Introduction

Concerned citizens, small businesses, elected officials, and municipal staff in the city of Beaufort and town of Port Royal, SC, formed a Sea Level Rise Task Force (Task Force, Appendix A) in December 2014 to address the area’s vulnerability to sea level rise and develop adaptation strategies to address potential impacts. Beginning in January 2015, the Task Force met regularly (monthly or bi-monthly) to address areas of concern in the two municipalities and connect with different public officials, stakeholders, and residents to identify possible resilience strategies.

Task Force Mission Statement

In light of increasing frequency of tidal flooding along low-lying areas of the municipalities of Beaufort and Port Royal, the Task Force will focus on impacts on public property, critical infrastructure, and the safety and well-being of citizens under different scenarios of storm surge and sea level rise. The Task Force will make recommendations as to how these coastal communities can become more resilient to the inundation threats.

Task Force Goals

- Provide an information sheet for municipalities that can be shared with council members and interested citizens (Appendix B).
- Provide information about “at risk” locations within the two municipalities.
- Prepare a list of recommendations of possible actions, including infrastructure planning, to address current and future impacts of storm surge and future sea level rise.
- Provide the press and interested community leaders with educational materials about sea level rise so they can, in turn, encourage continued public discussion about pro-active community responses.
- Explore possible sources of funding
Vulnerability to Sea Level Rise in Beaufort and Port Royal

Sea level rise refers to the increase in sea levels both globally and locally. Global averages of sea level have been increasing due to ocean warming and glacial ice melt. Local levels of sea level rise differ from global averages due to local patterns of land movement, coastal erosion, and ocean currents.

The nearest long-term tide gage to Beaufort and Port Royal is located at Fort Pulaski, GA. Since 1965, local sea level has risen 6 inches in this area, with a 1 foot rise in the past century (Figure 1). Sea level rise into the future is expected to occur at a faster rate than in the past 100 years. However, exactly how fast this will occur is still uncertain. The rate is dependent on how fast land-based ice sheets and glaciers melt. Given the uncertainty around the rate and amount of sea level rise, the technical report on sea level rise scenarios for the US National Climate Assessment (Parris et al. 2012) recommends considering a range of sea level rise scenarios depending on how much risk is tolerable for planning purposes. These scenario ranges are represented by the dashed lines in Figure 1.

![Historic and Projected Sea Level Rise, Fort Pulaski, GA](image)

**Figure 1.** Historic and Projected Sea Level Rise, Fort Pulaski, GA. Historic data from the Fort Pulaski tide gauge are displayed with future global sea level scenarios provided by the U.S. National Climate Assessment and incorporate the gradual sinking of the land surface in the region.

Impacts from sea level rise

As the base sea level increases, the most notable impacts from sea level rise are increasingly higher and higher high tides. Land that is not normally inundated at high tide will become more regularly flooded. Specific impacts the Task Force discussed include:

- Sea level rise scenarios of 1-6 feet;
- Higher “King Tides” (the highest seasonal tides that occur each year);
- Increased nuisance flooding (flooding at high tides that impacts roadways, property, etc.)
Identifying Areas of Concern

Fortunately, much of the City of Beaufort and Town of Port Royal are located on areas with higher elevation compared to many other South Carolina coastal communities. Therefore the Task Force was able to focus on specific locations in the communities where there are already signs of inundation from exceptionally high tides. King Tides that occur today provide a hint of what future sea level rise will look like, as these tides are typically 1-2 feet higher than the average high tide.

To visualize the areas that will be inundated by sea level rise and identify neighborhoods and infrastructure at risk, the Task Force used NOAA’s Sea Level Rise and Coastal Flooding Impacts viewer and Climate Central’s Surging Seas Risk Zone Map. These tools helped Task Force members identify six areas of concern where high exposure to flooding coincided with property, businesses, infrastructure, and other community amenities.

