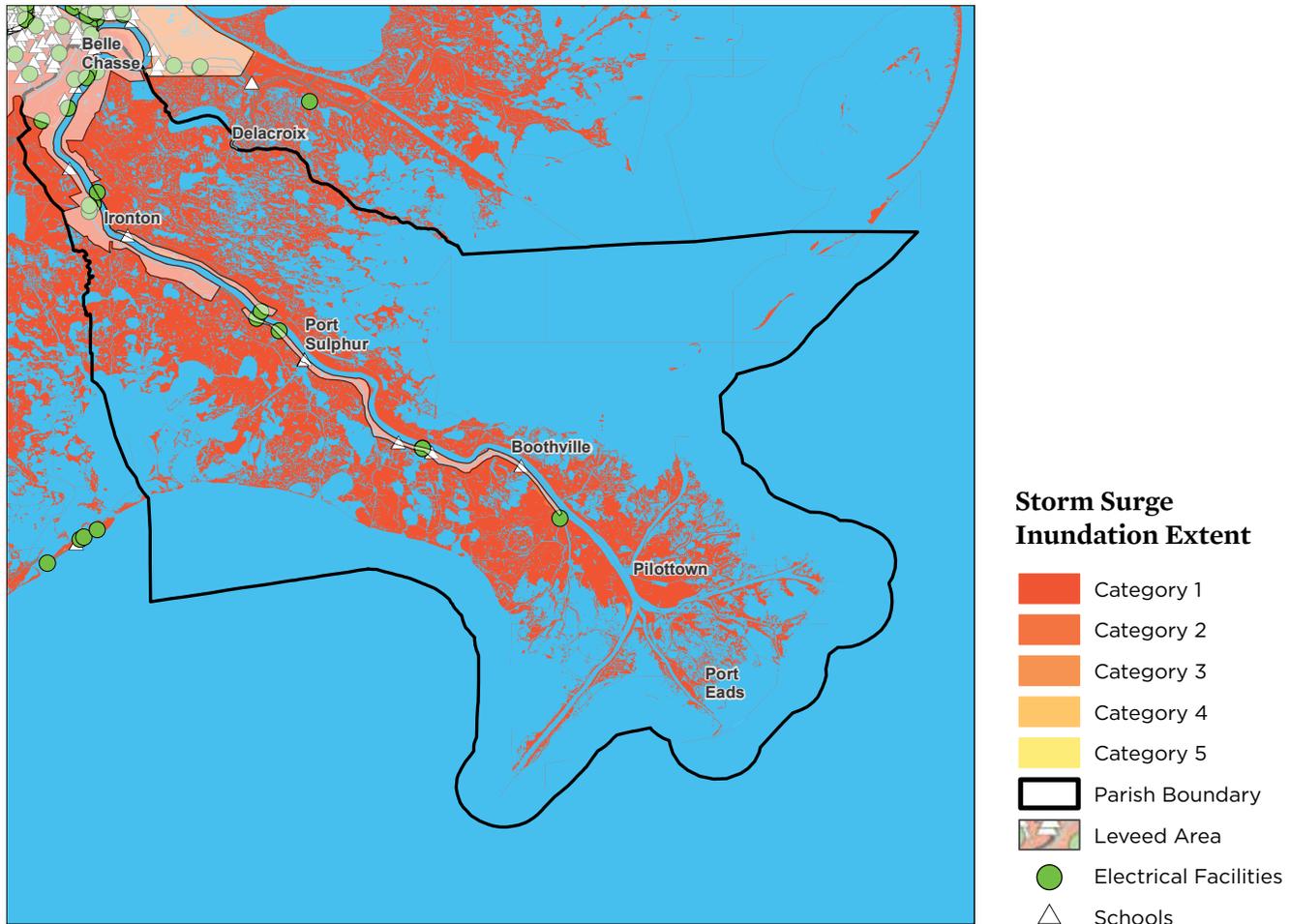
Hurricane Katrina made landfall in the town of Buras in Plaquemines Parish, and the parish was hit again by



Andrea Booher/FEMA

Residents of Plaquemines Parish talk with a FEMA representative outside of their flooded home following Hurricane Katrina.

FIGURE ES-8. Plaquemines Parish, LA: Present-day Exposure to Storm Surge from Different Categories of Hurricanes



When Hurricane Katrina made landfall as a Category 3 storm in Louisiana in August of 2005, it did so in Plaquemines Parish. While media attention during and after the storm focused primarily on New Orleans, just to the northwest, the smaller towns of Plaquemines Parish were devastated by a storm surge of approximately 12 feet. Unlike New Orleans, many of the towns of Plaquemines are largely unprotected by levees and are therefore vulnerable to complete inundation with only a Category 1 storm, as this map shows. The parish is home to over 23,000 people.

SOURCE: UCS ANALYSIS USING NOAA'S STORM SURGE MODEL (SLOSH, AT WWW.NHC.NOAA.GOV/SURGE/SLOSH.PHP)

Hurricanes Rita in 2005 and Isaac in 2012. In addition to the death and devastation caused by Katrina, coastal towns in Plaquemines Parish lost between 40 and 70 percent of their residents to displacement. Despite federal government disaster assistance of nearly \$20 billion to Louisiana, in the wake of Katrina and Rita, residents in smaller coastal communities like those in Plaquemines have had difficulty accessing the aid and are still struggling to rebuild.

The state of Louisiana's 2012 Comprehensive Master Plan for a Sustainable Coast, developed in partnership with

the U.S. Army Corps of Engineers, is an ambitious attempt to stave off threats to this coastally dependent state by investing in ecosystem-based defenses, like barrier islands and wetlands, alongside human-made defenses like levees. The centerpiece of the \$50 billion, 50-year plan, the Mid-Barataria Sediment Diversion, is designed to replenish sediment in the Mississippi delta to help build and maintain land and protect coastal wetlands. This and other aspects of the plan, however, are controversial. Some scientists estimate that land loss will outpace the effectiveness of the diversion and believe that

the 2012 iteration of the plan used inadequate projections of sea level rise. Others worry that it could leave some communities unprotected. Ironically, the BP oil spill has renewed focus on the need to invest in coastal protection and restoration, and the damage settlement reached with BP could provide a source of funding for this effort.

The reality is that severe risks from sea level rise, past decisions that have undermined natural coastal barriers, and the inevitable limits of engineering solutions, mean that many communities in coastal Louisiana face very tough choices. The challenge will be finding equitable ways forward that give these communities a voice in the process and marshal the resources they need to make those choices. Community members are building alliances for a better vision for the future, with the ongoing support of groups including the Gulf

Restoration Network, the Gulf South Rising movement, and the Sierra Club.

Reverend Tyrone Edwards, pastor of the Phoenix Zion Travelers Baptist Church, speaks to new opportunities to get this right.

“We found out that disasters and coastal restoration are big money. It’s more about giving contracts to some people than protecting [Louisianans/people in Plaquemines Parish]. Oftentimes, the work is overpriced [and too much spent on overhead and subcontracts]. If more of the money were used correctly, we could have more projects done.

... It is key that local people are employed in the coastal restoration projects. That’s one way to work towards making communities whole.”

Policy makers and agencies must ensure that investments in climate resilience are better targeted and more equitably shared, and communities on the front lines of climate change should have a direct voice in shaping their future.

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