Agenda Item Summary

File ID: 21-0490 DEPT-6 **Meeting Date:** 3/23/2021

PLACEMENT: Departmental

TITLE:

SUMMARY OF THE RESILIENCE PROGRAM'S - SEA LEVEL RISE REPORT

EXECUTIVE SUMMARY:

County staff will present the Resilient Martin Sea Level Rise report. The report and PowerPoint presentation will be submitted as a Supplemental Memorandum to this Agenda Item.

DEPARTMENT: Public Works

PREPARED BY: **Name:** Kathy FitzPatrick
Title: Coastal Engineer

REQUESTED BY: Kathy FitzPatrick

PRESET:

PROCEDURES: None

BACKGROUND/RELATED STRATEGIC GOAL:

Martin County Public Works Department (PWD) is responsible for handling stormwater and drainage and responds to flooding events when they occur. It was the tracking and mapping of these events that first revealed the clustering of repeated flooding events, often adjacent to or near the County's extensive tidally influenced waterway system. It became apparent that these tidal waters were exhibiting impacts from increasing sea level. Using the data collected, the Public Works Department began to anticipate flooding events by tracking predicted high tide cycles, often referred to as King Tides. Surveys of these events indicate that flooding events have become more numerous, with a longer duration, and often more severe. Over the past 2 years dedicated survey crews have further documented this phenomenon at sentinel sites.

Based on the changing conditions documented with these observations, the Board of County Commissioners initiated resilience planning to expand the set of tools available to address these changing conditions. The County has been successful in obtaining grants from the state of Florida's Resilient Coastlines Program to conduct the studies and data analysis that are necessary to provide a sound basis for the County's resilience planning. This work dovetails with County's ongoing floodplain management, water quality efforts and environmental planning.

In addition to the work completed that has delineated priority areas most in need of resilience efforts, the resilience program, Resilient Martin, has launched a website and initiated efforts to

engage and inform the public about the County's efforts. A Facebook Live event in late 2020 received a high level of viewership and staff is developing other strategies to engage stakeholder groups in a two-way dialogue. Public involvement in the County program, along with increased understanding gained from data collection and technical analysis will advance the County's adaptive planning efforts, reduce flooding impacts and increase resilience. This established program will increase our ability to compete successfully for grant funding that can be used to support the targeted monitoring, data collection and analysis required for efficient planning and construction of adaptation and mitigation projects. Finally, the work has also increased the likelihood for an improved CRS score in the next review cycle (2021) and further reductions to local flood insurance rates.

The Resilient Martin Sea Level Rise Report identifies challenges facing the County, presents results from data analysis that shows expected impacts specifically from increased sea level and presents a wide array of recommendations for adaptation actions.

ISSUES:

Project prioritization and planning philosophies will require additional considerations that acknowledge expected changes and emphasize resilience. A structure to standardize adaptation measures in the development of County projects will be essential. Educational materials will need to be developed to engage the public and encourage their participation in adaptation activities. Additional data and analysis will provide necessary information on how stormwater networks are functioning and changes in groundwater levels will impact that function.

LEGAL SUFFICIENCY REVIEW:

To the extent this item contains legal issues; it has been reviewed for legal sufficiency, although this is primarily a matter of Board policy.

RECOMMENDED ACTION:

RECOMMENDATION

Receive the presentation on resilience efforts along with the Resilient Martin Sea Level Rise Report. Direct staff to:

1) Initiate the development guidance documents for adaptation action strategies that include but are not limited to:
   - Engineering standards for resilient project development
   - How to assess the viability of exfiltration trench/soil storage as water levels rise
   - Living shoreline/seawall design criteria for both internal use and for use by private property owners
   - Impacts to stormwater management as groundwater levels change
2) Initiate amendment(s) to the Comprehensive Growth Management Plan to improve resilience with emphasis on the Shoreline Protection Zone.
3) Include a resilience review for future Capital Improvement Projects that fall within the vulnerable areas as depicted in the SLR Report, using criteria that includes resilient engineering standards as they become available.

Move that the Board approve the Resolution to Initiate Text Amendments to the Comprehensive

Growth Plan.

ALTERNATIVE RECOMMENDATIONS

None

FISCAL IMPACT:

RECOMMENDATION

The fiscal impact will be staff time to work on the above recommendations as well as an estimated cost of $15,000 for a consultant to assist staff on Recommendation Number 2 if approved.

Funding Source	County Funds	Non-County Funds
Subtotal		
Project Total		

ALTERNATIVE RECOMMENDATIONS

None

DOCUMENT(S) REQUIRING ACTION:

☐ Budget Transfer / Amendment ☐ Chair Letter ☐ Contract / Agreement

☐ Grant / Application ☐ Notice ☐ Ordinance ☒ Resolution

☐ Other:

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Prepared By: Clyde Dulin
Martin County
Growth Management Department
2401 S.E. Monterey Road
Stuart, FL 34996

BEFORE THE BOARD OF COUNTY COMMISSIONERS
MARTIN COUNTY, FLORIDA

RESOLUTION NUMBER 21-

A RESOLUTION OF MARTIN COUNTY, FLORIDA, TO INITIATE TEXT AMENDMENTS TO THE COMPREHENSIVE GROWTH MANAGEMENT PLAN

WHEREAS, a Sea Level Rise Report was presented to the Board of County Commissioners on March 23, 2021 and the report contained a vulnerability assessment and recommendations for responses to Sea Level Rise; and

WHEREAS, the Report recommends developing programs that help property owners adapt their properties and mitigate future flood risk; and

WHEREAS, Shoreline Protection Zone policies in the Comprehensive Growth Management Plan may conflict with Sea Level Rise mitigation along the rivers and canals; and

WHEREAS, the Martin County Comprehensive Growth Management Plan, Section 1-11, Amendment Procedures, states that the Martin County Board of County Commissioners may, by resolution, initiate a request to amend, modify, add to, or change the Comprehensive Growth Management Plan.

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF COMMISSIONERS OF MARTIN COUNTY, FLORIDA, THAT:

The Martin County Board of Commissioners herein initiates a Comprehensive Plan Text Amendment to Chapter 8, Coastal Management Element of the Martin County Comprehensive Growth Management Plan and any other Chapter of the Plan necessary to maintain internal consistency.

DULY PASSED AND ADOPTED THIS 23th DAY OF MARCH 2021.

ATTEST:

BOARD OF COUNTY COMMISSIONERS
MARTIN COUNTY, FLORIDA

_____
CAROLYN TIMMANN,
CLERK OF THE CIRCUIT
COURT AND COMPTROLLER

BY:_____
STACEY HETHERINGTON, CHAIR

APPROVED AS TO FORM
AND LEGAL SUFFICIENCY

BY:_____
SARAH W. WOODS,
COUNTY ATTORNEY

SEA LEVEL RISE REPORT

2021 IMPACT & ANALYSIS

TABLE OF CONTENTS

ABBREVIATIONS

AAA ..... Adaptation Action Area

Compact ..... Southeast Florida Regional Climate Compact

CRS ..... Community Rating System

DEP ..... Florida Department of Environmental Protection

FEMA ..... Federal Emergency Management Agency

GIS ..... Geographic Information Systems

GHG ..... Greenhouse Gas

IPCC ..... Intergovernmental Panel on Climate Change

MHHW ..... Mean Higher High Water

MLW ..... Mean Low Water

MSL ..... Mean Sea Level

NASA ..... National Aeronautics and Space Administration

NFIP ..... National Flood Insurance Program

NIBS ..... National Institute of Building Sciences

NOAA ..... National Oceanic and Atmospheric Administration

NOS ..... NOAA's National Ocean Service

NTDE ..... National Tidal Datum Epoch

RCP ..... Representative Concentration Pathway

SFWMD ..... South Florida Water Management District

SFHA ..... Special Flood Hazard Area

SLAMM ..... Sea Level Affecting Marsh Model

SLR ..... Sea Level Rise

SLR Report ... Resilient Martin Sea Level Rise Report, Impact & Analysis

USGS ..... United States Geological Survey

WMP ..... Watershed Management Plan

GLOSSARY

Adaptation (to climate change) The process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. Adaptive capacity is the ability to make these adjustments.

Anthropogenic
Environmental change caused or influenced by people, either directly or indirectly.[i]

Assets
People, resources, ecosystems, infrastructure and the services they provide. Assets are the tangible and intangible things people or communities value.[ii]

Bathtub Method/Model
The projected sea level rise at a point in time is added to the current water elevation and overlaid on the existing topography to identify inundated areas.

Climate change
The increasing changes in the measures of climate over a long period of time – including precipitation, temperature and wind patterns.[iii]

Exposure
The presence of people, assets, and ecosystems in places where they could be adversely affected by hazards.[iv]

Global warming
The rise in global temperatures due mainly to the increasing concentrations of greenhouse gases in the atmosphere.[v]

Hazard
An event or condition that may cause injury, illness or death to people or damage to assets.[vi]

Hazard mitigation
When used by the Federal Emergency Management Agency (FEMA), the effort to reduce loss of life and property by lessening the impact of near-future disasters.

IPCC AR5 RCP 8.5 scenario
This condition (known as a representative concentration pathway or RCP) for the concentration and trajectory of greenhouse gases was developed and intended by members of the Intergovernmental Panel on Climate Change (IPCC) to be a "very high baseline emission scenario" representing the 90th percentile of the volume of emissions that could occur in various future years if society does not make efforts to reduce greenhouse gas emissions. It is a "business as usual scenario."

Reference: https://www.carbonbrief.org/explainer-the-high-emissions-rcp8-5-global-warming-scenario

Impacts
Effects on natural and human systems that result from hazards. Evaluating potential impacts is a critical step in assessing vulnerability.[vii]

King Tide
A non-scientific term describing an especially high tide caused by alignment of the gravitational pull between the sun and moon. A King Tide usually occurs three to four times a year.

Mitigation (of climate change)
A human intervention to reduce emissions or enhance the sinks of greenhouse gases.[viii]

Projections
Potential future climate conditions calculated by computer-based models of the earth system. Projections are based on sets of assumptions about the future (scenarios) that may or may not be realized.[ix]

Relative Sea Level Rise
The way the height of the ocean rises or falls relative to the land at a particular location.

Resilience
The capacity of a community, business or natural environment to prevent, withstand, respond to and recover from a disruption.[x]

Risk
The potential total cost if something of value is damaged or lost, considered together with the likelihood of that loss occurring. Risk is often evaluated as the probability of a hazard occurring multiplied by the consequence that would result if it did happen.[xi]

Scenarios
A set of assumptions about the future regarding the level of mitigation efforts and other physical processes that have a level of uncertainty.

Sea Level Rise (Absolute Sea Level Rise)
The height of the ocean surface above the center of the earth, without regard to whether nearby land is rising or falling.

Sensitivity
The degree to which a system, population or resource is or might be affected by hazards.[xii]

Uncertainty
A state of incomplete knowledge. Uncertainty about future climate arises from the complexity of the climate system and the ability of models to represent it, as well as the inability to predict the decisions that society will make.[xiii]

Vulnerable populations
Vulnerable groups of people include those with low income, some communities of color, immigrant groups (including those with limited English proficiency), Indigenous peoples, children and pregnant women, older adults, vulnerable occupational groups, persons with disabilities and persons with preexisting or chronic medical conditions.[xiv]

Vulnerability
The propensity or predisposition of assets to be adversely affected by hazards. Vulnerability encompasses the degree of exposure, sensitivity, potential impacts and adaptive capacity.[xv]

Vulnerability assessment
A process for identifying who or what is impacted by climate change. It is the combination of exposure, sensitivity and adaptive capacity.