1. Boundary Street Area
2. North Street/Waters Edge Area
3. Downtown Historic Beaufort
4. Beaufort Airport
5. Mossy Oaks/Southside Park
6. Cypress Wetlands
7. The Sands and adjacent areas of the Town of Port Royal

Selecting a Sea Level Rise Scenario for Recommendations

After careful review of the inundation impacts of different scenarios of future sea level rise on the six areas of concern, the Task Force determined that preparing for a 3 foot rise in average sea level offers the most practical and achievable resilience actions. At 3 feet or less, the impacts appear localized and allow for site specific adaptation, mitigation and retreat. Above 3 feet, the impacts appear much broader and more far reaching: as a community, this is a scenario we should avoid by installing small measures now and respecting our community contribution to this global challenge. It is also recognized that taking these resiliency measure sooner than later will also provide protection in the near term from storm surge in these areas.
Resiliency Recommendations for Areas of Concern

**Boundary Street:**

Boundary Street could be a vulnerable piece of the community’s infrastructure because it is one of only two roads connecting the sea islands to the mainland. Currently, the City of Beaufort is undergoing a major project to reduce traffic on Boundary Street, relocate utility lines and accommodate new stormwater infrastructure. These measures all improve the resiliency of the area. Notable to Boundary Street is the purposeful purchase of property on its southern edge, facing Battery Creek. These properties will be undeveloped, and offer a scenic view of the marsh: they will also act as a buffer for high tides and storm surge. Similar retreat can and should be employed on the North side as conditions require.

Looking specifically at Boundary Street near City Hall raises concerns about other parts of Highway 21. Resiliency planning should be a key component of transportation plans at the local, regional and state level as improvements are made to this evacuation route. Special attention should be given to preservation of wetlands, raising of road beds and bridge repair.

[Image of map showing inundation levels at 3 feet of sea level rise. Map created by Andrea Sassard at the S.C. Sea Grant Consortium using data from NOAA Office of Coastal Management Sea Level Rise Inundation Extent dataset.]
North Street/Waters Edge Area:

With a 3 foot sea level rise alone, the North Street/Waters Edge community does not appear to experience infrastructure damage or threat to homes. However, at this level of sea level rise combined with King Tides or storm surge (see Appendix B), inundation at this location would be severe. Therefore, special attention should be paid to relocating utilities in these vulnerable edge properties. The City of Beaufort is currently submerging utilities below ground and encasing them in cement. New homes should be encouraged to raise electric systems above 8 feet, which can be accomplished with changes to the building codes.

North Street/Waters Edge inundation at 3 feet of sea level rise. Map created by Andrea Sassard at the S.C. Sea Grant Consortium using data from NOAA Office of Coastal Management Sea Level Rise Inundation Extent dataset.
Downtown Historic Beaufort:

This is a critical area for resiliency efforts. With just a 3-foot rise in sea level this high-value historic and tourism area would be inundated causing great harm to the Beaufort economy. In addition, this area is the access point for rising seas to inundate other significant parts of Beaufort and cut off a vital access road leading to the downtown business district. Numerous utilities and community resources, including Waterfront Park, are located in this area, making the threat and opportunity here not just one for nearby residents but for the entire community.

Resiliency recommendations are two-fold. First, private landowners and a non-profit organization own the property that can provide a line of defense. Over the years, most of these property owners have crafted relatively small bulkheads along the water’s edge to protect against unusual high tides and storm surge. Current bulkheads are not sufficient to make this area resilient to a 3-foot rise in sea level. State regulations could allow for enhanced bulkheads to be built slightly landward of these existing bulkheads. However, most important would be for these efforts to be coordinated and comprehensive and not just piecemeal – as rising waters would find the path of least resistance. These private bulkheads would need to be continuous from King Street south and west to the Federal Street pond. The Federal Street pond is connected to the salt marsh via a pipe under Federal Street. This access point currently has a water flow regulator to block higher tides from entering the pond. Federal Street itself at this location might need to be elevated to be an effective barrier to a 3-foot rise in sea level.

In addition to construction of new bulkheads, installation and protection of living shorelines is an appropriate response where possible. The City of Beaufort, which owns the street terminus when the street ends at the water can employ native plantings, support the marsh habitat and encourage a healthy buffer to absorb the storm energy. Additionally, further development of the marsh and critical area – due to docks, yards and other waterfront development – should be limited or prevented to the extent it impacts the healthy marsh buffer surrounding this area.

