Climate Adaptation Efforts of Coastal Cities in the Southeast United States

Kieran Valk
Introduction

Atlantic coastal cities in the American Southeast are currently facing constant threats of property destruction and human displacement due to climate change. Millions of people live in coastal areas and billions of dollars of property and infrastructure has been developed in vulnerable locations. Coastal cities in the Southeast geographical region face the same set of unique climatic dangers such as increased rates of hurricanes, storm surges, nuisance flooding, sea level rise, and land erosion/subsistence. However, these climactic threats can be mitigated by increasing resiliency through climate adaptation.

The following is a case study on the methods coastal cities in the Southeastern United States are adapting to the changing climate and its special effects on coastal regions. The scope of this study is limited to this region for three reasons. First, the National Oceanic and Atmospheric Agency used this region in its Fourth National Climate Assessment. Second, the American Southeast despite being a large area share similar geography, weather patterns, cultures, peoples, and climate threats. Third, focusing on a specific region increases the potential of cross-jurisdictional learning. For actions combating climate change to be effective and efficient, ideas and plans must be shared, and it is best to share among groups that are similar. The specific cities in this study have been chosen because they have a metropolitan area population of around two hundred thousand or more to maintain a congruency of size and to include cities from each coastal state.

The information gathered is focused around what cities are currently doing in the area of climate adaptation and their efforts or lack thereof: how cities are preparing for sea level rise, accommodating for nuisance flooding, changing their layouts, and any other efforts in the adaptation field. The information comes from official city websites, published documents, and phone and email conversations with municipality staff. Due to the complexity of this topic only brief summaries of individual cities will be given to offer an overarching view of the state of city adaptation across the region.
The purpose of writing this piece is not to evaluate if methods of climate adaptation are practically effective or cost efficient; rather, it is provided here to demonstrate patterns of adaptation efforts among cities. The record for this is not good. Out of seventeen cities examined, only nine have municipal climate adaptation strategies in place and three are in the process of creating strategies. This record is a great concern because these cities are not small towns, they are the largest coastal cities in the Southeast and every year they face greater climate threats. Strategies and plans are critical for battling coastal climate change and without them cities will continue to be threatened.

*The cities are in geographical order down and around the coast from North to South. This is to keep cities with similar geographies grouped together as their solutions will be more alike.*

**Virginia**

**Norfolk**  
Metro Population: 1,672,319  
Locus of action: **Office of Resilience**  
Municipal adaptation strategy in place: **Yes**  
Projects/programs in progress or completed: **Yes**

Norfolk is 96 square miles located at the junction of the Elizabeth River and the Chesapeake Bay. The city lives closely with water; 42 square miles (43.9%) is water and 54 square miles of are land. There are 144 miles of shoreline along lakes, rivers, and bay front. The average elevation is 7 feet.

Norfolk, Virginia is one of the leading cities in coastal climate adaptation, having been part of the Resilient Cities 100 project and Norfolk created a resiliency strategy in 2015. The city works closely with the City of Hampton Roads, the City of Virginia Beach, and Norfolk Naval Station.
while creating strategies and implanting infrastructure development because of their close proximity. Furthermore, in 2015, the cities engaged in the Dutch Dialogues which brought together various water management experts from New Orleans and the Netherlands (the City of Hampton, n.d.). The Dutch have been living with water for hundreds of years and have developed many successful strategies to exist alongside it. The Dutch Dialogues involved a series of workshops to help develop plausible water management strategies.

The three cities are currently working together to implement smart strategies to retrieve better data on sea level rise and flooding. One program that they have implemented is called StormSense, which involves installing sensors all across the participating cities and giving updated real-time information on current water levels (Virginia Institute of Marine Science, n.d.). The available information can “empower property owners to take responsibility for their assumed risk of living adjacent to floodplains,” according to scientist Derek Loftis et al. (2018). When citizens have access to real-time information, it can reduce the pressure on emergency responders during flooding as citizens can respond to the information themselves and take the proper precautions.