EXECUTIVE SUMMARY 01

INTRODUCTION

Climate change is a global issue with long-term implications, especially for coastal communities like Martin County. Compelling scientific evidence shows trends in rising amounts of greenhouse gases (GHG) in the atmosphere, resulting in increasing temperatures, warming seas, shrinking ice sheets and increasing ocean acidification. These conditions will increase in intensity and frequency until they are effectively addressed. The alternative is an even more chaotic future. The trend toward changing conditions creates a story of extremes that chronicles the dangerous occurrences of prolonged drought, intense storm events, flooding and storm surge, prolonged periods of punishing high or low temperatures and rising sea level. It is the point where these conditions intersect, that presents the greatest amplification of impact and the daunting challenge to coastal communities preparing for a future affected by climate change. If we have learned one thing from the global pandemic, it is that we must prepare for external shocks. But we have also learned that with proper planning we can build effective strategies.

"Resilient Martin" (RM) is a program established by Martin County to identify and address these future climate threats to both the natural and built environments. The RM program provides a coordinated and multidisciplinary approach to climate change resilience that can be clearly communicated to the public. As an initial step, this Sea Level Rise (SLR) Impact & Analysis Report (SLR Report) has been developed to review and analyze existing County technical data, identify data gaps and provide recommendations for data acquisition, adaptation steps and policy development.

The work summarized in this SLR Report begins a centralized effort to deliver the changes needed to respond and adapt to the impacts we cannot avoid, and build a cleaner, healthier, more resilient economy that adds value to the entire community. The SLR Report is a stepping stone in the RM program's path, building upon efforts already initiated by the County and other entities.

THE THREATS

Martin County has many miles of ocean, estuarine and freshwater coastlines and marsh habitats, as well as constructed infrastructure and natural uplands that are fundamentally at risk from climate change. The County's infrastructure and natural resources serve the community needs and provide important resilience functions that stand to be impacted by future SLR and climate variability. These areas also pose significant concerns for long-term floodplain management.

The County has already begun to see the impacts from SLR and unpredictable weather patterns. This is manifested in nuisance flooding that is increasing in frequency and severity, extreme coastal erosion, recurring drainage issues, water quality degradation, ecosystem shifts and health impacts from vector-borne and heat-related illnesses. The SLR Report provides a vulnerability assessment and recommendations for actions that address sea level rise related issues including storm surge, king tides, elevated groundwater and saltwater intrusion. These issues are compounded by expected increases in extreme precipitation events that can result in flash flooding and acute stormwater runoff. More specifically, the County will need to formulate actions to address climate risks in identified vulnerable sectors such as critical facilities, land use, transportation and utilities, through modeling and mapping. This report is the first step in a process of adaptation and a more resilient Martin County

RESILIENCE PLANNING

Building resilience is crucial for ensuring the long-term viability of our county and health of our residents. Resilience planning provides the opportunity to develop actionable measures that can include updating land use codes, zoning, development standards, and other plans or policies to better withstand for predicted changes. The basic steps in resilience planning include: 1) identify challenges, 2) obtain and analyze best existing data, and identify additional data needs, 3) recommend optimized actions and 4) develop a timeline for implementation of the selected action. This report addresses steps 1 and 2, initiates step 3 and sets the stage for step 4.

Management decisions regarding the excessive water that comes with SLR and climate change are becoming increasingly more complex and far-reaching, and now include consideration of identified at-risk geographic areas and vulnerable populations. While the county is experiencing some SLR induced impacts, our higher land elevation is a benefit compared to lower lying communities to our south where immediate action is necessary. This means there is time to plan for cost-effective responses to expected impacts that will provide long-term savings to the County. For example, the National Institute of Building Sciences (NIBS) found that every $1 invested in disaster mitigation saves $6 in recovery costs.

Martin County has the ability, and a demonstrated desire, to plan more resiliently for the future. This is evidenced by the work performed to produce a critical SLR vulnerability assessment that was completed between 2018 and 2020 and drew upon information developed regionally coupled with other sound scientific data. It was fine-tuned to also address the new SLR criteria in FEMA's National Flood Insurance Program (NFIP), specifically the Community Rating System (CRS). The assessment also evaluated local infrastructure and assets and natural resources and businesses, while overlaying climate scenarios to identify impact areas. The results provide a better understanding of current vulnerabilities to SLR and help identify where more analysis is needed for better adaptation planning, all with the goal of creating a more resilient community.

After identifying vulnerabilities to the natural and built systems, the SLR Report focuses on strategies to reduce the effects of SLR, the most immediate climate issue facing the County. The wide range of information available allowed the County to undertake an extensive modeling effort analyzing future SLR impacts, however, more information and analysis will be necessary to fully understand the broad implications for the County. The relationship between SLR, precipitation and groundwater is one area requiring further investigation because sufficient data was not available for the analysis completed to date. However, ongoing work at the County level and at a regional level through a partnership between the SFWMD and USGS may provide new insights into this important element in resilience planning. More observations, modeling, qualitative and quantitative data and information will be needed to continue to adapt to a changing reality. This work will help to quantify the qualitative data we have showing an increase in the number and magnitude of episodic flooding events that appear to produce the same daily high tide scenario expected in the 2050-2060 timeframe. King Tides, storm surges and rainstorms will amplify the flooding and must be anticipated in future plans.

Future success in implementing the SLR Report recommendations will depend on a variety of factors. The solutions may include infrastructure maintenance and improvements, water management plans and environmental restoration of natural areas, as well as integration of adaptation elements into capital project design, revised building codes and development regulations that account for future flood risk. A direct outcome of the SLR Report development is the recognition of the added value from integrated County project management, collaboration and communication. Similarly, the County, business owners and residents must become part of the process to develop a joint response to these threats for the common good.

County staff needs to assess the current organizational structure before and during implementation to ensure a free flow of information and identify a decision-making hierarchy. Funding options for the proposed actions will need to be identified and regular hazard monitoring will be required to ensure the SLR Report is responsive to changing climate impacts. Because implementation presents a long-term challenge, periodic internal coordination along with updates to the County Commission on progress will be necessary. The County must act now to implement adaptation measures while there is still time to plan for a resilient future.

BACKGROUND 02

MARTIN COUNTY, FL

Martin County is located on the east-central coast of Florida. The Atlantic Ocean borders the county to its east, offering 21 miles of sandy coastline along two barrier islands separated by the St. Lucie Inlet. The northern barrier island, Hutchinson Island, extends from the borders of Martin and St. Lucie counties 7 miles south to the St. Lucie Inlet. The southern barrier island, Jupiter Island, extends from the St. Lucie Inlet 14 miles south to the Martin County/Palm Beach County line. Lake Okeechobee sits on the county's western border. The St. Lucie Canal, an artificial structure built to connect Lake Okeechobee to the St. Lucie River Estuary, moves forced discharges from Lake Okeechobee through the St. Lucie River, into the estuary and finally into the ocean at the St. Lucie Inlet. (Figure 1)

While the county occupies a total land area of 543.46 square miles,[xvi] the majority of its 160,000 residents, and almost all of its built environment, is clustered near the inland shorelines and ocean. These inland waterways include properties along the Indian River Lagoon, St. Lucie River, Manatee Pocket, Loxahatchee River and multiple rivers and creeks that provide 113 miles of shoreline. Martin County's strict growth management and conservation principles have resulted in a large percentage of publicly held, undeveloped land along and adjacent to many of these waterbodies.

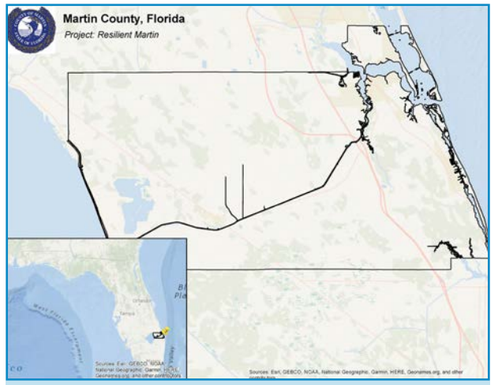


Figure 1: Location map

CLIMATE SCIENCE THE BIG PICTURE

The growing concentration of GHGs, including carbon dioxide, methane and nitrous oxide, in the atmosphere have resulted in an accelerated change in climate. GHGs in the atmosphere function as a heat trapping mechanism that is necessary to maintain the warmth required to sustain life. However, with ever increasing amounts of GHGs being released, they are capturing more and more of the heat before it can be reflected back into space, increasing the temperature on the earth's surface to dangerous levels. (Figure 2) In fact, more than half of all anthropogenic (originating by human activity) carbon dioxide emissions have occurred since 1990, retaining increasing amounts of heat within the atmosphere and resulting in these increased temperatures. [xvii] According to the Intergovernmental Panel on Climate Change (IPCC), during a period of nearly 200 years, human activities caused approximately 1.0°C of global warming above pre-industrial levels (years 1720-1800[xviii]), already resulting in harmful effects. Currently the world is on track to increase in temperature by an additional 50% in just 50 years or less, reaching 1.5°C of warming if the trend continues unabated.[xix] There is clear evidence of accelerating global temperature increases (2015-2018 warmest years on record), the rate and amount of sea level rise, shrinking sea ice, glacier mass loss and extreme weather events such as heatwaves as a result.[xx]

In resilience terminology, mitigation is a term that refers to actions that reduce GHGs like carbon dioxide to slow impacts related to climate change. In contrast, adaptation is the process of making adjustments to accommodate expected changes. Continued emission of GHGs will cause further warming and long-lasting changes in all aspects of the climate system. Limiting the impacts that society experiences from climate change will require substantial and sustained changes in day-to-day life. Reductions in GHG emissions from mitigation actions such as more fuel-efficient vehicles, sustainable building practices and changes to agricultural and ranching practices can limit climate change risks and exposure. The inherent uncertainties of human actions make absolute predictions of mitigation activities and the resulting effects on climate impossible, and lead to the range of potential climate responses and the corresponding SLR projections that guide adaptation planning.

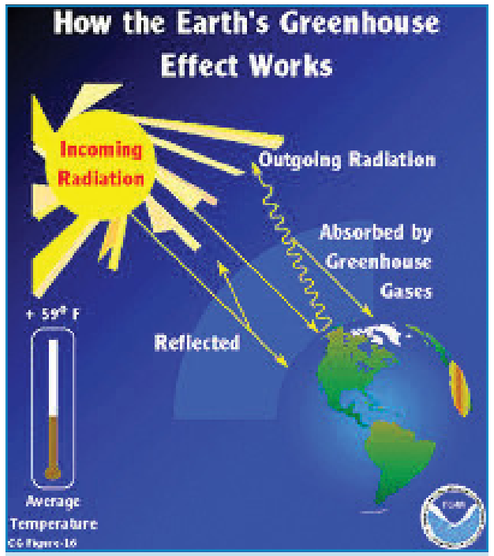


Figure 2: Global monitoring Laboratory, Earth System Research Laboratories www.esrl.noaa.gov/gmd/education/lesson_plans/

The surface temperature of the earth is projected to continue an accelerated increase during the 21st century, altering the climate that exists today. Evaporation increases as the atmosphere warms, which in turn increases humidity and the average rainfall amount. To that point, from 1958 to 2016 heavy rainfall events have increased in the northeastern states by 55 percent,

IMPACT ON NATURE

The rate of climate change may become the predominant impact for biodiversity, potentially leading to more species extinctions and widespread changes to ecosystems, particularly where "the rate of change is too fast and overwhelms the capacity of current ecosystems to adapt (Steffen et al. 2009)." Nearly one quarter of the approximately 1,200 species tracked by the Florida Natural Areas Inventory are projected to lose at least 50% of the area where they live to a sea level rise of 1 m by the year 2100. The greatest threat to species is anthropogenic habitat loss (Benscoter et al. 2013), but combined effects from threats of climate change are especially dangerous for many species. Some species will be unable to relocate due to lack of suitable habitat or anthropogenic barriers obstructing their movement, a study (Noss et al. 2014) found that 76% of 236 species threatened by sea level rise would be unable to relocate further inland. While climatic changes will lead to contraction of the range of some species, these same changes could lead to the range expansion of other species, particularly non-native, invasive species.

midwestern states by 42 percent, and southeastern states by 27 percent.[xxi] Alternatively, warming temperatures and changing precipitation patterns can also lead to droughts. NASA research shows that humans have been influencing global patterns of drought and precipitation for nearly a century. Heat waves will be more extreme and last longer. The ocean will continue to warm and acidify, and global mean sea level will continue to rise. Climate change has differential impacts on coastal ecosystems, freshwater wetlands and upland ecosystems. Coastal ecosystems are subject to the "squeeze" effect when they are located between the barriers presented by development, and inundation and flooding from rising sea levels. These habitats become flooded over time and are blocked from migrating inland by development. Plants and animals have diminishing areas to live, move and survive.[xxiii] Species migration and trends toward extinction from changing habitats and ecosystems will be an expected but unwelcome result of these shifts.[xxiv]

Climate change not only threatens our communities, ecosystems and lifestyle, but also poses risks to our economic sustainability. The climate crisis will only amplify economic trends of heightened risk and cost, economic instability, healthcare pressures and food scarcity. These risks are occurring in all countries but tend to be unevenly distributed and are generally greater for people in underdeveloped countries.[xxv] It has also increased global inequality as a result of economic declines in hotter, poorer countries and increases in cooler, wealthier countries.[xxvi]

Observed impacts due to climate change are occurring now and must be addressed to maintain the day-to-day functions of society. Extreme weather events will only get more frequent as warming continues – not heading toward a new, stable level of activity, but rather tipping further into chaos.[xxvii] Although mitigation options are a key element of a climate change strategy, a review of those options was not within the scope of work presented in this report.