Coordination with Public Works is essential for management of stormwater, water, sewer and power utilities in this vulnerable area. In addition, any changes to the Federal Street floodgate, including replication of that system or innovation for another solution, should be vetted by the local engineers.

Waterfront Park is an asset that should also be protected with ongoing maintenance. The large park may flood with high tides, but its greenspace will allow for water absorption before private property or utilities are impacted. For events and expansion, electric switches and operations should be located as far away from the water edge as possible.

The Task Force recommends further, more detailed engineering studies in this area to guide the most appropriate actions of those recommended above.
Downtown historic Beaufort inundation at 3 feet of sea level rise. Map created by Andrea Sassard at the S.C. Sea Grant Consortium using data from NOAA Office of Coastal Management Sea Level Rise Inundation Extent dataset.

Satellite image of existing small bulkhead on private property in Beaufort’s Historic Area.
Suggested continuous bulkheads constructed on private property in Beaufort’s Historic Area.
**Beaufort County Airport on Lady’s Island:**

Because of its low elevation the Task Force ranked this airport as one of the most vulnerable areas. With only a 2 foot sea level rise, the runway becomes vulnerable to inundation. In fact, this is already occurring during extreme high tides (known as “King tides”), which are often 1-2ft above the average high tide mark. At a 3-foot sea level rise, the southwestern portion of the property would likely be inundated leaving no access to the runway and several hangars would be vulnerable to flooding.

The Task Force believes that there is ample opportunity for the airport to increase its resilience to sea level rise during future FAA approved improvements to the airport. Options include raising the elevation of the runway and taxiway when repaving or extending, improving water drainage infrastructure, and evaluating the location and access to hangars. These recommendations were discussed with the airport administration and provided to the FAA (Appendix C).
**Mossy Oaks and Southside Park**

These residential communities have the good fortune of an elevated railroad bed separating them from rising sea level. However, each rail crossing has one in and out flow pipe allowing water to feed small ponds. These pipes currently do not have water flow restrictors as the Federal Street Pond has. Such restrictors will be necessary to protect these communities from a 3-foot and higher rise in sea level. Adaptive measures will be meaningful here to homeowners and those who enjoy the Spanish Moss Trail.

Mitigation should include identification of the drainage system internal to the neighborhood and active management. Retreat can be employed by restricting development in the drainage areas and in existing isolated freshwater or saltwater wetlands that will grow and expand as the water level rises.

Similar to the North Edge area, new development should be encouraged to raise electric systems, which can be accomplished with changes to the building codes.

Mossy Oaks and Southside Park inundation at 3 feet of sea level rise. Map created by Andrea Sassard at the S.C. Sea Grant Consortium using data from NOAA Office of Coastal Management Sea Level Rise Inundation Extent dataset.
Cypress Wetlands:

It was determined that a 3-foot rise in sea level would have minimal impact on this area because there are no dwellings, roadways or utilities in this low-lying area. This natural drainage system is a wonderful example of a natural solution, similar to a living shoreline, that could be employed and enjoyed in other areas of concern and existing neighborhoods.

The Sands and Adjacent areas of the Town of Port Royal:

The specific impact of rising sea level on this area cannot be determined at this time because it is undeveloped. It is noted that future use of this low-lying area must consider impacts of rising sea level on the master plan for the site.

Conclusion

The Task Force was able to identify areas of concern in Beaufort and Port Royal and recommends taking the initial steps to build resilience in the area where retrofitting, mitigation, adapting, or retreating are appropriate. It recommends the City and Town invest in detailed studies in these areas to better determine what specific actions can make the areas more resilient. In addition, collaboration among all the municipalities in the region and Beaufort County will provide more opportunities to leverage resources. Beaufort County has already taken the initial steps toward sea level rise adaptation by incorporating strategies into its Comprehensive and Hazard Mitigation Plans.

