

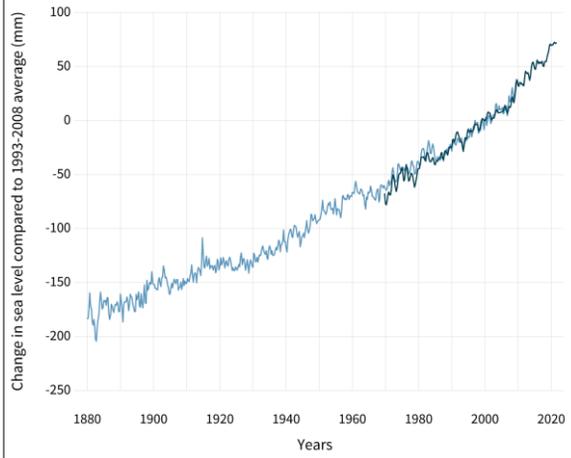
Global Sea Level Change and Local Impacts in South Carolina

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GLOBAL SEA LEVEL



Global Sea Level Rise

- Tide gauge data (from 1880's)
- Satellite data (from 1992)

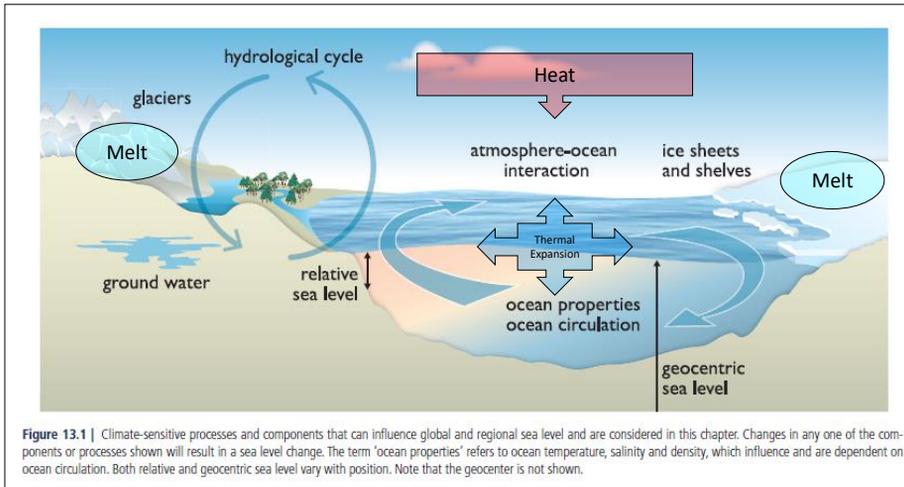
Global sea level has risen 8-9 inches since 1880 with about 3 of those inches occurring since 1993.

In 2020, global sea level set a new record high—91.3 mm (3.6 inches) above 1993 levels.

www.climate.gov

- Seasonal (3-month) sea level estimates from [Church and White \(2011\)](#) (light blue line) and University of Hawaii [Fast Delivery](#) sea level data (dark blue). The values are shown as change in sea level in millimeters compared to the 1993-2008 average. NOAA Climate.gov image
- The rate of sea level rise is accelerating: it has more than doubled from 0.06 inches (1.4 millimeters) per year throughout most of the twentieth century to 0.14 inches (3.6 millimeters) per year from 2006–2015. Based on analysis and data from Philip Thompson, University of Hawaii Sea Level Center.

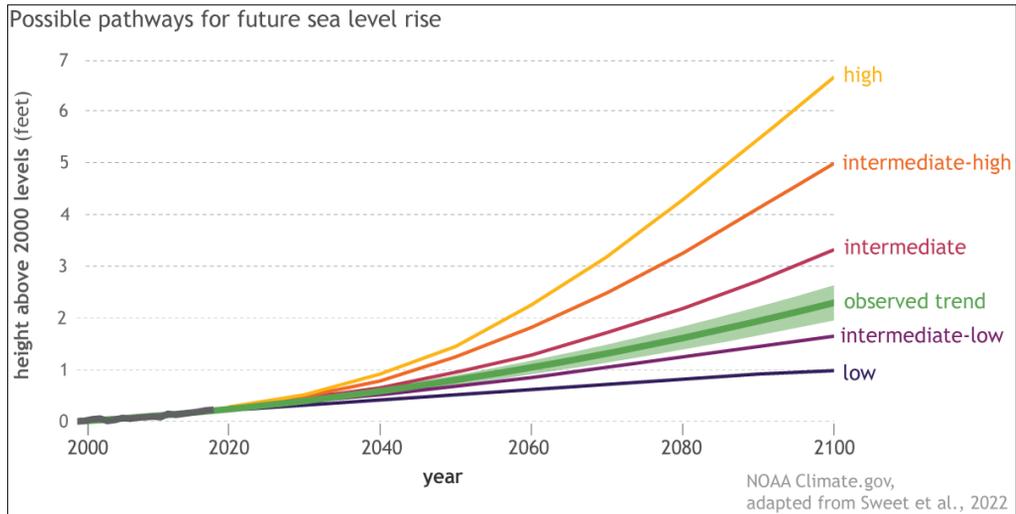
What drives global sea level change?



Source: 2014 National Climate Assessment

- Two factors drive global sea level rise:
- 1. Thermal Expansion: ocean absorbs the heat from the atmosphere and this causes the water to warm and expand.
- 2. Land-based ice sheets and glaciers melt and add additional water to the ocean.

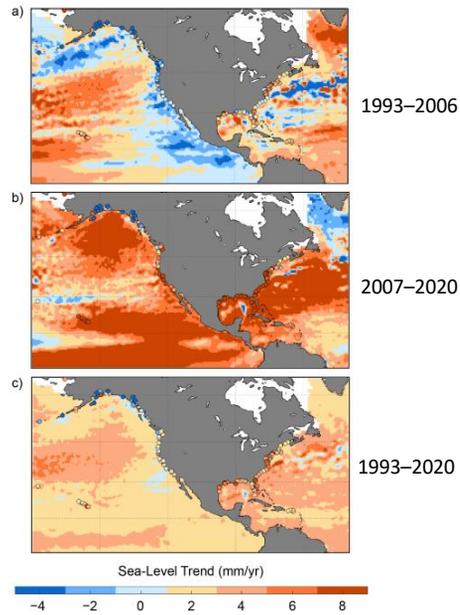
Wide range of future SLR projections due to uncertainty
of ice melt and emissions



- Future projections of sea level rise are uncertain due to uncertainty in:
 - 1. future carbon emissions/warming of the atmosphere
 - 2. the rate of ice melt from land-based ice sheets and glaciers.

