



CLIMATE RESILIENCE INDEX

A COMPARATIVE ANALYSIS FOR MEASURING PROGRESS

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ESI CENTER FOR THE
FUTURE OF CITIES

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INTRODUCTION

In an era defined by the alarming impacts of climate change, the need for cities to cultivate resilience against environmental and economic challenges has become increasingly important. The goal of this research is to measure the climate resilience efforts in select American urban centers. As global temperatures rise, extreme weather events become more frequent, and sea levels continue to surge, understanding how cities navigate and adapt to these challenges is vital for ensuring a sustainable city.

Climate resilience refers to a community's capacity to recover from and withstand the impacts of climate-related changes on its environment, infrastructure, economic, and social make-up. Whether a city faces chronic challenges or acute shocks, it must adapt, bounce back, and continue functioning effectively to be considered resilient.

The research in this index builds upon the database of indices and metrics that ESI has amassed to evaluate and address the ever-changing nature of climate risks and the evolving needs of cities in their quest for climate resilience. The research team utilized ESI methodologies and analyses developed for research and reporting in support of return on environment studies for trails and open space organizations, impact statements for funding opportunities, and strategic planning exercises for economic development organizations.

ABOUT THE CLIMATE RESILIENCE INDEX

This climate resilience index is the culmination of a six-month research engagement led by Gina Lavery, head of **ESI Center for the Future of Cities** and completed by its 2023 Summer Fellows. It presents a framework for developing a systematic and standardized assessment of cities' preparedness and adaptive capacity to withstand and recover from climate-related risks and challenges. It uses metrics to evaluate the ever-changing nature of climate risks and the evolving needs of communities in the quest for climate resilience.

The research has culminated in an index developed to provide a holistic scoring system to evaluate climate resiliency based on a wide spectrum of environmental, economic, infrastructure, and social metrics. This framework allows for a systematic and standardized assessment of a city's preparedness and adaptive capacity to withstand and recover from climate-related risks and challenges. A pilot study of nine U.S. cities put the index into effect with an aim for evaluation of additional cities in the future. It serves as a launchpad for nuanced and comparative analysis and reliable benchmarking for measuring progress.

City leaders are encouraged to benchmark their climate resilience policies and initiatives based on the wide spectrum of metrics that factor into the challenges they face. The nine cities selected to pilot the index were further researched, case studies about them provide deeper insights. Ultimately, the goal is to promote knowledge exchange among decision makers, encouraging them to learn from successful strategies and replicate effective practices, calibrated to the context of their regions.

BACKGROUND RESEARCH

The first step was an extensive review of existing literature, academic studies, and reports on climate resilience. This background research helped to identify key concepts, methodologies, and best practices used in similar indices or assessments. To ensure effectiveness of the index, the background research delved into previous attempts at climate resilience assessments to identify lessons learned and areas ripe for improvement. The research team referenced the City Resilience Index, developed by Arup and the Rockefeller Foundation; The Urban Resilience Index, developed by the University of Notre Dame; the European Urban Resilience Forum; and the Asian Cities Climate Change Resilience Network (ACCCRN).

The background research phase also involved identifying and categorizing the various components that contribute to a city's resilience. This led to the definition of four major cornerstone categories with each category carefully broken down into relevant sub-indicators that capture measurable dimensions of resilience.

TYPES OF DATA, STANDARDIZATION OF METRICS, AND SOURCES

The four major measurable cornerstone categories are: environmental, economic, infrastructural, and social. Sub-indicators provided metrics to ensure a comprehensive assessment of resilience in each category—see page 7 for the list of sub-indicator metrics for each category. The metrics are based on primary and secondary data from various sources, including federal, county, and city-level agencies, bureaus, institutions, and financial reports. Other data and research were gathered from non-governmental organizations. Metrics measuring cumulative values, such as total emissions for a city, were standardized using city population to reduce bias against cities with larger populations.

Information for city case studies was collected from various news publications and city government institutions.

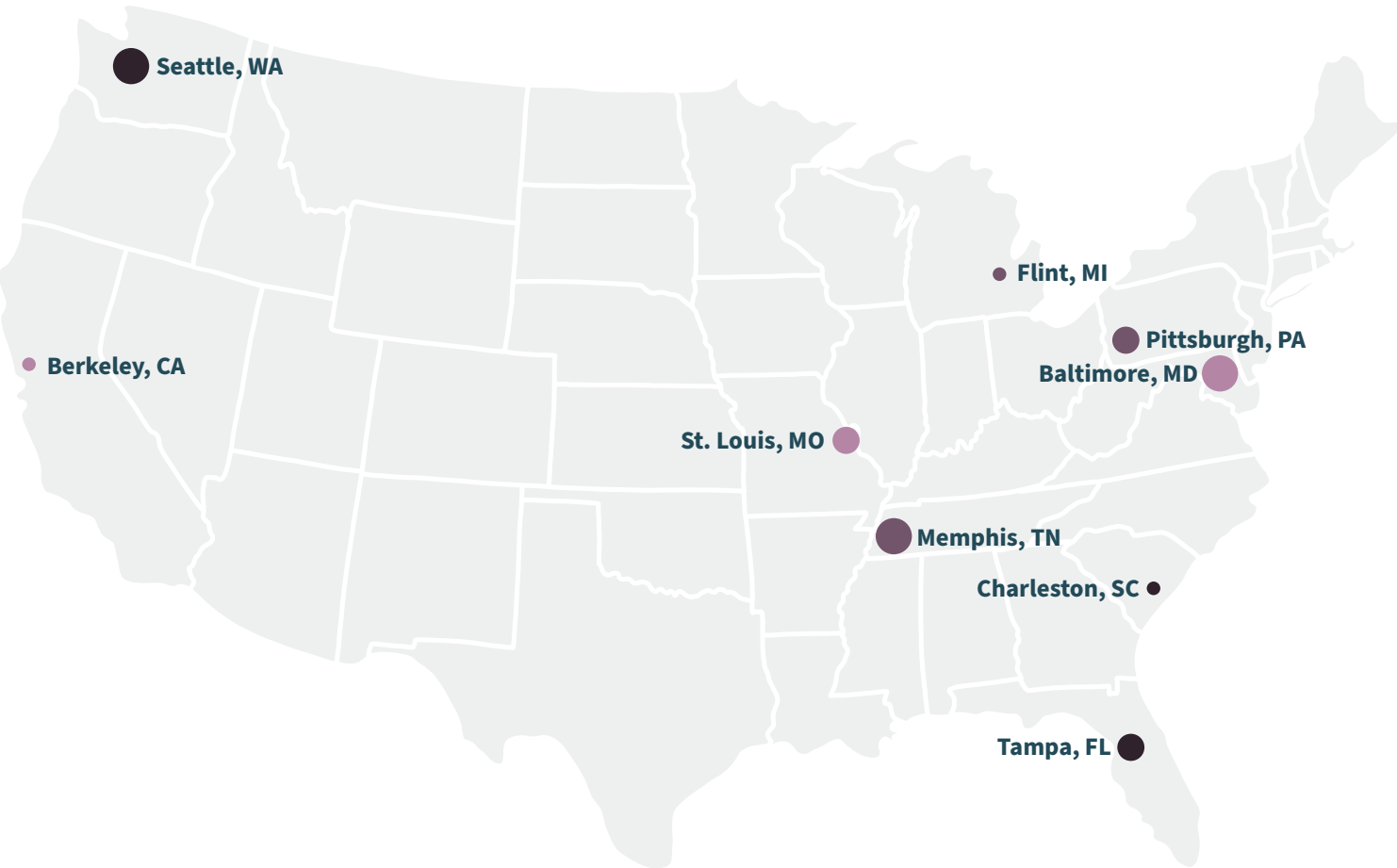
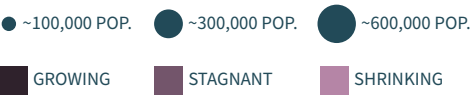
CITY SELECTION