Norfolk and Virginia Beach—located in the Norfolk metro area—also created a joint land use study to allow for municipal planning (Hampton Roads Planning District Commission, 2019). The study outlines in great detail the areas that will be most affected by sea level rise. The areas are mapped and there are specific suggestions to deal with potential flooding such as raising sections of road or redirecting storm water. The suggestions include comprehensive implementation steps, funding availability, and what groups would be responsible for carrying out the plans.

**North Carolina**
<table>
<thead>
<tr>
<th>Wilmington</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metro population: 282,573</td>
</tr>
<tr>
<td>Locus of action: <strong>Public Works Department</strong></td>
</tr>
<tr>
<td>Municipal adaptation strategy in place: <strong>No</strong></td>
</tr>
<tr>
<td>Projects/programs in progress or completed: <strong>Yes</strong></td>
</tr>
</tbody>
</table>

Wilmington is 41.5 square miles with the west side on the Cape Fear and Brunswick Rivers and the east side bordering the Atlantic Ocean. The city is mostly land with 41 square miles being land and 0.5 square miles being water (1.16%). The elevation is 30ft above sea level.

Wilmington does not have an official municipal strategy for combating and preparing for the various effects of climate change, but the public works department has been busy with upgrading infrastructure to accommodate flooding. In 2009 the city of Wilmington enacted the Comprehensive Storm Water Ordinance, which is designed to regulate how impervious surfaces are created and to ensure that proper drainage is constructed. The early adoption of this ordinance has given Wilmington a step-up in ensuring that all new development is built with input and advice from city stormwater managers.

Like most cities, Wilmington suffers from 50-year-old or older infrastructure that is beginning to deteriorate and cause system failures. Their flooding is generally due to old infrastructure failing and maintenance is needed. Repair and replacement crews can only work so fast to update systems. The repairs are completed with modern upgrades such as replacing metal culverts that last only 50 years with double box concrete culverts that have a much longer life expectancy and have better drainage performance. Impervious surfaces are also being removed to daylight ground that can soak up precipitation and flood waters. An example of this was the Clear Run Branch Drainage Improvement Project, which reengineered an existing stream to handle more water run-off and sequester more water (City of Wilmington, n.d.).
Other capital improvement projects include the municipality’s purchasing of several properties in flood-prone areas to convert them into water sequestration areas. These previously populated areas can be flooded to divert water from populated areas. Another current project is the new retrofit of the town hall that is designed to withstand extreme weather events. Upgraded infrastructure will reduce the need for repair in the future. The city is attracted to climate resilience—there is interest in the Dutch Dialogues and the creation of an official resiliency plan—but it is currently focused on maintenance.

**Jacksonville NC**  
Metro population: 177,000  
Locus of action: **Department of Stormwater**  
Municipal adaptation strategy in place: **Yes**  
Projects/programs in progress or completed: **Yes**

Jacksonville is 45.2 square miles located on the tidal New River. The city is mostly land with 44.5 square miles of land and 0.7 square miles of water (1.51%). The elevation is 15 feet above sea level.

Jacksonville has been very active in using the natural systems approach for improving resiliency—also known as green infrastructure—rather than strictly relying on grey infrastructure that is using concrete/asphalt in a centralized approach. The city recently rebuilt thirty acres of wetlands to compensate for twenty acres lost due to development. After a five-year study the wetlands were declared a success (City of Jacksonville NC, n.d.).¹ Wetlands help reduce wave energy and reduce land erosion. Currently, the city is measuring surface elevation levels and sediment levels to see if the wetlands will be able to withstand sea level rise. Too much rise and the wetlands could be drowned.

¹ https://www.jacksonvillenc.gov/343/Area-Wetlands-Wildlife
The city is replacing impervious surfaces on public lands where possible and building rain gardens and bio retention cells (engineered depressions in the land) to catch water runoff and allow it sink into the ground. There is strong encouragement for private properties to do the same. Additionally, there are plans to work on twelve sections of local streams to stabilize embankments and beds to prevent jams and ensure that water can flow.