Regional sea level

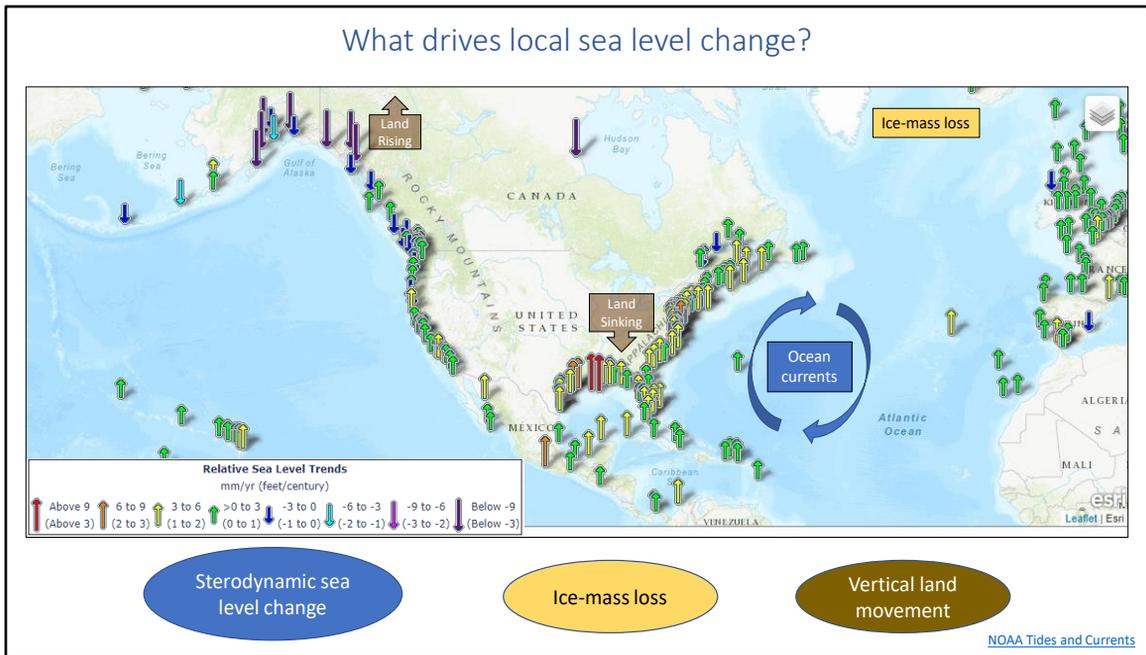
Sea level is not uniform around the world!



[Sweet et al. 2022](#)

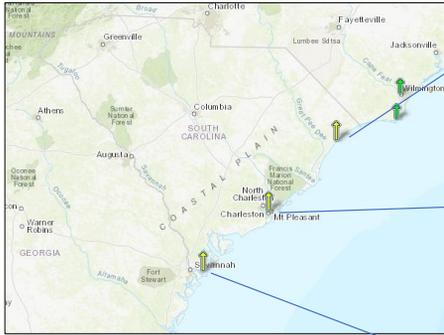
- While there is an average global sea level rise, sea level is not uniform around the world.
- These figures show the different rates of sea level change around North America in 3 time periods – warmer reds show higher rates of sea level rise, blues show a decreasing trend.
- The 3 time periods illustrate the acceleration of sea level rise in the last decade or so.

What drives local sea level change?

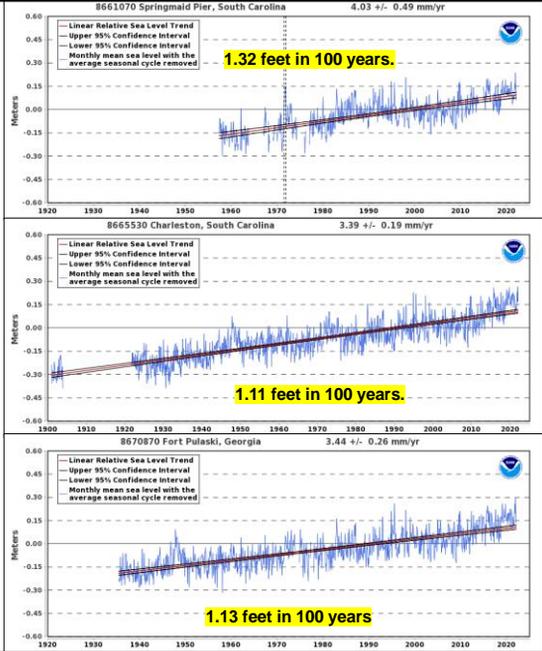


- 3 factors drive local sea level change:
- 1. Sterodynamic Variability: Sea level change that arises from variability in the ocean's circulation, temperature and saltiness. This includes large-scale climate signals like the seasonal cycle, El Niño-Southern Oscillation, North Atlantic Oscillation, and Pacific Decadal Oscillation. This also includes longer-term changes in ocean circulation that may occur in the future and global sea level rise associated with long-term warming of the ocean and associated expansion. It is very likely that the AMOC will decline in the future, although there is still disagreement as to the extent of this decline. A weakening AMOC will lead to an increase in sea level along the coastal Northeast and Southeast regions.
- 2. The ice-mass loss from ice sheets and glaciers to the ocean has a strong influence on regional sea level. Changes in Earth's GRD responses dictate the spatial distribution of water across the global ocean
- 3. Vertical Land Movement refers to either subsidence or uplift that occurs in coastal regions.

Local trends

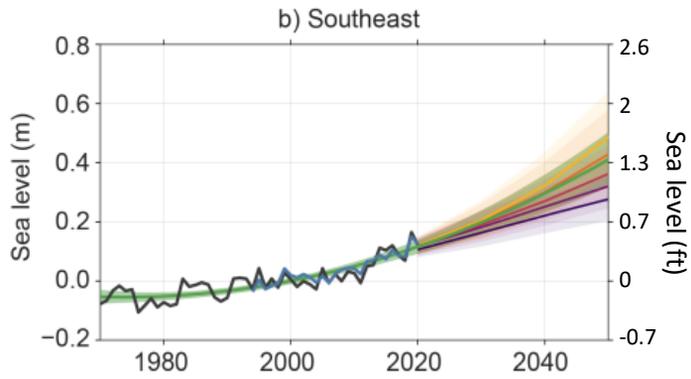


[NOAA Tides and Currents](https://tidesandcurrents.noaa.gov/)



- Local trends in South Carolina show over 1 ft of sea level rise in the last 100 years.

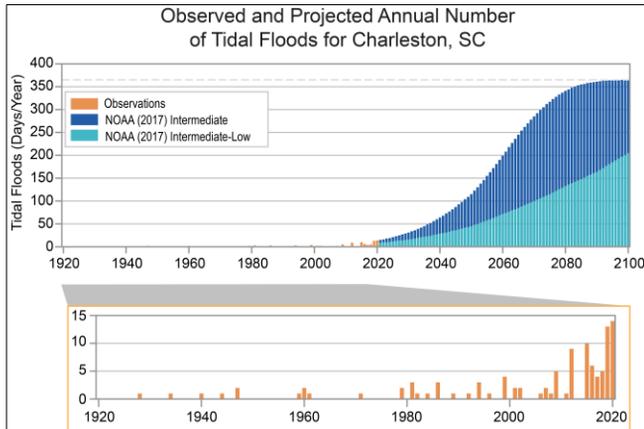
Future local projections



[Sweet et al. 2022](#)

- Local projections of sea level rise in the Southeast range between 1-2ft by 2050.