The Climate Resilience Index was tested with the analysis of nine cities across the continental United States, selected to provide a relatively diverse geographical view of the country. Selection was based on population size and growth rate to examine how cities of varying sizes and population dynamics cope with climate-related issues.

The selected cities were categorized by population: small (~100,000), medium (~300,000), and large (~600,000). Then they were organized into three distinct population growth categories: growing, stagnant, or shrinking.

Naturally, there are limitations and challenges in selecting only nine cities to encompass the diversity of the U.S. urban landscape. However, as an initial evaluation of the existing conditions, policies, programs, and mitigation efforts aimed to build climate resilience, this sample size was instructive for gaining an understanding of the complexities of developing an index of this magnitude, as well as the opportunities for future research.

SELECTED CITIES



THE INDEX

The methodology for the index was designed to provide a contextual and standardized assessment of city performance in the range of metrics. To achieve this, the research team employed a ranking process that compared each city's performance to the eight other cities using the national average/average of major MSAs as a reference point. This was done to facilitate a fair and relative evaluation, taking into account regional and national contexts.

Each city was scored individually within the four categories, considering its performance across the 17 sub-indicator variables. The scores were then standardized to ensure a uniform scale. This standardization allowed for easier comparison and interpretation of the results.

ENVIRONMENT

The first category examined each city's environmental sustainability, examining factors like air quality, green spaces, and the city's efforts in mitigating environmental impacts. This category indicates the city's commitment to sustainability and its approach to protecting the environment. The category was split into quantitative and qualitative metrics to provide a more accurate assessment of each city's environmental condition. This category received a 40 percent weighting in the final score.

The qualitative environmental analysis considered various aspects, including the reduction of destruction caused by extreme climate events, the decrease in the loss of life and property, and the response of federal and city governments to climate crises. The level of investment and capacity in disaster mitigation and relief within cities was considered, with a higher score given to those with greater commitments in these areas.

ECONOMIC

The second category focused in on each city's economic performance, analyzing indicators such as employment rates and financial burden. This category provides an understanding of the city's economic strength and potential for growth and prosperity. This category received a 20 percent weighting in the final score.

INFRASTRUCTURE

The third category considered infrastructure and connectivity, analyzing elements such as transportation investment and overall infrastructure development. The metrics in this category assess each city's capacity to support its residents' needs and facilitate efficient movement and communication. This category received a 20 percent weighting in the final score.

SOCIAL

The fourth category explored each city's social and cultural factors, evaluating education levels, political engagement, and social amenities. The metrics in this category gauge the city's inclusivity and cultural vibrancy. This category received a 20 percent weighting in the final score.

THE SCORECARD

Population Range	Small (~100,000)			Medium (~300,000)			Large (~600,000)		
	Berkeley, CA <i>shrinking</i>	Flint, MI <i>stagnant</i>	Charleston, SC <i>growing</i>	St. Louis, MO <i>shrinking</i>	Pittsburgh, PA <i>stagnant</i>	Tampa, FL <i>growing</i>	Baltimore, MD <i>shrinking</i>	Memphis, TN <i>stagnant</i>	Seattle, WA <i>growing</i>



ENVIRONMENT

Standardized Score*	33.2	9.2	34.4	5.2	29.2	30.4	11.2	29.2	27.6
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* Total of quantitative and qualitative scores



ECONOMIC

Standardized Score	10.8	9.6	8.0	14.8	10.8	8.4	6.8	9.6	10.4
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INFRASTRUCTURE

Standardized Score	8.0	13.3	5.3	13.3	2.7	14.7	12.0	7.3	13.3
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SOCIAL

Standardized Score	14.7	5.3	11.3	10.0	12.0	8.0	7.3	3.3	17.3
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Scoring & Ranking

Total Score	66.7	37.5	59.1	43.3	54.7	61.5	37.3	49.5	68.7
Overall Ranking	2	8	4	7	5	3	9	6	1

Scores may not sum due to rounding

THE METRICS

ENVIRONMENT

- Emissions Per Capita
- Air Quality Index
- Land Cover (%)
- 10-Year Temperature Change (%)
- Number of Water Contaminants
- Qualitative: Effectiveness of Response

ECONOMIC

- Unemployment Rate (%)
- Median Housing Cost Ratio (Renters)
- Median Housing Cost Ratio (Mortgage)
- Homes Sold Above Listing (%)
- Mean Travel Time to Work (minutes)

INFRASTRUCTURE

- Transit Investment/Expenditures Per Capita
- Building Inspection Expenditures Per Capita
- County Level Infrastructure Expenditure per capita

SOCIAL

- Voter Turnout (%)
- Education Levels (%)
- Access to Arts

DISCUSSION

Based on the results of the ESI Center for the Future of Cities Climate Resilience Index, Seattle, a large, growing city, emerges as the overall frontrunner (scoring 68.7) resulting from strong economic, infrastructure, and social metrics. The city has a socially engaged population as indicated by its high score (17.3). And, although its infrastructure score is among the highest in the sample (13.3) it is going further with advances in commuter management (see the case study on page 24). Seattle sets a benchmark for other cities signifying that it is a model for achieving climate resiliency.