CLIMATE CHANGE IMPLICATIONS TO COASTAL FLORIDA

There are indications everywhere that Florida's climate is changing. For example, mangroves are extending their range further north, tropical species are appearing in subtropical zones and mobile species are migrating north, following cooler water and air temperatures. Regionally, in the coming decades, rising temperatures will increase sea levels, increase storm damages, threaten entire ecosystems on land and water and increase the frequency of dangerously hot days.

According to the U.S. Environmental Protection Agency[xxviii], projected impacts for Florida and our region include:

- **Rising Seas and retreating shores.** Sea level along the Florida coast is projected to rise one to four feet in the next century. Rising sea levels will submerge existing wetlands and dry land, accelerate beach erosion and exacerbate coastal flooding.

- **Flooding from storms impacting homes and infrastructure.** Warming oceans provide tropical storms and hurricanes with more energy. While scientists do not have conclusive evidence that recent intensification reflects a long-term trend, we do know that storms, including destructive precipitation events, are more intense than in the past and are projected to increase.[xxix] Both the built and natural environment in Florida are vulnerable to the impacts of stronger storms and accelerating sea level rise. More intense or more frequent rainstorms can increase the likelihood of flooding from a combination of rainfall, sea level rise and the eventual increase in groundwater level. (Figure 3) This Image, produced by Miami-Dade County in its *2018 Septic Systems Vulnerable to Sea Level Rise Report*, shows how future sea level rise will impact groundwater in that region. The land will become saturated much more quickly and stormwater pipes may be unable to drain because they are submerged. Increasing numbers of coastal homes and infrastructure will flood more often as storm surge and extreme tides add to the rising sea level. This is likely to increase the number of homes and businesses that are found in the general floodplain and Special Flood Hazard Areas.[xxx] As a result, property owners can experience rising insurance rates, or perhaps the inability to get insurance at all, in response to these changes. It has also been speculated that 30-year mortgages will be increasingly difficult to obtain.

- **Changes to marine ecosystems.** Florida's coral reefs are susceptible to climate change effects such as warming ocean water, increasing land-based pollution, rising sea levels and ocean acidification. Corals receive both their color and life sustaining energy from algae, zooxanthellae, that lives within it. Stressful conditions caused by climate change, such as warming seas, degraded water quality in our estuaries and near shore areas , due in part to impaired fresh water discharges and other Central and South

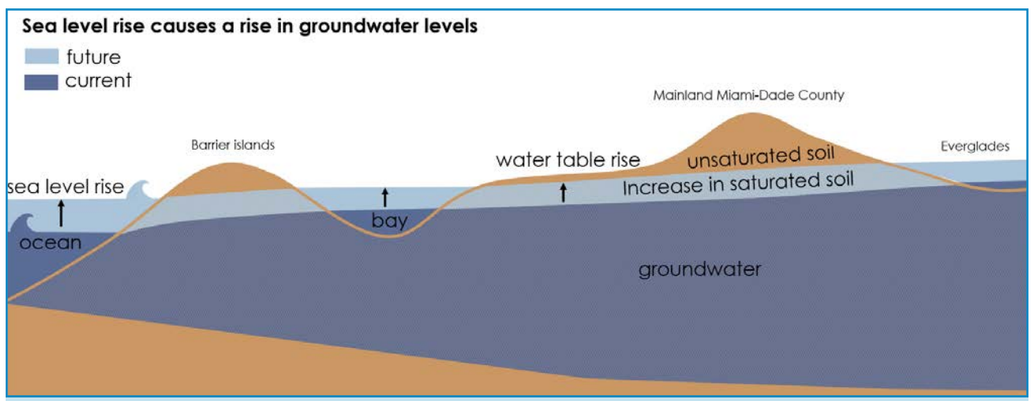


Figure 3: Future Sea Level Rise

WATER MANAGEMENT IN SOUTH FLORIDA

The C&SF system was constructed in the 1940s as a series of canals, levees and pumping structures to move inland water from wetlands and swamps out to the ocean. Lake Okeechobee is the center of the C&SF system and is regulated to accommodate inflow of stormwater runoff from the north and water supply needs to areas around and south of the Lake. As weather patterns have changed incrementally, a pattern is slowly emerging where extremes become the norm, the wet season is producing higher rain volumes and the dry season is becoming drier. The 1940s system used to manage water has not evolved with the changing precipitation patterns.

- **THE ESTUARY**
  The St. Lucie River and Estuary in Martin County acts as a relief valve, shunting damaging waterflows from the Lake when water levels reach certain established levels. Without an evolved regulatory framework to meet the needs of these spikes in precipitation, the waterways within Martin County will continue to decline. These forced discharges not only impact the estuary but also interact with the near shore reef tract in the Atlantic Ocean. The high volume of fresh Lake water discharged into Martin County to maintain lake levels disrupts the saltwater ecosystem balance and has in the recent past contaminated the ecosystem with other pollutants contained in the discharged lake water.

- **THE EVERGLADES**
  The Everglades are vulnerable to both changing climate and rising sea level. Human activities have diverted the natural flow of water away from the Everglades and directed it east and west out of Lake Okeechobee. Restoration of the historical southward flow of water is crucial to the health of the northern estuaries and also for the success of integrated water management strategies in their effort to prevent further saltwater intrusion from occurring in the region.

  Much of the Everglades is less than three feet above current sea level. The rising sea may submerge the low-lying portions of the ecosystem, further inhibiting drainage patterns, and push further inland or upstream into the Everglades. This shift would allow salt-tolerant species like mangroves to spread inland invading and overwhelming cypress swamps and eliminating habitat for species that do not tolerate saltwater habitats. Increasing salinity may also threaten the quality of our aquifers, which are the primary sources of drinking water for South Florida.

Florida (C&SF) system canals and increased acidity from rising CO2 levels, cause the corals to expel the algae and turn white, a process known as “bleaching.” This signifies a weakened state the corals can recover from if conditions return to acceptable levels. If conditions do not improve the coral will eventually die. Loss of coral reefs is important to our economy because they provide critical habitat and food source for a diverse range of commercially and recreationally important species as well as shoreline protection during storms and marine life that produces lifesaving pharmacological products. Harmful algal blooms are linked to warming waters and increased stormwater runoff, both climate change effects, and it appears that the outbreaks in our communities are becoming more acute. Changes to our marine ecosystems are also demonstrated by recent fish kills in Biscayne Bay, which researchers believe have occurred because the bay’s saltwater became so hot, it could no longer retain oxygen in the amounts necessary for marine life to thrive.[xxxii]

- **Impacts to water resources, habitat and the Everglades.** Our changing climate is likely to increase the need for water to support agricultural and residential irrigation, ranching and increasing human consumption by a growing population. Hotter air temperatures increase the rate of evapotranspiration, the combined rate at which water is lost through plant hydration and evaporation. The total demand for water is likely to increase more than 25% during the next half century. This will make it even more important to manage water supply resources carefully and find ways to capture and retain stormwater as it occurs.

- **Compromising human health.** The onset of the COVID-19 epidemic has demonstrated how important it is to maintain the highest possible resilience in the human population, to better fend off disease. Hot days can be unhealthy—even deadly. Certain populations, including children, the elderly, the sick and the poor, are especially vulnerable. High air temperatures can cause heat stroke and dehydration and affect human cardiovascular and nervous systems. According to EPA, by 2086 temperatures in most of the state are likely to rise above 95°F between 45 and 90 days per year, compared to less than 15 days per year today. Higher humidity will further increase the heat index and associated impacts on health. Air conditioning once thought of as a luxury will become essential, especially for the homebound, but may be cost prohibitive for some. Increased air conditioning creates a feed-back loop where more fossil fuels are burned to generate electricity which in turn heats the air, increasing the need for air conditioning. Warmer air can also increase the formation of ground-level ozone which has a variety of health effects, aggravates lung diseases such as asthma and increases the risk of premature death from heart or lung disease. As the climate changes, continued progress toward clean air will be more difficult. Standing water caused by increased precipitation and/or drainage systems that are compromised by SLR provide a breeding habitat for mosquitos in Southeast Florida. Recent outbreaks of Dengue Fever,[xxxiii] a dangerous mosquito or vector-borne disease, have further highlighted the tie between climate change and disease.[xxxiv]

- **Importance of natural environment.** The local climate experiences periods of extended drought and water shortages, intense rain and flooding and hurricane force winds and storm surge. Natural areas provide buffers during storms and wetlands absorb excess storm water during extreme precipitation events. These vegetated spaces also allow for aquifer recharge, absorbing excess rainwater and storing it for use later. Green spaces lower the air temperature and can be an important tool in “heat island” areas. The County has invested significantly in environmental conservation and restoration efforts through strong regulations, capital projects and innovative water quality improvement projects.

Understanding the facts about climate change impacts to the local community is a critical first step when formulating corrective action. Understanding the way that multiple factors can coalesce to intensify storm damage is essential when formulating an effective adaptation strategy. The SLR Report was developed to address these impacts and begin the discussion of what the County will do to prepare for a changing future.

THE SLR REPORT DEVELOPMENT PROCESS 03

VISION, GUIDING PRINCIPLES AND GOALS OF THE RESILIENT MARTIN PLAN

The vision of the Resilient Martin Plan is that Martin County will be an innovative leader by proactively planning for community resilience to the challenges posed by sea level rise based on a data-driven and transparent process. The County will collaborate with federal, state, regional and municipal partners. Our community members will be a vital part of this ongoing process as well.

Guiding principles are committed to sound science and data with continued transparency. Those principles include the following:

- Implement recommendations through a process that is integrated with cross-disciplinary planning and project development
- Communicate with residents and business owners to provide discourse about projected impacts, County response plans and areas of shared responsibility across the community
- Create and leverage partnerships with state and federal agencies, other local governments, non-governmental agencies and community stakeholders to build broad adaptation planning efforts across the region
- Build and maintain quality data and information systems to respond to climate change

The County's resilience efforts to date have been based upon best available information and have provided important empirical information the County can incorporate into its decision-making. This initial work is meant to evolve— responding to and incorporating new data and analyses over time. Preparing for a future that is inherently uncertain will require a continual review-assess-update process. Four goal areas are established in the SLR Report to address these issues:

1) County Assets & Infrastructure: Build upon the County's technical vulnerability assessment to provide relevant and actionable information as a basis for sound fiscal and policy decisions.

2) Land Development: Ensure development decisions incorporate future risks and vulnerabilities.

3) Natural Resources: Harmonize water management, water quality and natural systems planning to protect resources.

4) Socioeconomics: Create pathways for two-way communication with the community on its resilience planning efforts and gather information to address perceived needs.