Larger projects include removing an old dam that is causing upstream flooding and purchasing properties that see continual flooding. Hurricane Florence has rendered several properties unlivable so the city will be demolishing the buildings allowing the area to flood freely. The city has also been involved in reintroducing oysters into the nearby New River to clean the water and to help reintroduce native species and habitat. Oyster colonies help reduce wave energy, curtailing land erosion (City of Jacksonville, n.d.).

**South Carolina**

*Charleston*
Metro population: 713,000
Locus of action: **Mayor’s Office on Resiliency & Emergency Management**
Municipal adaptation strategy in place: **Yes**
Projects/programs in progress or completed: **Yes**

Charleston is 127.5 square miles located on the tidal Stono, Ashley, Cooper, and Wando Rivers and the Atlantic Ocean to the southwest. The city includes 109 square miles of land and 18.5 square miles of water (14.5%). The harbor is 7 miles long with an average width of 2 miles and an entrance width of 1 mile. The elevation is 20 feet above sea level.

---

In 2015, Charleston developed a sea level rise strategy that was recently updated in 2019. This comprehensive strategy outlines infrastructure plans, suggested governance changes, updated land use practices, and resource availability in a changing climate. There are several projects that have been completed and are ongoing (City of Charleston SC, 2019). Charleston has been updating its drainage system because much of it is still made of clay piping which is prone to bursting. The larger brick sewers that have become clogged due to years of neglect have been cleaned and the brick covered by concrete to prevent new buildup of debris. In addition to updating old systems, the city has been adding new systems with double box concrete culverts to drain areas that have only started to flood in recent years as well as building new pumping stations.

Charleston has been greatly affected by nuisance flooding which is a great impediment to daily life. Tidal waters back up storm sewers flooding roads and yards even on sunny non-storm days. To prevent this, the city has installed check valves that prevent water from traveling in the reverse direction in pipes. These valves have been installed all over the city (City of Charleston SC, n.d.). The city has also raised the sea wall of a main park area by two feet and updated other parts of it because it was built over a hundred years ago and could no longer keep up to modern sea levels.

**Georgia**

*Savannah*

Metro population: 389,494  
Locus of action: **Office of Sustainability**  
Municipal adaptation strategy in place: **Yes**  
Projects/programs in progress or completed: **Yes**

---

4 https://www.charleston-sc.gov/1995/Check-Valve-Program
Savannah is 108.7 square miles and located on the Savannah River about 20 miles up from the Atlantic Ocean. It has 103 square miles of land and 5.6 square miles of water (5.15%). The elevation is 49 feet above sea level.

Savannah and the surrounding Chatham county in conjunction with Georgia Institute of Technology has implemented an extensive smart sea level sensor program to detect potential flooding. The program involved installing low-cost, reliable sensors on all tidal-influenced waterways in the area. The sensor network offers hyper-local, real-time information and data on the changes in tides to residents and city officials. So far there has been one year of data recorded and includes one hurricane. The information is used for real-time emergency response in the case of dangerous flooding, but also for informing capital outlay and infrastructure plans. The Smart Sea Level Sensor project is also using the data for advance ocean modeling with a ten-meter resolution to help the city in its future planning (Smart Sea Level Sensors, n.d.).

Savannah is not developing green infrastructure, but it is involved in other projects to mitigate the damage of flooding. The city and the county together have acquired approximately five hundred properties that are now being used as floodplains to prevent the need to continually rebuild. Moving residents out of flood prone areas while providing a place for floodwater to drain into eliminates the cost of rebuilding and reduces the flooding risk to surrounding areas. In the acquired areas, the city started the Urban Tree Nursery Project where tree saplings are planted and grown, helping with water absorption (City of Savannah GA, n.d.). Once the trees grow larger, they are transplanted to low tidal areas that need increased vegetation for water absorption and erosion control.