Nuisance flooding

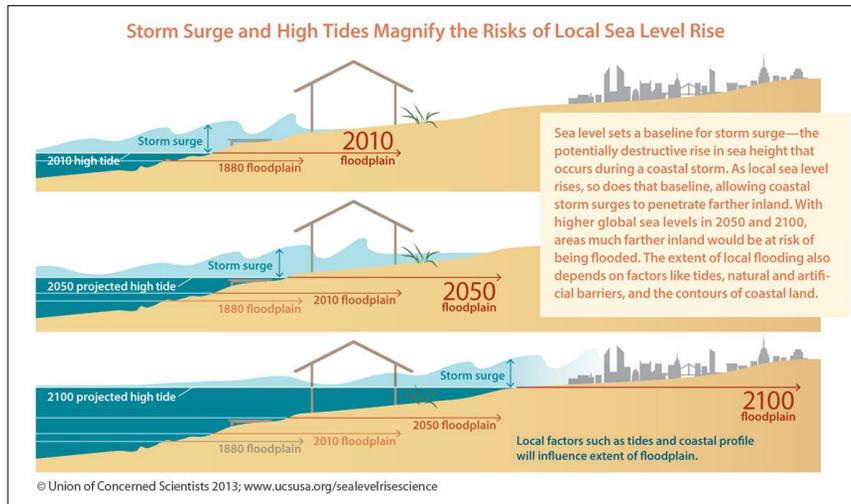


[State Climate Summaries](#)



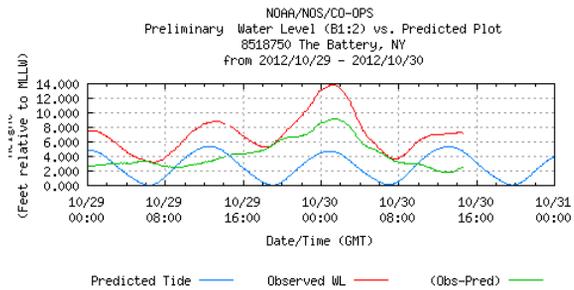
- One impact of sea level rise in South Carolina is increasing occurrences of tidal flooding or nuisance flooding.
- The last decade has seen a significant increase in number of days of nuisance flooding in Charleston.
- Projects under an intermediate level of sea level rise indicate tidal flooding will occur every day, twice a day, by 2080.

Storm Surge



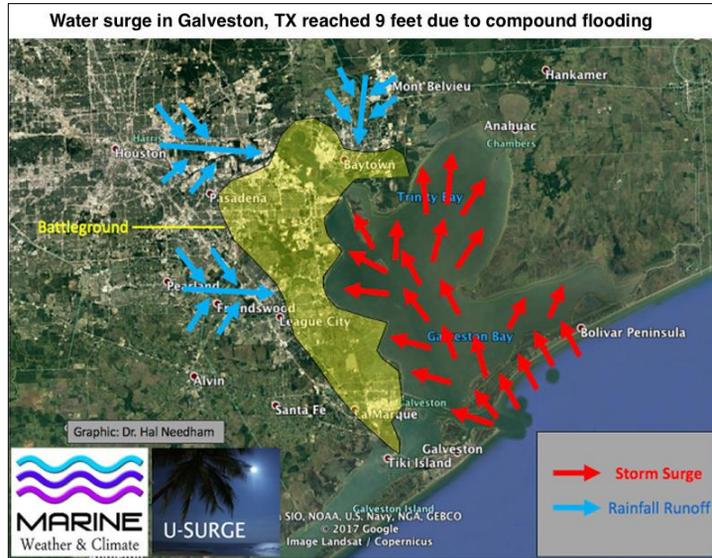
- While storm surge is not caused by sea level rise, it is exacerbated by sea level rise.
- This is because the base sea level is higher, allowing the possibility for storm surge to reach farther inland.

Real world example: Storm surge on a high tide

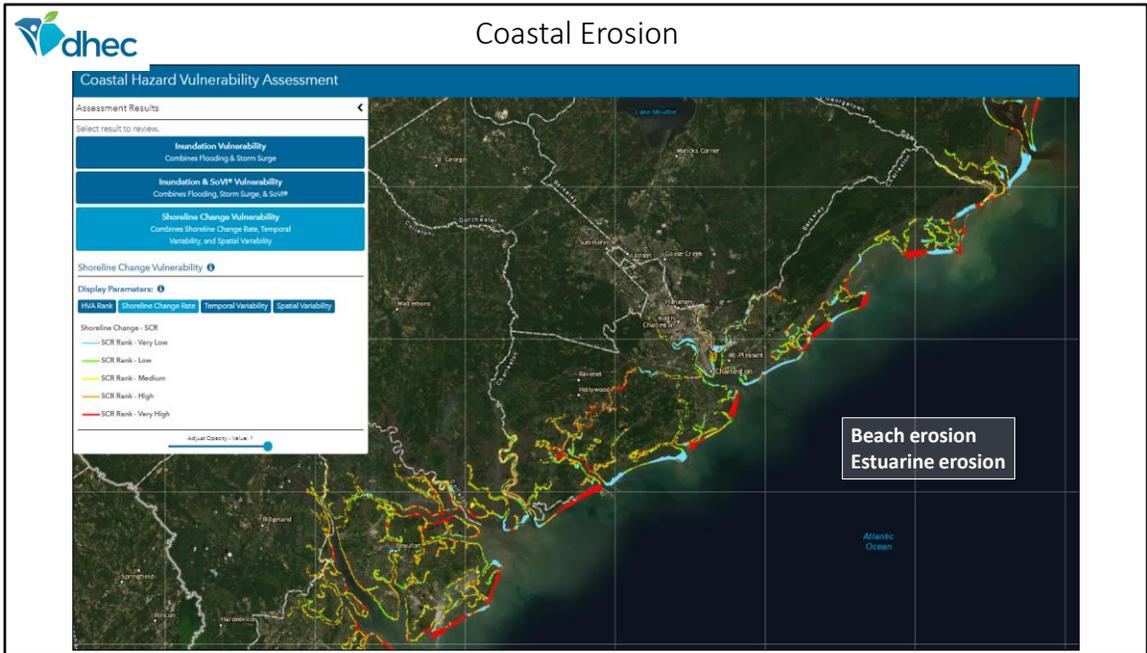


- A real life example of storm surge with a higher base sea level can be seen during Superstorm Sandy in New York. You can see the predicted tide (blue) and the observed water level (red).
- The storm hit right at high tide, causing very high water levels and catastrophic flooding.