Directly following Seattle in the index are: Berkeley, a small city with a shrinking population with an overall score of 66.7; and Tampa, a medium, growing city, scoring 61.5 overall.

The evaluation of sub-indicators and research into case studies revealed that climate resilience and readiness in Tampa provides a benchmark for other coastal cities—as they are especially susceptible to flooding, hurricanes, and sea level rise. Tampa stands as a model for coastal cities that also face socioeconomic difficulties yet must advance toward climate resilience, serving as a gauge of environmental, economic, infrastructure, and social readiness to measure progress.

The index underscores the challenges some cities face and points to the need for tailored interventions to address specific weaknesses. Cities facing economic challenges, like Baltimore, a large city with a shrinking population, having the lowest overall score in the sample (37.3) and therefore the

lowest ranking (9), stand to benefit from measuring its climate resilience progress against peer cities. The climate resilience index provides a tool to measure focused strategies as cities strive to bolster economic resilience and social engagement which aim to also build environmental sustainability.

Similarly, St. Louis, a medium sized city with a stagnant population, which had the lowest environment score of all nine cities (5.2) established a targeted initiative, the 100 Resilient Cities and Equity Indicators Project which aims to foster sustainability and conservation efforts in tandem with equity and inclusion (see case study on page 22). Pittsburgh, with a low infrastructure score (2.7) and Memphis, having a low social score (3.3) demand concerted efforts to bridge the necessary gaps to achieve comprehensive climate resilience.

Overall, understanding the complex range of strengths and challenges in addressing climate change is pivotal for fostering collaboration and informed decision-making by city officials and civic leaders. By acknowledging and addressing these variations, stakeholders can utilize the ESI Center for the Future of Cities Climate Resilience Index to measure and gauge efforts and resources effectively, ultimately fostering a more resilient urban landscape.

CASE STUDIES

Baltimore, MD
Smart Surface Initiative to Combat Urban Heat

Berkeley, CA
Community Resilience Centers

Charleston, SC
Flooding and Sea Level Rise Strategy

Flint, MI
Drinking Water Crisis

Memphis, TN
Mid-South Regional Resilience Master Plan

Pittsburgh, PA
Accelerated Adoption of Electric Vehicles

St. Louis, MO
The Equity Indicators Project

Seattle, WA
Commuter Strategies to Reduce Carbon Emission

Tampa, FL
Regional Resiliency Action Plan

As the American landscape is increasingly shaped by climate volatility and shifts of urbanization, cities stand at the forefront of resilience and sustainability efforts. The case studies presented here offer a glimpse into the diverse strategies undertaken by municipalities across the United States to address pressing environmental challenges. From Berkeley's community-centric approach and Baltimore's smart surfaces initiative, to Pittsburgh's electric vehicle adoption strategy and Seattle's innovation district, the programs featured in the case studies encapsulate the multifaceted endeavors aimed at mitigating climate change impacts. Stories from Memphis' resilience planning, Charleston's flood prevention strategy, Flint's infrastructural challenges, St. Louis' equity-focused approach, and Tampa's regional action plan underscore the imperative for adaptive, community-driven solutions in fostering resilient, equitable, and sustainable urban environments.

BALTIMORE

MARYLAND

LARGE CITY / SHRINKING POPULATION

MAJOR CLIMATE STRESS: EXTREME HEAT

TREE EQUITY SCORE: 85

OVERALL
RANKING

9

CATEGORY RANKINGS



CASE STUDY: SMART SURFACES TO COMBAT URBAN HEAT ISLAND EFFECT

Baltimore is not alone in facing the stress of increasing extreme heat. As in many cities worldwide, the urban heat island effect has exacerbated climate change. Built up long ago, Baltimore has expansive man-made heat absorbing surfaces including buildings, industry, and parking lots. Furthermore, there is a dearth of open space and tree cover, particularly in minority and lower-income neighborhoods. Baltimore, as well as other cities, is exploring smart surfaces in earnest to mitigate the effects that the built environment has on climate change and in doing so striving to reduce climate inequities.



Source: Yianni Mathioudakis for Unsplash

CASE STUDY: SMART SURFACES TO COMBAT URBAN HEAT ISLAND EFFECT

Climate change projections for Baltimore indicate a threefold increase in days exceeding 90 degrees by 2050. To address the impact that the built environment has on the rise of urban heat, the city has partnered with The Smart Surfaces Coalition to promote the adoption of smart surface interventions. When implemented collectively, heat attenuating infrastructure such as reflective surfaces, porous pavement, bioretention basins, trees, and solar panels contribute to combating global warming while improving quality of life in the city.

The Smart Surfaces Coalition developed a Baltimore-specific cost-benefit tool to aid decision-makers in choosing smart surfaces. The model is dynamic, allowing for the analysis of different scenarios, helping city officials understand the financial and other benefits of investments in sustainable building materials and green infrastructure. For example, the cost-benefit model can be used to estimate the impact of a 10 percent increase in tree cover in a specific neighborhood. Compared to existing modeling software like BenMAP from the EPA, the Smart Surfaces Coalition model addresses various estimation gaps, including indirect energy benefits, ozone concentration reductions, health benefits of emissions reductions, and heat-related mortality reductions.

The Smart Surfaces Coalition enlisted local stakeholders to outreach into low-income neighborhoods and coordinate with city agencies. The Baltimore Neighborhood Indicators Alliance and the University of Baltimore are two organizations

that were involved. In many cities, the urban heat island effect reveals a correlation between low-income communities and the damaging effects of excess summer heat. This environmental inequity is felt throughout Baltimore in lower-income neighborhoods, such as Brooklyn-Curtis Bay, Cherry Hill, and Madison East End, which are predominantly communities of color that have inadequate open space and tree

coverage, resulting in higher temperatures, poorer air quality, public health issues, and increased energy costs. By investing in smart surfaces, including planting trees in these neighborhoods, the city can address disparities while improving the quality of life for neighborhood residents and mitigate some of the urban heat island effect that Baltimore has overall on climate change.

Use of the Smart Surfaces Coalition analytical tool to inform policy helps dispel misconceptions that smart surfaces and green infrastructure are expensive community improvement investments. Instead, the model reveals the significant, multi-faceted benefits gained and can help cities achieve a healthier, more sustainable, and equitable future.

The Smart Surface Coalition's initiatives have been validated by successful studies in El Paso, Philadelphia, and Washington, DC. These studies demonstrate the cost-effectiveness of smart surfaces in addressing climate change and equity issues. Shifting to smart surfaces would aid in cooling and greening urban areas for healthier neighborhoods.