RESILIENT MARTIN GRANT FUNDING

The goals of the Florida Department of Environmental Protection's (FDEP) new Resilient Coastlines program aligned well with the foundational work required to establish the County's Resilient Martin program. Grant funds through this program were awarded in 2018 and again in 2019 and supported the initial data collection, data gap analysis, extensive asset mapping, SLR vulnerability assessment, examination of the County's CRS program, SLR vulnerability modeling and development of outreach materials.

Focused work on SLR was initiated in 2018 in conjunction with the broad SLR policy framework previously created within the Coastal Management Element of Martin County's Comprehensive Growth Management Plan. The first step in the SLR Report development process was to gather existing data sets and create a base of information. It was then possible to build a composite series of advanced digital maps that included County assets and infrastructure. Map series were broken down by infrastructure type: critical facilities, potable water, transportation network, stormwater and sanitary sewer. This approach used water levels from the SLR projections to determine potentially inundated areas along with the corresponding amount of risk to the facilities located within them. These are essential, but initial, tools that enable the County to identify general "hotspots" deserving closer inspection for potential resilience projects.

In 2019, the FDEP Office of Resilient Coastlines funding continued to support the County's efforts to develop the basis for a comprehensive adaptation strategy. The new work included a vulnerability assessment, review and development of new SLR related CRS activities along with a resident engagement program and adaptation recommendations. The modeling work from this effort is reflected in both the SLR Report and the economic analyses included within the plan.

MARTIN COUNTY PARTICIPATION IN FEMA'S CRS PROGRAM

During the process of future-risk planning, projects containing common elements can be identified and aligned, creating multiple benefits for the community through a single effort. One such opportunity incorporated into this assessment involved linking the County's climate risks to a FEMA risk mitigation program – the CRS. Addressing SLR activities is a relatively new element within the national CRS program and acknowledges the financial and societal benefits realized through effective disaster preparation. (Figure 4). A faster return to pre-disaster conditions has sociological and psychological benefits. Therefore, FEMA has created the CRS program that offers tangible benefits to local governments that conduct a vulnerability assessment addressing specified criteria.

240 Florida Communities Participating in CRS		
CRS Class	Total Communities	Percent Discount
9	13	5%
8	43	10%
7	75	15%
6	69	20%
5	38	25%
4	1	30%
3	1	35%

Figure 4: CRS Communities in Florida

The CRS program "rewards" local governments that enhance their floodplain management strategies through a myriad of approaches including regulation, public information, data collection and management and planning. The CRS was designed to help local governments meet a central goal: improving information, planning and regulation related to flood risk.

Achieving these goals will benefit the community by simultaneously saving money and becoming safer and more resilient.

Upon review of the County's current CRS activities, the development of a Watershed Management Plan emerged as an activity that would both improve the County's CRS score and provide major benefits to the floodplain management program. Improving the County's current ranking of 6 to a CRS Class 5 will increase the average per policy savings to $92 annually. Policy holders in the SFHA will see an estimated savings of $181 and the total community-wide average savings would be over $1.4 million. Very few communities have been able to achieve this level of success in the CRS program in Florida.

By integrating a Watershed Management Plan into the SLR Report, the community will see tangible benefits in reduced insurance rates and increased resilience.

Linking resilience planning and CRS participation influenced the modeling approach. The SLR Report modeled two of the planning horizon years used by the Southeast Florida Climate Compact (2040 and 2070), but also included the year 2100 and storm surge conditions to adhere to the CRS watershed management planning criteria.

MARTIN COUNTY RESILIENCE WORKING GROUP

Throughout the development of the SLR Report, the County relied on the members of an established diverse internal working group to provide data, review and comment as the work progressed and assist with overall coordination. It was important to have this input while developing the recommendations in the SLR Report, given that all of the members will be involved in implementing the SLR Report. Additional departmental-specific meetings have been held throughout the planning process, focusing on obtaining additional data and better understanding specific programmatic issues. A key benefit from this broad-based participation was to gain information that allowed the recommendations to build upon existing efforts related to resilience, thereby reducing duplication and clarifying the feasibility of future actions.

OUTREACH

Outreach activities were initiated as the program took shape. A presentation on the progress of the Resilient Martin program was made to the community in two well received Facebook Live events and the recording is available on the Resilience webpage **(www.Martin.FL.US/Resilience)** where it can be viewed by interested persons any time. The County will seek continued opportunities to connect with stakeholders and have them actively participate in the resilience planning effort. A concerted effort must be made to understand and address the effect of coastal and inland flooding on more socially vulnerable residents by developing effective ways to engage these residents in a dialogue. With further work anticipated on the economic impacts of climate change, outreach will continue to be a high priority to communicate with, and receive feedback from, all sectors of the Martin County community.

OTHER RELATED ACTIVITIES TO RESILIENCE PLANNING

Martin County efforts to mitigate and reduce damage from floods or storms has been an ongoing process as evidenced by a number of hazard mitigation projects implemented in years prior to establishing a resilience program. With the refocusing on the broader concept of resilience planning, the County has also been able to compete more successfully in emergency response and adaptation grant programs. Some of these projects receiving federal funding through FEMA include:

- Restored and enhanced storm protection for an evacuation route at Bathtub Reef Beach through reconstruction featuring a wider berm and dune plantings.
- Elevated several houses in St. Lucie Settlement (following hurricanes in 2004), a community that is subject to substantial flooding. Typical flooding depths inside the homes prior to elevating the structures was 1-2 feet.
- Improved the drainage and elevated a portion of Southeast MacArthur Boulevard in 2005 to reduce the probability of flooding during storms.
- Repaired the Jensen Beach Causeway West Island and will construct hazard mitigation on the East Island by adding 295 linear feet of new rip rap and a 100-foot living shoreline for added storm and flood protection.
- Repaired damage to shoreline and other facilities at the Stuart Causeway East and West Islands, and added rip rap on the south shoreline of the East Island to reduce future storm damage.
- Constructed new shoreline armoring at Indian RiverSide Park to protect the historic structure and seawall at The Mansion at Tuckahoe.
- Repaired the shoreline at Rio Nature Park and added gabions along the bank to add protection from future storms.
- Replaced asphalt shingle roof with new metal roofs at the Pavilion and Hut Roofs location to improve resistance to future storm damage.
- Reconstructed the dock at Indian RiverSide Park using materials such as "fibergrate" and stronger pilings, and installed a gangway lift to raise the access ramp in high wave conditions.
- Submitted a grant application to fund home acquisition and drainage improvements on Merrit Way, Mockingbird, St. Lucie Settlement and in Hobe Heights.

The following presents the history of recent SLR project efforts.

PROJECT MILESTONES/TIMELINE

(Fall 2017)
Established an internal Martin County staff Resilience Working Group to coordinate project and planning efforts

(November 2018)
Received FDEP Resilient Coastlines Program grant funding for initial SLR vulnerability maps

(November 2018 - April 2019)
Developed SLR projections and initial SLR vulnerability maps

(Ongoing)
Mapping flooding complaints and identify chronic problem areas

(May 10, 2019)
Submitted final Resilient Coastlines report to FDEP

(August 2019)
Awarded FDEP Resilient Coastlines Program grant funding to develop a Resilience and Watershed Management Plan

(August 2019 - June 2020)
Developed Resilience and Watershed Management Plan

(October 2019)
Hosted NOAA's Adaptation Planning for Coastal Communities training

(October 2019)
Established king tide water elevation documentation program to survey flooding at specific, known vulnerable locations

(May 2020)
Released new Resilient Martin web page

(June 2020)
Conducted Resilient Martin Facebook Live events for the public

(September 2020)
Presented Martin County's Resilient Martin Sea Level Rise Summary Report to the Martin County Board of County Commissioners

REGIONAL SLR PLANNING AND POLICY

The state of Florida has over 1,350 miles of coastline that is integrally linked to the state's economy. Florida's coastline touches 35 coastal counties (including Martin County) containing 76% of Florida's population with $584 billion dollars in overall economic activity, which was 79% of the state's total economy (in 2012) [xxxv] While Florida's coasts are at risk due to storm events, the impacts from SLR are more widespread.

Laws and policies in Florida have been created to recognize the importance of proactive planning for future flood risk. In 2011 and again in 2015, legislation was passed that included permissive and mandatory provisions within the state's Growth Policy Act to address SLR planning.[xxxvi] Most recently in the 2020 legislative session, new requirements were signed into law mandating that construction projects utilizing state funds must conduct a sea level impact projection (SLIP) study to assess flooding, inundation and wave action. This requirement pertains to new coastal structures over the project's expected life or 50 years, whichever is less.[xxxvii] The tide is turning toward incorporation of climate change into local and state decision-making and risk planning.

Many local governments have already begun to plan for adaptation. In Southeast Florida, Monroe, Miami-Dade, Broward and Palm Beach counties formed a regional collaboration, known as the Southeast Florida Climate Compact (Compact) in 2009. The Compact has completed substantial work to understand the science related to SLR at the regional level through the development and updating of the "Unified SLR Projections (Figure 5)".[xxxviii] These projections for SLR represent potential future conditions calculated by computer-based models. The projections are based on sets of assumptions about the future (scenarios) regarding the level of mitigation actions and other potential conditions. They are estimates. Being the first regional collaboration in Florida to create such working relationships across county boundaries, the Compact has spurred other regional efforts in Tampa Bay, Southwest Florida and East Central Florida, among others. The value of this work is seen in the examples of local government policy and planning initiatives the Compact has produced. The work products and experiences of the Compact have been extremely valuable in the development of this SLR Report.

During a multi-year process that incorporated user feedback and new scientific information, the Compact periodically updated their projection estimates (originally created in 2011, updated in 2015 and 2019). This work was conducted by a group that included Compact staff along with other agency experts and is based on the most up-to-date, peer-reviewed literature and climate modeling data. The 2019 Compact projections represent estimates of SLR developed by the IPCC Fifth Assessment Report and NOAA.[xxxix] The projections account for physical processes such as the gravitational effects of ice melt, changes in ocean dynamics, vertical land movement and thermal expansion from warming of the Florida Current that produce regional differences in Southeast Florida's rate of SLR compared to global projections.[xl] The 2019 Compact projections show higher and faster SLR than previous 2015 Compact estimates. The SLR Report uses these projections to provide a foundation for the analysis performed.

Models for each of the projection curves assume different future conditions involving mitigation efforts and physical processes. (Figure 5) The 2019 projections utilize three curves to serve as guidelines for resilience planning, in descending projection order, the NOAA High curve, the NOAA Intermediate High curve and the curve corresponding to the median of the IPCC AR5 RCP 8.5 scenario. A fourth curve, the NOAA Extreme curve, is included to illustrate the possible upper limit of SLR in response to potential ice sheet collapse in the latter part of the century and is included for informational purposes. These projections start from "zero" in year 2000 and are referenced to mean sea level at the Key West tide gauge. SLR is projected to be:

- 10 to 17 inches by 2040
- 21 to 54 inches by 2070
- 40 to 136 inches by 2120 above mean sea level

The blue shaded zone between the IPCC median curve and the NOAA Intermediate High curve represents the generally recommended range of sea level elevations for use in planning most projects within a short-term planning horizon (up to 2070). A "range" is typically used for SLR projections, because there is some level of uncertainty regarding the future actions that will be taken globally to mitigate GHG emissions or melting of ice sheets. The NOAA Intermediate High Curve has been used as the conservative projection. That uncertainty increases further out in the projections, especially beyond the year 2070.

The County studied other SLR projections used by neighboring regions when selecting the appropriate set of projections for the SLR analysis. The Compact selected NOAA's projections. These were ultimately selected by the County for three principal reasons:

1) Martin County is within the jurisdiction of the same water management district – the SFWMD - as the four counties comprising the Compact (Monroe, Miami-Dade, Broward and Palm Beach).

2) Martin County shares similar geomorphology and wave energy with Palm Beach County, a member of the Compact.

3) The Compact has abundant historical data that has been well-developed and updated over time; this period of record provides high confidence in the Compact's selected SLR projections.

