Town of Edisto Beach Flooding and Sea Level Rise Vulnerability Assessment

2021 REPORT

Contents

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Executive Summary

Edisto Beach has experienced an increase in flooding frequency from a variety of sources in the past six years. Extreme events have resulted in the most significant impacts with regard to scale, duration, and level of disruption. However, the rising sea level also is exacerbating problems currently and leading to additional challenges such as corroding underground infrastructure and decreasing stormwater drainage capacity.

Sea level has risen in South Carolina about 1.1 feet since 1900, with about 6 inches of that rise occurring since 2000. Edisto Beach has experienced a noticeable increase in the frequency of tidal flooding since 2015, with events unrelated to any storms causing major-level flooding and disruption, also known as “sunny day floods.”

The S.C. Sea Grant Consortium (SCSGC), Carolinas Integrated Sciences and Assessments (CISA), and College of Charleston’s Lowcountry Hazards Center (LCHC) assessed Edisto Beach’s vulnerability to flooding and sea level rise using a variety of methods. SCSGC and LCHC developed a high-resolution flood model to assess vulnerability to properties and roads. SCSGC and CISA conducted workshops with town staff and residents to describe current challenges and experiences with flooding, and to identify concerns for the future.

Groundwater impacts from rising sea level are currently occurring, and as sea level continues to rise, impacts to buried infrastructure such as septic systems, underground piping, and underground utility connections will increase. Rising groundwater tables also will decrease the ability for heavy rainfall to drain into the ground, leading to more frequent and persisting standing water after storms.

In the flood modeling vulnerability assessment, researchers identified that a tipping point exists when the water reaches between 2 feet and 3 feet above Mean Higher High Water (MHHW). When this threshold is crossed, the percentage of parcels that have water covering at least 5% of the property at high tide jumps from 8% to 30%. At the 4-foot mark, the percentage jumps to 54% of the total parcels in Edisto Beach.

Surface flooding is not the only impact from sea level rise and increased flooding from rain. Persistent impacts to groundwater and the frequency of standing water likely will begin when the sea level reaches 1.5 feet above current MHHW due to naturally occurring tidal variation. Using the National Oceanic and Atmospheric Administration (NOAA) intermediate and intermediate high sea level rise scenarios, this could happen sometime between 2040 and 2060. More study is needed to determine the groundwater impacts and develop a timeline for those impacts.

The frequency of community disruption from standing water, street flooding, and submerged septic systems due to heavy rain is also likely to increase. This is because the rising sea level and associated groundwater level increases will reduce the drainage capacity and capability of ditches and engineered systems. This means that a rain event that would not have caused persistent and disruptive flooding in 2021 may do so in the future.

The Town of Edisto Beach can work with residents and property owners to identify measures to reduce flooding disruption and damage in the short and mid-ranges. Studying groundwater and developing impact-based timelines are crucial next steps. Continued and sustained engagement with residents and property owners is essential to educate about the increasing risks, what the town is able to do, and what residents themselves can do to ensure a safe and livable property within impact-based timelines.

Introduction

Like all South Carolina coastal communities, the Town of Edisto Beach has experienced an increase in the frequency and severity of flooding from multiple sources since 2015. This report assesses the effects of flooding from all sources with regard to community disruption, municipal functionality, and cascading impacts, as well as assesses the Town of Edisto Beach's vulnerability to sea level rise.

How This Study Was Completed

Town staff requested that S.C. Sea Grant Consortium (SCSGC) and the Carolinas Integrated Sciences and Assessments (CISA) assist with developing an initial report about the town's vulnerability to sea level rise and flooding. CISA and SCSGC determined that the town would benefit most from using the Vulnerability, Consequences, and Adaptation Planning Scenarios (VCAPS) process. VCAPS was used to deeply explore the current problems and what the town currently is doing to address those problems, as well as identify what future problems may be encountered under future conditions and next steps for how Edisto Beach can study and implement adaptation measures. The workshops were intended to be held in-person with town staff, but due to the COVID19 pandemic, they were held using internet-based video conferencing via Zoom, on August 10, 2020 and December 11, 2020. The results of those workshops were then compiled by SCSGC and CISA, along with partners with the College of Charleston's Lowcountry Hazards Center, who developed high-resolution mapping and conducted digital analyses.

The town issued a request for residents to provide photographs of flooding along with location and event data in April 2020. This resulted in 21 submissions via email and through a website mapping tool. On September 28, 2021, the research team and the town hosted an information-gathering event at Edisto Beach Town Hall, 2414 Murray Street, Edisto Beach, providing residents and stakeholders an opportunity to add observations and concerns for the future. Eight residents attended the event, with an additional resident providing input separately.

For more details on who participated and how this report was funded, see Appendix A.

About Edisto Beach

The Town of Edisto Beach is a barrier island community in Colleton County, S.C. It lies adjacent to Edisto Island, which is in Charleston County. It is comprised of 68 square miles and has just under five miles of tidal shoreline.

The town is located just east of Edisto Island, an Atlantic Ocean sea island located approximately 30 miles south of Charleston, South Carolina, and about 50 miles north of Savannah, Georgia. Located at the end of S.C. Highway 174, a national scenic byway, Edisto Beach is one of the few remaining non-commercialized, family-oriented beaches on the East Coast. It is a place devoid of traffic lights and has a top speed limit on roads of 35 mph. Development began on Edisto Beach in the 1920s prior to the construction of the bridge to the mainland. Early beachgoers had to time their arrival to coincide with low tide in order to cross the marsh areas by driving on beds of oyster shells. Development was slow in the early days but began to increase following the Second World War.

As the result of development and the increase in number of permanent residents, Edisto Beach was incorporated as the Town of Edisto Beach in 1970. Originally located in Charleston County, the residents of Edisto Beach voted in the mid-1970s to leave Charleston County and annex to adjoining Colleton County. Although located in Colleton County, Edisto Beach is as close to the suburban and urban areas of Charleston County as to Walterboro (the Colleton County seat), the largest municipality in Colleton County.

Much of Edisto Beach's development occurred gradually. In the early 1980s, Fairfield Ocean Ridge developed a set of parcels. Much of the land in this area was marshy in nature and required substantial amounts of fill. In order to provide sanitation service in a dense development, Fairfield transferred 3.6 acres in 1985 to develop a wastewater treatment plant.

Commercial activity on Edisto Beach supports the permanent residents and visitors to the beach, and includes a grocery store, gift shops, restaurants, boat tours, guided fishing trips, and water sports. Edisto Beach is a casual, relaxed place with a natural feeling experienced by permanent residents and visitors. Edisto Beach enjoys a moderate climate with average summer temperatures in the 80s, and winter temperatures in the 50s-60s.

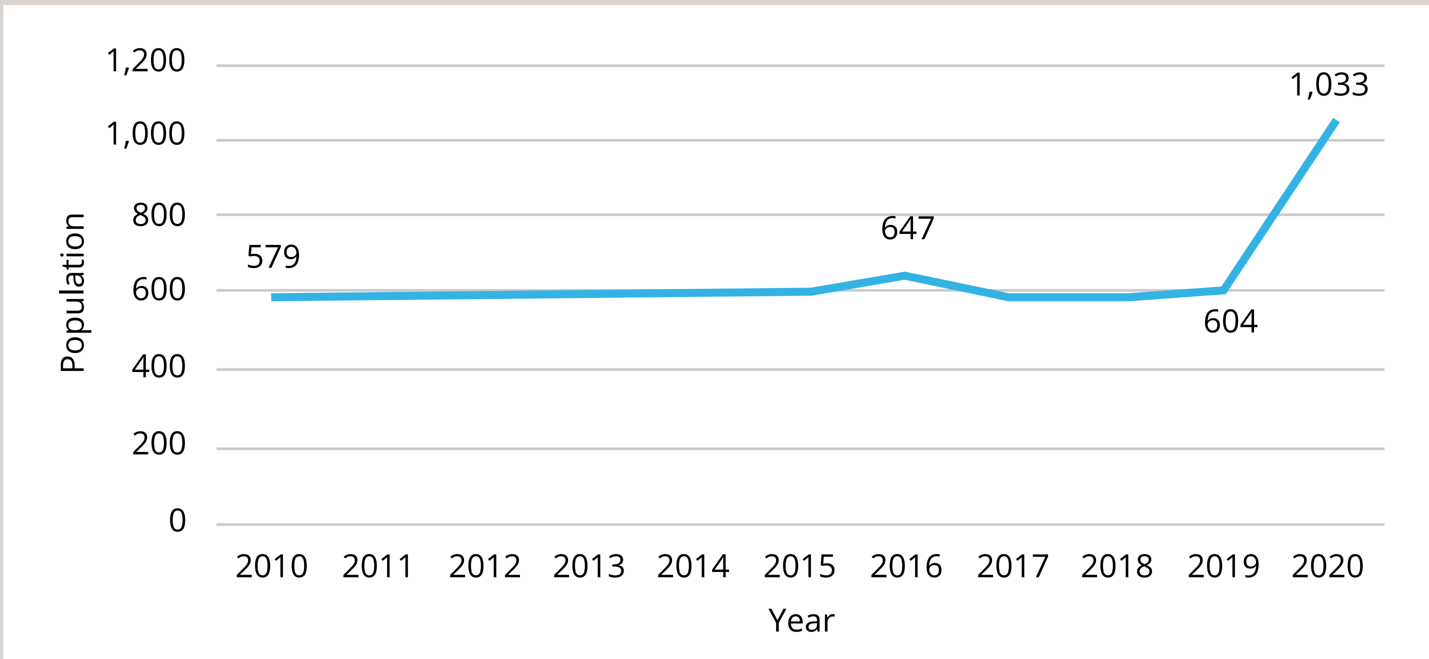
Demographics

According to the U.S. Census Bureau American Community Survey 5-year estimates, population has remained relatively steady in Edisto Beach from 2010-2019, growing from 579 people in 2010 to 604 people in 2019[1]. Recently released 2020 Census data indicate that population has increased to 1,033 in 2020[2] (Figure 1). It should be noted that the relatively large increase in reported population from 2019-2020 can be partially explained by the nature of the data. While the 2020 Census data represents an actual count, The US Census Bureau American Community Survey conducts annual surveys to estimate population during non-Census years (e.g. between 2010 and 2020). These surveys, combined with the Census count from 2010, are used to produce these "off-year" population estimates. Anecdotally, it is believed that the population of Edisto Beach was under-counted in 2010, and that the 2020 count is more in line with **expectation**[3]. Median age in the town is at 66.8 years old; and 56% of the population is over the age of 65. Median age is higher than state and county averages, as South Carolina's median age is 39.1 years and Colleton County's median age is 42.5 years. Further, only 1.3% of town residents are under 18. Median annual household income in Edisto Beach is $83,750 (57% higher than the state average), and poverty rate for all individuals is very low at **1.5%**[1]).

Only 36% of town residents are classified as in the labor force, compared to the state average of 61%, indicating a high number of retirees living in the community. Unemployment in the town is low at 3.7%. Educational attainment is high with 98.3% of those over 25 having completed high school and 59.2% having completed their bachelor's degree; compared to state averages of 87.1%, and 28.1%, **respectively**[1]. With a relatively older population and a relatively low level of labor force participation, access to hospitals and other critical facilities are of high importance during flooding events.

Health insurance coverage is widespread at 98.2% of residents. In terms of race and ethnicity, 97% of the town is White and 1% of residents are Black/African American. Only 1.4% of residents rely on public assistance income, and 12.3% received SNAP/food stamps in 2019. More than 98% of households have a computer, and 92% have broadband internet **access**[1].

Figure 1: Town of Edisto Beach Population, 2010-2020

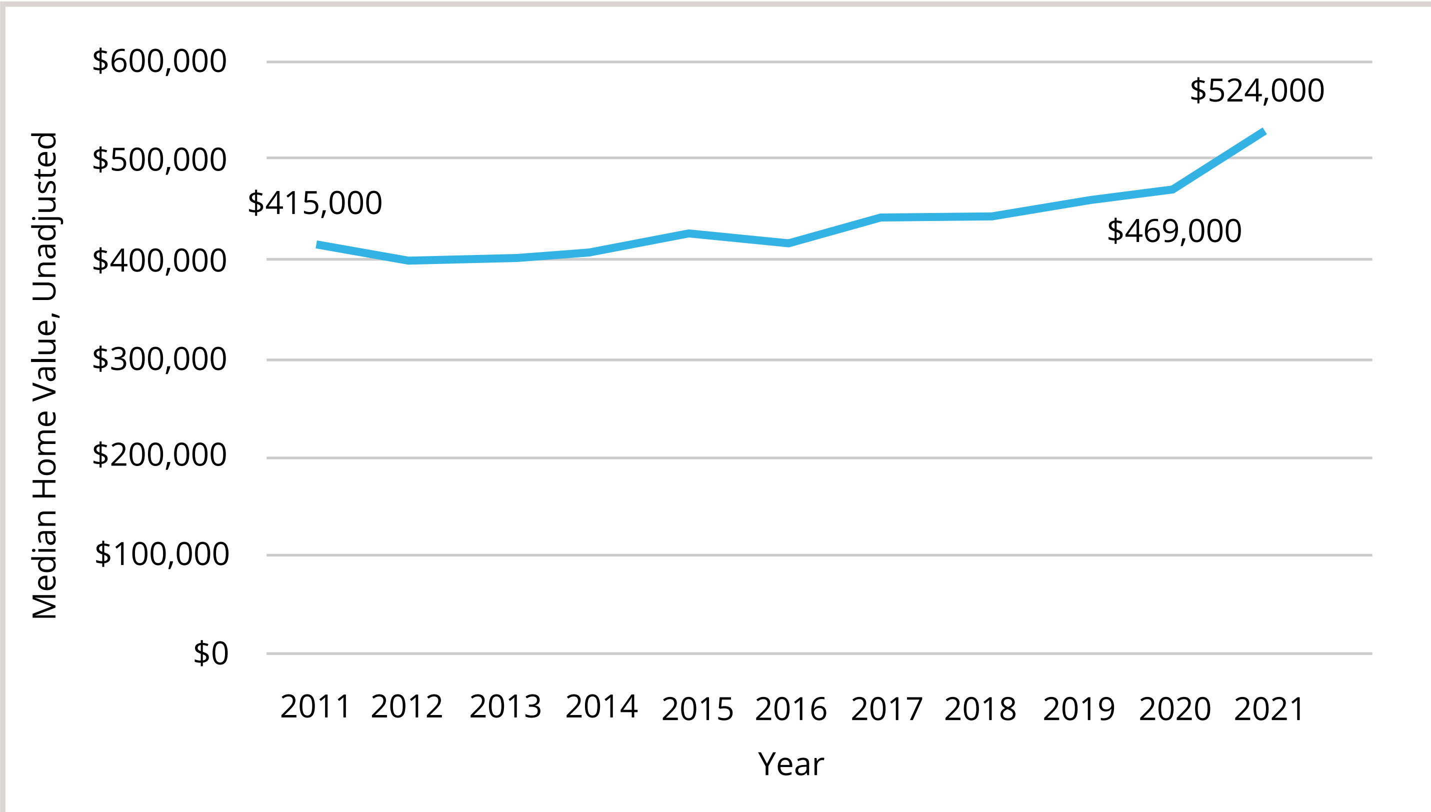


Source: US Census Bureau American Community Survey 5-yr Estimates, 2010-2019; 2020 US Decennial Census.

As of 2021, the industries that are the most prevalent employers in the town include the Retail Trade sector (28.6% of workers), the Accommodation and Food Services sector (26%), and the Real Estate, Rental, and Leasing sector (13.4%)[4]. According to the 2021 Colleton County tax roll, out of 2,512 total parcels within the town limits, 474 are taxed at a rate of 4%, indicating the home is a primary residence. A majority of property owners are not full-time residents. Most properties, according to town staff, are considered as short-term rentals. While the town's population of full-time residents is around 1,000, that does not consider how the island's transient population increases dramatically during high rental periods, with the overall population of the island sometimes swelling to more than 20,000 during peak vacation season.

The U.S. Census American Community Survey's most recent data for median home values in Edisto Beach is from 2019. Due to recent significant changes in coastal South Carolina real estate values as of the writing of this report, data from Zillow are shown below (Figure 2) to illustrate housing market trends. It is important to note that these data reflect all properties on Edisto Island, including and beyond the town's boundary. Median home values on Edisto Island have increased by 26% from 2011-2021 and have notably increased by 12% from October 2020-August 2021.

Figure 2: Median Home Values on Edisto Island and Edisto Beach, 2010-2021



Source: Zillow, Data Retrieved 10-8-2021

Note: For 2021, the data are from August. All other data points are from October of each year.

Table 1: Median Home Values in Edisto Beach, 2011-2021

Year	Median Home Value
2011	$415,000
2012	$398,000
2013	$402,000
2014	$410,000
2015	$422,000
2016	$419,000
2017	$439,000
2018	$449,000
2019	$460,000
2020	$469,000
2021*	$524,000

** For 2021, the most recent month is August. All other data points are from October of each year.*

Source: Zillow

Flood Insurance

The Town of Edisto Beach participates in the National Flood Insurance Program (NFIP), which allows property owners to purchase federal flood insurance through the Federal Emergency Management Agency (FEMA). The entirety of Edisto Beach's incorporated limits is within the Special Flood Hazard Area. The town participates in the FEMA Community Rating System, which provides flood insurance premium discounts to policy holders in exchange for the municipality taking community-wide flood mitigation steps.

As of April 2021, the Town of Edisto Beach has a CRS class rating of 6, which provides NFIP policy holders a 20% discount on their rates[5]. As of 2021, 1,621 NFIP policies are in force within the town, with a total insured value of over $452 million, including both buildings and contents. The total premiums paid for these 1,621 policies is over $1.26 million[6].

NFIP policyholders in the 29438 ZIP code of Colleton County filed the highest value of claims in 2016 (Matthew), and 2017 (Irma), with the value of 2016 NFIP claims reaching more than $2.75 million[7]. See Appendix H for annual NFIP claims since 1984.

Municipal Disaster Losses

Between 2015 and 2019, Edisto Beach was substantially affected by at least one major disaster event per year. After each event, it submitted requests to the S.C. Emergency Management Division (SCEMD)/FEMA for reimbursement for disaster-recovery losses that directly affected municipal property, services, and staff time. Below in Table 2 is a breakdown of each event's request amount.

Table 2: Disaster Recovery Reimbursement Requested from SCEMD/FEMA

Event	Amount
2015 – October Floods/Joaquin	$1,448,502
2016 – Hurricane Matthew	$3,281,139
2017 – Tropical Storm Irma	$792,323
2018 – Hurricane Florence	$46,856
2019 – Hurricane Dorian	$754,416
Total since 2015	**$6,323,236**

Source: Town of Edisto Beach

Overview of Town of Edisto Beach Efforts to Measure Conditions

In 2019, Edisto Beach recognized a need to better understand and characterize local tide conditions given the distance from the NOAA gauges in Charleston Harbor and at Fort Pulaski, GA. Through a partnership with the S.C. Beach Advocates Association, the town installed a low-cost tide sensor at Bay Creek Park. Tidal information is collected every six minutes and will be available to managers and the public via a website currently under development. The data collected at the site can help inform researchers to better understand highly localized tidal flooding conditions.