The Wildflower project in Baltimore is converting vacant lots into urban meadows. In doing so, the project is establishing open space for growing native plants, effectively greening dense neighborhoods, reducing the urban heat island effect while improving livability.

Source
[Smart Surfaces Coalition](#)



BERKELEY CALIFORNIA

SMALL CITY / SHRINKING POPULATION

MAJOR CLIMATE STRESS: EARTHQUAKES & LANDSLIDES

BUILDING INSPECTION EXPENDITURES PER CAPITA: \$19

OVERALL
RANKING

2

CATEGORY RANKINGS



CASE STUDY: COMMUNITY RESILIENCE CENTERS

Like most communities in California, the City of Berkeley is susceptible to multiple hazards, including earthquakes, wildland-urban interface fires, landslide and liquefaction areas, and urban creek flooding. The city is in continual preparation for the forecasted Hayward fault event, as well as other major regional climate related emergencies. Through collaborative, innovative endeavors to achieve disaster preparedness, Berkeley has leveraged a State of California program, Community Resilience Centers. In doing so the city has emerged as a leading force in the pursuit of climate resilience.



Source: Zetong Li for Unsplash

CASE STUDY: COMMUNITY RESILIENCE CENTERS

The resilience strategy for Berkeley outlines six goals, the first of which is to build a connected and prepared community. The Community Resilience Center (CRC) program is an example of its success.

The California CRC program provides funding for the construction and improvement of resilience centers at the neighborhood level throughout the state. In Berkeley, these centers are designed to support communities during climate-related and other disasters while also promoting long-term resilience, preparedness, and recovery. The program offers funding for planning and implementation grants, enabling community-serving institutions to act as comprehensive emergency response centers, and provide year-round services.

Examples of the types of expenses covered by CRC funding include: retrofitting resilience centers to provide emergency shelters with features like solar installation, energy and water efficiency upgrades, broadband infrastructure, and energy storage systems. The funding can also be used for improving the surrounding areas by incorporating community gardens, shade trees, and low-carbon transportation to and from the centers. Moreover, CRC grants support community development, climate resilience awareness, local workforce training, distribution of essential resources like food and clean water and disaster preparedness programming such as first responder training for climate emergencies.

City of Berkeley Six Goals for Climate Resilience

1. Build a Connected and Prepared Community
2. Accelerate Access to Reliable and Clean Energy
3. Adapt to the Changing Climate
4. Advance Racial Equity
5. Excel at Working Together within City Government to Better Serve the Community
6. Build Regional Resilience

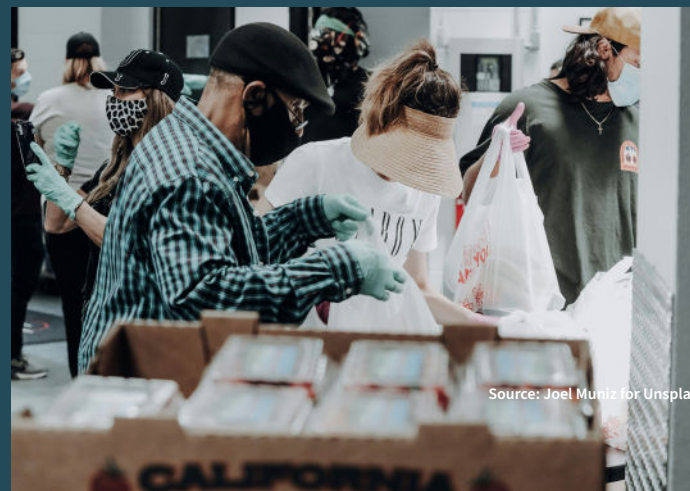
The eligibility to apply for CRC funding requires the involvement of multiple stakeholders and the active participation of community-based organizations and residents in governance and decision-making processes. Applicants may include community-based organizations, schools, and small businesses, amongst others. In return for hosting training sessions, the city provides these local organizations with a cache

of emergency supplies to help serve their community, acting as hubs for assistance and information during and after disasters.

Implementation of Community Resilience Centers in the City of Berkeley, stands as a testament to the city's success in driving tangible change. Resilience centers at the neighborhood level are being constructed and improved to provide vital support during climate-related disasters, while fostering long-term preparedness and strategies for recovery.

Berkeley Ready leads the city's disaster preparedness initiatives. It manages the emergency response team, provides resources and tool kits so households and businesses can be prepared, and makes caches of emergency supplies available to neighborhoods in need.

Source
[Berkeley Climate Action Plan](#)



Source: Joel Muniz for Unsplash

CHARLESTON

SOUTH CAROLINA

SMALL CITY / GROWING POPULATION

MAJOR CLIMATE STRESS: HURRICANES & COASTAL FLOODING

ANNUAL PRECIPITATION: 46.3"

OVERALL
RANKING

4

CATEGORY RANKINGS



CASE STUDY: FLOODING AND SEA LEVEL RISE STRATEGY

The oldest part of the City of Charleston is on a peninsula at the confluence of three rivers near the Atlantic Ocean. As a coastal city, Charleston, experiences frequent flooding and anticipates sea level rise. The National Oceanic and Atmospheric Administration projects that its coastline will rise 10–14 inches in the next 30 years. This amount is equivalent to sea level rise in the previous 100 years. To address the impacts of this impending surge, Charleston has initiated a comprehensive flood and sea level rise mitigation strategy that incorporates a range of stormwater and flood retention infrastructure improvements.



Source: Alexander Santiago for Unsplash

CASE STUDY: FLOODING AND SEA LEVEL RISE STRATEGY

The strategic infrastructure improvement plan has five main objectives aimed at achieving a more resilient and sustainable future for the Charleston area. Comprehensive in scope, the plan seeks to protect citizens and neighborhoods from the impacts of flooding, protect critical city infrastructure, preserve the region's economic viability, protect and maintain natural and economic resources, and engage regional partners to reduce the impact of sea level rise and flooding.

Complicating implementation is the historic built environment and aging infrastructure. The strategy includes numerous infrastructure projects focused on resiliency and sustainability. Two of the most significant projects are the Spring-Fishburne Drainage Project and the reconstruction of the Low Battery seawall. The Spring-Fishburne Drainage Project is a \$198 million project to improve drainage and reduce flooding events and severity. The project consists of a network of surface pipes and vertical drop shafts leading to a series of tunnels that pump water into the Ashley River. The main focus area of the project is the Charleston peninsula, the section of the Charleston region that receives the most routine flooding. Many portions of the project are already complete, and upon full completion in 2025, the system's stormwater flow capabilities will be ten times greater, drastically reducing the occurrence of flood events.