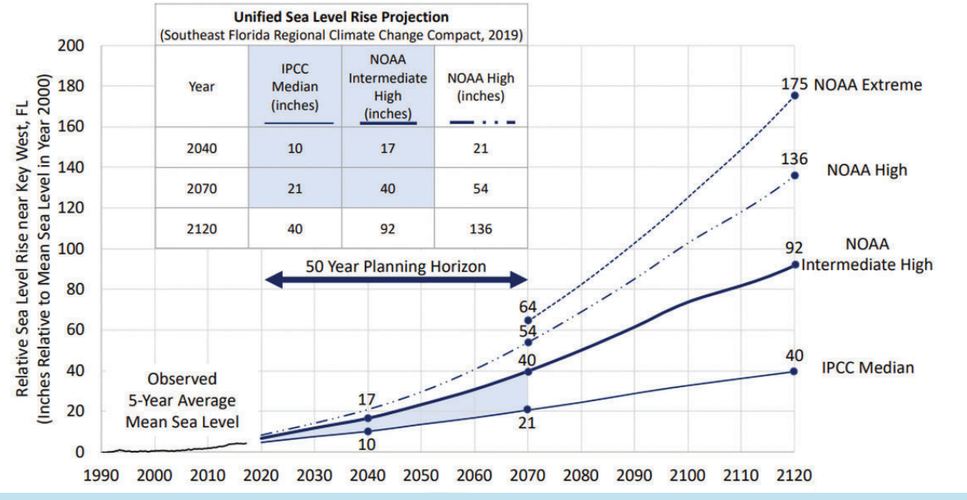


Figure 5: Southeast Florida Climate Compact Projections

STANDARDIZING SLR MEASUREMENT

Understanding trends in sea level, as well as the relationship between global and local sea level, provides critically consistent data about the impacts of the earth's climate on our oceans and atmosphere. Water level measurements at tide stations are referenced to stable vertical points (or benchmarks) on the land and a known relationship is established. But because the heights of both the land and the water are always changing, the land-water interface can vary and must be defined over time.[xli]

- **The Importance of Land Elevations.** Land elevations can change due to processes such as subsidence, glacial rebound or large-scale tectonic motion. Because of these changes, surveyors have established reference points, or datums, that allow them to measure the actual change in land and water elevations. A vertical datum is a surface of zero elevation to which heights of various points are referenced. The current vertical datum for the contiguous United States and Alaska is the North American Vertical Datum of 1988.

- **The Role of Sea Level Elevations.** Changes in global temperatures, hydrologic cycles, coverage of glaciers and ice sheets and storm frequency and intensity are examples of known effects of a changing climate, all of which are directly related to, and captured in, long-term sea level records. Sea levels also have some predictable cycles that must be accounted for so they are not incorrectly attributed to SLR. Average elevations like mean sea level (MSL) are determined by using the average of water levels during a lunar cycle (18.6 years). The term MSL can also refer to a tidal datum, or vertical reference defined by a specific phase of the tide. These phases of the tide are important for different reasons. For instance, mariners want to know how shallow the water will get, so the average of the lowest tides – mean lower low water (MLLW- the lowest high tide of the day) – is their preference. When looking at potential flooding impacts, the average of highest tide of the day is more important, so mean higher high tide (MHHW) is used.

- **The Relationship Between Land and Sea Level Elevations.** Depending on the rates of vertical land motion relative to changes in sea level, observed local sea level trends may differ greatly from the average rate of global sea level rise, and vary widely from one location to the next. By combining factors that contribute to local rates of relative sea level change, coastal managers and engineers can begin to analyze and plan for the impacts of sea level rise.

- **The Use of Local Information.** All tide stations express water levels like MSL relative to a datum so that they can be compared easily. "Relative Sea Level" trends account for both land and water elevation changes and therefore represent the changes observed by the public. For this reason, they are typically the most critical sea level trend for coastal applications. For this project, the Key West tide gauge (ID: 8724580) (Figure 6) was used because it has collected the longest continuous wave and water level data in our area. That is essential to understanding and factoring in sea level changes. NOAA's VDATUM tool (Figure 6) converts sea surface elevations between the various datums.

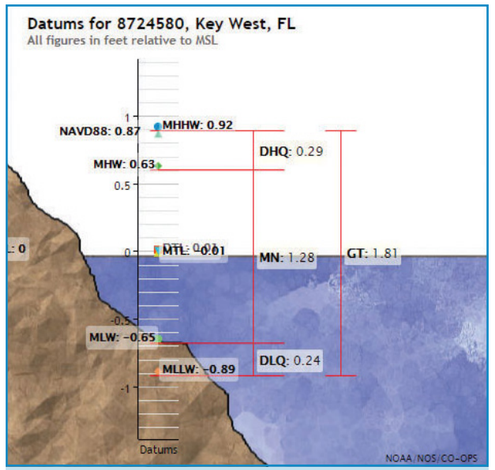


Figure 6: Key West Tide Gauge used in conversions between tidal datums

- **Tying it All Together.** The County's SLR vulnerability assessment combines County datasets with publicly available GIS data to identify and map the location and elevation of various elements like roads or storm drains. Water levels corresponding to the elevations predicted in the SLR projections are then overlaid onto the maps using the Bathtub Method. It is then possible to see where the water levels are projected to exceed the elevation of the land and various other map components like roads or drainage structures and makes it possible to identify vulnerable "hot spots."

While the SLR projections and water depths address the impacts to individual map features, the projections do not consider their interrelated function in the system they serve such as local stormwater capacity, functionality or drainage potential, or any specific floodproofing efforts. Additionally, the vulnerability assessment did not factor in ongoing capital improvement projects that will be designed to adapt and prepare for the impacts of SLR. The best any model can do is represent conditions at the specific point in time that was investigated. This is why new data must be collected and incorporated into the models on a regular basis, and adaptation plans modified based on updated results.

SLR VULNERABILITY ASSESSMENT MARTIN COUNTY 04

The goal of a SLR vulnerability assessment is to identify the geographic areas (hot spots) and infrastructure of a community that could potentially be damaged, compromised or inundated by rising sea levels. To systematically tackle an issue as complex as this, the County started with existing data, identified areas where more information was needed, searched out new data sources and then acquired the new data where available.

SLR impacts will take different forms, some easily quantifiable (example: area of impact calculations) and others only abstractly measurable (example: biological activity changes due to an increase in water level and a decrease in habitat). When the combination of impacts to natural areas, man-made infrastructure and various other socioeconomic factors are viewed together they present complex challenges and require innovative solutions. To start formulating a response, the County had to first understand what the future impacts (vulnerability) from SLR will be and where they will occur.

This section details the data and methodology used in the assessment, summary of results and modeling limitations. The County's initial work focused on mapping low lying zones of the county along with associated assets to identify potential "hot spot" areas in the future years (2040, 2070 and 2100). The vulnerability assessment for the next phase of analysis provided more detail by utilizing the model's analytic capabilities to assess functional impacts to individual components of County infrastructure.

Phase 1 (CM933)
Identify location and estimated ground elevation to identify vulnerable hotspots

Phase 2 (R1911)
Assess critical functional elevation points to determine when the system might fail.

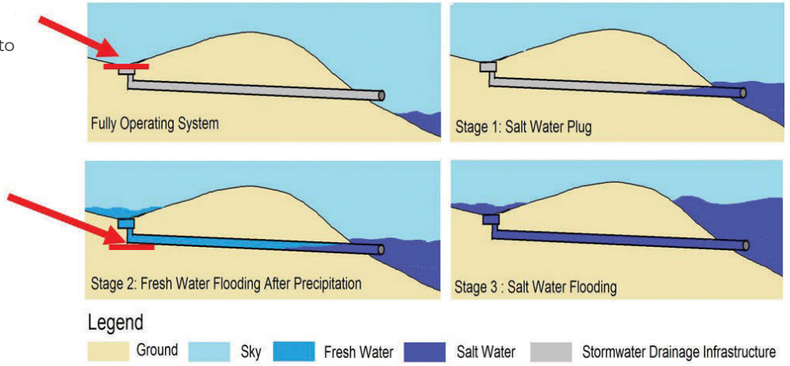


Figure 7: Stages of Stormwater Infrastructure Failure due to Sea Level Rise

Figure 7 illustrates the progression of the modeling output. In the first step, hot-spot areas and the infrastructure within them were mapped and analyzed using the average ground elevation. Moving to a more refined analysis in the next step, the specific elevation that controls infrastructure function was added to the analysis. The projected sea levels were then used to determine the operability of the system as those water levels rise.

The vulnerability assessment began by looking at the entire county and used a computer model to determine the areas that would be impacted by rising water levels in the ocean, estuaries, creeks and rivers. To do this the County used a proprietary modeling approach based on the "bathtub method" coupled with a comprehensive data set to conduct the vulnerability assessment. By using precise and accurate information such as building elevation certificates, road or stormwater structure elevations and locations of critical services, it is possible to predict the timeframe for impacts and determine the appropriate level of response. This analysis produced a series of impact maps that indicate projected SLR effects at certain times in the future. Not surprisingly, these impacts were concentrated within what can be defined as the "coastal zone" (area indicated in green in Figure 8, primarily located east of Florida's Turnpike and encompassing 165 square miles, however with the compounding effects of SLR, flooding outside of this zone can be expected to increase as water levels rise.

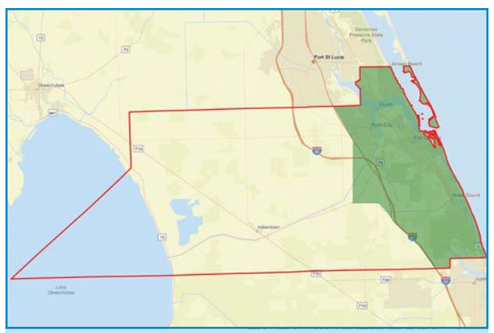


Figure 8: Coastal Zone

Finally, while the most extreme SLR projection has a low likelihood of occurrence, it is important to consider the possibility of that projected condition, one which could actually develop during extreme episodic events such as storm surges and King Tides. As explained earlier, the exact rate at which these changes will occur depends on society's unknown future mitigation response actions. Smart adaptation implementation provides useful improvements and employs "no regrets" strategies that make sense even if SLR slows. As stand-alone projects, they will still provide value to the community.

Moving forward, the County must take every opportunity to acquire more and better data, stay current on the science of SLR and projections and use this information to improve model output.

IMPACT SUMMARY BY SECTOR 05

GENERAL INUNDATION

Direct damage, impaired access or service interruption to homes, businesses, community facilities and their associated infrastructure represents a serious socioeconomic threat to the county. The inundation map series provides a good overview of projected flood water depth estimates across Martin County. The map series is only intended to provide a general estimate of water depths and show the overall trends and scale of potential impacts from SLR at the 2040, 2070 and 2100 timelines. Table 1 provides an approximation of vulnerable land area in the county (shown in square miles). Figure 9 provides an example map and legend for the predicted inundation impacts in the year 2070. This area represents the highest density of commercial and residential development in the County.

TABLE 1 : VULNERABLE LAND AREA AT MHHW

	Total Coastal Land Area
2040	7 square miles
2070	10 square miles
2100	20 square miles
2100 + 100 Year Surge	91 square miles

Table 1: Vulnerable Land Area at MHHW.

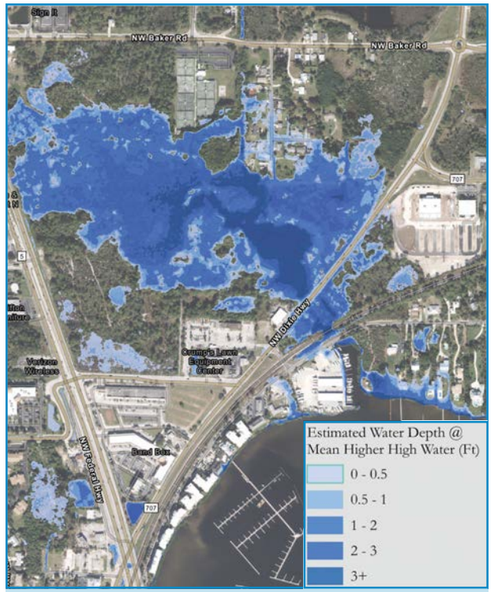


Figure 9: Example projected water depth mapping for NOAA Intermediate High at MHHW SLR scenario in 2070

FUTURE LAND USE

Existing and future land use planning efforts need to incorporate adaptation strategies to reduce future risk for residents and businesses. This process involves decisions about existing land use, potential future development activities and proper design for new development and redevelopment that can adapt to future climate conditions, specifically flood risk. Land use policies are an important avenue to creating a resilient Martin County.