Compound flooding =
rainfall + storm surge



- Compound flooding is a fairly new topic of research. It is the combination of rainfall, riverine, and storm surge flooding.
- Many coastal storms are moving more slowly than they used to and dropping much more rain. This is why compound flooding is being explored more recently.
- All these different types of flooding affect our built and natural infrastructure



- Coastal Erosion is another coastal dynamic that is being exacerbated by sea level rise.
- A shoreline change analysis commissioned by SCDHEC shows that over half of South Carolina’s coastline has long-term erosion – both beachfront and estuarine.

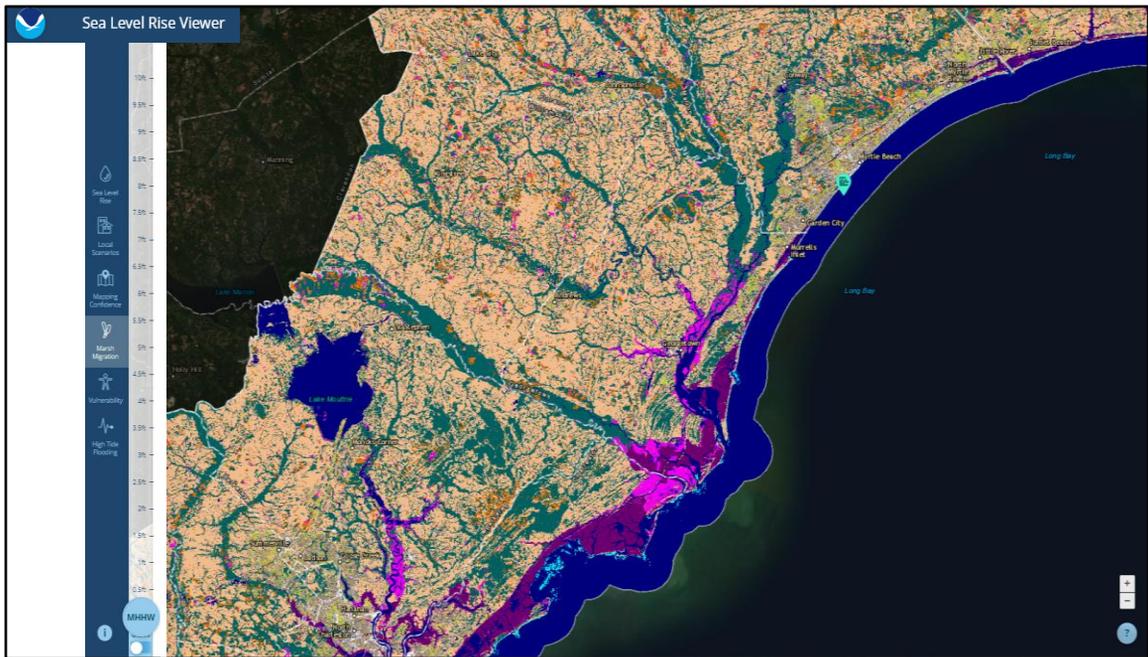
Beach erosion



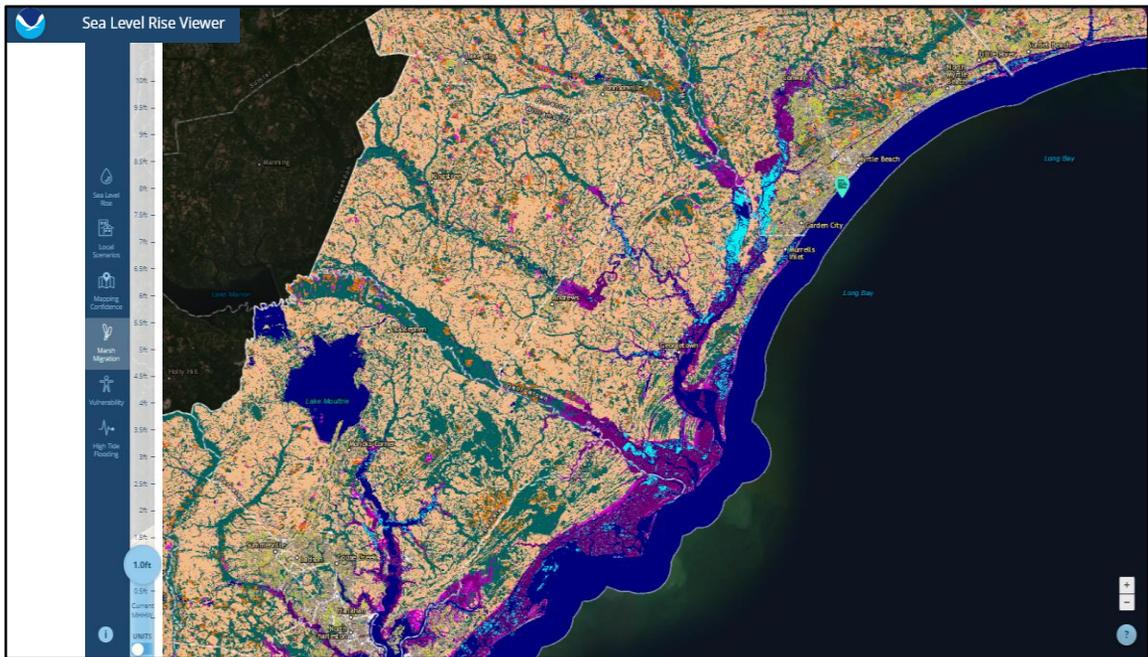
Estuarine erosion



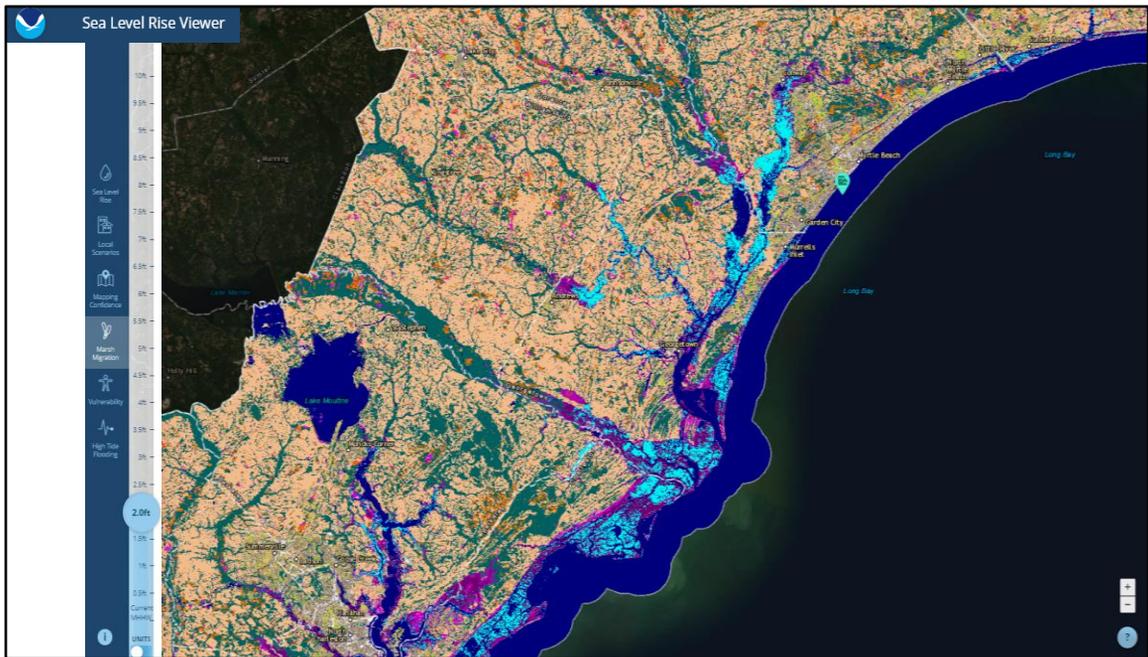