5 https://www.sealevelsensors.org/
6 https://www.savannahga.gov/2697/Urban-Tree-Grant
Atlantic Beach is 13 square miles located on a roughly 2.5-mile-wide strip of land between an intracoastal waterway to the west and the Atlantic Ocean the east. The majority of the city’s area is water—9.5 square miles (73%)—and 3.5 square miles of land. The elevation is 10 feet above sea level.

Atlantic Beach is currently starting the process of planning for climate adaptation. They recently applied for a grant from the Florida Department of Environmental Protection to begin the process. There was, however, a coastal vulnerability assessment created in 2019 including flood maps that indicated which parts of the city will be affected by sea level rise. The city is mostly residential so the most affected areas will be private residences. Residential buildings are in danger because there is a law in Atlantic Beach and many other ocean-front cities that prohibits buildings from exceeding thirty feet to discourage the construction of high rises. As a result, most houses are built on unraised concrete slabs that are likely to be flooded. While the law remains in place buildings will not be able to be raised to mitigate flooding damage.

Like many cities in Florida, Atlantic Beach works closely with county and regional groups to do environmental work. Atlantic beach is working with the North East Florida Regional Group (NEFRG) and will be working closer in the future as the drainage for Atlantic Beach is directly
connected to the municipalities surrounding it (Lahav, n.d.). The NEFRG has been highly involved in bringing together municipal decisionmakers, business leaders, and community leaders to discuss sea level rise. In 2019, the NEFG helped Atlantic Beach and surrounding communities host “Beaches Sea Level Rise Forum” for community members. In 2020, in conjunction with the NOAA, the NEFG hosted a “Nature-Based Solutions for Coastal Hazards” workshop. In this area of Florida, it is important that any climate adaptation work has to be done together with other municipalities to ensure that no solution creates problems for another municipality.

**Daytona**
Metro Population: 649,202
Locus of action: N/A
Municipal adaptation strategy in place: No
Projects/programs in progress or completed: No

Daytona Beach is 64.93 square miles on the Atlantic Ocean to the east. The city’s “beach side” is split from the rest of the city by the Halifax River Lagoon. The city is a majority land at 58.7 square miles and 6.25 miles of water (9.6%). The elevation is 13 feet above sea level.

Despite sustaining significant damage from Hurricane Dorian, other hurricanes, and flooding, the municipality has no available plan for adaptation strategies. There is also no evidence of projects dealing with sea level rise or flooding.

**Miami**
Metro population: 6,158,824
Locus of action: Department of Resilience & Sustainability
Municipal adaptation strategy in place: Yes
Projects/programs in progress or completed: Yes

---

7 https://www.nefrc.org/resiliency
The City of Miami, not including its suburbs, is 56.6 square miles located on the Atlantic Ocean to the east. It is not completely open to the ocean as it is next to several small islands including Miami Beach. The city is mostly land with 35.9 square miles of land and 20 square miles of water. Miami is also one of the most densely populated cities in the United States at 11,136.6 people per square mile. The average elevation is 6 feet above sea level. The full metropolitan area is 6,137 square miles with the highest elevation at 53 feet above sea level.

In 2017, Miami announced the Miami Forever Bond to fund climate change adaptation. The full bond is about $400 million with $200 million of it going directly to protecting against sea level rise (City of Miami, n.d.). So far that funding has helped complete several projects including installing forty backflow valves, raising seawalls, and installing new pump stations with backup generators. The city has also raised roads in several neighbourhoods to prevent road swelling but has residents have complained because the water now flows off of the streets and floods their properties. Additionally, the city has invested in green infrastructure by turning parks into bioswales, also known as drainage cells, by installing ponds and letting parks flood and absorb flood waters.

The city of Miami Beach additionally engaged in building up natural storm surge defenses in 2013. In conjunction with the Nature Conservancy and Southeast Florida Climate Compact, a dune regeneration project was launched to increase the resilience of the dune networks along the Miami Beach coast (The Nature Conservancy, 2014). The increased vegetation levels help reduces erosion rates and promote the longevity of the dunes allowing them to defend the mainland longer.