The Town of Edisto Beach also works with private engineering firm Coastal Science and Engineering to develop an annual beach monitoring report. This report assesses erosion rates relative to beach nourishment projects and sedimentation data at the mouth of Big Bay Creek.

Town staff serve on the Edisto River Basin Council, whose purpose is to work with local stakeholders to develop a water management plan for the next 50 years. Through this process, the town is tracking surface and groundwater conditions in the incorporated limits that affect the Edisto River Basin. For more information, visit the **water assessment study website**.

Overview of Current Rainfall and Sea Level Trends Influencing Flooding

Flooding in Edisto Beach comes from multiple sources that often interact and exacerbate conditions. These sources include tidal flooding, sea level rise, and extreme precipitation. All sources contribute to increases in groundwater, which leads to drainage problems and standing water.

- Sea level has risen by about 1.1 feet since 1901 at the Charleston Harbor gauge[8].
- Since 2000, sea level has risen about 6 inches[8].
- Sea level will continue to rise, with projections for South Carolina calling for between 0.2 feet and 0.4 feet by 2030, 0.4 feet and 0.9 feet by 2040, and 0.6 feet and 1.4 feet by 2050. These amounts are on top of what has occurred between 2000 and 2020 (See Appendix F).
- There is no documented trend in Edisto Beach for changes in frequency of extreme heavy rain due to a lack of long-term measuring stations.
- Anecdotally from residents, rainfall intensity and the frequency of extreme rainfall events has increased, but that increase can't be quantified.

This section describes how conditions have been documented and highlights changes that have occurred.

About Tidal and Rainfall Records

Edisto Beach lacks its own long-term recording stations for tides and rain. As a result, we are using the nearby measurement sites for characterizing past, present, and future conditions.

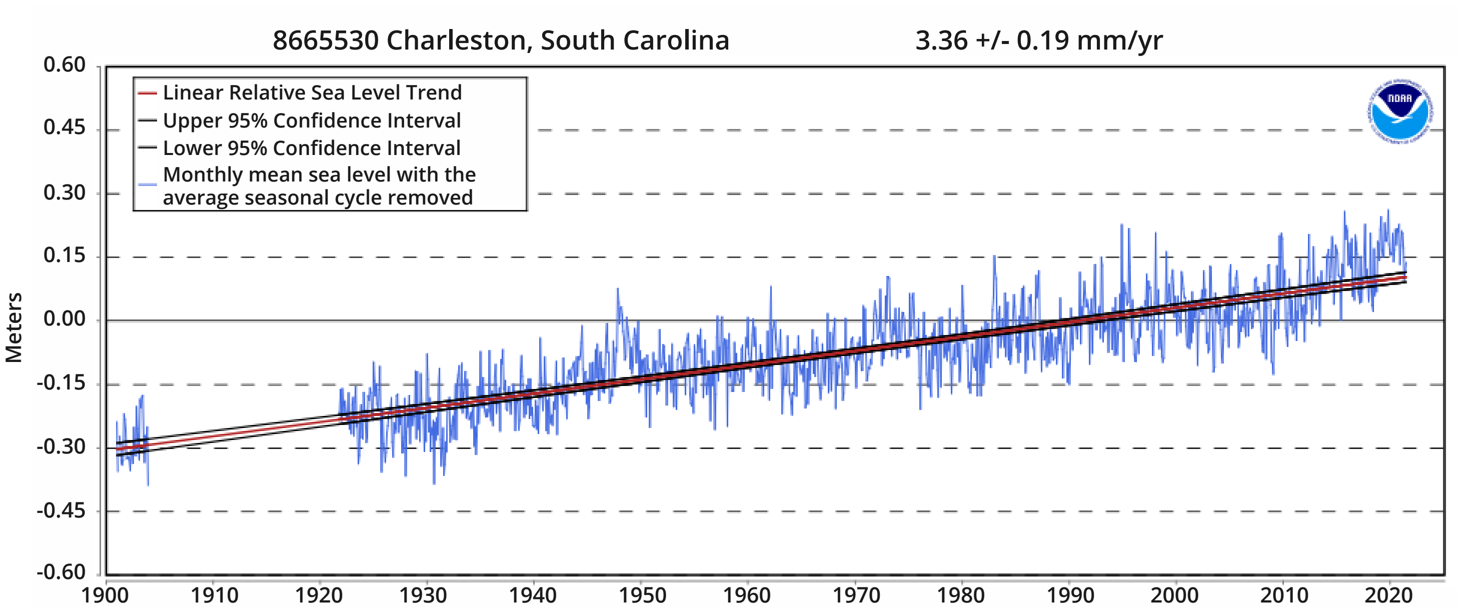
For tidal measurements: Edisto Beach sits between two NOAA tide gauges: one in Charleston Harbor and one at the entrance of the Savannah River in Fort Pulaski, GA. Because of the distance between the two and the localized nature of impacts, neither gauge fully reflects the number and type of storm surge or tidal flooding events experienced at Edisto Beach. However, the overall trends and average measurements taken at both gauges are virtually identical. Since the Charleston Harbor gauge is closest to the Town of Edisto Beach, this report will use that recording site for past trends and future sea level projections based on the 2018 National Climate Assessment.

For rainfall measurements: The closest long-term measurement sites are in Yemassee and Summerville. These long-term measurement sites date back more than 100 years, making their data more appropriate for analyzing long-term climate trends. As the Yemassee site is closest to Edisto Beach geographically, this report will use that site for documenting long-term past trends. For extreme rainfall events in 2015, 2016, and 2017, this report uses data from National Weather Service (NWS) Cooperative Observers Program sites and backyard recording stations for the Community Cooperative Rain, Hail and Snow Network program on Edisto Island.

Past Sea Level Trends in South Carolina

Since 1900, the sea level has risen about 1.1 feet at the Charleston Harbor gauge[8]. In this time frame, the average rate of rise per year is about 3.36 millimeters[8], as illustrated in Figure 3. Since 2000, the sea level at the gauge has risen about 6 inches, though calculations for a precise amount will not be complete until 2025 when NOAA releases a new tidal epoch datum.

Figure 3: Sea Level Trend at Charleston Harbor Gauge

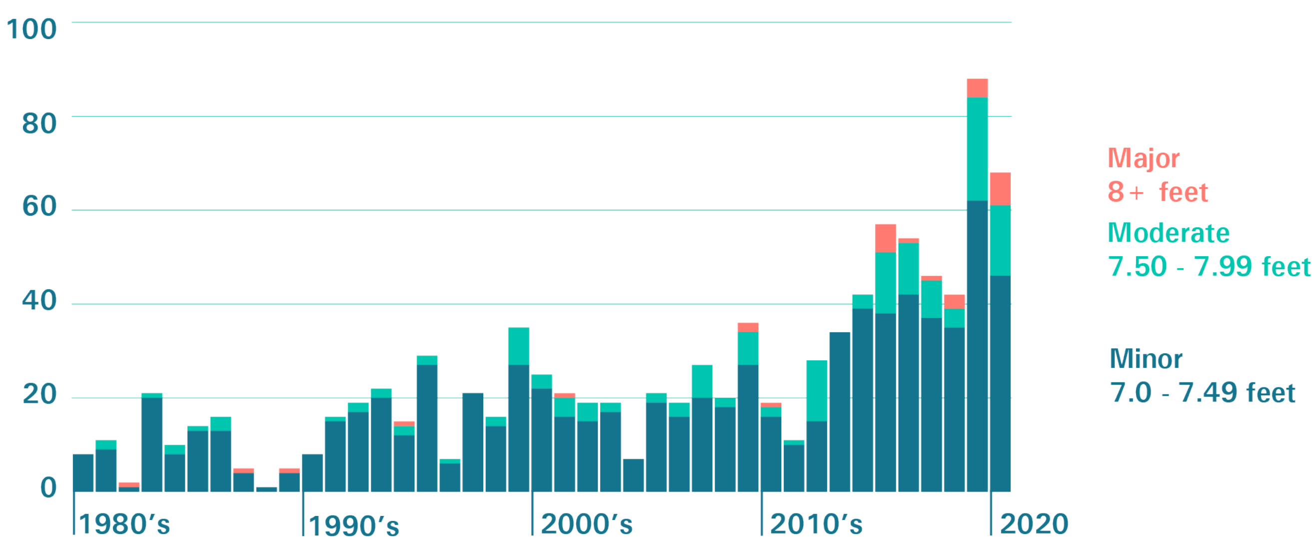


Source: NOAA/National Ocean Service; COOPS

This observed rise since 2000 connects with an abrupt increase in the frequency of tidal flooding and the number of days when the water at the gauge reaches the minor flooding threshold of 7 feet above Mean Lower Low Water (MLLW) set by the NWS[9].

As illustrated in Figure 4, the number of flood days in 2015 set a record at the Charleston gauge, at 44 days. In 2016, the tide gauge reached that threshold 45 days. Then in 2019, the gauge recorded 77 flood days, and in 2020, it recorded 57 days. For more information about tidal flooding records broken down by number of events and thresholds, see Appendix B.

Figure 4: Total Number of Annual Flood Days at Charleston Harbor Gauge



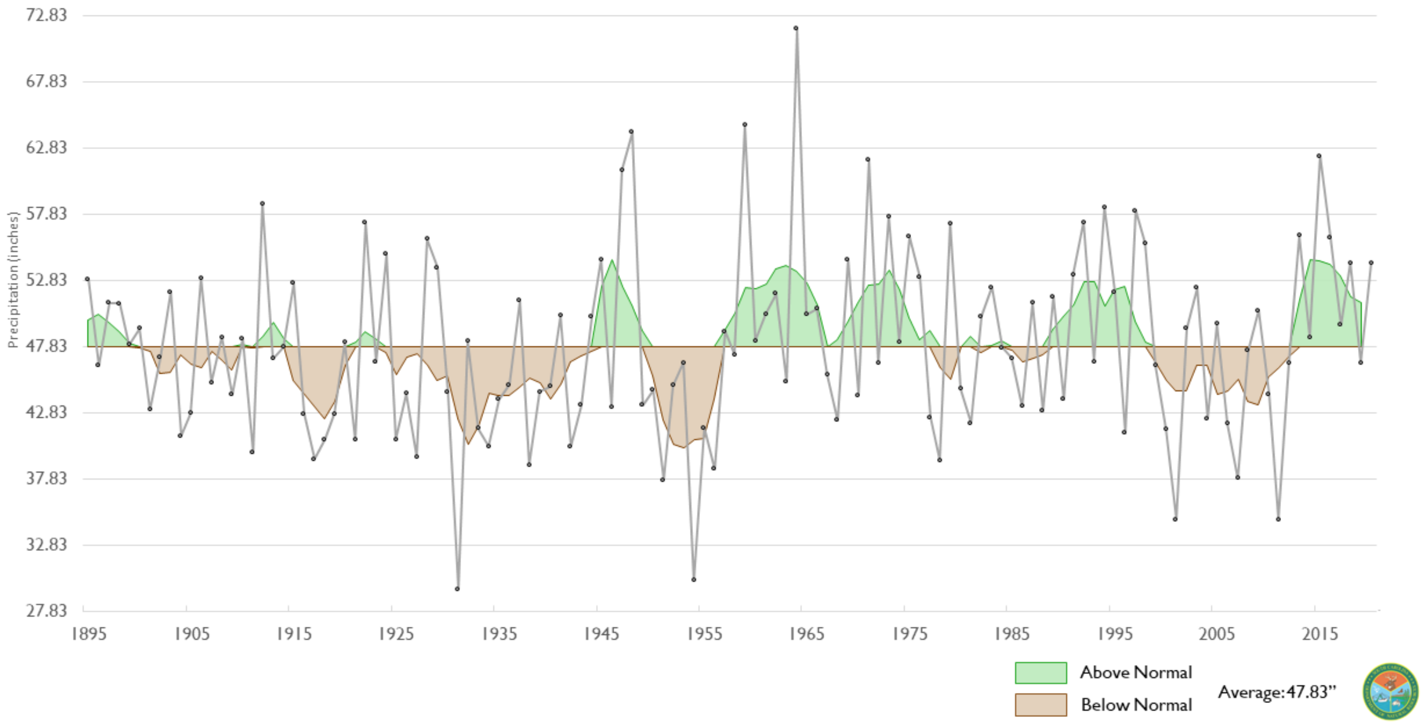
Source: NOAA/NOS, NWS, S.C. Sea Grant Consortium

Past and Current Rainfall Observations

Documenting and characterizing rainfall patterns in Edisto Beach is very difficult due to the highly localized nature of summer thunderstorms, climatic variations in coastal South Carolina influenced by the ACE Basin, and a lack of long-term rain gauge recording stations.

For the purposes of this report, we will use the long-term station in Yemassee for documenting annual rainfall maximums and the S.C. Southern Climate Division for annual averages. At this station, as with all other long-term reporting stations in S.C., there is no strong signal for changes in average annual rainfall (see Figure 5).

Figure 5: Southern Climate Division Annual Average Precipitation (1895-2020)



There is a small signal for an increase in the average precipitation for fall, which is calculated using all rainfall in the full months of September, October, and November. See Appendix D for graphics illustrating these trends.

This data does not break out changes in the frequency of heavy rain events, nor is it able to highlight any changes in extreme events or changing intensity at this scale. However, there is a statistically significant trend towards more intense precipitation, particularly for the more extreme, less likely events with lower probability of occurrence (i.e., the 50-, 100-, 200-, 500-, and 1,000-year events). The 50-year event has a 2% chance of happening in any year regardless of what happened in previous years. Similarly, the 100-year event has a 1% chance, the 200-year event a 0.5% chance.

Hurricanes and Other Tropical Cyclones

Edisto Beach has been affected by numerous tropical cyclone events in the past 150 years. A storm making direct landfall is rare (but happened in 1874, 1885, and 1928). However, a storm several hundred miles away can cause extreme damaging impacts. Since 2015, Edisto Beach has been substantially affected by five tropical cyclones, with several others causing minor disruption during the event. See Appendix C for documented details of three major storms from the Office of the State Climatologist. NFIP claims totals are for properties located in the 29438 ZIP code in Colleton County. See Appendix H for a map of this area.

- **2015 - October extreme rain and flooding:** This event is commonly connected to offshore **Hurricane Joaquin**, but it was not technically a tropical cyclone impact. In this event, a combination of an upper air weather pattern and the position of the storm 200 miles offshore generated a plume of tropical moisture that dropped more than 20 inches of rain in parts of South Carolina. Nearly 14 inches of rain over five days fell at a NWS reporting station at Edisto Island Middleton Plantation. Street flooding and standing water that resulted from the super saturated groundwater table persisted for more than three weeks and required mechanical pumping to fully clear certain areas that lack a natural drainage outlet. The town's sewer system and wastewater plant (WWTP) experienced significant inundation. Municipal damage totaled $1,448,502, which included significant inundation to the town's sewer system and WWTP. In 2015, 20 NFIP claims were paid, totaling $76,552. The town's beaches suffered from severe erosion valued at $1,406,869.
- **2016 - Hurricane Matthew:** This storm moved parallel to the southeast coast before making landfall in northern Charleston County. Matthew brought tropical storm-force winds, about 17 inches of rain at the NWS station at Edisto Island Middleton Plantation, and a 5.5-foot storm surge that caused major flooding, beach erosion, beach washover, and other damage. Municipal damage totaled $3,281,139. In 2016, 291 NFIP claims were paid, totaling $2,758,235.
- **2017 - Tropical Storm Irma:** This massive storm traveled up the west coast of Florida, with tropical storm-force winds extending out more than 500 miles from the center. Irma caused tropical storm-force winds, nearly 6 inches of rain at the NWS station at Edisto Island Middleton Plantation, and the third highest storm tide, totaling 9.92 feet above MLLW, recorded at the Charleston Harbor gauge. Municipal damage totaled $792,323. This number is artificially deflated because the beach erosion to the town's beaches was estimated to exceed $1 million. However, the town did not move forward with the project and the amount is not included in official S.C. recovery costs. In 2017, 63 NFIP claims were paid, totaling $524,968.
- **2018 - Hurricane Florence:** This slow-moving storm made landfall near Wilmington, N.C., but the sustained heavy surf caused moderate beach erosion and washover issues in Edisto Beach. Municipal damages totaled $46,856.
- **2019 - Hurricane Dorian:** This storm moved parallel to the southeast coast before making landfall in North Carolina, causing moderate beach erosion and minor flooding. Municipal damages totaled $754,416.

- **2020 - Hurricane Isaias:** This storm moved parallel to the southeast coast before making landfall near Myrtle Beach, S.C. No municipal damage claim was filed.

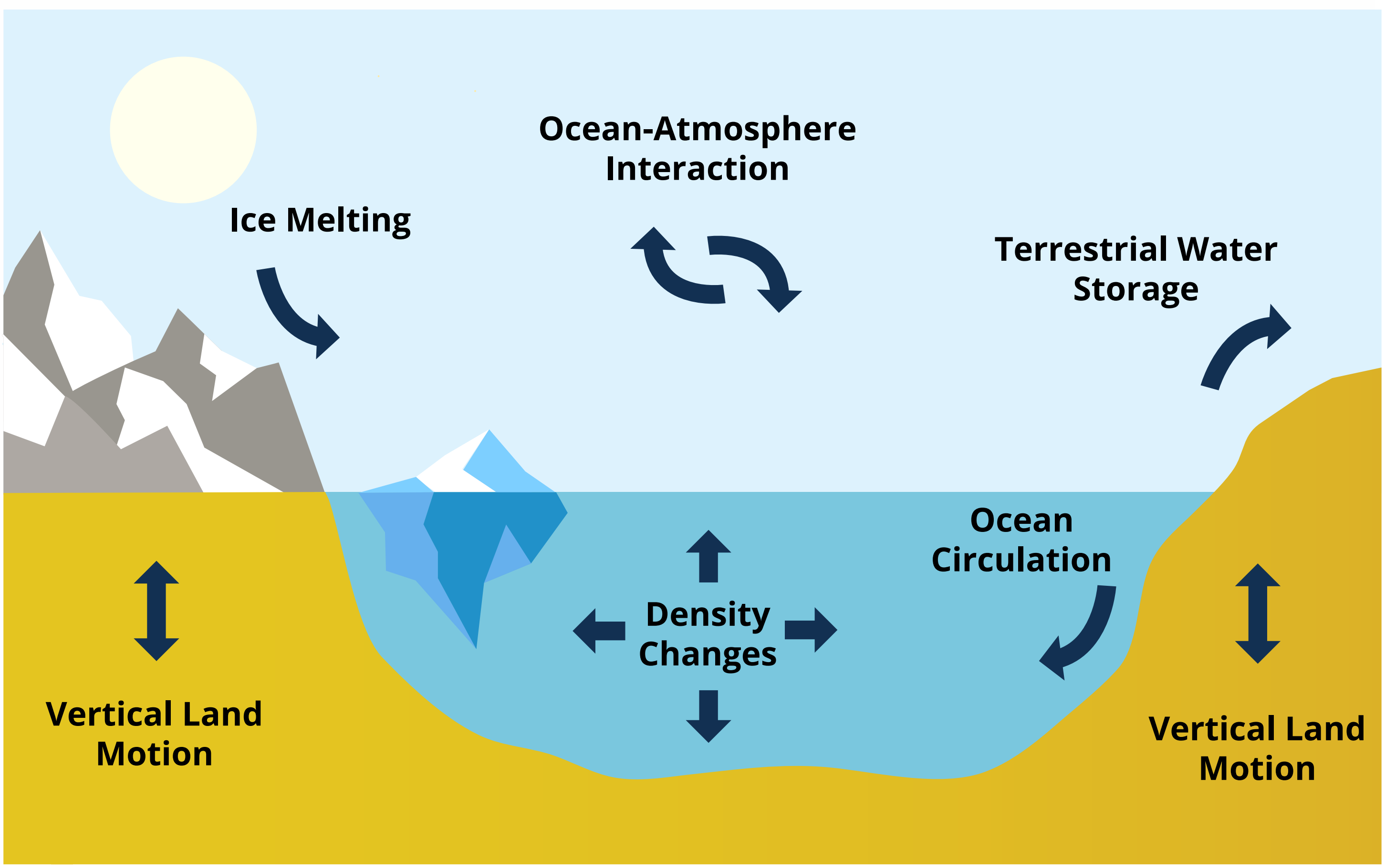
Future Flooding and Storm Risks

Flooding in Edisto Beach is occurring with increasing frequency and severity. This section will describe how that flooding may change due to sea level rise, changes to rainfall, and tropical cyclones.