- These are images of common impacts from both beachfront and estuarine erosion.
- It often results in emergency protective measures (i.e. sandbags) or hardened structures (i.e. seawalls) to address the erosion.
- These hard measures can often exacerbate the problem in neighboring areas.



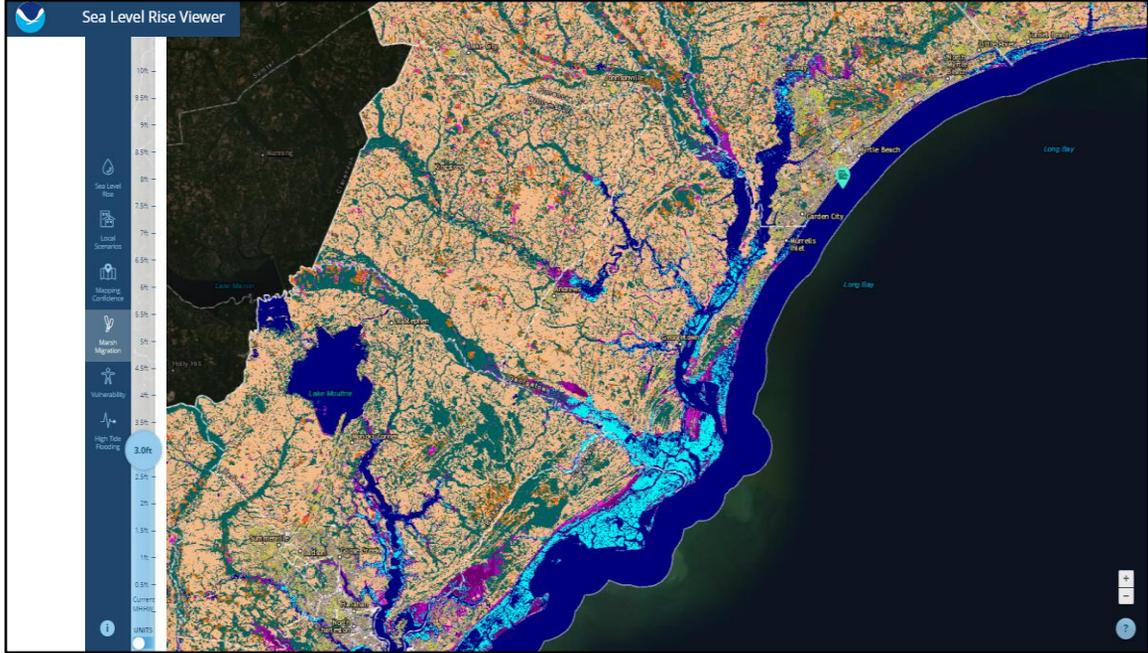
- Another impact of sea level rise is marsh loss.
- South Carolina has 20% of all the marsh on the US East Coast, but we are at risk of losing that marsh.
- The purple in this image is existing marsh with current sea levels. The next 3 images add 1ft, 2ft, and 3 ft of sea level rise. You will notice a conversion of purple to blue, which is a conversion of marsh to open water.



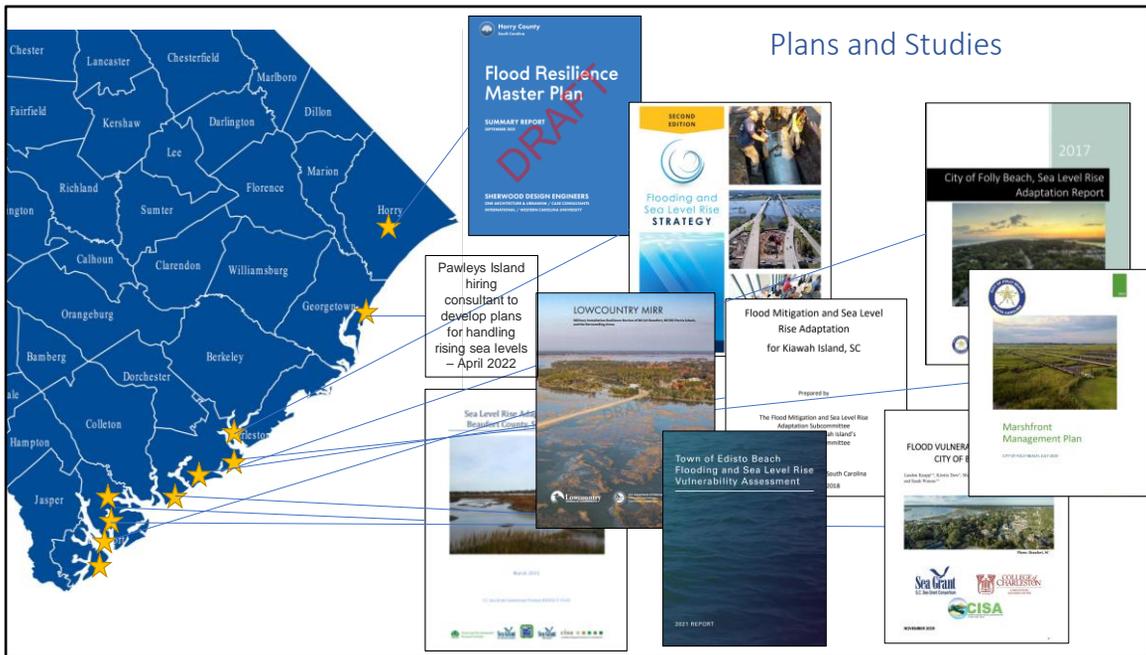
- Marsh with 1ft of sea level rise.
- You will notice a conversion of purple to blue, which is a conversion of marsh to open water.