Flood and Sea Level Mitigation Infrastructure Plans for Charleston

1. Storm drainage upgrades
2. Deep tunnel and pump system
3. Storm surge wall
4. Sea wall
5. Drainage canals
6. Bluebelt program for floodplain management

The Low Battery seawall is a 100-year-old seawall protecting the southern portion of the Charleston peninsula. The seawall protects against minor fluctuations in sea level and prevents flooding of city streets. Over time, as sea levels have risen, the seawall has become less effective at preventing flooding and experiencing erosion. Reconstruction includes repairing the wall

and raising the height to account for rising sea levels. A taller seawall protects street-level roads and buildings and provides additional allowance for more amenities. In addition to repairing the seawall, more stormwater drainage lines are being constructed to prevent flood events.

The Flooding and Sea Level Strategy includes many other measures to prevent flooding, account for sea level rise, and improve drainage, including elevated buildings, increased green spaces, public awareness and education, and data monitoring and analysis. These efforts reflect the city's commitment to strategically approaching the issue of climate change and making vital planning decisions for the future of Charleston.

The City of Charleston Bluebelt Program guides strategic flood mitigation policies to reduce flood hazard risks. The goal is to restore natural floodplain functions while restoring natural habitats and improving water quality.

Sources

[Charleston, SC Flooding & Sea Level Rise Strategy](#)

[Sea Level Rise and Flooding: an Introduction, City of Charleston](#)



FLINT MICHIGAN

SMALL CITY / STAGNANT POPULATION

MAJOR CLIMATE STRESS: TORNADOES

ANNUAL PRECIPITATION: 31.4"

OVERALL
RANKING

8

CATEGORY RANKINGS



CASE STUDY: DRINKING WATER CRISIS

Cities throughout the United States are served by aging infrastructure. The drinking water crisis experienced in Flint, Michigan from 2014 to 2019 serves as a warning about what happens when governments and agencies fail to meet residents' essential, basic needs. Citizens rely on their government and the agencies charged with response to disasters and emergencies to lead safe, multi-pronged recoveries. The cost of failure is staggering. Despite the seemingly hefty price tag associated with implementing measures to construct sustainable infrastructure and mitigate devastation, the value of city resilience is immeasurable.



Source: Adobe Stock

CASE STUDY: DRINKING WATER CRISIS

In April 2014, the City of Flint, Michigan, changed its water supply source to the Flint River to reduce costs. Despite knowing that the water from the Flint River contained highly corrosive compounds and that the aging system of water lines throughout the city contain lead, the necessary water treatment process was not implemented. Soon after the switch was made, lead quickly leached into the drinking water, dispensed from spigots and faucets in homes and buildings throughout the city.

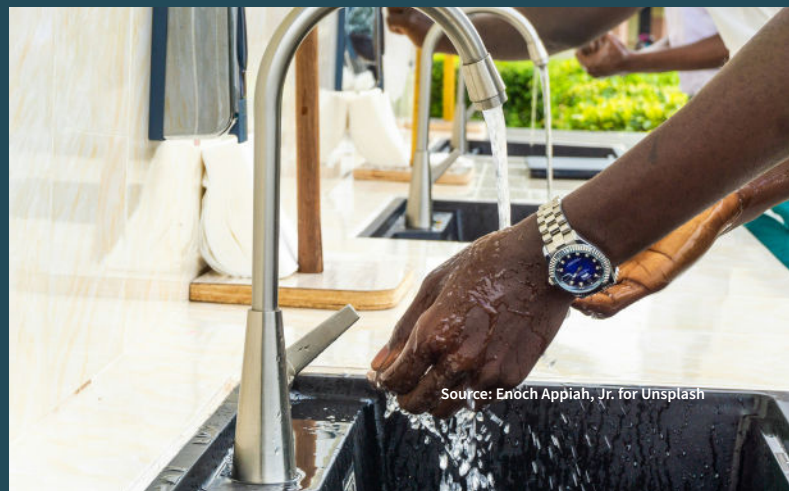
The consequences of the Flint water crisis were catastrophic. The lack of potable water was devastating, disrupting the daily lives of thousands of Flint residents. They did not have drinking water, nor could they conduct daily tasks like cooking, bathing, and cleaning without fear. Elevated lead levels were detected in Flint children's blood, indicating long-term impact. Lead exposure, especially in children, can result in severe and irreversible damage to cognitive development causing learning disabilities and behavioral problems. In addition to lead contamination, residents also faced exposure to harmful bacteria and other toxic substances, causing an upsurge in waterborne illnesses.

The City of Flint was placed under state-appointed emergency management until safe drinking water was restored to all. The water crisis exposed the realities of infrastructure mismanagement and poor emergency response. Most of Flint's

population is African American and many residents live in poverty. These marginalized communities suffered disproportionately, as authorities consistently downplayed the mistakes made by agencies, disregarding residents' concerns. This crisis highlighted the systemic inequalities that persist in the United States, where vulnerable communities are often left to bear the brunt of poor decision-making and inadequate infrastructure investments. Furthermore, the crisis revealed failures of government response at various levels. Local officials downplayed the severity of the issue, while state and federal agencies were slow in their response. The lack of transparency and accountability in handling the crisis fomented public mistrust of government and the agencies charged with providing safe, essential, basic public services. Government and agency officials involved in decision-making that led to the crisis have been held to account in on-going investigations.

In response to the Flint drinking water crisis, federal, state, and local governments created new regulations and protocols for water testing, lead pipe replacement, and disaster management reforms were developed to address such emergencies. Ultimately this crisis underscored the importance of community engagement, communications, and activism to raise awareness, provide assistance, and demand accountability.

Since July 2016, the water system in Flint, Michigan has met state and federal standards for clean drinking water. The city has replaced water lines throughout the system.