---

8 https://www.miamigov.com/Government/Departments-Organizations/Office-of-Capital-Improvements-OCI/Miami-Forever-Bond
Fort Myers
Metro Population: 739,224
Locus of action: N/A
Municipal adaptation strategy in place: No
Projects/programs in progress or completed: No

Fort Myers is 40.4 square kilometers located on the tidal Caloosahatchee River which leads to the Gulf of Mexico to the west. The city is mostly land with at 31.8 square miles compared to 8.6 square miles of water (21.2%). The elevation is 10 feet above sea level.

There is no evidence that Fort Myers is being proactive regarding climate change or adaptation. The last master plans were created in 2007/08 and have no mention of climate change or increased rates of sea level rise, extreme weather events, or flooding.

Sarasota
Metro population: 720,042
Locus of action: Office of Sustainability / Tampa Bay Regional Resiliency Compact
Municipal adaptation strategy in place: Yes
Projects/programs in progress or completed: Yes

Sarasota is 25.9 square miles located on Sarasota Bay, which is separated from the Gulf of Mexico by several barrier islands. The city’s area includes a lot of water as it spans the bay to include the barrier islands. It is 14.9 square miles land and 11 square miles of water (42%). The elevation is 16 feet above sea level.
In 2017 Sarasota released a Climate Adaptation plan and has been active in adaptation projects since then (City of Sarasota, n.d.). Soon after the plan was released, in 2018, the city designed and built living shorelines along some of their vulnerable coast. These living, green infrastructure projects offer both protection from climate change effects and protection for the habitat of various aquatic species. The city is continually looking for more areas where living shorelines and sea walls can be implemented; the city finds these projects preferable to hardened grey infrastructure.

In terms of grey infrastructure, the transportation department of the City of Sarasota is raising the road along the bayfront by a foot to protect against sea level rise. Along with raising the road, they are updating to storm water systems to increase capacity. However, there are also plans to build new roundabouts in known vulnerable areas which could mean complications in the future.

Electricity, as in the majority of municipalities along the southeastern coast, is run by a private utility company that creates a disconnect in resiliency efforts. The areas where Sarasota does control electricity have experienced adaption. Water pump stations have undergone hardening and the city has waterproofed the electrical systems to ensure they run during emergency situations. There have also been discussion and plans to build a new lift station for storm water to increase drain efficiency. Additional lift stations will increase the speed at which flooded areas can be drained.

*Tampa*
Metro population: 3,068,511
Resiliency/ Sustainability office: Mayor’s Office/ Tampa Bay Regional Planning Council
Municipal adaptation strategy in place: In progress
Projects/programs in progress or completed: No

---

Tampa is built on a peninsula in the Tampa Bay. The city is 175 square miles with 113 square miles of land and 61 square miles of water (35%). The highest point of the city is at 48 feet. The cities of St. Petersburg and Clearwater are on the other side of the bay blocking Tampa from the ocean. St. Petersburg is 137 square miles with a maximum elevation of 44 feet. Clearwater is 39 square miles with an elevation of 30 feet.

The City of Tampa is in close proximity to the City of St. Petersburg and the City of Clearwater, making any adaptation efforts a combined effort. In 2018, the Tampa Bay Regional Resiliency Coalition was created to help the municipalities and county governments in the Tampa Bay area address climate resiliency adaptation (Tampa Bay Regional Planning Council, n.d.). The current efforts of the resiliency council are getting cities to undergo vulnerability assessments. These assessments are in the process of being created and action plans will be outlined after the assessments are finished.

Tampa and surrounding cities on the gulf side of the Florida peninsula do not have to worry about King Tides as much as the Atlantic side does. King Tides are the largest tides of the tidal cycle. These tides often cause nuisance flooding because they overload storm water systems. The Tampa Bay area is instead more concerned about Sea Level Rise (SLR). In April 2019, the Tampa Bay Climate Science Advisory Panel published a memorandum suggesting that NOAA SLR low prediction should not be used in infrastructure planning because it has already been surpassed; instead, they recommend using the medium projections (Tampa Bay Climate Science Advisory Panel, 2019). The memorandum is supported by the Tampa Bay Regional Resiliency Council and is recommended for cities in the area.