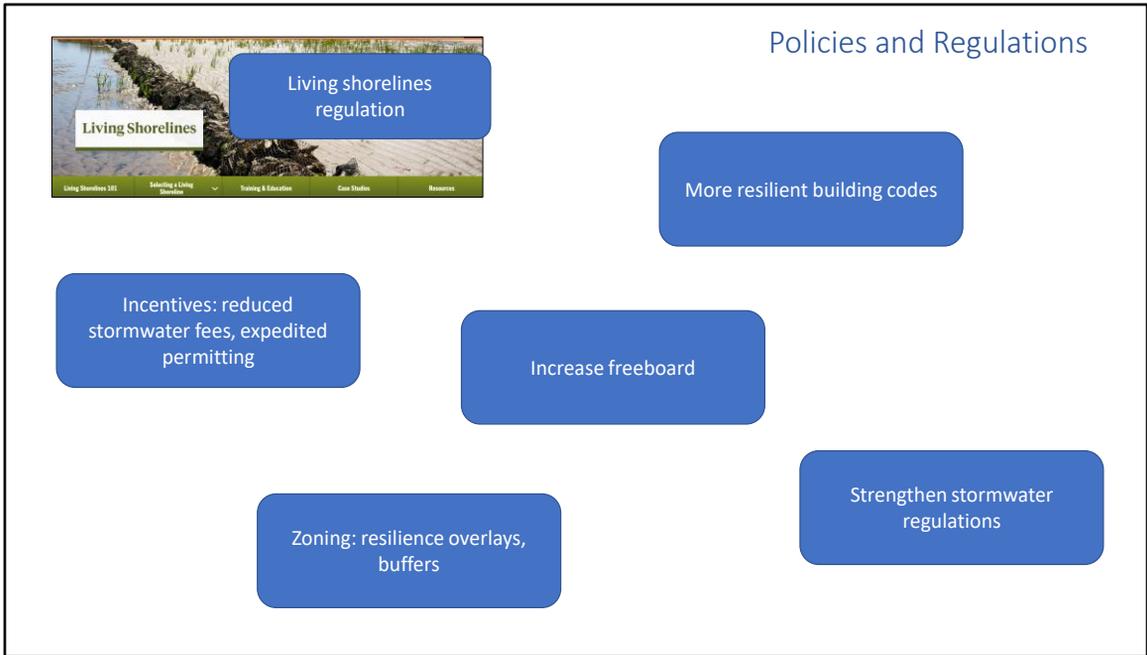
- Marsh with 2ft of sea level rise.
- You will notice a conversion of purple to blue, which is a conversion of marsh to open water.



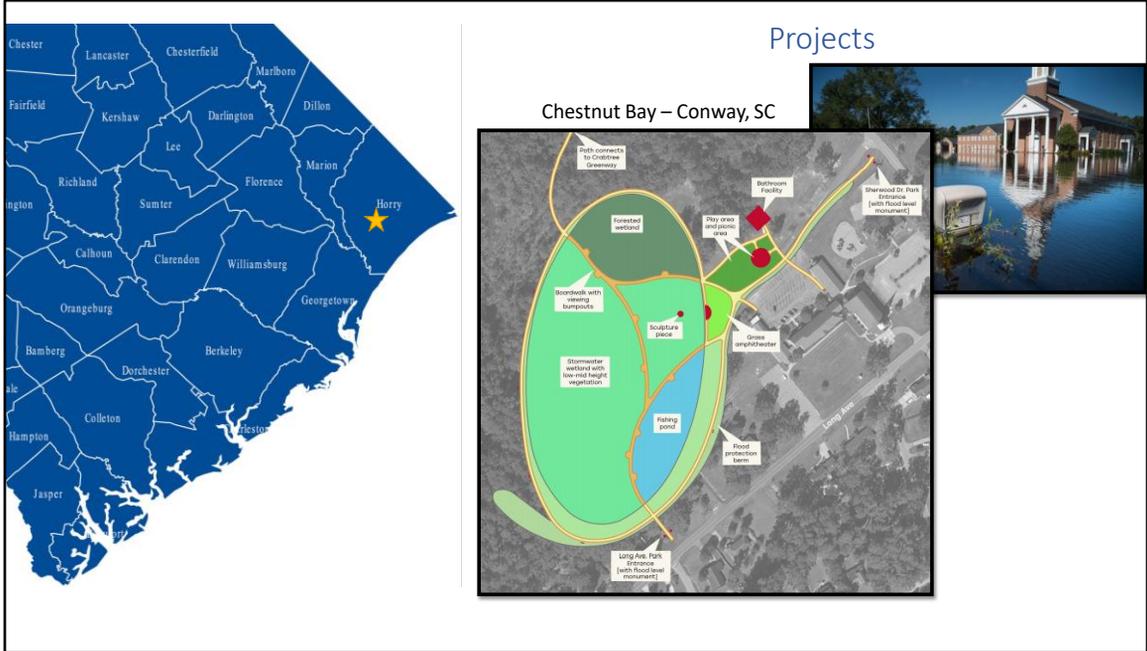
- Marsh with 3ft of sea level rise.
- You will notice a conversion of purple to blue, which is a conversion of marsh to open water.



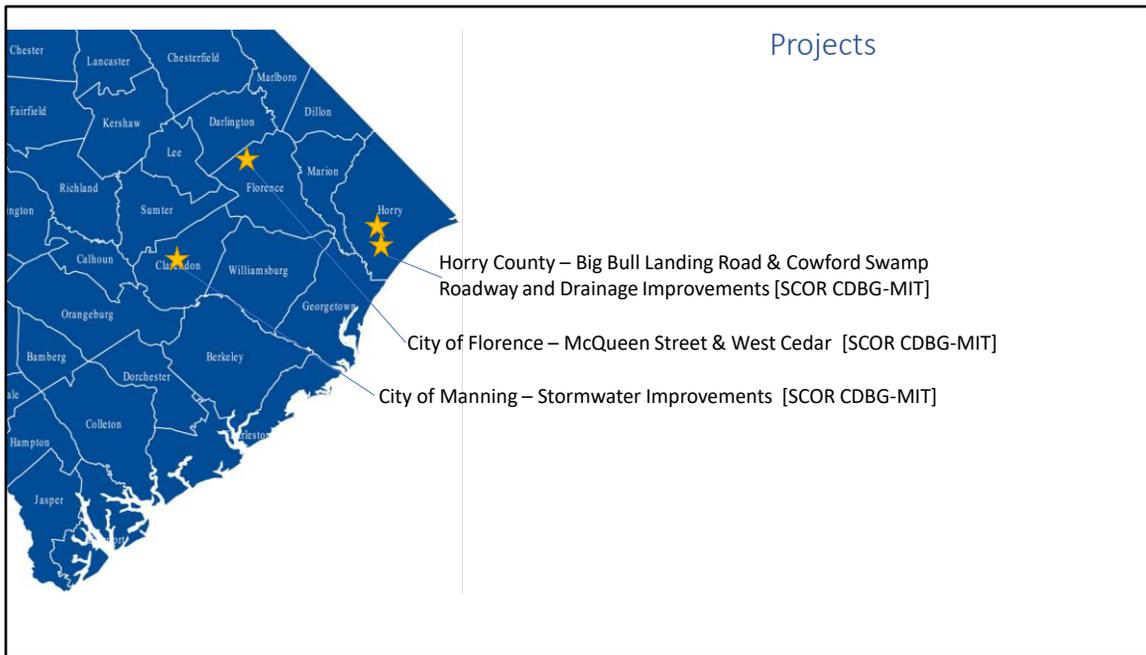
- South Carolina is preparing for, responding to and adapting to sea level rise in many ways.
- Since 2015, a number of sea level rise plans, flooding plans, and resilience plans have been developed by coastal communities.