About Sea Level Rise

Sea level rise is caused by a number of factors illustrated in Figure 6. The predominant sources of sea level rise in Edisto Beach since 1900 have been a combination of land elevation changes, increasingly warm ocean temperatures causing expansion and increase in volume of the water, and slowing of the Gulf Stream current offshore that pulls water away from the coasts.

Figure 6: What Causes Sea Level Changes

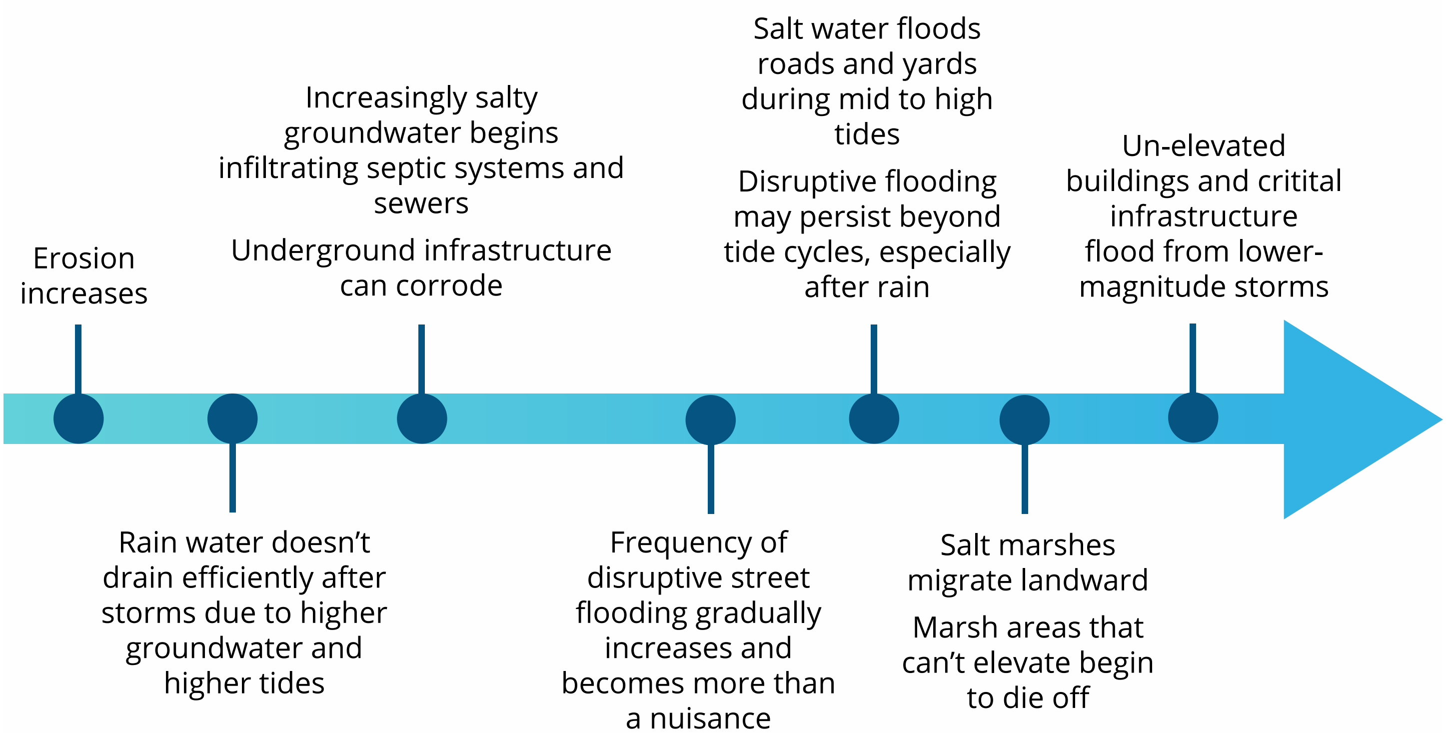


Source: Sarah Watson, S.C. Sea Grant Consortium, recreated from Milne, 2009

However, sea level rise is projected to increase in the future due to those factors, plus a large influence of melting glaciers in Antarctica and Greenland. How fast glaciers will melt and precisely when South Carolina's coast will see the direct influences is still unclear, however projections provide a range of possibilities based on current evidence and understanding about the interactions of these changing processes.

We can see the effects of sea level rise through changes in how often various types of problems, such as street flooding and erosion, occur. Figure 7 illustrates some of the primary indicators that Edisto Beach and other South Carolina coastal communities are experiencing. The dots on the line are an attempt to illustrate how the effects initially seem small, but then suddenly lots of problems develop quickly and the frequency at which they occur accelerates.

Figure 7: Effects of Sea Level Rise in Coastal Communities



Source: Sarah Watson

One of the biggest challenges when it comes to envisioning the effects of sea level rise is connecting with tidal variation. Projections center on the rise in mean sea level, but that does not communicate how high tide in the future will look. Using a "total water level" approach can help communicate this. In Table 3, top flood heights since 2015 are listed.

Table 3: Recent Flood Heights at Charleston Harbor Gauge

Date	Event	Height Above MHHW	Total Storm Tide
09/11/2017	Tropical Storm Irma	4.16 Feet	9.92 Feet
10/08/2016	Hurricane Matthew	3.53 Feet*	9.29 Feet
11/24/2018	Thanksgiving Weekend King Tide	3.00 Feet	8.76 Feet
10/27/2015	October 2015 King Tide	2.93 Feet	8.69 Feet
11/07/2021	November 2021 King Tide	2.74 Feet	8.50 Feet
10/18/2020	October 2020 King Tide	2.43 Feet	8.19 Feet
11/15/2020	November 2020 King Tide	2.37 Feet	8.13 Feet

** Matthew's height in Edisto Beach was ~5.5 feet, with total storm tide of nearly 11 feet above MLLW.*

Source: NWS/COOPS

In Table 4, we use memorable flood heights connected with sea level rise to paint a fuller picture of what this means for the future. A current full or new moon tide is similar to 1 foot above MHHW, which may reach the minor flooding threshold set by NWS Charleston. This threshold is 7 feet above MLLW, or 1.24 feet above MHHW.

Table 4: Total Water Approach in Edisto Beach

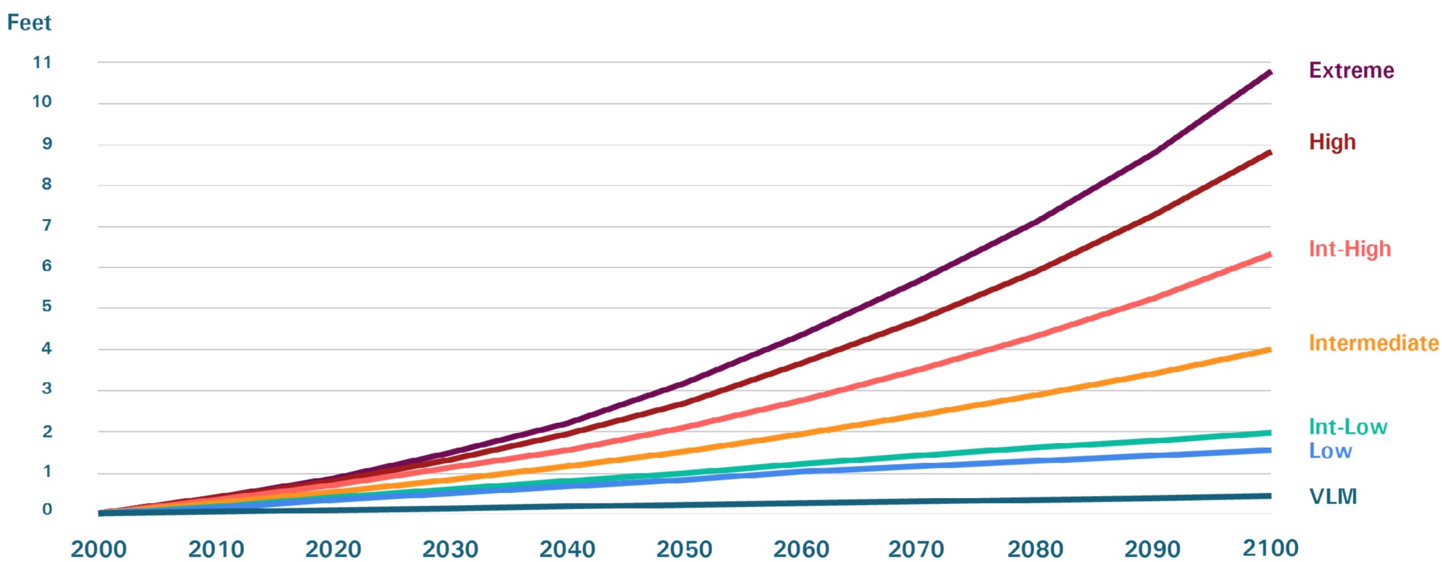
Above MHHW	Current Equivalent Event	Sea Level Rise (SLR)
1 foot	Full/New Moon Tide	MHHW + 1ft SLR
2 feet	King Tide	Full/New Moon + 1ft SLR
3 feet	Thanksgiving 2018 King Tide	King Tide + 1ft SLR
4 feet	Tropical Storm Irma	Thanksgiving 2018 + 1ft SLR
5 feet	Hurricane Matthew	Irma + 1ft of SLR
6 feet	None Documented	Matthew + 1ft of SLR

Note: MHHW using the 2000 NOAA Tidal Epoch datum at the Charleston Harbor gauge is 5.76 feet.
Source: Analysis by S.C. Sea Grant Consortium

Future Sea Level Projections

NOAA developed a suite of projections for future sea level rise in 2017[10], which is the basis for the Fourth National Climate Assessment released in 2017[11] and 2018[12]). The U.S. Army Corps of Engineers has taken those projections and localized[13] them to the NOAA tide gauges, which are considered the reference data points for localized relative sea level rise[8]. In Figure 8, the projections downscaled to the Charleston Harbor gauge are illustrated. A chart with scenario numbers for each decade is in Appendix F.

Figure 8: NOAA 2017 Sea Level Projections for the Charleston Harbor Gauge



Source: NOAA et al, 2017, U.S. Army Corps Sea Level Change Calculator, S.C. Sea Grant Consortium

The projection line labeled VLM solely depicts the rate of rise based on geological vertical land movement[10]. The rate of VLM in this projection is not highly localized and is not connected to local groundwater withdrawal or building compaction of soils. The projection line labeled Low depicts the rate of rise as the historic linear trend and does not include effects from climate change. The other projections connect sea level rise with global climate change emissions scenarios[10].

States and communities along the east coast have varied approaches for selecting planning scenarios. Recommended practices include selecting multiple scenarios to apply to various types of decision-making based on lifespan, risk tolerance, implementation timeline, and ability to retrofit.

What This Means

Projection graphics show a perfectly smooth curve upward, which can make it difficult to envision what sea level rise means and how we will experience the effects. In the past five years, Edisto Beach has experienced flooding events with increasing frequency, severity, and duration, though some years have been worse than others. King Tides typically now occur several times a year. Heavy rain has less room to infiltrate into the water table because the groundwater is higher.

As sea level continues to rise, these sorts of events will continue to occur with increasing frequency and **severity**[14]. Groundwater may emerge in low spots and not drain for long periods. The groundwater in places will become **saltier**[15]. Some years the flooding may not seem all that unusual, with not as many events as recent years. If those years have longer dry periods or even short-term drought, heavy rain won't cause persistent flooding. But other years will seem like flooding is much more frequent, with duration lasting longer and community disruption increasing. During a year with wetter than normal conditions, persisting standing water and failed septic systems in the lowest areas will become much more common and last much longer.

At 3 feet of sea level rise, when the annual average of the highest high tide of the day reaches 3 feet above what sea level was in 2000, more than one-third of the parcels on the island are modeled to have the water layer covering the center of the property (*see Assessment of Sea Level Rise Impacts to Edisto Beach section below*). Many of these parcels do not touch a tidal water outlet. For these parcels, the hazard won't necessarily come from an outlet that can be managed with a tidal flap valve. The water will not necessarily be there every high tide. But rather these are areas where groundwater routinely emerges. The salinity of that groundwater will increase substantially. Marsh grass may take over. When it rains, water will not drain easily as there will not be room in the groundwater table.

What is especially important to note is that while this is visualized best on the **modeling platform** at 3 feet above MHHW, that does not mean those effects begin only when sea level reaches that height. Due to daily and monthly tidal variation, this type of disruption may begin much sooner, with frequency and duration gradually increasing. In the most vulnerable spaces in Edisto Beach, these types of conditions may begin occurring with increasing frequency around the 1.5 feet of SLR mark. The timeline for this may be as soon as 2040 based on the NOAA projections in **Appendix F**. There will be years where the frequency and duration of tidal flooding will be much worse than others due to larger-scale annual weather patterns and astronomical **cycles**[16]. There also will be a seasonality driven component tied to the earth's position to the sun, with the highest tides of the year typically occurring during the fall.

Future Rainfall Projections

Projections for how rainfall may change in the future currently are not able to provide details for changes in the intensity, duration, and frequency of rainfall events. General projections from the National Climate Assessment predict an overall annual increase in total precipitation of between 5% and 10%. However, that average does not include the variations that make up that average. But scientists predict that the frequency and intensity of extremes – both wet and dry – will continue to **increase**[17]**.** This translates to longer dry periods, more extreme wet periods with high impact and high intensity **events**[18]. According to the National Climate Assessment 4, the frequency and severity of extreme precipitation events are projected to continue increasing in the Southeast. By the end of the century, projections indicate that the number of heavy rainfall days (two-day events with at least a five-year return period) will double, with a 21% increase in the total amount of rain falling on the heaviest precipitation **days**[18].

It's important to note that the frequency of community disruption from standing water, street flooding, and submerged septic systems due to heavy rain is likely to increase due to sea level rise reducing the drainage capacity of engineered systems, ditches, and the groundwater table. This means that a storm that would not have caused persistent and disruptive flooding in 2021 may do so in 2031 or 2041.

Future Hurricanes and Other Tropical Cyclones

Edisto Beach has experienced a range of effects from hurricanes and tropical storms, with each individual event bringing specific hazards based on storm direction and dynamics. Hurricanes and tropical storms are primarily fueled by warm sea surface temperatures. Atmospheric steering currents and upper-level winds affect how storms travel and maintain intensity. Precisely how Edisto Beach's future risk for hurricanes and tropical storms may change is unclear. However, climate science research is highlighting three core ways future conditions may affect storm frequency and **effects**[19].

Frequency

There is no strong consensus on how climate change will affect the total number of storms that form. Some research hints that the overall number of storms may decline due to increases in wind shear and other forces that inhibit tropical cyclone development. Other research hints to an increased frequency in lower-level events due to wider expanses of ocean with tropical cyclone-sustaining water temperatures and better detection of storm formation via satellites.

Intensity

There is research highlighting the potential for an increased frequency of high intensity events with rapid intensification due to warmer sea surface temperatures. This type of event has been seen in the Atlantic and Gulf of Mexico more frequently in the past five years, with storms such as Harvey, Irma, Maria, Michael, Dorian, Laura, and Ida rapidly intensifying, in some cases overnight from a tropical storm-level cyclone to a major hurricane of at least Category 3 **strength**[19].

Long-Duration Events

Other research highlights the potential for the frequency of slow-moving storms that have weaker winds but produce extreme levels of rain, similar to Hurricanes Harvey and Florence. These types of storms are the result of very weak to nonexistent upper-air steering currents and can linger over a region for days. As those types of storms weaken in intensity, especially if they were previously a very strong hurricane, the storm spreads out, affecting a wider area with heavy rainfall. Additionally, a warmer atmosphere can hold more water, further increasing the rainfall potential.

Assessment of Sea Level Rise Impacts to Edisto Beach

The College of Charleston's Lowcountry Hazards Center created the Edisto Beach Sea Level Rise viewer displaying maps for the town at tide heights ranging from average higher high tide (MHHW) condition and elevated up to 6 feet above that base MHHW level at half-foot increments. (See Figure 8 for graphic illustrating datums.) This is intended to demonstrate what projected sea level rise could look like on top of today's average higher high tide. The elevation data used as input to the flood model was captured in late December of 2016, so any more recent changes to the elevation of the beach from public works or due to subsequent disaster events are not captured. Those tidal flood layers were then used to model the potential impacts of future flood conditions to properties, businesses, and roads of the town. These assets of the town were considered vulnerable to sea level rise when the modeled flood waters touched any part of a building's footprint or reached the center of a property parcel or roadway.

When considering the results of this analysis it is important to note that although the flood layer may cross the center of a parcel or touch the footprint of a building or business, that does not indicate a total loss of the integrity of the structure or functionality of the property. Buildings on Edisto Beach are often elevated above ground level using pilings or other techniques, which are not taken into account in this assessment. This assessment, however, could be beneficial for identifying accessibility issues for those assets as elevated structures could still have water at ground level impeding mobility. The roadways analysis further identifies accessibility vulnerabilities that could be encountered under future conditions. This does not take into account partial accessibility of a road or potential improvements, the latter of which this report hopes to inform. For a detailed breakdown of the methods utilized during this study, see Appendix I.

Results of the analysis reveal a nearly steady rise in the vulnerability of parcels, buildings, businesses, and roadways as water levels rise above MHHW on Edisto Beach up until the 2-ft level (see Table 5, Figure 9 below).

When the water reaches the 3-ft level above MHHW, the number of vulnerable assets increases precipitously, with the following increases compared to the 2-ft level:

- Parcels: >250% increase
- Buildings: >140% increase
- Businesses: increase from 16 to 31 businesses
- Roadways: increase from 12% to 48% of total roadways

The increasing number of businesses affected continues into the 4-ft and 5-ft levels, with an additional 18 and 16 businesses at risk respectively with each foot of additional height above MHHW, with the 6-ft level potentially impacting an additional six businesses (71 total).

The industry at the highest risk for the highest level of flooding (6-ft above MHHW) includes office administration, landscaping, and housekeeping (Administrative, Support, Waste Management, and Remediation Services), with 14 businesses at risk accounting for potential revenue of $1,576,000 and 30 employees. However, the construction industry shows the greatest increase in vulnerability from the 2-ft to 3-ft level above MHHW, with a rise from two businesses affected to six accounting for an additional potential revenue of $438,000 and seven additional jobs.