Pensacola
Metro population: 497,883

---

11 http://www.tbrpc.org/resiliency/
Locus of action: **Mayor’s Office**  
Municipal adaptation strategy in place: **In Progress**  
Projects/programs in progress or completed: **No**

Pensacola is 40 square miles located on Pensacola Bay, which is separated from the ocean by two barrier islands that make up the Gulf Islands National Seashore. The city includes 18 square miles of water (44%) but is majority land (22 square miles). The elevation is 102 feet.

The City of Pensacola established a Climate Mitigation and Adaptation task force to study the effects of climate change on the city. In 2018, the taskforce provided recommendations to the city in a final report. The report suggested expanding permeable surfaces throughout the city, creating inland flooding adaptation action areas, and limiting development in hazardous coastal areas. The taskforce was dismantled after the report was completed and not much has come from the recommendations. The only exception is that, under the new mayor, the city will be hiring a sustainability coordinator in the 2020 year and is currently conducting a climate resiliency study on flooding. Pensacola is unique in Florida because it has shoreline elevation, so sea level rise is not as much of a concern as inland flooding is.

**Alabama**

**Mobile**  
Metro population: 413,757  
Locus of action: **N/A**  
Municipal adaptation strategy in place: **No**  
Projects/programs in progress or completed: **No**

The City of Mobile is 159 square miles located at the delta of the Mobile River and on the west side of Mobile Bay. The city is mostly land (117 square miles) with 41 square miles of water (26.1%). The elevation ranges from 10 to 211 feet above sea level.
Despite sustaining significant damage from Hurricane Katrina, other hurricanes, and flooding, the municipality has no available plan for adaptation strategies. There is also no evidence of projects dealing with sea level rise or flooding.

**Mississippi**

*Gulfport-Biloxi*

Metro population: 397,261  
Locus of action: N/A  
Municipal adaptation strategy in place: Yes  
Projects/programs in progress or completed: No

The City of Gulfport is 64.3 square miles on the Mississippi coast with the Gulf of Mexico to the south. The city is mostly land (56.9 square miles) and 7.3 square miles of water (11.4%). The elevation is 20 feet above sea level. The City of Biloxi is 13 miles to the east of Gulfport with an area of 46.7 square miles with 38.2 square miles of land and 8.5 square miles of water (18.1%). Biloxi sits on a peninsula between the Biloxi River, Big Lake, and Mullet Lake to the north and the Gulf of Mexico to the south. The elevation is also 20 feet above sea level.

In 2008, Mississippi’s Coastal Hazard Outreach Strategy Team (C-HOST) was created to bring municipalities, such as Gulfport and Biloxi, along Mississippi’s coast together to discuss ideas of coastal hazard mitigation. It seems that this group has since disbanded and there are no longer people in the municipal governments that are involved in it.

The Mississippi Emergency Management Agency in 2017 released a Regional Hazard Mitigation Plan with specific annexes for each county. The Harrison County Annex C includes both Gulfport and Biloxi and recommendations on what the municipalities can do in terms of hazard
mitigation. The list includes priority level, funding source, and an implementation schedule. There are no civil servants actively working on these mitigation plans.

**Louisiana**

*New Orleans*
Metro Population: 1,262,888
Locus of action: **Office of Resilience & Sustainability**
Municipal adaptation strategy in place: **Yes**
Projects/programs in progress or completed: **Yes**

The City of New Orleans is 350 square miles with Lake Pontchartrain to the north, the Mississippi River along the south, and Lake Bourge on the southeast with the entrance to the Gulf. The city has slight majority of water with 181 square miles of water (52%) and 169 square miles of land. Due to years of subsistence – land sinking due to erosion and water levels rising due to waterways filling with sediment – the average elevation of the city is 1-2 feet below sea level, but some areas are as low as 6.5 feet below and as high as 20 feet above sea level.