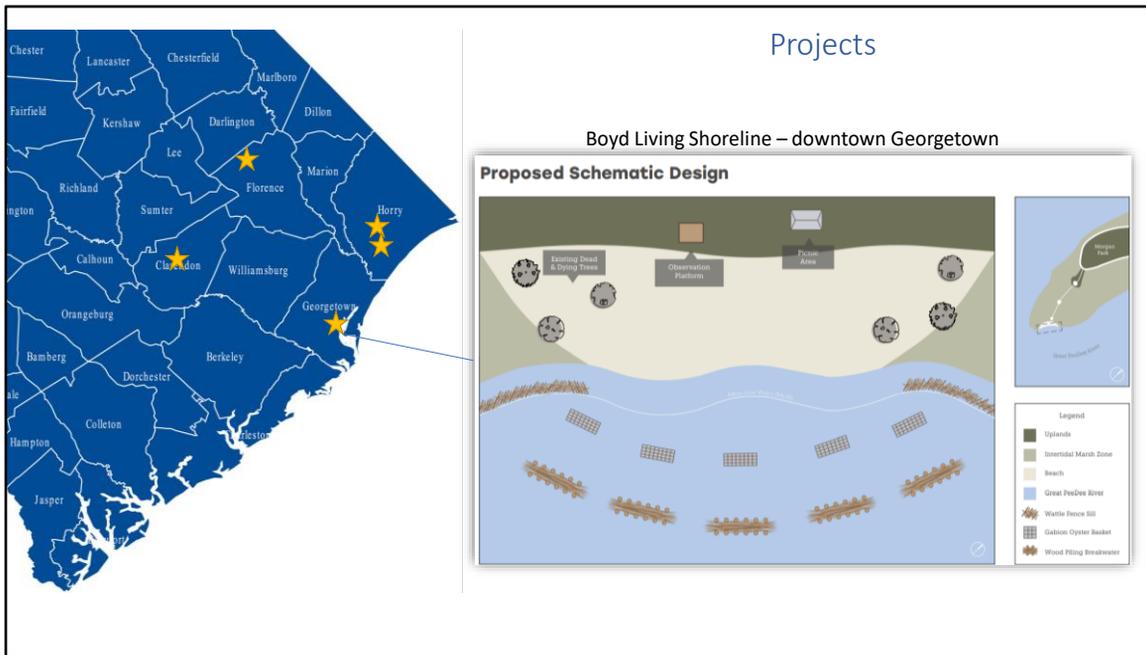
- There are a number of policies and regulations are being discussed, though few have been implemented thus far.
- As of May 2021, South Carolina has a living shorelines regulation and permitting process, which allows homeowners an alternative to seawalls for addressing shoreline erosion.



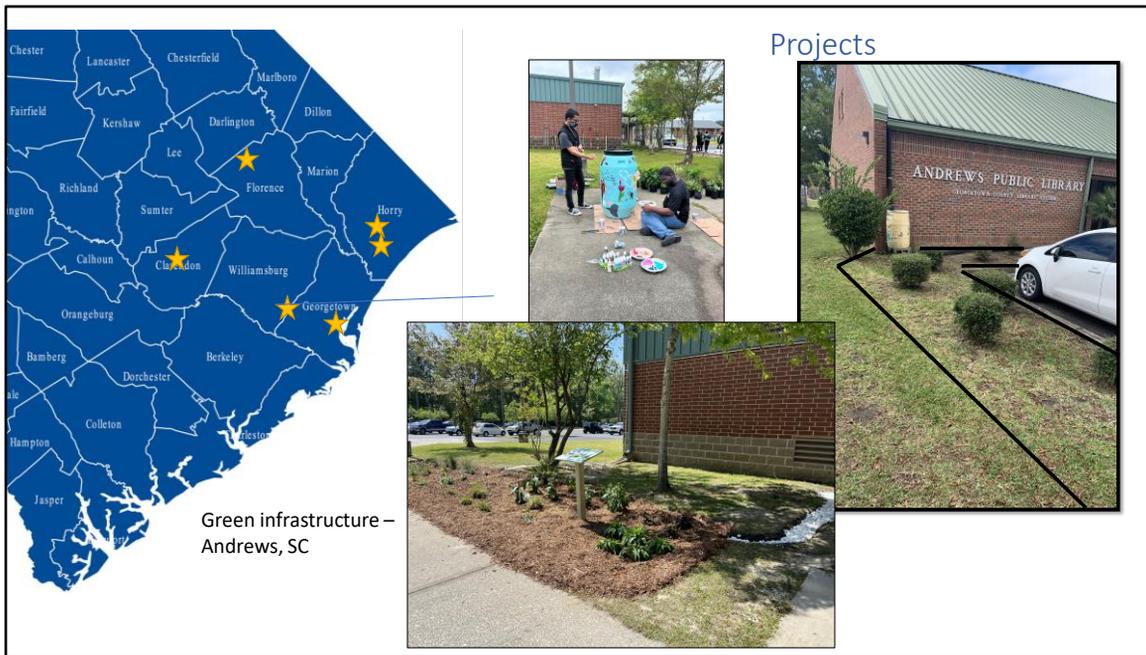
- Conway, SC, is looking to address flash flooding and riverine flooding by designing and building a created wetland in an area where repetitively flooded homes were purchased and demolished.



- The SC Office of Resilience is funding stormwater and drainage projects throughout the state.