MEMPHIS TENNESSEE

LARGE CITY / STAGNANT POPULATION

MAJOR CLIMATE STRESS: TORNADOES, FLOODS, HEAT WAVES

ANNUAL PRECIPITATION: 53.7"

OVERALL
RANKING

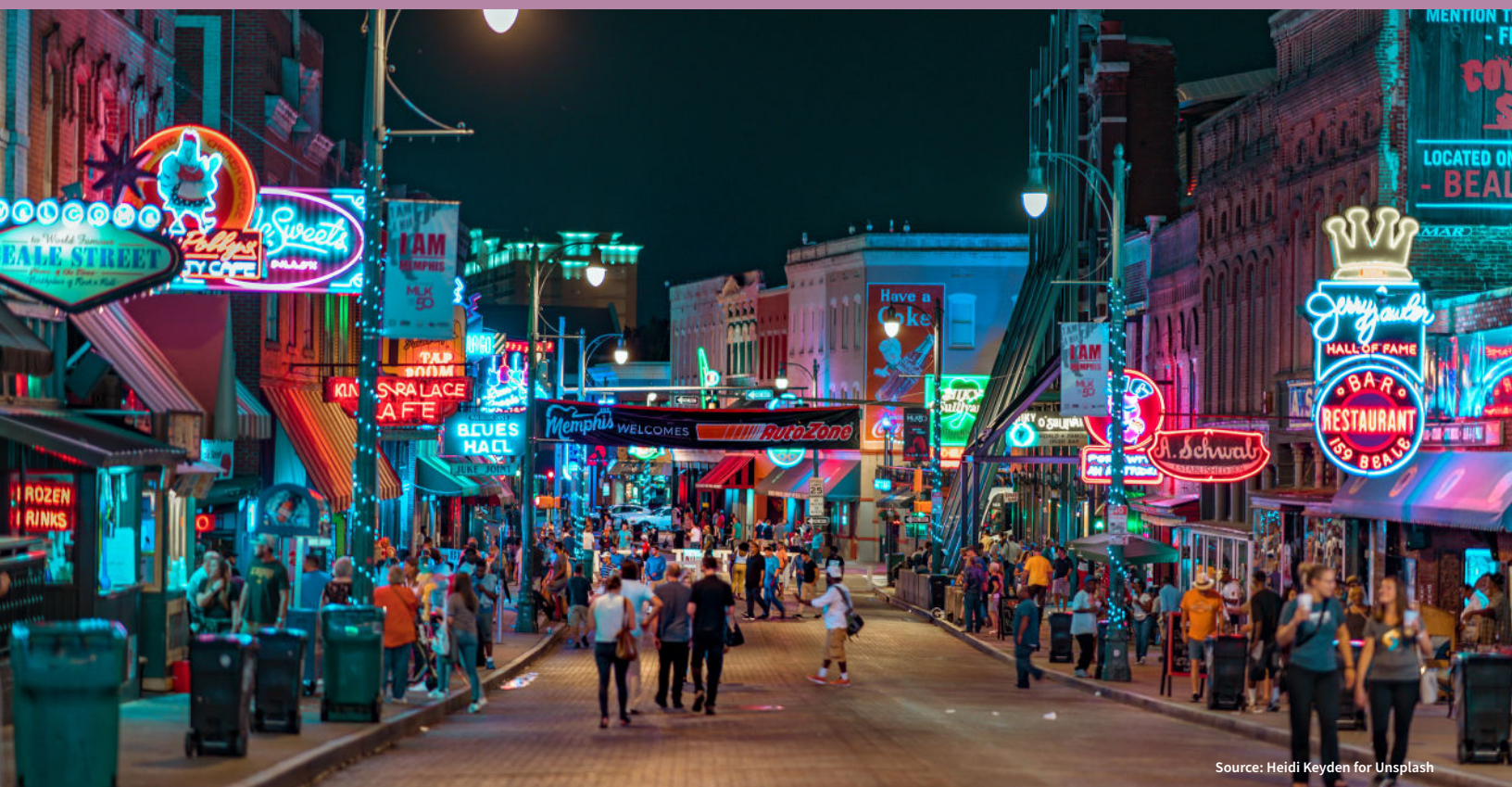
6

CATEGORY RANKINGS



CASE STUDY: REGIONAL RESILIENCE MASTER PLAN

In 2011, Shelby County faced unprecedented devastation when a series of storms unleashed more than 16 inches of rain, accompanied by tornadoes and straight-line winds, followed by widespread flooding along the Mississippi River and its tributaries. This single event, cause for three federally declared disasters, cost a staggering \$2 billion for recovery. The brunt of the catastrophic damage was borne by some of the most vulnerable communities in Shelby County that have yet to recover, and which remain susceptible to future climate-related disasters.



Source: Heidi Keyden for Unsplash

CASE STUDY: REGIONAL RESILIENCE MASTER PLAN

The unprecedented disaster in 2011 served as a catalyst for leaders in the Memphis area to begin steps to create a regional resilience master plan. Shelby County emerged as a prime candidate for the National Disaster Resilience Competition in 2014, a program sponsored by the U.S. Department of Housing and Urban Development (HUD). Teaming up with the Boston-based design and planning firm Sasaki, Shelby County crafted a compelling proposal, which was successful, as HUD granted the county a substantial \$60.4 million to develop and implement the Mid-South Regional Resilience Master Plan. This comprehensive plan comprises a multitude of projects and strategies aimed at aiding the 18 municipalities and four counties in the region to bounce back from the 2011 floods. Additionally, it extends its protections to safeguard against other climate-related threats, with the ultimate goal of enhancing environmental quality and socio-economic opportunities for all residents in the region.

The region-wide planning process engaged local officials, residents, and business owners across the Mid-South. They identified community objectives based on documented hazards and community priorities. The resulting toolkit bolsters resilience in the face of various hazards. The plan also distinguishes areas with higher and lower risk, tailoring suitable strategies for development, restoration, and conservation in each area. In high-risk areas, the team tailored conventional best practices to address the nuances of coping with multiple hazards, such as implementing flood resilience in earthquake-prone regions.

The City of Memphis implemented a comprehensive flood prevention program to address challenges arising from flash flooding. In doing so, the city identified weaknesses in storm water management

Mid-South Regional Resilience Master Plan Goals

1. Safeguard Regional Infrastructure
 2. Provide Multi-Benefit Solutions
 3. Prevent Interruptions
 4. Protect Property
 5. Promote Public Safety
 6. Enhance Quality of Life
-

and developed retention strategies that mitigate flood risks. Additionally, residents are connected via the 311 service which facilitates response to flood incidents.

Incorporating the Memphis Area Climate Action Plan within the framework of Shelby County's Resilience Plan was a central focus. This climate

action plan outlined strategies to measure emissions and provided guidance to the City and County governments on climate action. It built upon prior regional efforts to gain sustainability and recognized the connection between the regional economy and emissions.

The Climate Action Plan laid out a road map for the Memphis area to reduce greenhouse gas emissions below 2016 levels, with targets of 15 percent by 2020, 51 percent by 2035, and 71 percent by 2050. Although most of the 2020 reductions were expected from actions outside local control, the mid-term and long-term targets necessitated local action, collaboration, and investment.