New Orleans was part of the Resilient Cities 100 program and has been advanced in climate adaptation due to its close relation to sea level rise and destruction sustained from Hurricane Katrina. In 2015, the city released the Resilient New Orleans plan. Before the plan was created, the Army Corps of Engineers created a large, hardened series of dikes and levees called “The Wall.” These hardened infrastructure projects do not have a great track record of being full-proof in Louisiana and they are also much of the reason why New Orleans is suffering from subsistence (Campanella, 2018).¹³ The creation of the Resilient New Orleans plan involved discussions with water managers in Rotterdam Netherlands as the water issues that New Orleans suffers from are similar to the issues that much of the low-lying Netherlands experiences. To

prevent subsistence, the city has created plans of blue infrastructure to incorporate more water into the city by turning parks and other areas into small lakes and building canals so that water can seep back into the ground. With more surface water, more of it can seep into the ground and fill dry cavities underground, preventing them from collapsing and the ground above sinking (Greater New Orleans Inc., n.d.). This strategy is used throughout the Netherlands.

With the Dutch company Deltawares, the City of New Orleans launched the Urban Water Plan to combat subsistence. The company will be installing sensors underground across the city to measure ground water levels. With the data, accurate estimates of subsistence rates can be calculated, and green infrastructure can be built in areas that it will be most effective.

**Texas**

*Houston*

Metro Population: 6,997,384  
Locus of action: **Office of the Mayor**  
Municipal adaptation strategy in place: **Yes**  
Projects/programs in progress or completed: **Yes**

Houston is 637 square miles next to Trinity and Galveston Bay. The city is mostly land (599 square miles) and has 22 square miles of water. Over the years, the city has expanded into marshes and bayous, which has led to significant flooding. The elevation of the non-marsh areas averages at 50 feet above sea level.

Houston was a member of the 100 Resilient Cities program through which it hired a resiliency officer. More recently, in 2019, the city released a Resilient Houston Assessment. The city also hosted *Living With Water* conferences to connect Dutch water management experts with local

14 https://livingwithwater.com/blog/urban_water_plan/plan/
leaders to discuss resiliency strategies (City of Houston, n.d.). Due to how recently the plans have been put in place, there is no information on current projects or completed projects.

**Corpus Christi**
- Metro Population: 442,600
- Locus of action: N/A
- Municipal adaptation strategy in place: No
- Projects/programs in progress or completed: No

Corpus Christi is 460 square miles in southeastern Texas on the Corpus Christi Bay. The bay is separated from the gulf by Mustang and Padre barrier islands. The majority of area is water at 305 square miles (66.4%) and 154 square miles of land. The elevation is 7 feet above sea level.

Corpus Christi is at increasing risk of damaged property due to flooding. With increased levels of precipitation, FEMA’s updated flood maps in 2015 have declared a significant increase in property that is at risk. Roughly $2.9 trillion dollars of property is located in higher risk flood zones (Crow, 2018).

In 2014 the city was awarded Gulf of Mexico Spirit of Community Award for its work in creating an Integrated Community Sustainability Plan (Powell, 2014). There have been no updates to this plan and no information or evidence that any of the recommendations have been acted on.

---

15 https://www.houstontx.gov/mayor/chief-resilience-officer.html
Summary & Analysis

There is a wide range of responses to the impacts of climate change. Some cities have projects in the works. Some have created plans while others do nothing. Cities with proactive plans have a higher tendency to pursue green and blue infrastructure solutions such as creating floodplains and retention ponds or rejuvenating coastal ecosystems. Cities with more reactive plans favor traditional grey infrastructure such as updating stormwater drainage, expanding drainage, or building sea walls. Both reactive and proactive plans for infrastructure help with climate resilience, but for complete resilience it is important for cities to diversify their efforts. Creating a plan for adaptation is a crucial step to climate resiliency. Plans allow for cities to measure their progress, prepare for the future, and compare progress to other cities. They also allow outside organizations to evaluate the effectiveness of adaptation practices. The cities that have not created plans and acted on them will experience more significant impacts from climate change as other cities have in the past.