While this analysis highlights vulnerabilities to the headquarters of these companies, the construction industry is already being impacted at current water levels. The high groundwater table in the town has resulted in an inability to obtain new septic permits (see section below). With the sewer system currently at capacity and a moratorium in place on adding properties to the system, new construction in areas where percolation is not sufficient is effectively halted.

Analysis of the road network on Edisto Beach revealed a similar trend, with an increase from 12% of total roadways (16,266 feet) at risk at the 2-ft above MHHW level to 48% (67,171 feet) at the 3-ft level (See Table 5). At the 4-ft level, 72% of roadways on the beach were modeled as vulnerable, reaching a maximum of 94% of roadways at the modeled 6-ft level.

Paved roadways resulted in relatively modest levels of risk prior to the 3-ft level, when the amount raised from only 6% at risk at the 2-ft level up to 45% at the 3-ft level. Privately maintained roads experienced a similar jump in modeled vulnerability from the 2-ft to 3-ft level, with 60% of those at risk at the higher water level compared to 24% at the lower level. Dirt roads experienced a >25% increase in their vulnerability at each foot of increased water level from 12% at 2-ft to 39% at 3-ft and 67% at 4-ft. Road ownership showed similar trends as well.

Table 5: Results of a tidal flooding analysis conducted at increasing elevations of tide height above mean higher high water (MHHW)

	Feet above Mean Higher High Water (MHHW)					
Level	**1**	**2**	**3**	**4**	**5**	**6**
Parcels	41	231	826	1,467	1,869	2,128
Parcels % (total 2512)	2%	9%	33%	58%	74%	85%
Buildings	114	376	921	1,309	1,581	1,727
Businesses	11	16	31	49	65	71
Roads (total ft)	1,626	16,266	67,171	101,401	120,686	132,683
Roads (%)	1%	12%	48%	72%	86%	94%
Road Material						
Paved Roads (ft)	0	5,185	36,816	56,436	67,673	76,225
Paved Roads (%)	0%	6%	45%	70%	84%	94%
Dirt Roads (ft)	0	3,211	10,653	18,113	23,320	25,683
Dirt Roads (%)	0%	12%	39%	67%	86%	95%
Private Roads (ft)*	1626	7,870	19,703	26,852	29,693	30,776
Private Roads (%)*	5%	24%	60%	82%	91%	94%
Road Maintenance						
SCDOT Maintained (ft)	0	2,713	27,411	43,883	53,618	61,922
SCDOT Maintained (%)	0%	4%	41%	66%	80%	93%
Other Maintained (ft)	0	5,683	20,057	30,666	37,374	39,985
Other Maintained (%)	0%	14%	48%	74%	90%	96%
Private Roads (ft)*	1,626	7,870	19,703	26,852	29,693	30,776
Private Roads (%)*	5%	24%	60%	82%	91%	94%

** Private roads is a category of both material type and maintenance entity; those roads are privately maintained and do not have the material (paved/dirt) specified in the dataset*

Source: Analysis conducted by the College of Charleston's Lowcountry Hazards Center

Figure 9: Modeled tidal flooding on Edisto Beach at heights of 2-feet and 3-feet above mean higher high water (MHHW)

Source: Analysis conducted by the College of Charleston's Lowcountry Hazards Center

Types of Flooding and Causes Currently Observed

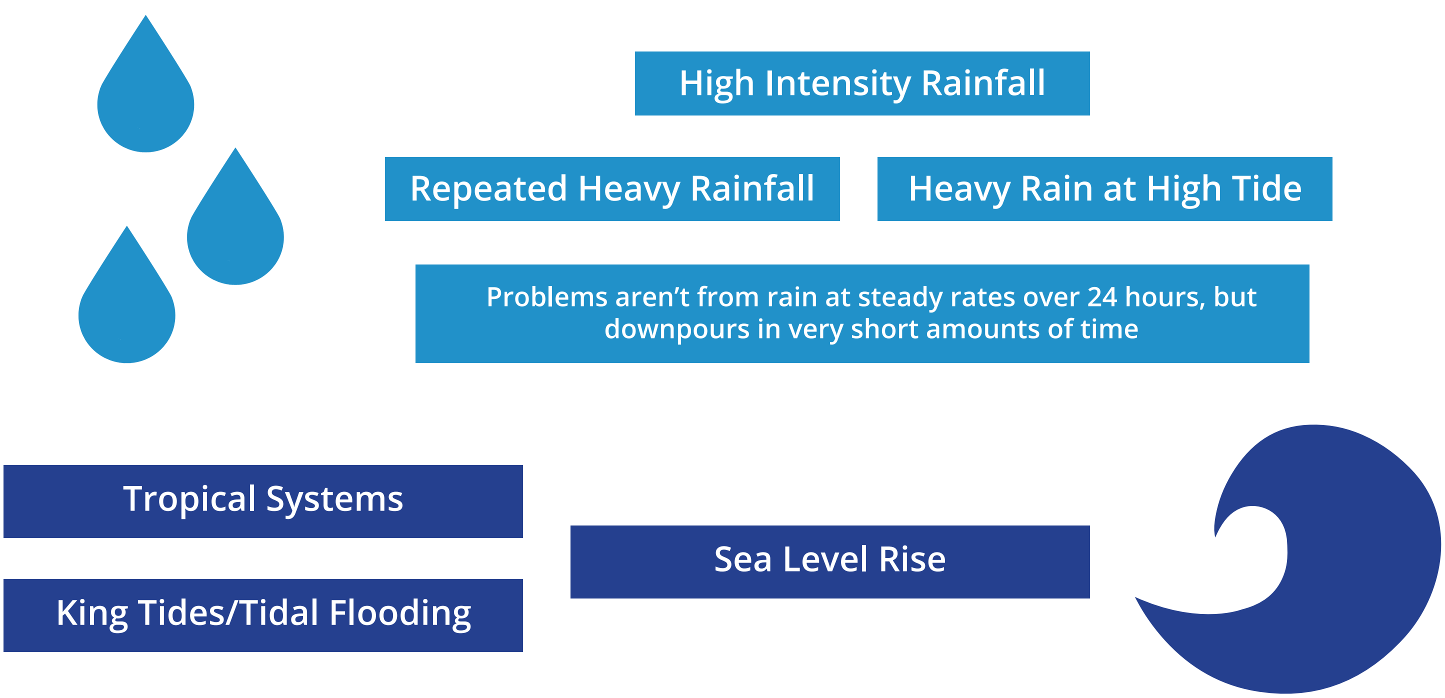
Flooding in Edisto Beach comes from multiple sources, and where the flooding occurs depends on the source and current conditions. The source can be broken down into water from the sky (rain) and water from the ocean (tidal flooding and storm surge.) Both influence the depth of groundwater, which affects drainage speed and efficacy.

Flooding from rain comes primarily from localized downpours, known colloquially as “rain bombs” that drop inches of rain in a short time, or major storms such as tropical cyclones or nor’easters.

Water from the ocean causes flooding during [King Tides](), tidal flooding events that occur without a storm, and during storm surges from tropical systems or winter storms.

Both sources also influence the depth and salinity of the shallow aquifer, exacerbating flood conditions as the aquifer’s capacity to absorb and hold flood waters is reduced.

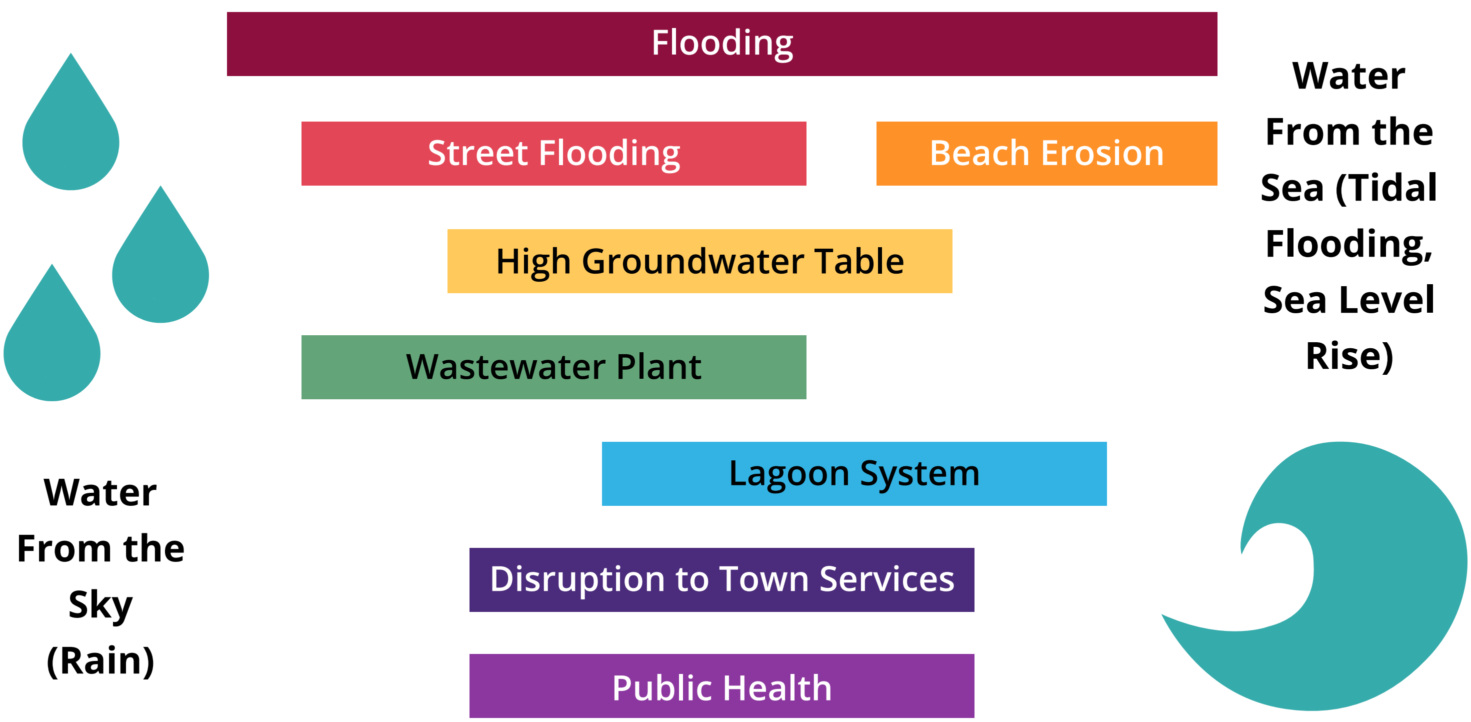
Sea level rise is a factor that influences flooding from high tides and storm surges as well as rainfall. As the sea level increases, tidal flooding becomes more frequent during full and new moons, and more moderate storms can cause major tidal flooding. The effects on rain are primarily due to a gradually rising groundwater table, resulting in standing water, and when rain at high tide blocks stormwater from draining off land.



Impact Diagram

In August and December 2020, town staff participated in workshops with the research team to identify how flooding currently affects Edisto Beach and the implications of those impacts. The team used a Vulnerability, Consequences, and Adaptation Planning Scenarios (VCAPS) process as the primary method. Additional information about the process is in Appendix A. The diagram developed in that process was then simplified substantially, with the details separated out under the below categories.

This diagram takes the core sources of flooding and connects the primary and secondary impacts discussed during the VCAPS workshops. We have attempted to line them up so readers can see the general scale for what flooding sources cause the various impacts. This is displayed here to give readers a visual guide as they read through the subsequent sections on observations and impacts currently experienced as well as the discussions of what the town is currently doing to manage impacts.



Observations About Current Flooding Impacts

This section describes the observations discussed during the VCAPS process about how flooding currently affects Edisto Beach.

Flooding

Flooding in Edisto Beach has several sources. However, because the workshop discussions focused on the town as a whole and not individual neighborhoods or properties, it is difficult to separate the causes. For this section, we will combine the causes and simply focus on the impacts.

Key determinants:

- Groundwater levels (i.e. if it has not rained for a while, the water drains much more quickly).
- Tide level during the rainfall event.
- Flooding does not persist as long on dirt roads.
- If the property is lower than the road, the property will flood.

This has caused:

- Public and private property damage.
- Trees and vegetation falling because of saturated soils.

Street Flooding

Streets and roads on the beach flood for various reasons depending mostly on location and material. Interior roads that lack natural drainage outlets flood from frequent heavy rain or extreme rain during a single storm. Water subsides due to infiltration into the shallow groundwater aquifer. If the aquifer is already full, water will sit on the road until it eventually evaporates, seeps into the aquifer gradually, or is mechanically pumped by town staff. Roads along tidal marshes or near other saltwater sources flood during unusual high tides. The water from this type of flooding typically subsides when the tide goes down, but at times does not subside for longer periods due to the water level staying high during storms. Water subsides faster on dirt roads than those that are paved.

This has caused:

- Transportation issues

    - Residents cannot get in or out of their driveways.
    - Residents who drive through floodwater risk damaging their vehicles.
    - All motorists, including residents and town staff, risk driving into ditches that are not visible because both the road and ditches are flooded.
    - Municipal vehicles suffering from salt corrosion.
- Complaints from residents about the side effects of flooding – water draining to dirt roads, potholes and ruts created.
    - Road beds on dirt roads are degrading, requiring the town to stabilize and re-grade dirt roads, effectively elevating them. This can cause flooding on bike paths and yards that are now below road grade.
- Public health issues from people coming into contact with contaminated floodwater
- Standing water can also be a mosquito breeding ground.

High Groundwater Table

Also called the groundwater table, the shallow aquifer responds relatively quickly to increasing tides and frequent or heavy rainfall. Under certain conditions, the groundwater table occasionally rises such that it emerges as standing water in low places and/or keeps stormwater from infiltrating, resulting in persisting standing water in some yards and roads. After extreme events, such as the 2015 extreme rainfall and Hurricane Matthew, standing water did not go away for weeks and had to be pumped out of low-lying areas with no natural outlet. These types of conditions are becoming more frequent due to rising sea level and more frequent heavy rains.

This has caused:

- Existing septic system failures
    - Vacation rental homes cannot be rented while system has failed.
    - Homeowners cannot stay at home while system has failed.
    - Homeowners cannot sell property if septic systems do not pass inspection without replacing the system.
    - New septic systems can't get approval because percolation tests fail.
    - Property owners cannot transfer or sell property with an existing residential or

    commercial structure.

  - Property owners cannot build a residential or commercial structure.
  - Lots of septic systems fail during extreme flood events.
  - Engineered systems are an alternative, but are not a fail-safe.
  - The homeowner is not required to tell the town that the system has failed, but the town notices the flooding or septic companies at the property.
  - A temporary sewer moratorium is in place, and the town is not currently adding any new homes into the sewer system.
  - Developers are having a problem getting septic permits or have to put in an engineered system rather than a traditional system, which is more expensive.
  - Can become a health concern when they dump into a drainage ditch if it contaminates stormwater which isn't treated.
- Standing water near septic systems may be contaminated with sewage.
  - This causes a public health risk to people playing in floodwater.
    - Vacationers are not aware of risk of contamination.
    - Police officers spend time trying to communicate risk.
    - Police officers may be exposed to contaminated floodwater without proper protective equipment.
- Street flooding after heavy rains.
- Transportation issues
  - Water subsides faster on dirt roads than paved.
  - After an extreme event, such as Irma or Joaquin, water may take weeks to subside on some streets.
  - Flooding does not persist as long on dirt roads.

Increasing Saltwater Content in Groundwater

Edisto Beach is a low-lying barrier island. As sea level rises, salt water will gradually infiltrate the shallow groundwater table. This is causing the salt level of the groundwater and the soil to increase, resulting in corrosion of buried infrastructure.

This has caused:

- Fire hydrants corroding, along with other below ground piping.
- Corroding communications utility connections.
- Other buried pipe connections corroding.
- Manhole covers for sewer lines corroding.
- Need for reverse osmosis drinking water.

Wastewater Plant

While much of Edisto Beach's wastewater is treated through individual on-site septic systems, part of the island was developed on filled marshes and, as such, could not obtain septic permits. The town was conveyed 3.6 acres in 1985 from Fairfield Ocean Ridge (Fairfield) for use as sewer treatment lagoon or wastewater treatment plant (WWTP) to service properties, including a reservation of 50,000 gallons per day for Fairfield, which was critical to Fairfield's development. This facility is in the center of town. The plant does not discharge effluent into any waterbody; rather the treated effluent is sprayed onto the adjacent golf course. However, flooding in areas that are serviced by public sewer has resulted in an increase of flow during events to the WWTP, particularly if stormwater breaches the public sewer. The WWTP is only permitted to treat wastewater, not storm water. It also has limitations on expansion because of effluent disposal.

This has caused:

- Excessive flow to the WWTP due to high inflow during flooding events.
    - If the house is connected to the sewer system, flood waters may inadvertently drain from the yard into the sewer system, which leads to more volume than the system is permitted to hold.
    - Can affect the digestive microbes, also referred to as "bugs," composition in the wastewater treatment system. This is usually a short-term problem but can result in effluent that isn't properly treated.
    - Creates a problem with capacity for effluent – pumped to the golf course adjacent Planned Use Development for irrigation. This becomes a flood event with treated effluent.
- Golf course is a spray field for treated effluent.

    - Spray field sometimes floods.
    - If the course is inundated with water and its lagoons are overwhelmed by the flooding, there is nowhere to spray the effluent.
    - Must still spray treated effluent.
    - A WWTP pond and backup treated effluent pond provide some additional storage capacity during high flow events.
    - During an extreme event such as after a hurricane, the problem is somewhat relieved because there are fewer people adding to the sewer system.
- An overflow of a lift station would lead to environmental hazards to be reported to S.C. Department of Health and Environmental Control (SCDHEC).
    - Depending on the amount spilled, requires flushing and clean up.
    - Could be fines associated if there are additional impacts.
    - Permit potentially could be revoked if it happens too frequently.
- Stormwater system damage because of sedimentation (e.g., pumps burn out).
    - Stormwater infiltration into the system that caused issues with the lift stations.
- Could become a bigger issue during summer months with a higher population of tourists on the island.
- There are capacity challenges with the sewer collection system, but not within the treatment system.
- Electrical equipment damaged when WWTP flooded during hurricanes.
- Solids deposited in the WWTP (dredged and taken to a special landfill).
- Owners of new or pending construction are requesting to tie in to the WWTP due to problems obtaining a SCDHEC septic permit because the soil is not percolating enough (likely due to high groundwater.) Currently there is a connection moratorium in effect.

Lagoon System

Edisto Beach has two lagoon systems that act as stormwater basins. The system in the Planned Use Development is privately owned and managed by the Ocean Ridge Homeowner's Association. These lagoons can be artificially staged at a higher level by gates. If the lagoons are not lowered ahead of storm events or **King Tides**, the lagoons can overflow.

The system between Jungle Road and Palmetto Boulevard consists of a series of interconnecting lagoons that are either individually owned or owned by the municipality. Both systems outfall into Big Bay Creek.