Acknowledgements

The Task Force wishes to thank all the elected leaders of the City of Beaufort and Town of Port Royal for their support and cooperation. Coastal municipal governments engaging their residents in the planning process for sea level rise resiliency promotes a better understanding of the issue and appreciation for the steps needed to protect the community.
Appendix A

Beaufort and Port Royal Sea Level Rise Task Force

Co-Chair: Chris Marsh, Ph.D., Executive Director, LowCountry Institute

Co-Chair: Jack Nietert, Beaufort resident, retired clergyman

Dan Ahern, engineer, National Stormwater Center

Bob Bender, Curator, Lowcountry Estuarium

Stephen Borgianini, Ph.D., University of South Carolina-Beaufort

Chris Carnevale, Coastal Climate and Energy Coordinator at Southern Alliance for Clean Energy

Jim Crower, Port Royal resident

Kirstin Dow, Ph.D., Carolinas Integrated Sciences and Assessments* and the University of South Carolina

Megan Feight, Beaufort business owner and resident

Elizabeth Fly, Ph.D., Coastal Climate Extension Specialist, Carolinas Integrated Sciences and Assessments* and South Carolina Sea Grant Consortium*

Kim Gundler, Co-owner of Beaufort Kayak Tours and Beaufort resident

Alice Howard, Beaufort County Council

George Johnston, Beaufort County Resident and Beaufort County Rural and Critical Lands Preservation Board

Billy Keyserling, Mayor of Beaufort

Frank Knapp, President and CEO, South Carolina Small Business Chamber of Commerce

Greta Maddox, Owner of Seaside Getaways

Kate Schaefer, Coastal Conservation League

Sumi Selvaraj, Graduate Research Assistant for Carolinas Integrated Sciences and Assessments*

Joe Staton, Ph.D., University of South Carolina-Beaufort

*Professional support, research and expertise generously provided by these members and their parent organizations
Appendix B

Sea Level Rise, Storm Surge, and Planning for the Future
Beaufort and Port Royal Taskforce Information Sheet

What's the connection between sea level rise and storm surge?

Sea level rise refers to the increase in sea levels both globally and locally. Global averages of sea levels have been increasing due to ocean warming and glacial ice melt. In addition, local sea level rise varies depending on local patterns of sinking land, coastal erosion, and ocean currents. In Beaufort and Port Royal, SC, local sea level has risen 6 inches since 1965 based on data collected at the nearest tide gauge in Fort Pulaski, GA (Figure 2). Some of the first impacts of sea level rise include higher King Tides, more nuisance flooding, and mixing of salt water with freshwater further upriver.

Storm surge typically impacts the same areas threatened by future sea level rise. Storm surge, unlike sea level rise, occurs only when a storm approaches the coast. Storm surge is the rise in water above the normal tide that occurs when winds from a storm push water towards the shore. It can result in coastal flooding and damage. Thus, if a storm occurs during high tide, a community will experience more storm surge than if the same storm had occurred during low tide.

![Figure 1. Sea level rise magnifies the risks of storm surge and high tides](image)

![Figure 2. Historic and Projected Sea Level Rise, Fort Pulaski, GA](image)

Sources: NOAA, USACE, Parris et al. 2012

Figure 2. Historic data from the Fort Pulaski tide gauge are displayed with future global sea level scenarios provided by the U.S. National Climate Assessment and modified to incorporate the gradual sinking of the land surface in the region.
Why is there so much uncertainty in determining how fast sea level will rise in the future?

There are three reasons for the uncertainty in accurately projecting future sea level rise. (1) Sea level fluctuates annually as the oceans cool down and heat up, and therefore estimates of long term trends in sea level rise require data from many years. (2) Scientists are still discovering new information about how fast the ocean will warm or glacial ice will melt—and both of these factors cause global sea levels to rise. As a result, scientists use different global sea level rise scenarios to estimate how fast and how much sea level will rise (see Figure 2). (3) While all scientific models predict that the rate of sea level rise will increase in the future, these models differ because they attempt to predict future global changes that involve complicated environmental interactions, such as an ice-free Arctic Ocean accelerating the rate of Greenland’s glaciers melting. As shown in Figure 2, slight differences in the estimated rate of sea level rise results in large differences when projected a century into the future.

Why should municipal and county governments be discussing sea level rise now?

One of the goals of community planning is to move the community toward what it should look like in 50 or 100 years, especially when today’s actions either help or hinder the ability of the community to be successful in the future. Three examples of how municipal and county governments provide forward-thinking planning include protecting historic buildings, planning parks and establishing zoning ordinances that define how a community grows.