The future land use map series presents an overlay of the estimated average water depth, which is represented in light blue to dark blue (minimal flooding to higher flood depths), and the County's standard land use classification system. An example County land use designation map, depicting predicted conditions in the year 2070 and using the NOAA Intermediate High (NIH) SLR projection, is shown in Figure 10. In total, 538 square miles of land are covered by this dataset. Figure 10 presents the physical area of land use (in square miles) impacted by SLR inundation and the percentage of total land use impacted for each category by the year 2070.

Figure 10: A representation of the water depth overlay for the NOAA Intermediate High 2070 condition and the land use designations.

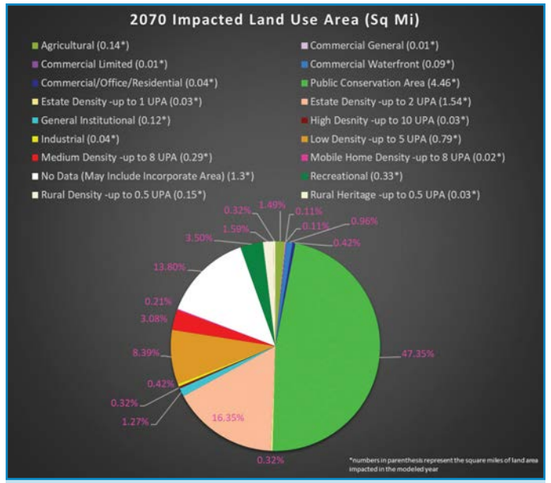


Figure 11: 2070 Impacted Land Use Area in Square Miles.

TRANSPORTATION

Martin County relies on a functioning transportation system with good roadway conditions to move people safely and efficiently around the county and to provide evacuation routes when conditions necessitate. The causeways provide a vital link between the barrier islands and the mainland. The transportation network includes numerous assets that are critical to the social, economic and physical well-being of our community, as well as emergency response. These transportation assets use the roadway system to connect the county to other services regionally and beyond, and they support vehicular movement, public transit, and bicycle/pedestrian paths. The roadway system's vulnerability to flooding from SLR and intensifying storm events not only puts these assets and access to them at risk, but also affects other sectors, amplifying socioeconomic and public health risks.

This vulnerability assessment map series highlights effects to roadway systems. Figure 12 below provides an example of how the impacts through time are displayed. Features such as roads, bridges, causeways and railroads were analyzed for inundation due to rising seas. Inaccuracy resulting from LiDAR processing may cause minor discrepancies near the landward extent of bridges and causeways.

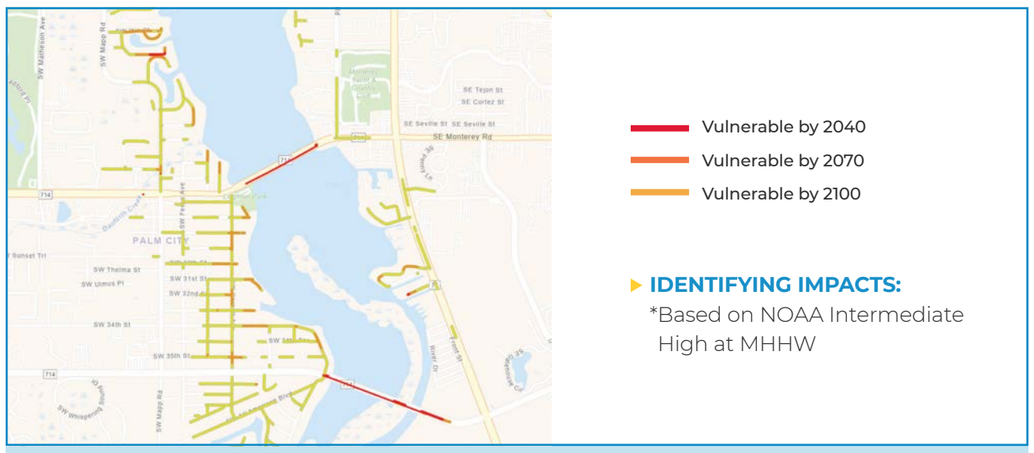


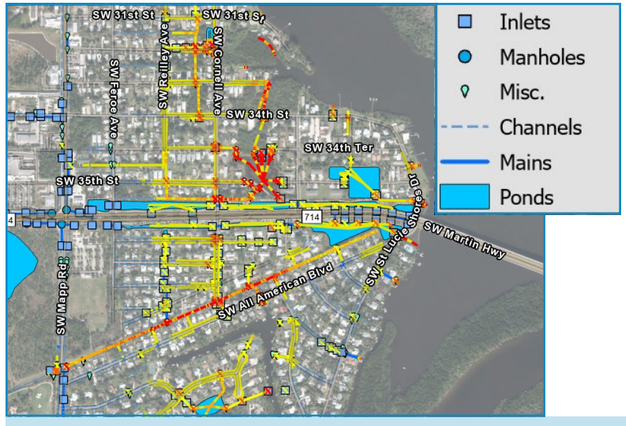
Figure 12: Transportation SLR vulnerability in Palm City, Florida and the surrounding area by year of impact

STORMWATER INFRASTRUCTURE

The stormwater management system is critical for ensuring proper drainage to prevent roads and neighborhoods from flooding. Threats to the stormwater system include rising sea levels, rising groundwater levels and increased storm intensity and/or frequency. Gravity-fed components of the stormwater system are particularly vulnerable to rising sea levels because outfalls can be submerged, rendering them inoperative. In the future pumps may be required in locations where gravity systems can no longer operate. Rising groundwater levels associated with SLR add more stress to the system and could potentially damage or reduce the functionality of subsurface infrastructure. Additional analysis of the risk posed by rising groundwater levels is needed as new information on groundwater, including modeling results, becomes available. Exfiltration systems, which allow stormwater to percolate down through the sediments below are impacted by rising groundwater levels and more intense precipitation events, which limits the effectiveness of those systems.

This map series highlights predicted flooding that could reduce the functionality of the stormwater drainage system. Figure 13 depicts an example of the 2070 SLR maps representing vulnerable stormwater infrastructure. A summary in Figure 14 reflects the structure type, number and relative percentages of impacted structures in 2070. Figure 15 summarizes the number of linear miles of straight-line infrastructure like channels, ditches and piping that are vulnerable in the year 2070. The stormwater infrastructure considered includes:

- The infrastructure within Martin County's database included 6 backflow preventers, 4,611 inlets, 564 manholes, 439 ponds, 128 linear miles of mains, 700 linear miles channels, 4,223 miscellaneous infrastructure and a metadata file.
- The infrastructure within the City of Stuart's database (made available to the County for this analysis) included 969 inlets, 386 bottom-catch basins, 252 pipe ends, 6 linear miles of ditches and 19 linear miles of pipes.



IDENTIFYING IMPACTS:
2040 **(RED)**
2070 **(ORANGE)**
2100 **(YELLOW)**

*Based on NOAA Intermediate High at MHHW

Figure 13: Detected SLR vulnerability in stormwater structures using NOAA IH at MHHW by year of impact.

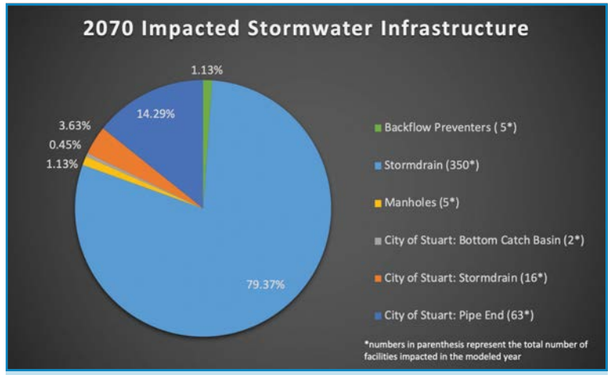


Figure 14: Represents SLR impacts by 2070 to stormwater structures broken down by type, percentage and total number.

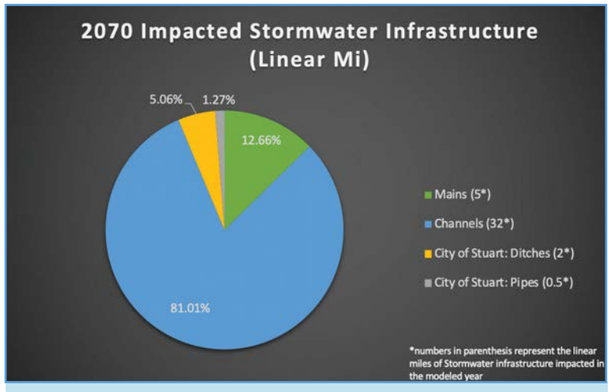


Figure 15: Represents SLR impacts by 2070 to linear stormwater structures broken down by type, percentage and total number.

POTABLE WATER

Saltwater intrusion impacts to water supply wellfields and infrastructure could have devastating effects on the water distribution system. Monitoring wells are established to identify saltwater intrusion before it can impact the water supply, thus ensuring a secure potable water supply for residents and businesses. The good news for Martin County residents is that both the County and the City of Stuart have wisely located their plants in higher elevation locations that are safe for years to come. The potable water map series identifies potential flooding impacts to supply well fields and the delivery system for potable water. Figure 16 provides an example of how the potable water vulnerability mapping is communicated in the map series. Figure 17 summarizes SLR impacts to potable water structures by the year 2070.

The potable water dataset includes over 28,079 features and contains mains, laterals, waterlines, services lines, 109 wells, 12,407 valves, 25 pumps, 18 plants, 8,372 meters, 4,001 hydrants, 3,315 water valves and 3,147 backflow preventers.

▶ IDENTIFYING IMPACTS:

2040 **(RED)**
2070 **(ORANGE)**
2100 **(YELLOW)**

*Based on NOAA Intermediate High at MHHW

Figure 16: Detected potable vulnerability using NOAA IH at MHHW by year of impact

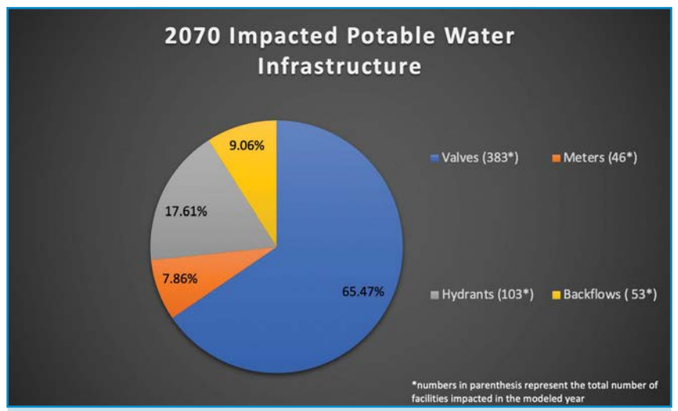
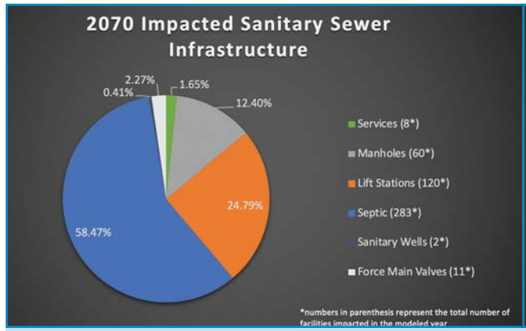


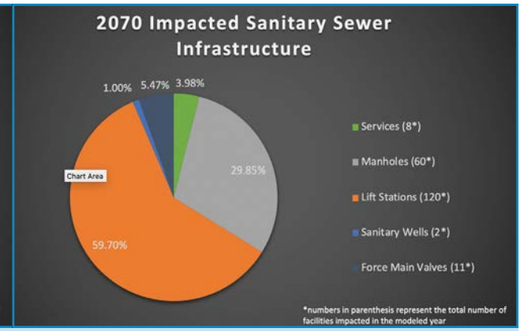
Figure 17: Represents the number of structures of stormwater infrastructure impacted by 2070.