This has caused:

- Sedimentation in stormwater ponds.
- Most of the interior lagoons are privately owned. The town only owns one lagoon. No recorded maintenance has been performed.
- Homeowners make changes that impact the functionality of the lagoons, can impact other property owners.
- Pipes between interconnected lagoons have failed.
- Most houses along the lagoons are raised.
- The Ocean Ridge Homeowner's Association keeps their lagoons artificially elevated for appearance. They can be drained to create capacity before storms.
- Lagoons also back up due to tidal back flow during **King Tide** events if the water level was not lowered beforehand.
- The pipes under state-maintained roads connecting the interior lagoons become silted in and blocked by debris.

Disruption and Damage to Town Services, Resources, and Assets

Flooding and standing water causes disruption and damage to town services, resources, and property. Standing water that is from a saltwater source is highly corrosive to vehicles and infrastructure. Town staff have to change operations to navigate flooded roads and provide additional public safety efforts.

This has caused:

- Garbage trucks can't get to houses on flooded streets.
    - Before major storms, town staff and contractors have walked through floodwaters to aid garbage collectors and then secure cans.
- Police dispatched to stop people from playing in floodwater; stop people from moving barriers and driving through floodwaters.

    - Police officers spend time trying to communicate risk.
    - Police officers may be exposed to contaminated floodwater without proper protective equipment.
- Reduced lifespan on municipal vehicles due to saltwater exposure.
- Depreciation speeds up on resources such as vehicles and infrastructure.
- Public health risks to town staff.
- Fire hydrant connections to pipes are corroding, along with other municipal subsurface infrastructure.
- Manhole covers for sewer lines are corroding.

Public Health Impacts

Recurrent flooding and standing water can pose a public health risk to residents, visitors, and town staff. Sewage-contaminated water can cause gastrointestinal illnesses and infections to eyes, skin, ears, and respiratory systems. Flooding may also cause mold growth in buildings and structures unless properly treated quickly. Mold exposure can cause an array of illnesses and irritations. Mosquitos breed quickly in standing water that has not been treated with larvicides. Mosquitos are vectors for a variety of severe illnesses such as West Nile Virus, Eastern Equine Encephalitis, and parasites that can infect **humans and pets**[2].

Public Health Impacts Discussed Were:

- Sewage contaminated floodwater poses a public health risk to people walking through it.
- Residents forced to walk through contaminated water can get sick.
- Town staff that walk through or come into contact with floodwater may not have proper personal protection equipment or knowledge of decontamination processes.
- Vacationers are not aware of risk of contamination and play in the water.
    - Police officers spend time trying to communicate risk.
    - Police officers may be exposed to contaminated floodwater without proper protective equipment.
- Additional concern about whether saltwater intrusion into the Santee aquifer, the town's current well source, will result in higher costs to treat water.

Beach Erosion

Beach erosion was not a formal topic of the workshops, but impacts from erosion and storms were discussed as causes of flooding and other effects. We felt it was important to create a beach erosion section since ways to manage erosion are of concern to the town and plans are underway to find funding to support restoration and management.

Beach Erosion has caused:

- Wave over wash during King Tides and storms, causing street flooding in the most vulnerable areas.
- No beach at high tide in places.
- Increased risk to houses during storms.
- Beachfront flooding caused by storm surge leaves sand in streets.
- According to SCDHEC, houses on the active beach must be removed.

How Edisto Beach Currently Addresses Some Identified Flooding-related Problems

Edisto Beach has learned from the multiple years of flooding how to address certain problems associated with flooding. We are not including a general flooding category in this section as responses are best categorized under the sections where they are most likely to find some of the discussion.

Street Flooding

- Engineering standards exist for roads. Engineering firm says they should have been built for a 10-year, 24-hour storm event.
    - There is no documentation indicating they were built to this standard.
- The state road stormwater system was never connected to interior lagoons.
- Dirt roads are a place of concern.
    - Most recent maintenance involved filling then topping with shell sand instead of only using shell sand.
        - Have also been elevated with various other composite material by hired contractors in the past.
        - Costs range from $6,000-$20,000 per block.
        - 3-7 inches raised in elevation ranging from the entire street to just a block.
        - Maintenance projects are inconsistent.
        - Renovation projects are not a long-term solution, as dirt will continue to erode and subside.
    - Dirt roads belong to the town; not under S.C. Department of Transportation (SCDOT) jurisdiction.
    - The town does not promote paving dirt roads.
        - More impervious surfaces will exacerbate flooding and keep adding to the problem.
        - Paved roads are more expensive to maintain.

- SCDOT has elevated some paved roads.
    - If neighboring home parcels are not level, the yards become drainage basins
        - Standing water in yards that are not close to lagoons.
    - Bike paths have not been elevated when SCDOT paved roads and adjacent housing were elevated.
        - They will eventually need to be raised level with the roads or they will become drainage basins from runoff.
    - FEMA flood maps were updated recently and are now less restrictive in terms of currently designated base flood elevation, which has resulted in lower required building heights for new or substantially improved construction.

High Groundwater Table

- Fire hydrants
    - The town has been sanding and repainting corroded hydrants.
    - Replacing hydrants is time-consuming and expensive (in 2020, the cost was about $5,000 for a new hydrant and about $5,000 to install).
        - What is causing the corrosion – is it surface flooding in general or is it the increasing salt content of the soil and groundwater?
        - Can we map hydrants that have been impacted to determine the most vulnerable areas?
        - Can we evaluate the longevity of hydrants and plan maintenance around that?
            - Is moving hydrants to higher ground if/when they are replaced an option?
- Some infrastructure that is affected, notably communications and electric connections that are run underground from above-ground wires, are privately owned. No coordinated conversation has been held with those parties yet.

Wastewater Plant

- Consulting firm looking at the lift stations to see how they can resolve infiltration issues.
    - The Town conducted smoke tests to identify penetrations to the system and corrected any identified penetrations.

- Infiltration through manhole covers that impacts the wastewater treatment plant was corrected with waterproof seals.
  - Can install barriers to prevent infiltration, but their efficacy is limited.
  - Seals are relatively cheap (about $30).
- Limited capacity for expansion.
  - Limited capacity means residential and commercial occupancy must be kept to a minimum on structures connected to public sewer.
  - Limited capacity also means no additional new connections, at the time of this report
  - One of the challenges of expansion is where to discharge the treated effluent. The current permit is solely for spraying effluent on the golf course, and if there are flooding problems there, additional spraying will exacerbate issues.

Lagoon System

- The town looked at possibly converting lagoons into stormwater ponds but found that SCDHEC requirements for stormwater retention ponds were cost prohibitive.
  - Roads drain to those lagoons, but SCDOT has no responsibility for maintaining the lagoons. They must be routinely treated with herbicide and dredged to maintain capacity.
    - Private lagoon owners are either not maintaining at all or are doing sporadic maintenance.
  - Vegetation cannot be cleared by the town unless it is in the right of way. SCDOT has agreed to remove vegetation from rights of ways on all state-maintained roads on the interior lagoon system.
  - Receiving a 319 grant from SCDHEC could fund a short-term, one-time fix to dredge lagoons, but it is not a long-term solution. Additionally, it's unclear whether the town would qualify for such a grant.
- The town would like to know what kind of maintenance can be done to expand capacity that would not be as extreme and costly as dredging.
- The town would like to know if studying the connections between the ponds could also help improve performance.
  - If connections could be made to function properly, it could help.

- Organize a mapping effort to better understand the full system.
    - Would require “herding the cats” to identify and contact all lagoon owners.
    - Would also require working with SCDOT.
    - Needed coordination. Homeowners could form a Homeowners Association to assist with organizing.

Disruption and Damage to Town Services, Resources, and Assets

- Emergency Response/Vehicle Maintenance.
- Limit expensive vehicles going into flooded areas.
- Use sealant spray undercoating for undercarriage of vehicles and salt-away to help with rust issues. Helps but does not stop it completely.
- For immediate public safety response during an event, the town procured a military surplus vehicle for free. The truck has a higher clearance, so saltwater exposure is more limited. It lacks the lifesaving equipment the fire trucks have.
- One squad unit vehicle is used to respond to most calls that are not fire-related to limit salt and water exposure.
    - Replace with a better equipped vehicle?
    - Limit responses to non-fire related calls?
- Regarding drinking water supply, the town may need to construct wells into the Middendorf aquifer, which is deeper than the Santee aquifer, in the event that saltwater intrusion contaminates the water supply.

Workshop Participant Concerns About Future Conditions

Town participants in the workshop highlighted the following issues as important concerns for the future.

- Residents have discussed with town officials about the increasing frequency of their docks getting overtopped at high tide and worry about what that means for the future.
- Reductions to tourism due to flooding and perception.
- Finding funding to pay for highly technical studies to identify measures to reduce flooding

- Finding funding to pay for infrastructure repairs and construction.
- Finding matching funds for beach replenishment project with U.S. Army Corps of Engineers.
- Long-term impacts to real estate market as well as the condition of individual properties that have been flooded or are near repetitive flooding (e.g., mold and mildew in houses).
- How will the drinking water supply be affected and are there alternative sources?
- What to do for houses that have permanently failed septic systems in the future.
- Effects on municipal budget from potential property value declines.
- Concerns about property owners leaving the beach permanently.

Public Comments from Engagement Event

On September 28, 2021, the research team hosted an event in town hall for residents to provide feedback on the findings and concerns identified during the workshops. The following is a list of all comments received:

- Often, water from King Tides enters through culverts and runs down into lower lying areas and does not recede, causing continuing degradation on unpaved roads and adjacent properties. Backflow prevention systems must be installed in these locations AND monitored and repaired when needed.
- We all are at risk of damaging vehicles.
- Damage to vehicles; bike paths on Yacht Club Road under sand.
- On Yacht Club Road, pool flooded, flowers dying, grass dying, killed 22 cedar trees, June 20, 2010 tide in for four days.
- The elevation of bike paths must be addressed in certain low sections.
- Better maintenance of unpaved roads. Paving will intensify flooding.
- More drainage. French drain under bike path on Yacht Club Road NOW.
- Education about tree removal – trees help absorb water.
- Drainage pipes should be put in by the best qualified contractors, not necessarily the cheapest. Results speak for themselves.
- Better/stronger tree ordinance.
- Town tree planting program.

- Install/maintain backflow prevention at all outfall locations. Jungle Shores and Whaley installed, but not functioning properly.
- Residents that block drainage pipes need to be educated and fined.
- How to adjust (lagoon levels) accordingly for King Tides?
- The causeway bridge is clogging up Scott Creek. This should have never been built without pipes for silt and water to flow.
- Sand bars forming in Scott Creek.
- Golf course needs to be responsible in Wyndham.
- Clean and maintain lagoons for better water flow.

The following is a list of concerns residents have for the future:

- Edisto Island relies on grocery store and other beach businesses. Flooding and changes will affect island residents as well. Consider island and beach a system at some point.
- Effects of sea level rise to our front beach and property owners.
- Business are based off island but could be affected by indirect flooding/decreased tourism (have operations on Edisto Beach, just not offices).
- Reopen the causeways. Both the island causeway and causeway to residential island on Scott Creek.
- Instill a sense of empowerment among residents that by working together we can confront these obstacles.
- Accountability for Wyndham for filling in the marsh at the end of Yacht Club.
- Foster hope with town actions.
- The town, working with residents, must secure funding and implement a robust wastewater treatment plan.

Questions for Future Study

Town participants and the research team have identified the following questions for future study. These questions are intended to inform or find specific measures that can reduce flooding such that the town can buy time against future impacts from sea level rise and climate change.

- Can we identify the causes of various types of flooding under specific conditions? How can that inform potential resilience measures?

- How can we develop science-based timelines for how sea level rise and future conditions will increase the frequency of flooding, community disruption, and infrastructure damage? How might these timelines be different around the beach?
- Can we develop an assessment of the number of hours that key roads may be flooded in the future based on tide charts and sea level rise projections?
- Can dredging lagoons create more capacity for stormwater or will groundwater infiltrate that space too quickly to have a positive effect? Is there a longer-term sustainable solution to improving maintenance?
- How will groundwater rise from sea level rise affect the dirt roads and the paved roads?
- Do homeowners know they can't occupy dwelling or flush the toilet when the septic system has failed? Do they know when it has failed? Can an education campaign assist to reduce public health impacts?
- Can a groundwater study be used to develop a model for predicting at what stage septic systems will fail and when?
- Can the Ocean Ridge Homeowner's Association work with experts to develop a system that informs when lagoons need to be lowered to reduce flooding from King Tides and heavy rains?
- Is there a sustainable funding mechanism to assist with maintenance that reduces flooding?
- How will drinking water supply needs change in the future? Is the Santee aquifer at risk of salt-water intrusion?
- Given sea level rise and rainfall projections, what is the efficacy lifespan of potential resilience measures?

Conclusion

Edisto Beach is at risk to flooding and sea level rise. Projections indicate flooding events will increase over time. Effects of sea level rise are already present and will continue to increase, particularly with a rising groundwater table, standing water, drainage problems, and tidal flooding. A tipping point for Edisto Beach exists between 2 feet and 3 feet of rise with the number of parcels affected increasing from 231 to 826.

However, the impact to groundwater and a dramatic increase in flooding frequency may begin when sea level rises about 1.5 feet due to naturally occurring tidal variation. Using the NOAA intermediate and intermediate high scenarios, this could happen sometime between 2040 and 2060.

Continued and persistent impacts to community functions, specifically to onsite septic and wastewater systems and transportation infrastructure, may reach a point where current resilience measures will no longer work in areas of the beach due to physical limitations from groundwater and persistent standing water. The most vulnerable properties on the marsh side of the beach will be the first to experience these effects.

The frequency of community disruption from standing water, street flooding, and submerged septic systems due to heavy rain is likely to increase. This is because the rising sea level will reduce the drainage capacity and capability of ditches, engineered systems, and the groundwater table. This means that a storm that would not have caused persistent and disruptive flooding in 2021 may do so in the future.

The Town of Edisto Beach can work with residents and property owners to identify measures to reduce flooding disruption and damage in the coming two decades. Studying groundwater and developing impact-based timelines are crucial next steps. Efforts to buy time may need to be creative and highly localized. Continued and sustained engagement with residents and property owners is essential to educate them about the increasing risks, what the town and other public entities are able to do, and what residents themselves can do.

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Additional Resources

Edisto Beach Flood Model

NASA Sea Level Rise and Flooding Days Projection Tool

National Climate Assessment 4: State Summary for South Carolina

Glossary

ACE Basin: A vast estuary and tidal marsh in Colleton, Beaufort, and Charleston counties where the Ashepoo, Combahee, and South Edisto rivers converge into the St. Helena Sound. It is one of the largest undeveloped estuaries on the east coast.

Annual Return Interval (ARI):

- 100-year storm: An event that has a 1 percent chance of occurring in any given year.
- 500-year storm: An event that has a 0.2 percent chance of occurring in any given year.
- 1,000-year storm: An event that has a 0.1 percent chance of occurring in any given year.

Groundwater: Water found below the surface, taking up space between soil particles and rocks. Groundwater is found in multiple layers, sometimes referred to as the water table or an aquifer.

Datum: A fixed point on a scale that determines a baseline for various types of measurements, such as the North American Vertical Datum or NOAA's Mean Sea Level datums. These points vary based on location.

Intensity, Duration, and Frequency (IDF) Curve: NOAA develops these measurements to identify the probability of certain levels of rainfall in any given year. These curves are based on 50-year averages and do not incorporate future conditions. In S.C., the curves were most recently calculated in 2006 and are commonly used for builders and engineers to design stormwater and drainage infrastructure.

King Tide: An especially high tide that typically corresponds with the alignments of the Earth, sun, and moon. These typically occur a few times a year, most notably in the spring and fall. The heights of these types of tides has increased due to sea level rise.

Mean Higher High Water (MHHW): A datum that marks the annual average of the daily highest high tide. Of the daily two high tides we experience, one is always higher than the other.

Mean Lower Low Water (MLLW): A datum that marks the annual average of the daily lowest low tide. Of the daily two low tides we experience, one is always lower than the other.

Mean Sea Level (MSL): A datum that marks the average sea level, with extreme variations and storm surges averaged out of the calculation.

Rain Bomb: Term used to describe a sudden, large amount of rainfall recorded in an area over a short period of time, often resulting in flash flooding. These can be difficult for weather forecasters to predict because they often happen over small areas.

Sea Level Rise: An increase in the volume of the ocean due to a variety of factors, such as thermal expansion (warmer water takes up more space,) melting glaciers in Antarctica and Greenland, and slowing down of large ocean currents. This results in more frequent tidal flooding.

Storm Surge: A temporary rise in the surface level of the sea associated with storms, caused by wind and changes in atmospheric pressure; can cause extreme flooding and damage.

Tidal Epoch: A 19-year cycle that NOAA uses to calculate datums such as Mean Sea Level and Mean Higher High Water. The 2000 tidal epoch is based on records from 1983 to 2001. Tidal epochs are reconsidered for revision every 20-25 years.

Tropical Cyclone: Fast moving storm system that forms over oceans, fueled by warm, moist air and typically characterized by a low-pressure center, strong winds, and heavy rain.

Appendix A: How This Study Was Completed

In February, 2020, the Town of Edisto Beach contacted S.C. Sea Grant Consortium (SCSGC) and the Carolinas Integrated Sciences and Assessments (CISA) for assistance characterizing sea level rise and flooding risks. After initial conversations with town staff, SCSGC and CISA suggested that using the Vulnerability Consequences and Adaptation Planning Scenarios (VCAPS) process would provide the community with a detailed view of what is currently occurring and what may happen in the future.

Additionally, SCSGC and the College of Charleston (CofC) Lowcountry Hazards Center extended high-resolution flood modeling developed for Charleston and Beaufort counties through a 2015 NOAA Regional Coastal Resilience Grant to include Edisto Beach in Colleton County. This allowed CofC and SCSGC to develop the modeling storymap used in the VCAPS process and the layers for the vulnerability analyses to roads in the town. As part of that process, SCSGC and CofC also digitized the town's drainage system map and developed a web-based GIS tool for the town to use.

The VCAPS exercises were intended to be held in person but were instead held via Zoom due to the pandemic. The meetings were held in August and December 2020.

The research and report were funded through several ongoing federal grants intended to provide technical support to local communities. The town contributed staff time.

The methodologies and findings in this report were reviewed throughout the process by a suite of local, state, and federal experts with knowledge of South Carolina's coastal processes. Reviewers include: Matthew Campo, Rutgers University; Charlie Kaufman, S.C. Emergency Management Division; Kirsten Lackstrom, CISA; Abi Locatis-Prochaska, SCDNR/ACE Basin National Estuarine Research Reserve; Doug Marcy, National Oceanic and Atmospheric Administration (NOAA) Office for Coastal Management; and Hope Mizzell, S.C. Office of the State Climatologist/SCDNR.