The cities in this study are similar in size, population, and geography, therefore sharing in their vulnerability and urgency to adapt to impending drastic climate change. Disasters cannot be predicted, and it is unknown which cities will experience calamitous circumstances. This creates a premium on the sense of urgency. When it comes to climate adaptation, the resilience efforts that must be put into place cannot be done overnight, therefore efforts must begin immediately to be ready for the next extreme event. The adaptation practices that are needed are similar in all the cities in the coastal Southeast. It is important then for these cities to engage with one another in cross-jurisdictional learning so best practices can be shared and improved. The Dutch Dialogues that several cities participated in are a great example of international cooperation. Another example is how cities in Florida have already created or joined regional groups focused on resiliency and are actively sharing information and ideas. These regional groups create a unified front towards climate adaptation. It would be helpful for more groups like these to be created within states and, even better, across state lines.
Cross-jurisdictional learning should not end when a plan is developed. Sharing successes, failures, and advancements in technology is of utmost importance. While monitoring a city plan, leaders should be attentive to how other cities’ plans are evolving. Breakthroughs and innovations can develop, and flexibility and nimbleness must be built into plans to add emergent infrastructure. This is where dedicated offices for climate resiliency that can analysis plans are a benefit. If businesses practice improvement through the philosophy of Continuous Quality Improvement—increasing efficiency and quality of product and company—then climate adaptation plans should be no different. As the climate changes, the plans must change with it.

Municipal governments cannot bring about change alone; they need the assistance of other institutions. Businesses have a large role to play in climate adaptation because of their unique position. Governments are limited by jurisdiction and are constrained by political turnover that can delay efforts and impact the much-needed momentum for change. Businesses offer long-term planning solutions; they do not work in four-year term limits but rather they have ten or even twenty-year strategic plans that allow for long-term improvement. It is worthwhile for business to invest in adaptation efforts to reduce climate change–related disruption of assets and supply chains. Businesses also have properties in more than one location automatically forcing them to think across geographical boundaries and making them engaged in cross-jurisdictional learning. Where municipal and state governments’ jurisdiction ends at borders, businesses’ influence does not, providing them the opportunity to practice climate risk management. Business and other nongovernmental organizations must encourage continual government investment in adaptation efforts while governments should take advantage of business pragmatism and engage them in contingency planning. Coastal climate adaptation is not the work of one institution but of many working together.

**Conclusion**
Climate change is accelerating, and the effects are becoming more and more dangerous. The impact of climate change–related extreme weather events, nuisance flooding, and land subsistence is being felt by coastal cities in increased levels every year. Municipal administrations and businesses are experiencing economic loss and citizens’ lifestyles are being threatened. It is for good reason that cities that have been affected the most by climate change have decided to invest in adaptation. Cities are learning from past mistakes and negligence in order to be better prepared in the future. However, many cities are not acting. It is important more now than ever to increase efforts in climate resilience adaptation because the impacts of climate change will continue to affect cities and their residence in the future.

Additional Resources

https://www.theinvadingsea.com/
https://riskfinder.climatecentral.org/

One notable nongovernmental effort in city climate adaptation that must be mentioned was the “Resilient Cities 100” program started by the Rockefeller Foundation. This program was significant because of its size, scope, and how it included cities from across the globe. The program provided funding and assistance for cities around the world to adopt resiliency plans and hire resiliency officers to be responsible for the plans’ implementation. Out of the hundred cities in the program, three of them are on the Southeastern coast and are included in this article: Norfolk, Virginia; New Orleans, Louisiana; and Houston, Texas. The program has since ended but has had major influence on coastal climate adaptation and has promoted cross jurisdictional learning. The cities that participated in the Resilient Cities 100 program had a head start on resiliency adaptation but now others are beginning to catch up by developing their own independent plans and putting strategies into direct actions.

References