Recovery from the type of calamitous weather events experienced in 2011 takes a long time. Doing so to create sustainability and resilience takes comprehensive commitment to ensure all, including vulnerable communities, can withstand and recover from climate-related disasters.

Sources

[Resilient Shelby: Executive Summary](#)

[Shelby County Resilience Planning and Implementation, Sasaki](#)

PITTSBURGH

PENNSYLVANIA

MEDIUM CITY / STAGNANT POPULATION

MAJOR CLIMATE STRESS: FLOODS

ANNUAL PRECIPITATION: 34.8"

OVERALL
RANKING

5

CATEGORY RANKINGS



CASE STUDY: ELECTRIC VEHICLE ADOPTION

Once an industrial powerhouse, Pittsburgh is now on a new mission to combat climate change and embrace sustainability. Of particular note is the concerted shift toward the adoption of electric vehicles, with the aim of reducing greenhouse gas emissions, notably carbon dioxide.



Source: Jorelyn Allen for Unsplash

CASE STUDY: ELECTRIC VEHICLE ADOPTION

The City of Pittsburgh has made a pivotal move within the city's climate action plan. Comprised of government bodies, nonprofits, and private sector champions, a task force has been established to steer Pittsburgh towards a greener, more sustainable future through electric mobility.

The central quest of the task force is to accelerate the adoption of electric vehicles (EVs) across Pittsburgh. To breathe life into this vision, the task force has embarked on a mission of awareness. The team seeks to educate residents and business owners on the benefits of EVs, including reduction of emissions and cost-effectiveness. The task force is also tackling barriers to adoption, such as addressing misconceptions about EVs, charging infrastructure gaps, and financial obstacles.

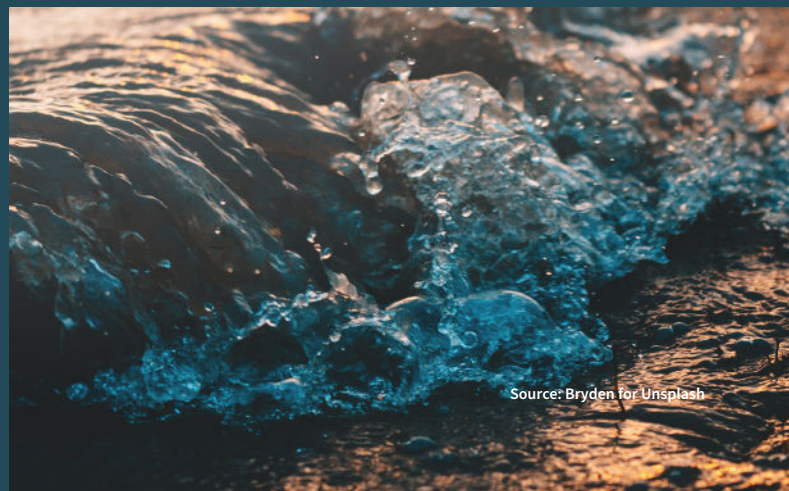
Pittsburgh's rapid move towards adoption of EVs was spurred by increasing evidence of climate change impacts including an air quality report from the American Lung Association, which revealed poor

air quality rates and childhood asthma rates twice the national average. Pittsburgh's Climate Action Plan, unveiled in 2018, highlighted transportation as a key contributor to greenhouse gas emissions. By promoting EVs, the task force aims to cut emissions significantly and foster a cleaner air environment.

The task force's mission, although still unfolding, is marked by an audacious goal: a fossil fuel-free fleet in Pittsburgh by 2030. This ambitious target signifies the city's commitment to reducing emissions and enhancing air quality. The city, through the EV Task Force, aims to lead the way in sustainable transportation and climate resilience. By encouraging the widespread adoption of EVs and expanding charging infrastructure, Pittsburgh stands at the forefront of a green, sustainable future.

Also happening in Pittsburgh: Upgrading of the stormwater management system with investments in new technologies to better handle heavy rainfall and reduce flooding.

Source
[City of Pittsburgh Department of City Planning Climate Action](#)



ST. LOUIS MISSOURI

MEDIUM CITY / SHRINKING POPULATION

MAJOR CLIMATE STRESS: TORNADOES, SEVERE ICE STORMS

ANNUAL PRECIPITATION: 41.1"

OVERALL
RANKING

7

CATEGORY RANKINGS



CASE STUDY: THE EQUITY INDICATORS PROJECT

Over the years, St. Louis has worked to overcome a multitude of environmental and social challenges that impact its economy and erode the quality of life for residents. By taking steps to promote racial equity, city resilience has emerged as a means to include diverse voices in developing a sustainable future. And St. Louis is not doing so in isolation, by joining the 100 Resilient Cities Network, it is gaining insights from other cities while prioritizing environmental equity.



Source: Kenny Nguy for Unsplash

CASE STUDY: THE EQUITY INDICATORS PROJECT

Some of the adversities St. Louis experienced in recent years have ranged from natural disasters including earthquakes and floods, to economic disruptions and social unrest. In response, the city's residents have consistently united, combining their efforts to devise collective solutions. The most recent Resilience Plan reflects the city's awareness of the persistent inequities affecting residents. This recognition prompted the City of St. Louis to become part of the 100 Resilient Cities Network, driven by a shared commitment to building a more resilient St. Louis, prepared to confront the challenges of the 21st century.

100 Resilient Cities (100RC) collaborates globally to enhance cities' resilience against various shocks and stresses, be they physical, social, natural, or economic. Over the past two years, St. Louis has enjoyed the benefits of its 100RC membership, including funding for a Chief Resilience Officer, essential resilience planning tools, and participation in a global network for the exchange of best practices and challenges. In 2018, with 100RC's support, the city produced a Preliminary Resilience Assessment, detailing its resilience challenges and opportunities.

Building upon this foundation, St. Louis' Resilience Strategy outlines actionable steps for the city and its partners to create a more resilient and equitable environment, benefitting all St. Louis residents. A central focus within this strategy is the Equity Indicators Project (EI), a response to

the call for racial equity benchmarking by the Ferguson Commission.* This project assesses racial equity between black and white residents through 72 selected indicators. St. Louis developed these equity indicators in collaboration with teams from fellow 100RC member cities like Dallas, Oakland, Pittsburgh, and Tulsa. These indicators provide a quantifiable measure of racial equity, establishing a baseline for tracking progress over time by using race-disaggregated data to calculate equity scores.