Communities would be wise to include sea level rise on their future planning list because many sea level rise impacts are already being seen in the form of more frequent higher tides inundating low-lying areas. Exceptionally high tides, called “King Tides,” and storm surges can impair or damage the community’s buried utilities as well as flooding buildings long before these areas are inundated permanently by rising sea level. For example, storm and sewer lines and buried communications infrastructure represent a significant capital expense for any community. Since almost all communities already have difficulty meeting their current financial commitments, preventing future catastrophic economic losses caused by storm tides, magnified by rising sea level, should be a high priority of every coastal community.

How can we plan for sea level rise?

Fortunately, much of the City of Beaufort and Town of Port Royal are located on areas with higher elevation compared to many other South Carolina coastal communities, and therefore they can focus their discussions about rising sea level impacts on specific locations where there are already signs of King Tide flooding impacts. The first step of this process is to involve employees responsible for managing underground utilities and drainage issues.

Engaging citizens in these conversations is also an important part of this planning because many of the preventative actions must be taken by the private sector and homeowners. Having well informed homeowners and business owners may help the community take preventative actions to reduce economic damage caused by flooding in the future.

---

Appendix C

Beaufort/Port Royal Sea Level Rise Task Force
C/O SCSBCC, 1717 Gervais Street, Columbia, SC 29201

September 27, 2015

Mr. Rusty Nealis
Program Manager
FAA Atlanta Airports District Office
Southern Region Headquarters
1701 Columbia Avenue, Suite 220
College Park, GA 30337

Re: Beaufort County Airport on Lady’s Island, SC

Dear Mr. Nealis,

Concerned citizens, small businesses, elected officials, and municipal staff in the City of Beaufort and Town of Port Royal, South Carolina, have formed the Beaufort/Port Royal Sea Level Rise Task Force to address the area’s vulnerability to sea level rise and to identify adaptation strategies that increase resilience to future impacts caused by rising seas. Aided with scientific and technical expertise from the Carolinas Integrated Sciences and Assessments program at the University of South Carolina, this Task Force has identified eight areas of concern that are particularly vulnerable to sea level rise and is working with public works staff and neighborhood associations to address impacts on public property, critical infrastructure, and the safety and well-being of citizens under different scenarios of sea level rise.

One of the eight areas of concern identified by the Task Force was the Beaufort County Airport on Lady’s Island, SC. The Task Force met with Jon Rembold, Beaufort County Airports Director in August 2015 to learn about planned safety and long-term improvements to the Lady’s Island airport and to discuss if future flood risks linked to sea level rise and storm surge amplified by climate change are being considered in these projects. We understand that there are several future safety improvements at the Beaufort County Airport and that those will be developed in cooperation with the FAA, but as of right now the proposed improvements do not consider vulnerabilities to sea level rise in the design.

Because of its low elevation the Task Force ranks the airport as one of the most vulnerable areas in the Beaufort-Port Royal area. With 2 feet of sea level rise, the runway becomes vulnerable to inundation. In fact, this is already occurring during extreme high tides (known as “King tides”), which are often 1-2 ft above the average high tide mark. At 3 ft of sea level rise, the southwestern portion of the property would likely be inundated leaving no access to the runway and several hangars would be vulnerable to flooding.
The Task Force believes that there is ample opportunity for the airport to increase its resilience to sea level rise during these improvement projects. Options include raising the elevation of the runway and taxiway when repaving or extending, improving water drainage infrastructure, and evaluating the location and access to hangars.

The Task Force asks that the FAA require the design of the new improvements to the Beaufort County Airport to address the impacts of future sea level rise. Recent federal policy that led to the creation of the 2012 and 2014 DOT Climate Adaptation Plans provide rationale for action by the FAA to require its future grantees, such as the Beaufort County Airports Board, to consider future flooding caused by sea level rise on planned airport improvement projects. This would ensure that the FAA’s investments would have a much longer lifespan by making the airport more resilient to future flooding.

Sincerely,

Chris Marsh, PhD.
Co-Chair
Beaufort/Port Royal Sea Level Rise Task Force

cc Jon Rembold
   Airports Director
   Beaufort County Airport