Workshop 1: Tuesday, August 11, 2020 Attendees

Sarah Watson – CISA and S.C. Sea Grant Consortium, Facilitator

Kirstin Dow – University of South Carolina, CISA Lead PI, Notetaker

Jory Fleming – CISA Climate Solutions Specialist, Diagraming

Amanda Farris, CISA Program Manager, Notetaker

Iris Hill – Town Administrator

Mark Aakhus – Assistant Town Administrator

Denney Conley – Fire Chief

Patrick Zemp – Utilities Director

Patti Smyer – Council Woman

Workshop 2: Thursday, December 10, 2020 Attendees

Sarah Watson – CISA and S.C. Sea Grant Consortium, Facilitator

Kirstin Dow – University of South Carolina, CISA Lead PI, Notetaker

Jory Fleming – CISA Climate Solutions Specialist, Diagraming

Amanda Farris, CISA Program Manager, Notetaker

Mark Aakhus – Assistant Town Administrator

George Brothers – Chief of Police

Patrick Brown – Building Code Administrator

Iris Hill – Town Administrator

Patti Smyer – Council Woman

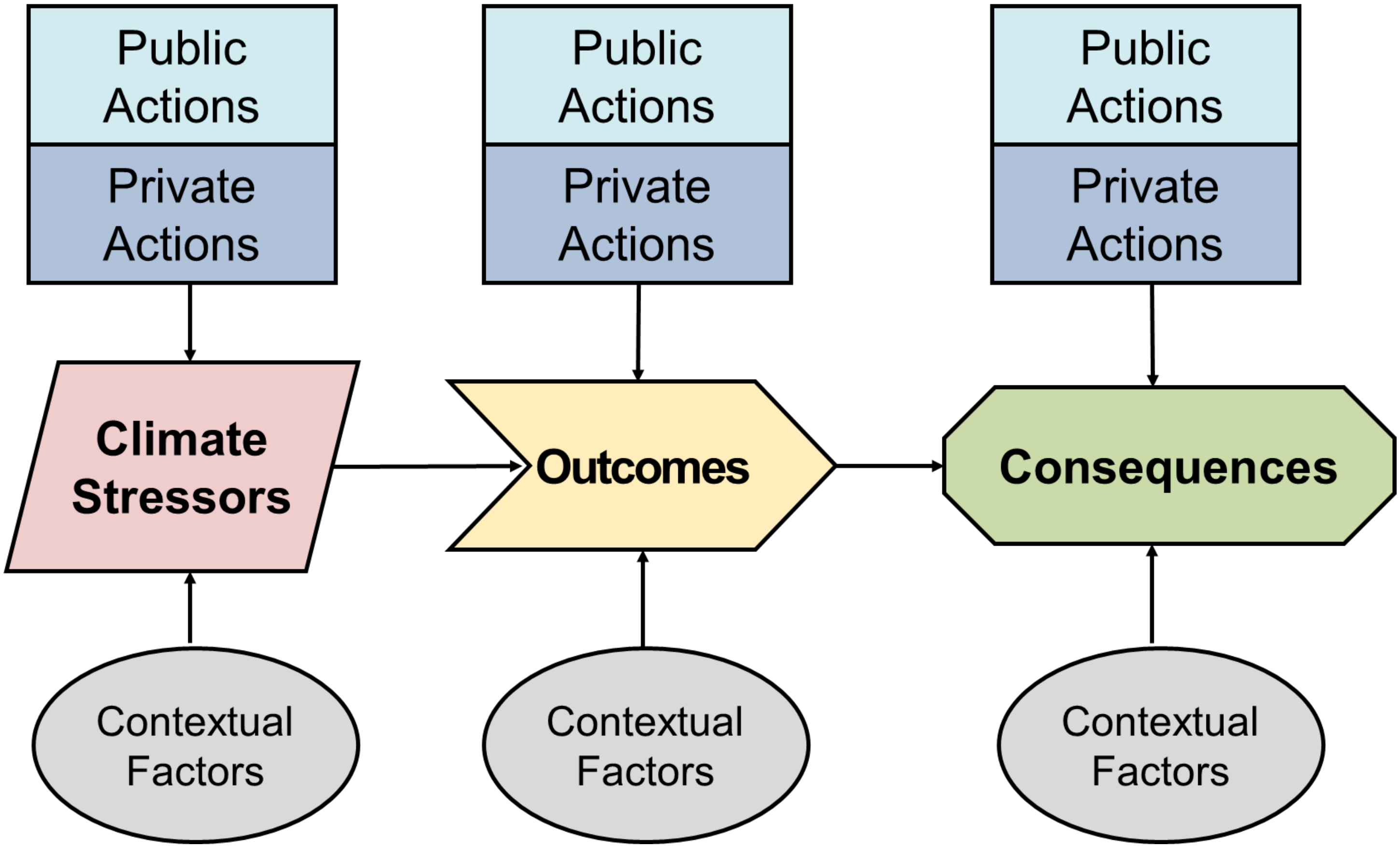
Patrick Zemp – Utilities Director

About the VCAPS Process:

This process is to assist local government staff with quickly identifying challenges and implications related to flooding and climate impacts. The discussion also identifies what specific steps can address those challenges, either through private actions or public actions. During the process, the conversation is mapped out on a diagram as illustrated in Figure 10. Read more information about how the process is conducted.

In this case, the diagram was simplified and translated into the groupings and headings in the sections "Observations About Current Flooding Impacts" and "How Edisto Beach Currently Addresses Some Identified Flooding-Related Problems." The research team felt that would better assist Edisto Beach with understanding the findings.

Figure 10: VCAPS Process Diagram



Appendix B: A Detailed Look at Tidal Flooding Records at the Charleston Harbor Gauge

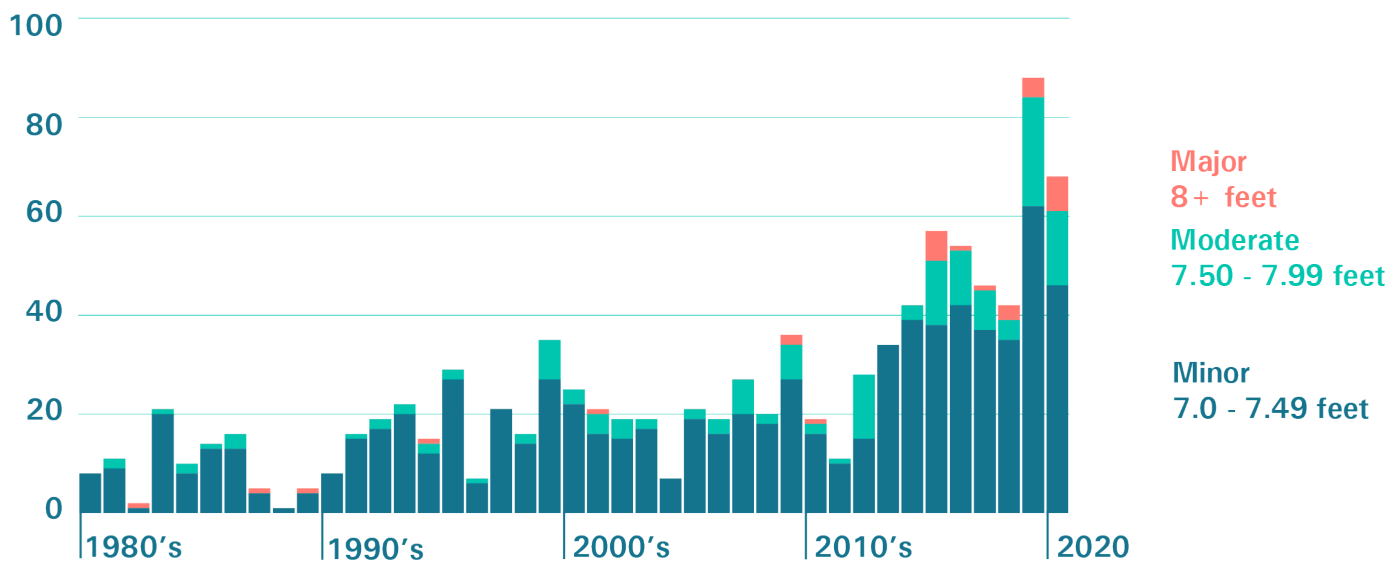
Tidal records at the Charleston Harbor gauge are kept by NOAA's National Ocean Service. The National Weather Service office in Charleston has developed a database of flooding records at the gauge and has posted on its website. The database solely counts events, or each time a tide reaches the designated minor, moderate, or major thresholds. Records go back to 1922 for the Charleston Harbor gauge. In **Table 6**, records since 2000 are listed by threshold level. In **Figure 11**, these data are compiled in an easy to read graph illustrating trends.

Table 6: Annual Flood Events Since 2000 at the Charleston Harbor Gauge

Threshold (feet above MHHW)	Minor (7.0-7.49 ft)	Moderate (7.5-7.99 ft)	Major (8.0+ ft)	Total
2000	25	3	0	28
2001	21	5	1	27
2002	19	4	0	23
2003	19	2	0	21
2004	7	0	0	7
2005	21	2	0	23
2006	19	3	0	22
2007	27	7	0	34
2008	20	2	0	22
2009	36	9	2	47
2010	19	3	1	23
2011	11	1	0	12
2012	28	13	0	41
2013	34	0	0	34
2014	42	3	0	45
2015	58	20	6	84
2016	55	12	1	68
2017	46	9	1	56
2018	42	8	3	53
2019	89	26	4	119
2020	68	22	7	97
Total	**706**	**154**	**26**	**886**

Source: National Ocean Service, National Weather Service

Figure 11: Total Number of Tidal Flooding Events at Charleston Harbor Gauge



Source: NOAA/National Ocean Service; S.C. Sea Grant Consortium

Appendix C: Documented Weather Measurements from Recent High-Impact Extreme Weather Events

These storm summaries are courtesy of the S.C. Office of the State Climatologist.

October 2015 Flood (10/01/15 – 10/05/15):

The National Weather Service (NWS) station at the Edisto Island Middleton Plantation observed 13.77 inches, and the station at the Edisto Beach State Park recorded 8.28 inches from October 1-3, the station stopped reporting after Oct. 3. Only one CoCoRaHS station on Edisto Island reported (SC-CR-40, Edisto Island 3.8 SW) and missed two days of data. They measured 9.00" from the morning of October 1 through the morning of October 5. However, here is some data from nearby CoCoRaHS observers:

Name	Station Number	County	Rainfall Total (10/01 – 10/05)
Kiawah Island 1.5 NW	SC-CR-83	Charleston	18.44"
Wadmalaw Island 2.3 SSW	SC-CR-98	Charleston	16.27"
Meggett 1.8 W	SC-CR-32	Charleston	14.60"
Beaufort 3.6 NNE	SC-BF-35	Beaufort	6.79"
Beaufort 4.3 SSE	SC-BF-40	Beaufort	5.45"

2016 - Hurricane Matthew (10/07/16 – 10/09/16):

WIND

Sustained tropical storm force winds (35+ mph), with higher gusts reported along the coast. Maximum wind gusts were of 88 mph were registered at the Hilton Head Airport, 71 mph at Beaufort Marine Corps Air Station (MCAS), and 70 mph at Beaufort County Airport. An offshore buoy (Fripp Nearshore, 41033) recorded a maximum wind gust of 84 mph.

SURGE

Up to 5 feet of saltwater inundation occurred on parts of Edisto Beach, and sand up to 5 feet deep was pushed onshore and covered more than a 1-mile stretch of Palmetto Boulevard near the beach. The most significant damage occurred on the northern end of the island.

RAIN

The NWS station at the Edisto Island Middleton Plantation observed 16.92 inches, and Beaufort MCAS recorded 13.97 inches.

Name	Station Number	County	Rainfall Total (10/07 – 10/09)
Meggett 1.8 W	SC-CR-32	Charleston	11.74”
Green Pond 1.3 S	SC-CL-14	Colleton	11.68”
Parris Island 1.7 N	SC-BF-53	Beaufort	11.00”
Bluffton 2.3 NNE	SC-BF-4	Beaufort	11.00”
Hilton Head Island 2.7 E	SC-BF-52	Beaufort	13.66”

2017 - Tropical Storm Irma 2017 (09/11/17 – 09/12/17)

SURGE

The storm surge produced by Irma was less than that produced by Hurricane Matthew (2016) along the coast of South Carolina. However, the slightly higher tides and timing of high tide with the peak storm surge caused water levels at the Charleston and Springmaid Pier gauges to exceed those observed during Matthew.

RAIN

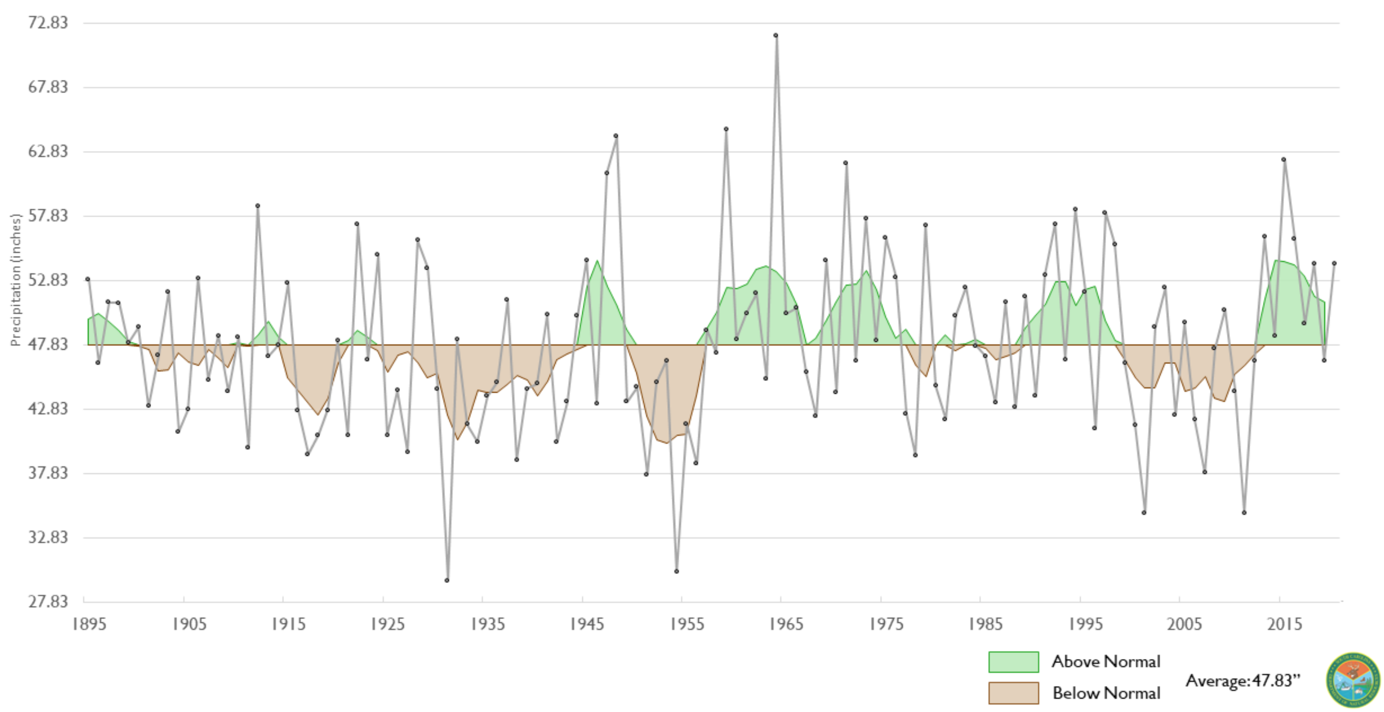
The NWS station at the Edisto Island Middleton Plantation recorded 5.99 inches.

Name	Station Number	County	Rainfall Total (10/07 – 10/09)
Wadmalaw Island 2.3 SSW	SC-CR-98	Charleston	7.11”
Meggett 1.8 W	SC-CR-32	Charleston	7.27”
Hollywood 2.3 W	SC-CR-105	Charleston	6.38”
Green Pond 1.3 S	SC-CL-14	Colleton	5.49”
Beaufort 3.6 NNE	SC-BF-35	Beaufort	8.96”

Appendix D: Annual Precipitation Records from the S.C. Office of the State Climatologist

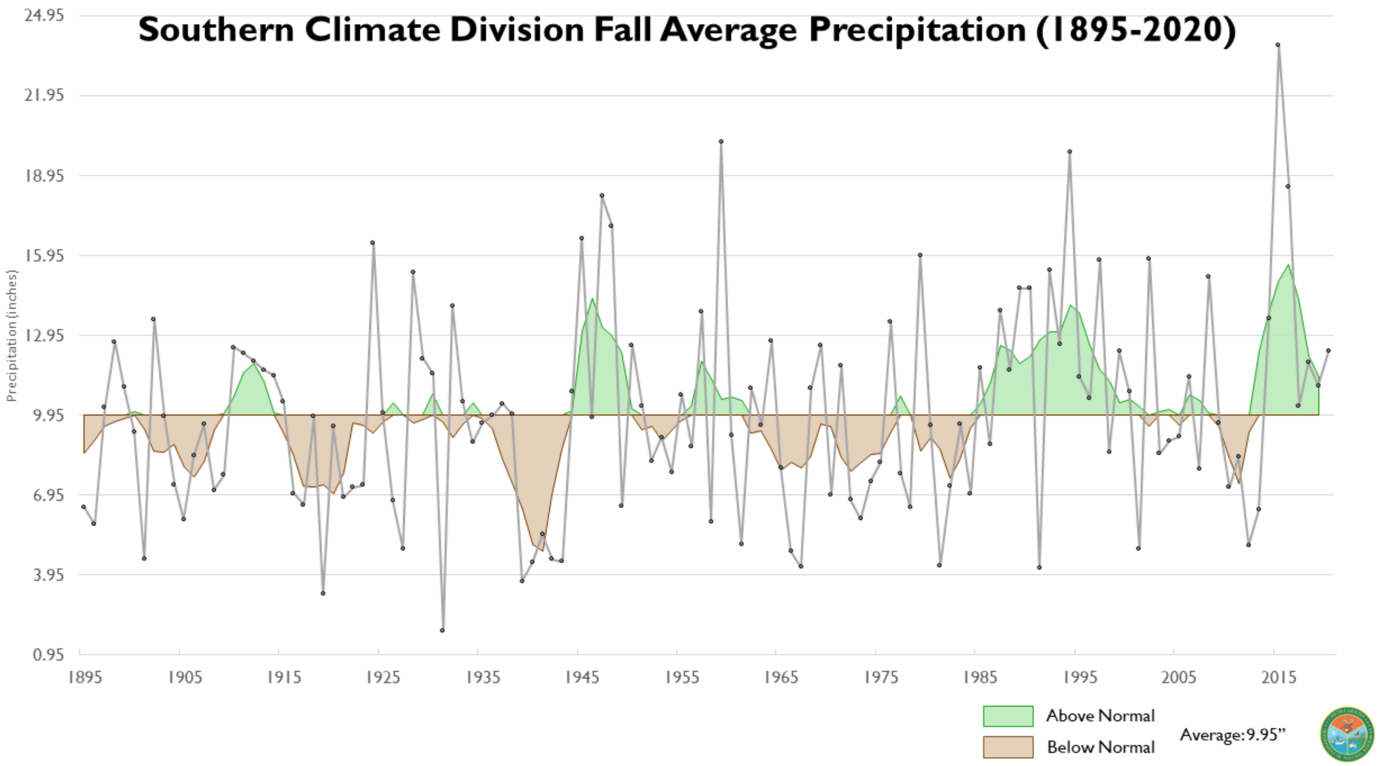
Assessing precipitation changes over the long term can be challenging due to a lack of long-term recording stations and the highly localized nature of rainfall. For the purposes of this report, we're using two separate recording methods to highlight how rainfall patterns may or may not have changed. Examining a larger area has more statistical significance than a single location. The National Climatic Data Center and the S.C. Office of the State Climatologist use climate regions to better examine averages over the long term. The Southern Climate Division in South Carolina comprises of Allendale, Bamberg, Barnwell, Beaufort, Berkeley, Charleston, Colleton, Dorchester, Jasper, and Hampton counties. As illustrated in Figure 12, there is no defined trend in changes in annual precipitation. There is a slight trend showing an increase in average precipitation in meteorological fall, which is September, October, and November, illustrated in Figure 13.