Yearly updates will showcase changes in these scores, along with discussions regarding recent efforts to improve racial equity. This information is available to elected officials, policymakers, community leaders, and all residents of St. Louis, fostering an understanding of regional equity challenges, monitoring changes, and holding leaders and institutions accountable.

The inaugural EI report was a significant stride toward racial equity for every St. Louisan and promotes greater overall resilience. The city underscores the pivotal role of honest and accurate data as the foundation of this effort, emphasizing its necessity for enhancing St. Louis' long-term resilience. Throughout the Resilience Strategy, each action will be linked with an Equity Indicator, enabling the ongoing measurement of their impacts over time, and reinforcing the city's commitment to a more resilient and equitable future.

* The Ferguson Commission was established in 2014 to study civil unrest following the death of Michael Brown, Jr. The report by this diverse, independent commission revealed the comprehensive, underlying conditions attributable to the events, and recommended actionable steps that government and agencies should take to bring about a stronger, more fair place for all residents of the region.

SEATTLE WASHINGTON

LARGE CITY / GROWING POPULATION

MAJOR CLIMATE STRESS: VOLCANOES, EARTHQUAKES

AIR QUALITY INDEX: 0.6934

OVERALL
RANKING

1

CATEGORY RANKINGS



CASE STUDY: COMMUTER STRATEGIES TO REDUCE CARBON EMISSIONS

The City of Seattle has attracted new businesses and an increasing workforce which has increased the demand for construction of new buildings and expanding infrastructure. With such progress comes the challenge to attenuate the environmental impacts of growth. The Seattle 2030 District plays a crucial role in bridging the gap between the private and public sectors, with a primary objective of reducing the environmental impact of buildings in Seattle.



Source: Luca Micheli for Unsplash

Comprised of 140 committed members, Seattle 2030 District (S2030D) is dedicated to significantly reducing water and energy consumption, mitigating stormwater pollution, and curbing carbon emissions from transportation by the year 2030. This focus is particularly essential as buildings and transportation are the primary contributors to climate change in the Pacific Northwest. The unique relationships between the S2030D and the community, private sector, public officials, and private sector make it a central nexus in the endeavor to enhance the health and environment of the region.

Transportation is a significant contributor to increasing carbon emissions, which is degrading air quality in the region. A significant cause stems from single-occupancy vehicle trips which are associated with commuting to work. With mounting public pressure for more stringent measures to combat emissions, proposed legislation now aims for significantly reduced emission by 2035, sooner than the previous target of 2040. To meet their transportation performance metrics, S2030D has established guiding principles that involve advocating for high ridership in mass transit projects, promoting the electrification of public transit, and endorsing public funding for lower-carbon commuting alternatives.

On the private side, large employers are participating in innovative ways. The commuter challenges engendered by the 2011 relocation of the Bill and Melinda Gates Foundation headquarters

and how this employer overcame them is an illustrative example of how technology is helping to meet regional air quality goals. The Foundation implemented a commuter management program using technology developed by a local firm, Luum, providing an internal platform that accommodates the work patterns of full-time employees, many of whom frequently traveled meaning that their commute via public transportation sometimes would be untenable. This program made possible daily versus monthly parking passes, and offered financial incentives for ridesharing directly linked to payroll. In 2010, 88 percent of employees commuted to work alone by car. Within one year of implementing this program, that figure drastically dropped to 42 percent and has continued to decline. Notably, there's evidence to suggest that this initiative has contributed to an overall reduction in downtown Seattle's traffic congestion. Furthermore, its success has led to replication by employers across in cities around the world, including Washington, DC, London, Beijing, and New Delhi.

Seattle 2030 District's commitment to reducing environmental impacts and its influence on transportation policy changes, exemplified by the decrease in personal vehicle usage, contribute significantly to enhancing the region's sustainability and environmental health. These efforts are pivotal in the larger context of addressing climate change and promoting responsible urban development.

TAMPA FLORIDA

MEDIUM CITY / GROWING POPULATION
MAJOR CLIMATE STRESS: HURRICANES, FLOODS
TEN-YEAR TEMPERATURE CHANGE: +38%

OVERALL
RANKING

3

CATEGORY RANKINGS



CASE STUDY: REGIONAL RESILIENCY ACTION PLAN

Like all Gulf Coast cities, Tampa is susceptible to dangerous hurricane events and flooding. As a fast-growing region, there is a need to ensure that infrastructure and communities are prepared and resilient. The Tampa Bay Regional Planning Council developed an award-winning Regional Resiliency Action Plan. By aligning this plan with federal resilience goals, embracing international best practices, and setting forth a comprehensive framework, it provides a blueprint for sustainable development for other cities to follow.



Source: Sagar Bhujel for Unsplash

The Tampa Bay Regional Planning Council (TBRPC) developed the Regional Resiliency Action Plan (RRAP) in cooperation with local governments and regional stakeholders. It is a dynamic document advising collaboration among government and community stakeholders to address resilience challenges and guide actions. To ensure diverse input, outreach engagement is ongoing to continually gain input from community leaders, which is crucial for successful implementation. Furthermore, the Resiliency Coalition aims for the RRAP to form a strong network to address equity gaps and uplift vulnerable populations.

The RRAP adheres to guiding principles: recommended actions must be feasible, measurable, and scalable, have a strong emphasis on community involvement, and data-driven decision-making. The plan is organized into five distinct categories Risk and Future Conditions, Community Vulnerability, People, Place, and Prosperity. These categories serve as the foundation for resilience assessments, with

Tampa Bay Regional Areas of Influence for Climate Resilience

1. Technical Assistance
2. Environment
3. Economics
4. Preparedness
5. Resiliency
6. Regional Review

goals of fostering leadership, improving energy efficiency, restoring habitats, enhancing multi-modal transportation resilience, and strengthening food systems, alongside supporting business and workforce development.

As the region grows and faces increasing extreme weather events and challenges like sea-level rise, traffic congestion, and economic disparities, the RRAP encourages collaborative preparation for natural disaster events. The regional planning council found that the resilience of the region was tested during the COVID-19 pandemic, and the action plan reflects lessons learned which will inform future response by the region.

In 2023, the Regional Resiliency Action Plan by TBRPC was chosen by the National Association of Regional Councils for its annual Achievement Award. This recognition of outstanding programs and services within regional councils and metropolitan planning organizations nationwide signifies a pivotal milestone for TBRPC’s journey toward building resilience. RRAP demonstrates the power of collaboration and the collective determination to fortify the community’s resilience in the face of multifaceted challenges.



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