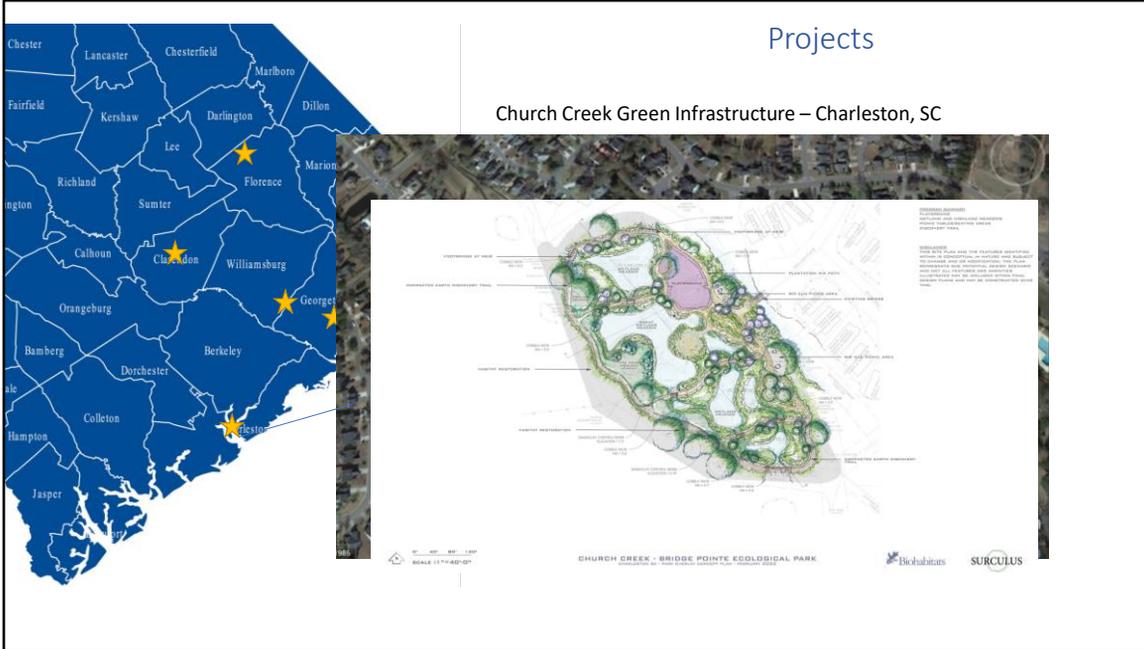
- The Nature Conservancy is designing a largescale living shoreline (1 acre) at Morgan Park in Georgetown, SC.



- The Nature Conservancy partnered with Clemson Extension to implement green infrastructure (rain gardens) in the town of Andrews to help manage stormwater.

Projects

Church Creek Green Infrastructure – Charleston, SC



- The City of Charleston is designing and implementing an ecological park with natural stormwater retention in an area where repetitively flooded townhomes were acquired and demolished.

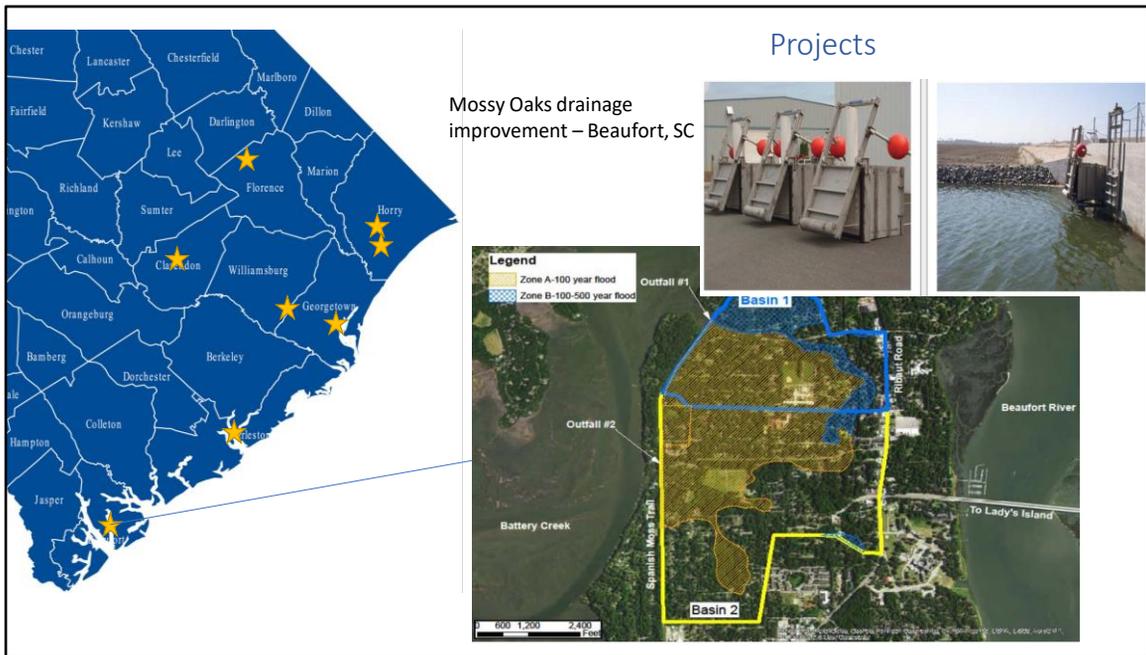
Projects

Seawalls and storm surge barriers

Stormwater pumps

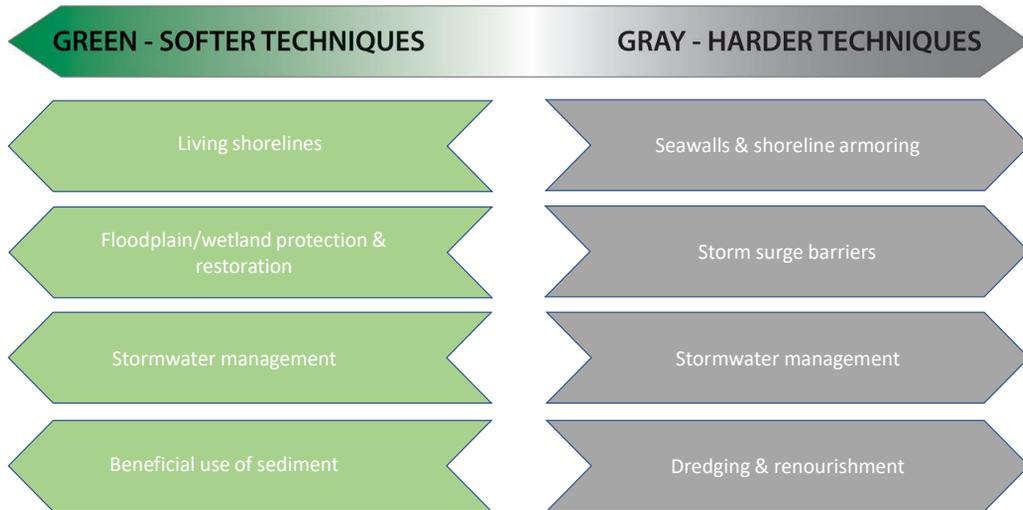
Marsh restoration

- Gray to green solutions are being used in Charleston – from sea walls to stormwater pumps to marsh restoration.



- The City of Beaufort is improving drainage in the Mossy Oaks neighborhood through improved conveyance and tidal flaps to prevent backflow flooding during very high tides.

Adaptation Strategies



- There is a spectrum of adaptation strategies that local communities can consider and implement based on the issue.

Thank you!

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