▶ SANITARY SEWER

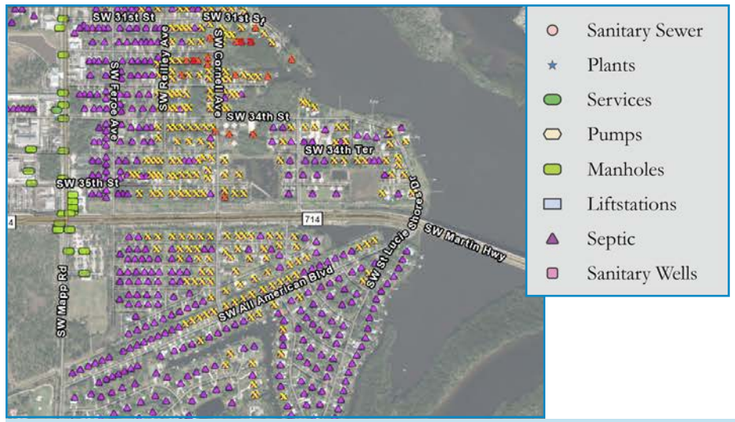
Potential impacts from climate change include sanitary sewer infrastructure damage associated with flooding (e.g., damage to sewer pumps and infiltration of seawater into the sewer system) and low flow caused by periods of drought. Collection systems are compromised when flows are no longer sufficient to carry sewage to treatment plants. This map series shows wastewater system features that may be impacted by regular tidal flooding throughout the county as sea level rises. The County's aggressive septic to sewer conversion program will minimize, and eventually eliminate, the risk to water quality associated with inundated septic systems.

The sanitary sewer database includes over 28,184 features and contains 1,253 services, 40 pumps, 2 City and County treatment plants, 6,235 manholes, 1,232 lift stations, 18,579 septic systems, 25 sanitary wells and 30 raw wells. The analysis showed that no plants or water sources were threatened. Figure20 is representative of how potential SLR vulnerabilities are identified in the model, providing an example of potential impacts to infrastructure. Based solely on static water levels, widespread impacts show up between the year 2070 and 2100, leaving ample time to plan for these changes. Figures 18 and 19 show the breakdown of vulnerable sanity sewer facilities with Figure 18 and without Figure 19 the completion of the septic to sewer conversion program. Summaries for both conditions were included to underscore the importance of completing this program before SLR amplifies the water quality impacts from existing septic systems.





Figures 18 and 19: Represent SLR impacts by 2070 to sanitary sewer structures broken down by type, percentage and total number, both with septic tanks (Figure 18) and without septic tanks (Figure 19).



▶ **IDENTIFYING IMPACTS:**
2040 **(RED)**
2070 **(ORANGE)**
2100 **(YELLOW)**

*Based on NOAA Intermediate High at MHHW

Figure 20: Representation of potential sanitary sewer infrastructure vulnerability by year of impact.

CRITICAL INFRASTRUCTURE

Martin County has an extensive inventory of critical buildings and facilities that were analyzed to determine their exposure to SLR and storm surge. Damage to community services like water and sewer, emergency shelters, hospitals, police and fire stations and elderly care facilities can disproportionately impact vulnerable populations, including those who are ill, immobile, elderly or economically disadvantaged. Flooded roads may reduce or eliminate access to these facilities, reducing their ability to operate. Disruption to the County's services as the community recovers from natural disasters - often caused or influenced by climate change effects - can be disastrous because the public's dependency on these services skyrockets during response efforts. Critical services are important not only during an episodic event, but also during slower moving hazards like a heat wave or poor air quality event. As has been underscored during the COVID-19 response, schools are critical facilities that are especially important to disadvantaged and vulnerable communities who rely on these services for childcare and meal services. The importance of building resilient critical infrastructure is clear. Martin County Emergency Management has well-established systems in place to communicate with the public, manage response efforts and keep staff safe as they care for and provide services to the public. Planning for resilience will greatly assist these efforts.

Facilities and buildings deemed important to Martin County were analyzed to determine their vulnerability to SLR. The analyzed critical facilities dataset (represented in Figure21) includes 2 airports, 5 broadcast stations, 1 coast guard center, 26 commerce related structures, 2 corrections facilities, 2 court houses, 18 fire stations, 8 health care facilities, 6 libraries, 7 police stations, 5 recreational facilities, 56 schools, and 115 utility related facilities, with 75 being located in residential communities. Because numerous data sources were compiled in this modeling effort, also included are 1,244 fire hydrants , 4 hospitals (which may include site-specific data), 27 school buildings (which may include site-specific data), 7 libraries (which may include site-specific data), 7 law enforcement facilities (which may include site-specific data) and 14 fire stations (which may include site-specific data). Although the water supply to fire hydrants is watertight, flooding may make them inaccessible for use. The assessment of these impacts will benefit from further review.

In most cases, the predicted impact is based on the ground elevation surrounding the infrastructure. More precise data was obtained for 35 of these structures. Elevation certificates for 9 fire stations, 2 police stations, 5 libraries and 19 other critical facilities allowed the analysis to be based on the structures' ground floor elevation and therefor represents actual flooding of the structure or asset.

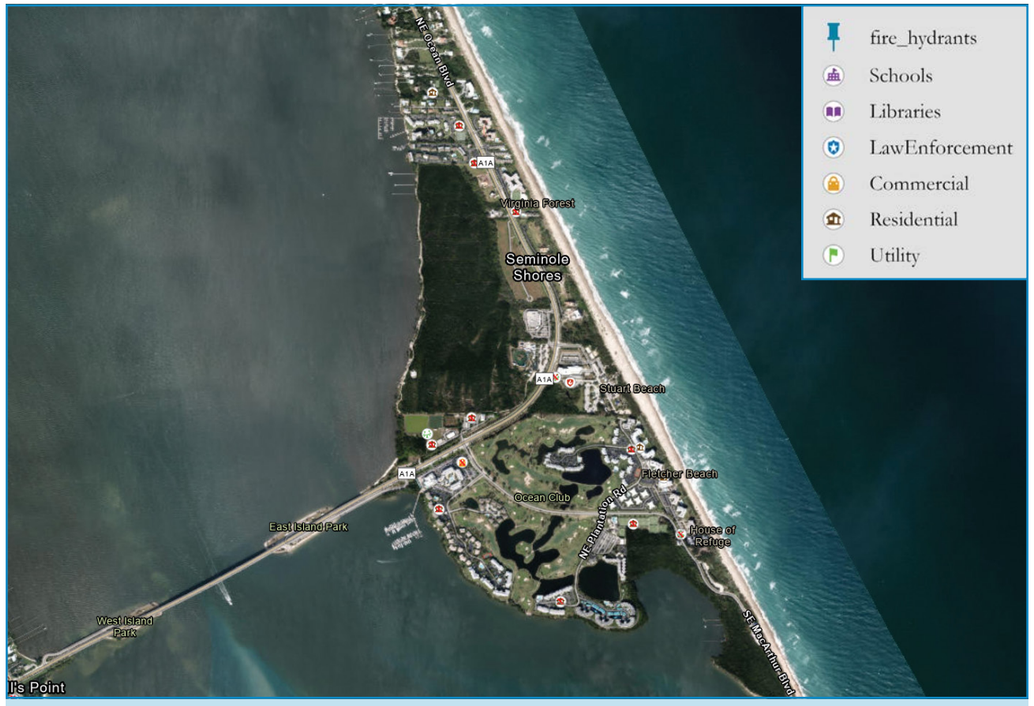


Figure 21: Example representation of critical infrastructure vulnerability map series for 2070. In the legend, "Commercial" and "Residential" icons refer to critical utility structures located in those zones.

VULNERABLE LOCATIONS

The map series that was created for this SLR Report also includes a map illustrating priority areas based on the level and immediacy of their vulnerability impacts. The 13 mapped areas (Appendix B) were identified using the combined information generated for the SLR Report. The information that contributed to an area's identification was based on a compilation and analysis of all the County infrastructure and assets contained within this "Impact by Sector" summary including critical Infrastructure, transportation, land use, potable water, sanitary sewer and stormwater. The analysis did not focus on the parcel level, but instead targets areas where impacts group together.

In general, the areas identified on this list have already experienced flooding either from seasonal tidal flooding or during heavy precipitation events. Certain capital improvements, more detailed planning or modeling and/or hazard mitigation projects would benefit these areas. As resiliency or mitigation grant funding becomes available these areas may be a targeted for future pilot projects.

ECONOMIC IMPACTS AND VULNERABILITY

06

The economics of adaptation actions is an important consideration for a local government. The effects of SLR and climate change, such as flooding from the encroaching seas and extreme precipitation, will increasingly impact the local economy. For example, as SLR encroaches into coastal areas and business districts, those properties may become less desirable, emergency service costs will increase, and business disruption costs will escalate. There are many important factors—like public health, the environment and equity—to consider when making programmatic adaptation recommendations. Those recommendations have a price tag that requires the cost-effective investment of public dollars.

The purpose of an economic vulnerability analysis related to SLR is to address these overarching considerations by examining the costs and benefits of adaptation. Local governments need this information to make informed and fiscally responsible decisions. By accounting for the costs of inundation risks under various scenarios, choices can be made about where, when and how to invest in adaptation responses to maximize benefits and minimize risk. It is important to understand how climate change and extreme events can cause greater damages and higher costs to infrastructure in the future if proactive adaptation measures are not taken. As mentioned earlier, research shows that money spent building or adapting structures to make them resilient will result in much less expensive storm damage recovery. It also creates a more attractive and "livable" community where people feel safe, and may also raise property values.

PRIOR ECONOMIC ANALYSIS

Some work on the economics of resilience has already been done for Martin County. In 2012, a *Community Resilience Analysis for Martin and Okaloosa County, Florida* was conducted to evaluate the costs and benefits, at the county level, for seven adaptation planning strategies: transfers of development rights, purchase of development rights, buyouts, rolling easements, conservation easements, land use designation changes and armoring. The analysis process began with a series of decision rules designed to ensure transferability to other coastal areas and included all parcels in the Coastal High Hazard Area (CHHA). Analysis was first completed at the parcel level on every single-family residential (SFR) parcel for each strategy. The parcel-level cost-benefit analysis estimated the measurable impacts that each policy change has on all people (or communities) in each county over a 20-year period. These impacts were monetized to quantify the impacts in terms of dollars. Overall, the analysis found that under 2012 conditions, multiple adaptation strategies were cost effective for the vast majority of single-family residential parcels in both counties. It should be noted that this was the case only if the strategies were implemented in the near term. This changes under the 2040, 2070 and 2100 future SLR scenarios, when conditions are predicted to deteriorate. Under these deteriorated conditions only one or two options remain feasible and they are considerably more expensive if implementation is delayed. In many cases the worsening conditions mean that no strategies would remain feasible and/or cost-effective. This underscores the importance of early action. These findings provide tools that are still available for consideration as Martin County moves forward with adaptation planning, but as time passes, that opportunity declines.

METHODOLOGY

As part of the current vulnerability assessment for this SLR Report, the County conducted an economic impacts analysis to evaluate the risk that SLR presents to businesses in terms of both wages and revenues. Public infrastructure and workplaces are both critical elements to the resilience of a community. If the number or quality of jobs decline due to business disruptions or relocations, then the value of property and sense of place are also at risk. The economic vulnerability assessment gives a range of the "at-risk" jobs and revenues to better inform the adaptation actions for the County. The analysis is based on current workplace locations and modeled inundation due to SLR at different times and under different scenarios. All financial impact results are shown as present value.