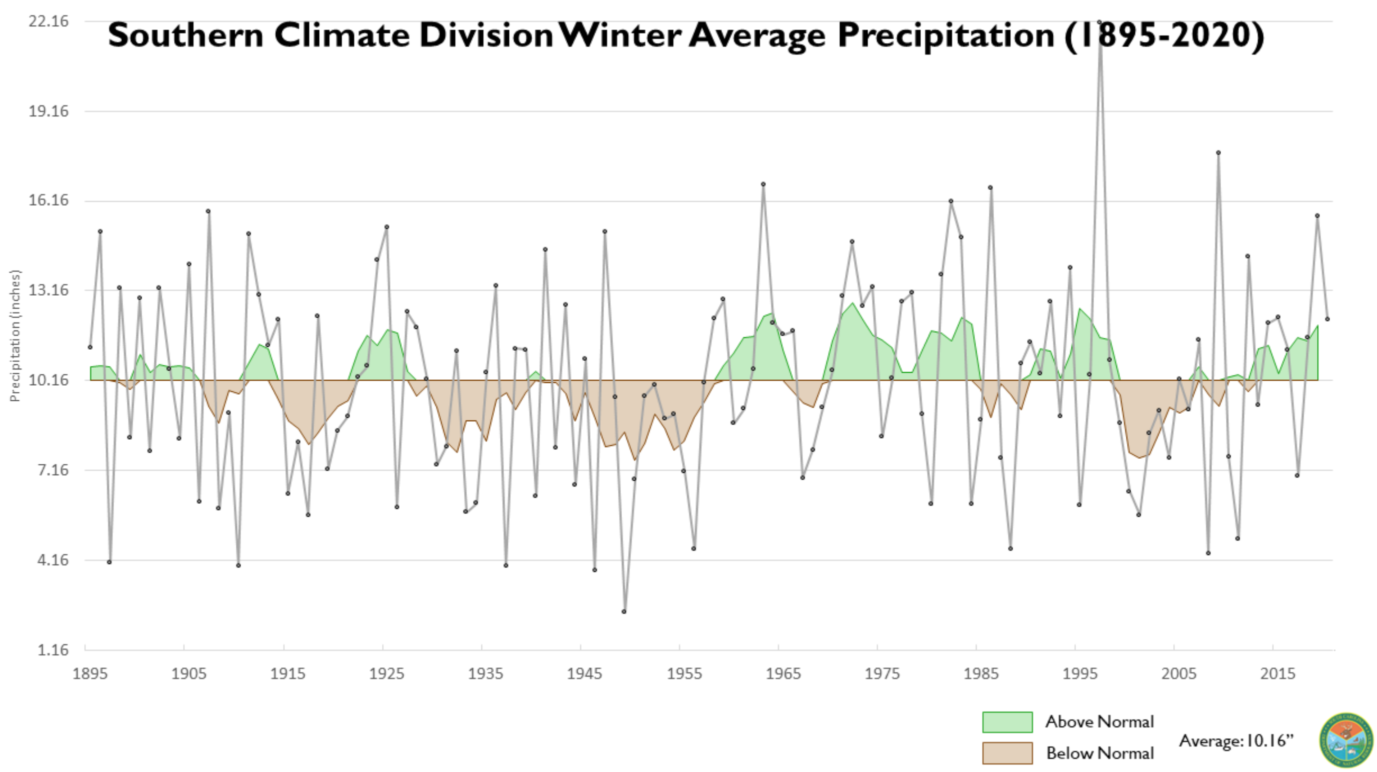
Figure 12: Southern Climate Division Annual Average Precipitation (1895-2020)

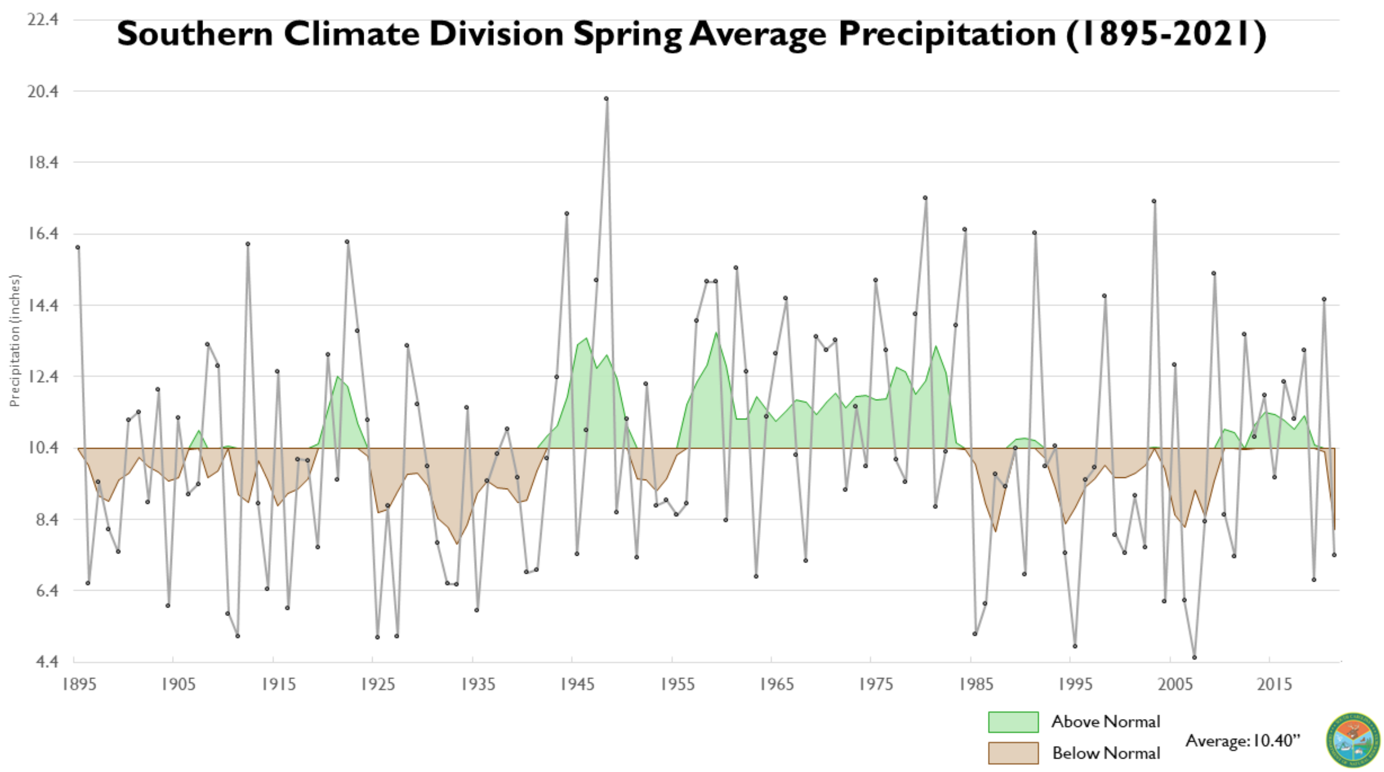


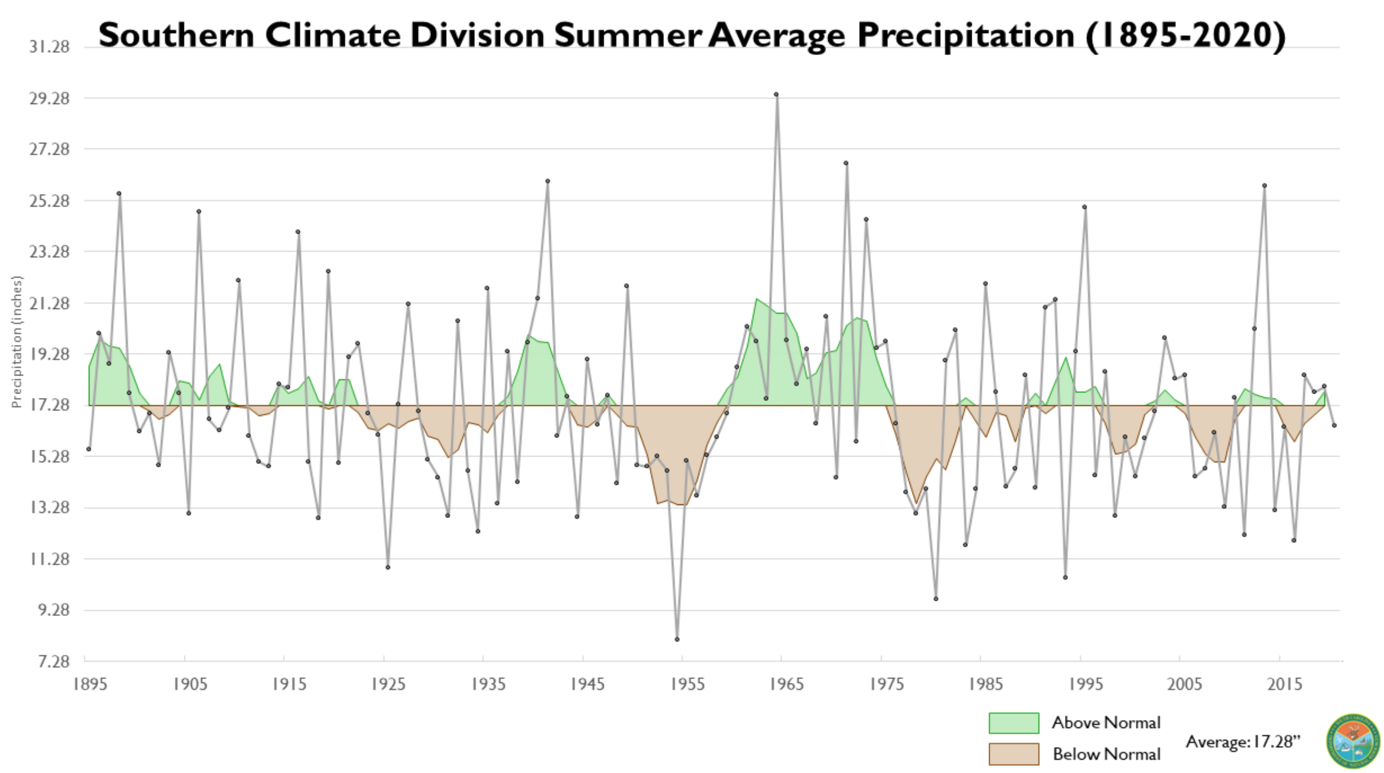
Source: Office of the State Climatologist/DNR

Figure 13: Southern Climate Division Seasonal Average Precipitation (1895-2020)

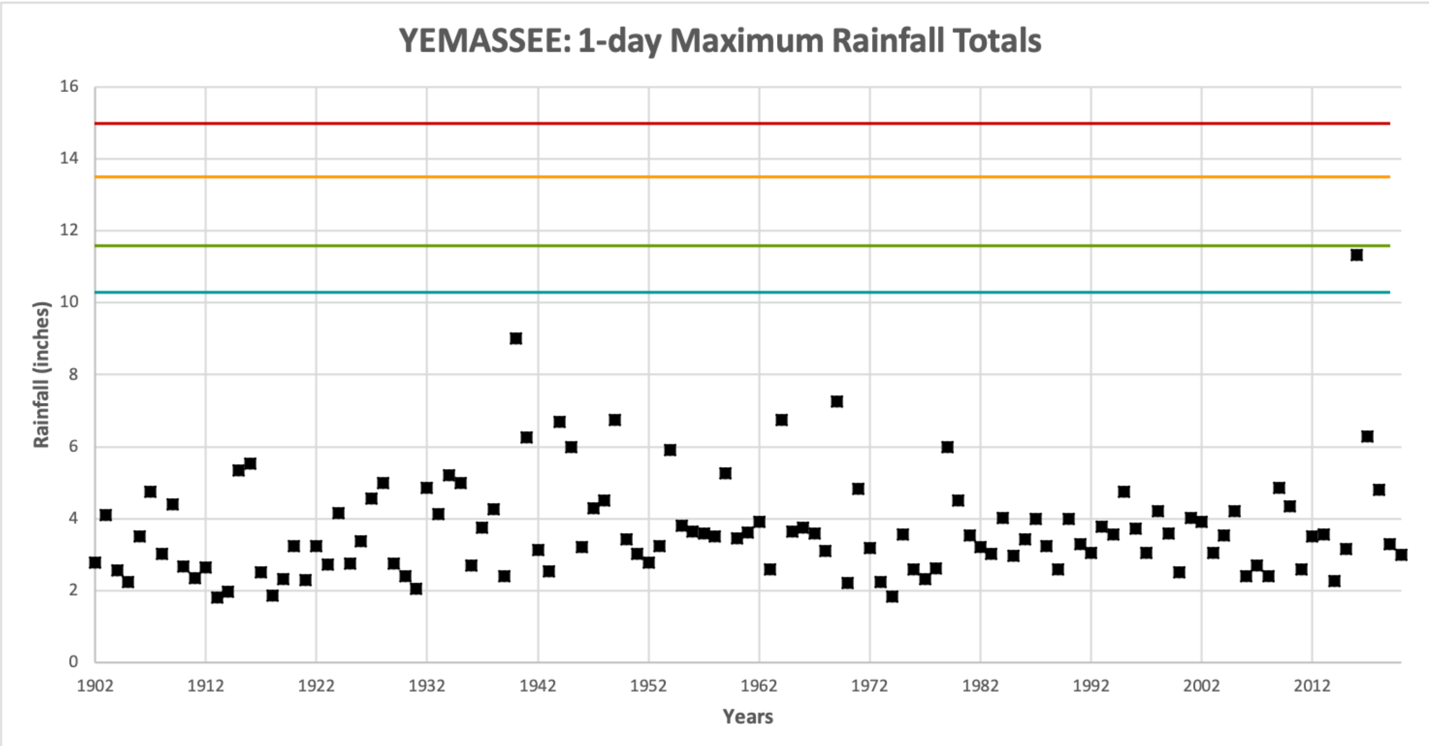


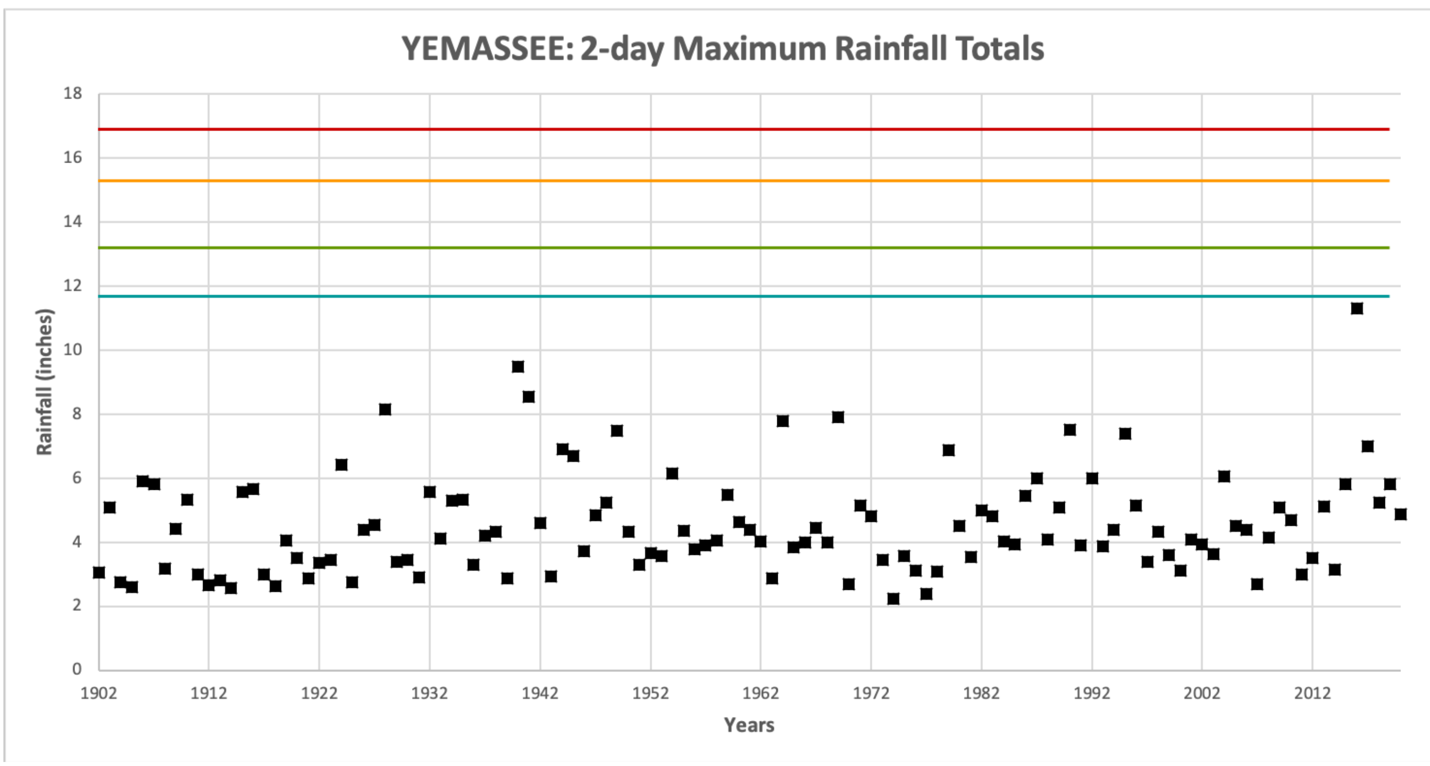


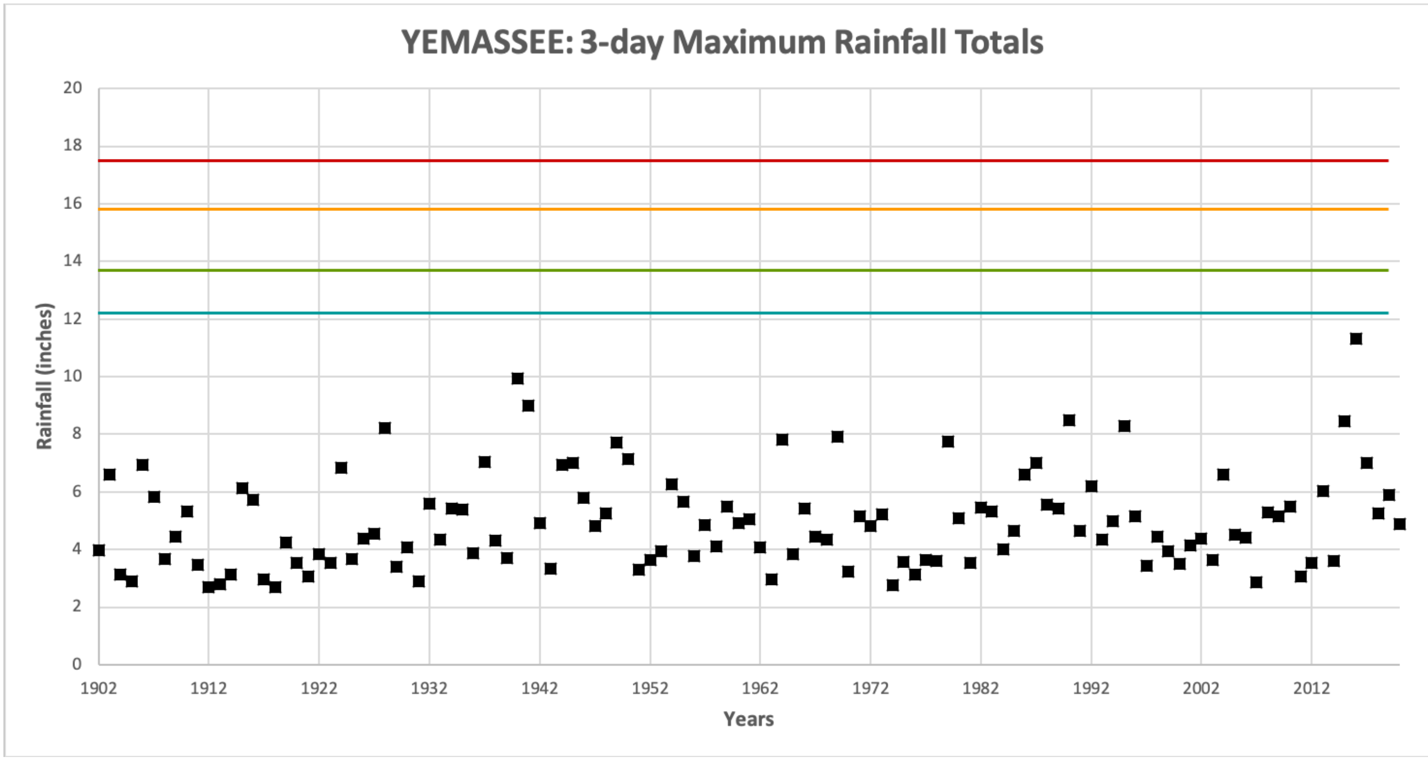

Southern Climate Division Spring Average Precipitation (1895-2021)
Precipitation (inches)
22.4
20.4
18.4
16.4
14.4
12.4
10.4
8.4
6.4
4.4
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
2015
Above Normal
Below Normal
Average: 10.40"

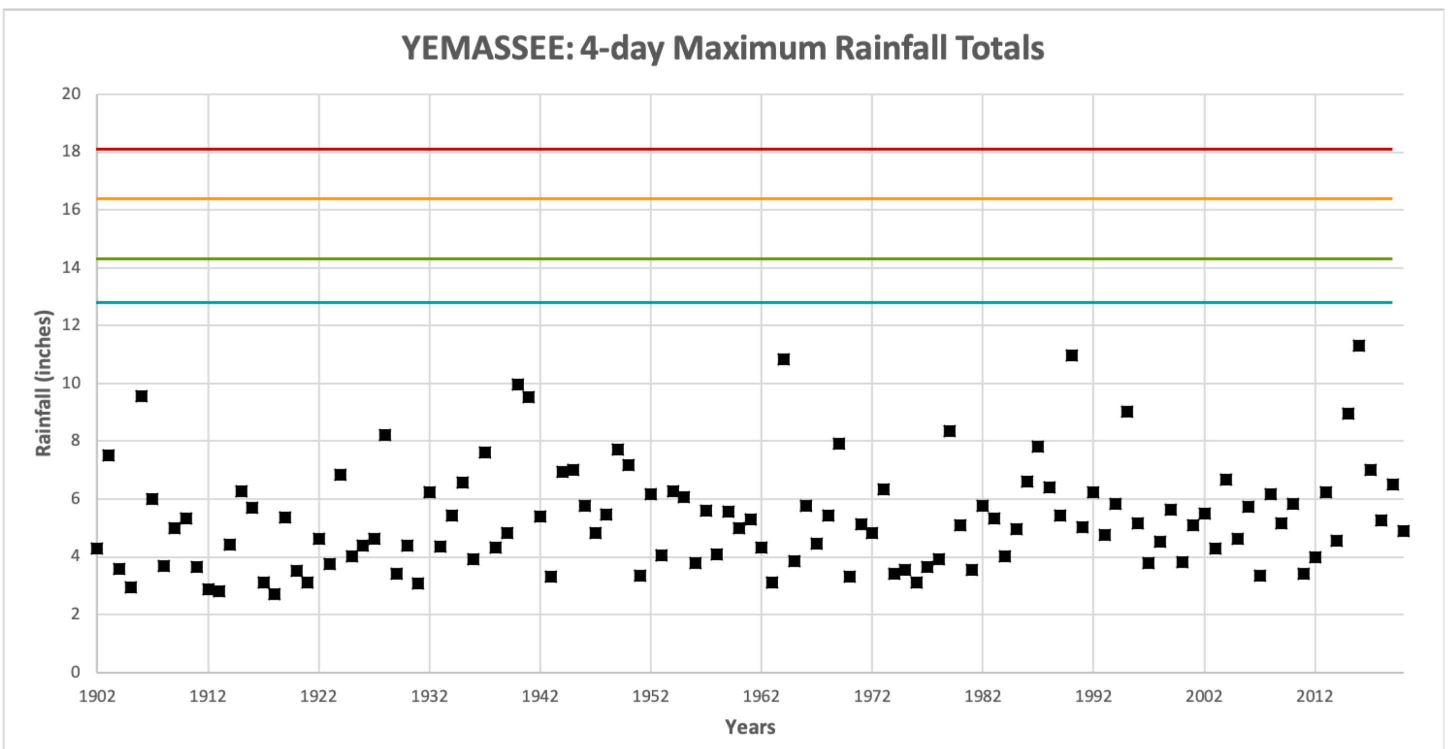

Southern Climate Division Summer Average Precipitation (1895-2020)
Precipitation (inches)
31.28
29.28
27.28
25.28
23.28
21.28
19.28
17.28
15.28
13.28
11.28
9.28
7.28
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
2015
Above Normal
Below Normal
Average: 17.28"

Zooming in to the long-term recording site at Yemassee, we can examine changes to daily maximum rainfall totals as a measure of how extreme precipitation may or may not be changing. There is no real trend in the 1-day or 2-day maximum rainfall totals. There is a slight upward trend in the 3-day and 4-day maximum rainfall totals.






YEMASSEE: 3-day Maximum Rainfall Totals
20
18
16
14
12
10
8
6
4
2
0
Rainfall (inches)
1902
1912
1922
1932
1942
1952
1962
1972
1982
1992
2002
2012
Years


YEMASSEE: 4-day Maximum Rainfall Totals
20
18
16
14
12
10
8
6
4
2
0
Rainfall (inches)
1902
1912
1922
1932
1942
1952
1962
1972
1982
1992
2002
2012
Years

Appendix E: Precipitation Intensity, Duration, and Frequency Annual Return Interval Estimates

This table is a full list of the NOAA Atlas 14 Intensity, Duration, and Frequency (IDF) return interval estimates, also referred to as IDF curves, for Edisto Island. NOAA Atlas 14 data was last updated in 2006 and is calculated using a 50-year average. It does not include future conditions. South Carolina is in the process of securing funding to update this data and include projections for the future, but that process may take several years to complete.

Some local governments, such as the City of Charleston, include an across-the-board percentage increase to account for future conditions when designing stormwater management and drainage systems. Other local governments, such as Horry County, require certain types of new construction to account for a relatively rare return-intervals, such as the 100-year event.

PRECIPITATION FREQUENCY ESTIMATES (inches)										
By duration for ARI (years):	**1**	**2**	**5**	**10**	**25**	**50**	**100**	**200**	**500**	**1000**
5-min:	0.522	0.608	0.69	0.784	0.881	0.967	1.05	1.12	1.22	1.31
10-min:	0.833	0.972	1.11	1.25	1.4	1.54	1.66	1.78	1.93	2.07
15-min:	1.04	1.22	1.4	1.59	1.78	1.95	2.1	2.25	2.43	2.59
30-min:	1.43	1.69	1.99	2.3	2.64	2.94	3.22	3.5	3.86	4.2
60-min:	1.78	2.12	2.55	2.99	3.51	3.98	4.43	4.91	5.54	6.13
2-hr:	2.13	2.57	3.14	3.72	4.39	4.99	5.55	6.14	6.89	7.59
3-hr:	2.28	2.75	3.37	4.03	4.81	5.52	6.22	6.96	7.94	8.88
6-hr:	2.7	3.24	3.98	4.77	5.75	6.66	7.57	8.54	9.86	11.1
12-hr:	3.13	3.76	4.65	5.62	6.81	7.94	9.08	10.3	12	13.7
24-hr:	3.55	4.31	5.57	6.6	8.04	9.22	10.5	11.8	13.6	15.1
2-day:	4.24	5.14	6.57	7.74	9.38	10.7	12.1	13.6	15.7	17.4
3-day:	4.56	5.52	7.02	8.23	9.92	11.3	12.7	14.2	16.4	18.1
4-day:	4.89	5.91	7.47	8.72	10.5	11.9	13.3	14.9	17	18.7
7-day:	5.61	6.75	8.43	9.75	11.6	13	14.6	16.1	18.3	20
10-day:	6.49	7.79	9.56	10.9	12.8	14.2	15.7	17.3	19.3	21
20-day:	8.58	10.2	12.4	14	16.3	18	19.8	21.6	24	25.9
30-day:	10.4	12.4	14.6	16.4	18.7	20.4	22.2	23.9	26.3	28.1
45-day:	12.9	15.3	17.9	19.8	22.3	24.2	26.1	27.9	30.4	32.3
60-day:	15.2	17.9	20.7	22.9	25.6	27.6	29.6	31.6	34.1	36

Source: NOAA Atlas 14, Vol 2, Version 3

Appendix F: Sea Level Rise Projections for South Carolina

Future rates of sea level rise vary depending on location for a number of reasons. The U.S. Army Corps of Engineers downscaled the global sea level rise projections developed for the Fourth National Climate Assessment for the NOAA CO-OPS tidal gauges around the country. These calculations were incorporated into the U.S. Army Corps of Engineers Sea Level Curve Calculator. The data for the Charleston Harbor Gauge is below. Links to both the calculator and the NOAA 2017 report that forms the scientific basis for these projection curves are at the bottom of Table 7.

Table 7: NOAA 2017 Sea Level Rise Projections for Charleston Harbor Gauge (in feet)

Year	VLM	Low	Int-Low	Interme-diate	Int-High	High	Extreme
2000	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15
2010	-0.11	-0.02	0.02	0.11	0.18	0.25	0.25
2020	-0.06	0.18	0.25	0.38	0.54	0.64	0.70
2030	-0.02	0.34	0.44	0.67	0.97	1.16	1.33
2040	0.02	0.51	0.64	1.00	1.39	1.79	2.05
2050	0.06	0.67	0.84	1.36	1.95	2.54	3.03
2060	0.10	0.87	1.07	1.79	2.61	3.53	4.22
2070	0.14	1.00	1.26	2.25	3.36	4.58	5.53
2080	0.19	1.13	1.46	2.74	4.18	5.76	6.97
2090	0.23	1.26	1.62	3.26	5.10	7.14	8.64
2100	0.27	1.39	1.82	3.85	6.18	8.68	10.65

Source: U.S. Army Corps Sea Level Curve Calculator, NOAA, et al 2017

Appendix G: Town of Edisto Beach Budget and Tax Information

Table 8: Municipal Budget and Tax Assessment Information for 2020-2021

Municipal Budget for 2020-2021	
General fund	$6,082,239
Water Fund	$1,560,660
Sewer Fund	$623,782
Civic Center Fund	$82,597
Total	**$8,349,278**
General Fund Break Down for 2020-2021	
General Government Operating	$1,787,112
Police	$1,329,565
Municipal Court	$97,223
Safety and Wellness	$3,700
Fire	$793,359
Public Works	$310,382
Building	$256,104
Contingency	$745,771
Total	**$6,082,239**
Bond Debt for 2020-2021	
General Fund Bond Debt	$175,400
Water/Sewer Fund Bond Debt	$420,000
Total	**$595,400**
2021 Tax Base and Associated Revenue	
2021-2022 Projected Property/Personal Tax Revenue	$1,380,390
Total Assessed Value	$55,095,489
Total Fair Market Value	$941,967,512
4% Legal Residence Assessed Value	$7,715,690 (419 parcels)
Other Assessed Value	$45,691,790 (2,323 parcels)

Note: Property Taxes account for 38% of General Fund Revenues

Appendix H: Paid Flood Insurance Claims for 29438 ZIP Code in Colleton County, 1984-2020

The annual number and value of NFIP claims paid out to NFIP policyholders in the 29438 ZIP code of Colleton County for the years 1984-2020 are provided in the table above. While this geography is slightly bigger than the Town of Edisto Beach (Figure H1), these data still provide a means to examine trends in residential flood damages for the Town. As of the writing of this report in November 2021, the “reported city” field of FEMA’s NFIP claims data (FEMA, 2021c) is undergoing a QAQC overhaul without an expected conclusion date. Therefore, the closest geography to the town’s boundaries was to partition the data according to County (Colleton) and ZIP code (29438). Due to this fact, the actual paid claims data for the Town of Edisto Beach may be slightly smaller than what is reported in the table below. Dollar values are shown in both nominal and real (inflation-adjusted) terms – adjusted with the Consumer Price Index for all urban consumers (CPI-U) to year **2020 dollars**[21].

This time series indicates a few peaks in claims over the years – 35 claims made during 1989 (Hurricane Hugo) for a total value of $25,139 ($52,470 in year 2020 dollars); 12 claims made in 1996 for a total value of $38,118 ($62,877 in year 2020 dollars); and 27 claims made during 1999 (Hurricane Floyd) for a total value of $21,344 ($33,158 in year 2020 dollars). The total value of paid NFIP claims reached over $100,000 for the first time in 2005. Not surprisingly, the number and value of paid NFIP claims in 2016 and 2017 are unprecedented. In 2016, 291 NFIP claims were paid in the 29438 ZIP code of Colleton County, totaling over $2.75 million. In 2017, 63 claims were paid, totaling over half a million dollars.

Year	Number of Claims	Value of Claims: Building	Value of Claims: Contents	Value of Claims: Cost of Compliance	Total – Nominal Dollars	Total – Year 2020 Dollars	Average Claim – Nominal Dollars	Average Claim – year 2020 Dollars
1984	0	$0	$0	$0	$0	$0	$0	$0
1985	1	$0	$0	$0	$0	$0	$0	$0
1986	6	$14,864	$812	$0	$15,675	$37,016	$2,613	$6,169
1987	6	$13,630	$0	$0	$13,630	$31,053	$2,272	$5,175
1988	0	$0	$0	$0	$0	$0	$0	$0
1989	35	$22,743	$2,396	$0	$25,139	$52,470	$718	$1,499
1990	4	$11,515	$0	$0	$11,515	$22,803	$2,879	$5,701
1991	1	$0	$0	$0	$0	$0	$0	$0
1992	4	$5,812	$0	$0	$5,812	$10,722	$1,453	$2,680
1993	6	$22,177	$705	$0	$22,882	$40,983	$3,814	$6,830
1994	4	$11,145	$0	$0	$11,145	$19,463	$2,786	$4,866
1995	5	$21,244	$1,477	$0	$22,721	$38,585	$4,544	$7,717
1996	12	$34,687	$3,431	$0	$38,118	$62,877	$3,177	$5,240
1997	1	$0	$0	$0	$0	$0	$0	$0
1998	6	$19,006	$1,274	$0	$20,280	$32,201	$3,380	$5,367
1999	27	$20,172	$1,172	$0	$21,344	$33,158	$791	$1,228
2000	2	$4,070	$0	$0	$4,070	$6,116	$2,035	$3,058
2001	3	$42,845	$0	$0	$42,845	$62,613	$14,282	$20,871
2002	11	$33,699	$6,947	$0	$40,645	$58,474	$3,695	$5,316
2003	0	$0	$0	$0	$0	$0	$0	$0
2004	4	$25,058	$0	$0	$25,058	$34,332	$6,265	$8,583
2005	10	$180,993	$0	$0	$180,993	$239,851	$18,099	$23,985
2006	0	$0	$0	$0	$0	$0	$0	$0
2007	1	$624	$0	$0	$624	$779	$624	$779
2008	0	$0	$0	$0	$0	$0	$0	$0
2009	0	$0	$0	$0	$0	$0	$0	$0
2010	0	$0	$0	$0	$0	$0	$0	$0
2011	0	$0	$0	$0	$0	$0	$0	$0
2012	1	$0	$0	$0	$0	$0	$0	$0
2013	0	$0	$0	$0	$0	$0	$0	$0
2014	0	$0	$0	$0	$0	$0	$0	$0
2015	20	$68,192	$8,360	$0	$76,552	$83,591	$3,828	$4,180
2016	291	$2,531,372	$210,613	$16,250	$2,758,235	$2,974,337	$9,478	$10,221
2017	63	$507,284	$17,684	$0	$524,969	$554,290	$8,333	$8,798
2018	0	$0	$0	$0	$0	$0	$0	$0
2019	1	$0	$0	$0	$0	$0	$0	$0
2020	0	$0	$0	$0	$0	$0	$0	$0

Data from: Federal Emergency Management Agency. 2021c. "OpenFEMA Dataset: FIMA NFIP Redacted Claims." URL: https://www.fema.gov/openfema-data-page/fima-nfip-redacted-claims. Accessed 11-9-2021.

Figure 14: 29438 ZIP code in Colleton County

Appendix I: Tidal Flooding Analysis Methodology

Tidal Flooding Model Development: The tidal flooding analysis conducted by the College of Charleston's Lowcountry Hazards Center was performed using tools in Esri's ArcGIS software. All analyses were constrained to the municipal boundary of the Town of Edisto Beach obtained from the S.C. Department of Transportation (SCDOT). A digital elevation model (DEM) representing the land elevation of Edisto Beach was obtained from NOAA, which was created from a LiDAR survey flown in late December 2016. A mean higher high water (MHHW) surface was also obtained from NOAA and uniformly elevated in 6-inch increments up to a height of 6 feet above MHHW. Flood depth layers were then created by subtracting the DEM elevation from the elevation of each tidal surface created in the previous step. The result of that process was the height each flood surface reached above ground level. This is commonly referred to as a "bathtub model"[22]. These flood surfaces were then intersected with the assets as described below. Finally, the number of assets touched by each flood layer were quantified.

Asset Vulnerability Calculation: Property parcels for the year 2020 were obtained from Colleton County and were counted when the flood layer crossed the center of a parcel. Building footprints for the year 2016 were obtained from Kucera and were counted each time a flood layer touched any part of the building. Business data for the year 2020 were obtained from Colleton County as point data, which were joined to their corresponding building footprint, and then counted each time a flood layer touched any part of the building. Road data for the year 2021 were obtained from SCDOT representing the center line of each roadway across Edisto Beach. Roads were quantified as the total linear feet of roadway covered by each flood layer.