This work identified vulnerable "at-risk" workplaces, which are those predicted to experience some level of inundation from SLR. Inundation in this exercise is defined as the water elevation relative to the ground surface (parking lot, yard, road), not to finished floor elevations. This means that business interruptions might occur due to access issues and not necessarily because of a flooded structure. While job and wage vulnerability does not present the entire picture of economic impacts, it is an important consideration. It should also be noted that the analysis does not address indirect impacts, those are the business disruptions in industries that would indirectly affect other industries and therefore ripple through the community. For example, a loss of $1 million in revenues within the Finance Sector is generally tied to about three times that much loss in the wider economy due to the spending and employment that is tied to the initial impact.

The Martin County Quarterly Census of Employment and Wages (Q3, 2018) data compilation was used for this analysis. Business information was identified by industry type, geocoded and examined to ensure only unique businesses in Martin County were included in the analysis. Additionally, Statewide Land Use Land Cover information was utilized to ensure the analysis was completed only for non-residential businesses. All the data points were mapped and the SLR and storm surge projections were applied using the same projection curves (NOAA Intermediate High) for the years 2040, 2070 and 2100 as were applied to the vulnerability assessment.

After accounting for the criteria detailed above, 3,905 workplaces were overlaid with the different SLR water depth projections for each time period, (2040, 2070, and 2100) as well as a NOAA High SLR scenario plus a 100-year surge event. For each of the SLR scenarios, the following information was calculated for inundated areas:

1) Number of workplaces within each industry sector

2) Number of jobs within each industry sector

3) Sum of total annual wages for each industry sector

4) Sum of annual revenues for each industry sector

Three categories of business impacts were developed based on depth of inundation. Using Flood Protection Level of Service guidelines for maximum roadway flooding, the following categories were used:

1) Minor impacts
(less than 0.5 ft of water depth),

2) Medium impacts
(0.5 ft to 1 ft of water depth), and

3) Major impacts
(greater than 1 ft of water depth).

RESULTS OF ECONOMIC ANALYSIS

In 2040, about $21 million in annual revenues are vulnerable to disruption from SLR alone (no storm surge impacts), with average estimated inundation depths of less than 6 inches (using NOAA Intermediate High (NIH)). It is important to remember that this estimate does not account for precipitation, nor for the number of businesses that are likely to be located in the area two decades from now. In the next two decades, additional businesses will open in the area, meaning this estimate can be assumed to be a conservative estimate for impacts resulting from sunny-day, high-tide flooding. To avoid increased costs and disruption by 2040 – working around more businesses and with future dollar costs – investments in resiliency need to start in the near term. By 2070, under the same scenario (NIH), inundation depths increase substantially to greater than one foot, primarily affecting the same businesses – again, without incorporating storm surge. Under the NOAA High scenario, this jumps to $100 million in vulnerable revenues and about 200 jobs, considering inundation only from SLR (see Figure 22 showing 2040 and 2070 at-risk revenues). By 2100, the estimate of revenue impacts is $341 million at NOAA IH and $1.2 billion at NOAA High without storm surge – which jumps to $5 billion with storm surge, and more than 2,000 jobs.

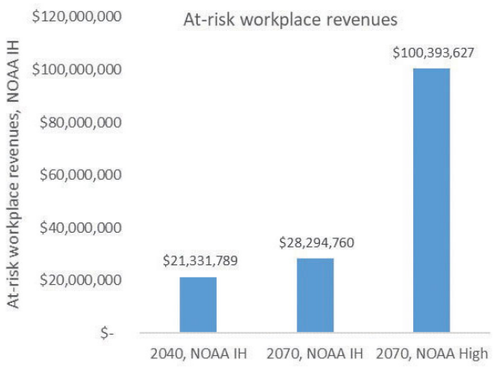
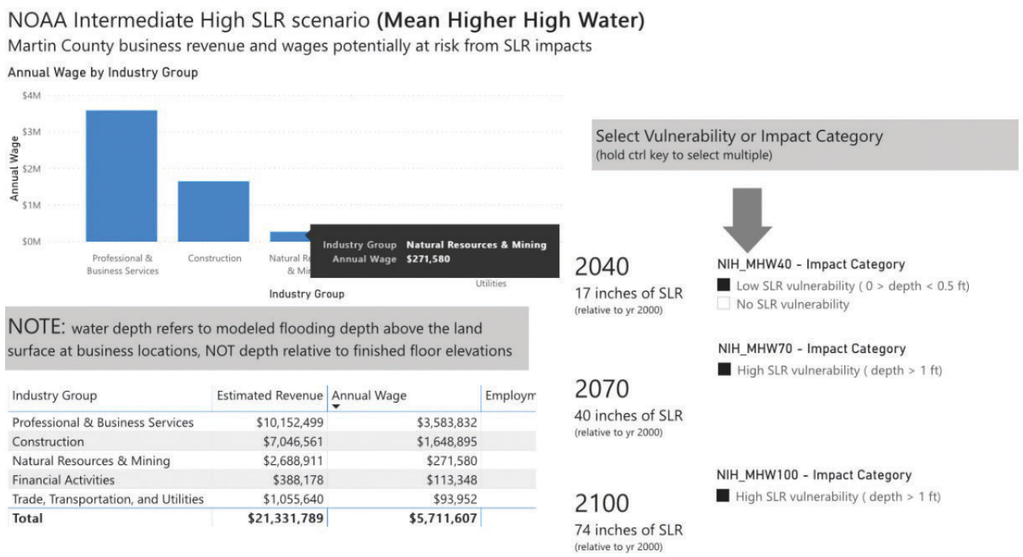


Figure 22: At-risk revenues in 2040 and 2070 (NOAA IH) and in 2070 also for NOAA High Scenario

As the 2012 study found, mitigation strategies that are cost-effective to implement in current conditions often are no longer cost-feasible if implementation is delayed. The significant increase in economic vulnerability from the 2040 to 2070 scenarios ($20 million to potentially $100 million) represents a conservative estimate of economic risks from delayed adaptation actions.

An interactive data visualization tool was developed to facilitate easy access to the economic vulnerability information developed for Martin County. This tool allows stakeholders to produce tables and charts for the time period, SLR scenario and location in which they are interested. The tool is accessible at **www.Martin.FL.US/EconVulnerability**.

Figure 23 provides a screenshot example of the interactive data visualization tool.



Industry Group	Estimated Revenue	Annual Wage	Employm
Professional & Business Services	$10,152,499	$3,583,832	
Construction	$7,046,561	$1,648,895	
Natural Resources & Mining	$2,688,911	$271,580	
Financial Activities	$388,178	$113,348	
Trade, Transportation, and Utilities	$1,055,640	$93,952	
Total	**$21,331,789**	**$5,711,607**	

Figure 23: This illustrates the 2040 at-risk revenues and wages (NOAA IH); note – the 2040 affected workplaces show up in the lowest water depth range (< ½ ft inundation depth), while the 2070 inundation at those same locations are in the highest water depth range (> 1ft inundation)

The following list highlights the important findings from the analysis of wage and revenue vulnerability:

1) As the 2012 study found, mitigation strategies that are cost-effective today, in current conditions, often are not cost-feasible if implementation is delayed since the strategies would need to address the more impaired future SLR conditions. The significant increase in economic vulnerability from the 2040 to 2070 scenarios (NOAA IH to NOAA High across that time period is $20 million in at-risk revenues to potentially $100 million in at-risk revenues) represents a conservative estimate of the economic risks from delayed adaptation actions.

2) There is an order of magnitude difference in total wage vulnerability between the 2070 and 2100 NOAA Intermediate High ($8 million in vulnerable wages compared to $80 million by 2100); this again highlights the importance of early and ongoing adaptation actions to prepare for the nonlinear increase in vulnerability.

3) The most vulnerable industry types in 2040 (based on the NOAA Intermediate High scenario) are Professional and Business Services and Construction, but the most vulnerable industry types by 2100 are more reflective of long-term risks. Leisure and Hospitality is the most vulnerable industry group in 2100; that includes marinas, restaurants, hotels, and other similar workplaces. Professional and Business Services and Trade, Transportation and Utilities are the other most vulnerable industry types by 2100.

4) A critical means of protecting jobs against SLR vulnerability in Martin County is raising awareness in the business community through a proactive outreach program. Business owners must understand that Martin County is preparing for climate change and SLR to ensure that its natural and built infrastructure is continually adapting to improve resilience. This message should also be accessible to businesses that are considering establishing a presence in the county. Information that describes how Martin County is prepared for a changing environment should be at the forefront and easily accessible.

5) Both public and private sector support is necessary to implement the financial investment that will be needed to prepare for SLR and other effects of climate change. These changes will be guided in part by the SLR information in this study and in other analyses that follow, as Martin County takes actions that will ensure resilience. These actions will reduce the vulnerability of existing jobs and make Martin County a more attractive place to live and work; retaining existing businesses and attracting new ventures. Continued messaging of the importance of capital investments – from both public and private sources – will be critical to ensuring a steady course of improved resilience and protection of the economic engine that is vital to the County.

07 RECOMMENDATIONS

The SLR Plan includes 48 recommendations grouped into 4 main areas:

1) County Assets & Infrastructure

2) Land Development

3) Natural Resources

4) Socioeconomic

The recommendations also indicate an implementation mechanism, which may include the need for additional data or analyses. Specific County procedures are identified where feasible. Finally, a projected timeline is established:

- Short (1-5 years)
- Moderate (5-10 years)
- Long (10+ years)

Martin County has already made significant investments to become a more resilient community. The County's response to extreme conditions presented by climate change, will be an evolving process, using data collected as conditions change to adapt to the expected impacts. The process to develop the Resilient Martin program has been data-driven and transparent. Through the leadership of Martin County's Board of County Commissioners and the strong support from the FDEP's Resilient Coastlines grant program and NOAA's Office for Coastal Management, in addition to the groundbreaking work of the Southeast Florida Climate Compact, the Resilient Martin program has leveraged the current body of knowledge to move forward.

Investments in becoming a more resilient community provide a high value return and this has been a driving force behind the development of the Resilient Martin program. The National Institute of Building Sciences (NIBS) released a report that determined the 6 to 1 return on pre-disaster mitigation also found that the financial benefits of exceeding local building standards, such as elevating homes higher than required in flood-prone areas and building structures to be more resilient yields $4 for every $1 spent. This underscores the fact that investing in resilience pays substantial dividends back to the community.

A coordinated effort among County staff, County programs, stakeholders, residents, federal and state agency resources and elected leaders generated shared support for the program and its initiatives. This SLR Report is one step in a larger process to preserve the quality of life in the Martin County as environmental conditions change, and it includes recommendations to assist in achieving that goal. The recommendations in the SLR Report have a short, medium and long-range timeframe or they are an ongoing process. To implement recommendations successfully, they must be woven into the fabric of normal County operations. This means integrating them into the existing decision-making processes including project review, budgeting and Comprehensive Growth Management Plan and code amendments.

With all these actions pointing in the same direction, the County can achieve the goal of becoming a more resilient community.

- **Floodplain Management.** One specific way to invest in becoming a more resilient community is to improve participation in FEMA's CRS program. The County's submission date for its next CRS review is May 1, 2021. This in-person review will be the next and best available opportunity for the County to incorporate this SLR Report into its documented strategy as it seeks to improve its CRS Class score. A Resilience and Watershed Management Plan includes a more detailed overview of the County's modeling efforts to date and when complete, may provide additional CRS credits. **If the Board of County Commissioners desires to use a Resilience and Watershed Management Plan to improve the County's CRS score, FEMA requires that the Board formally review and adopt it through a Resolution prior to its submittal to FEMA.**

- **Future Data/Modeling/Analysis.** Advancing to the next step in assessing climate change vulnerabilities requires more detailed data related to surface water/groundwater/SLR relationships, extreme precipitation events, hurricane induced storm surge and king tides, site-specific property information such as existing building and infrastructure elevations and the cost-benefit of specific adaptation projects. Much of the data for these analyses either does not exist or needs further refinement. For that reason, the County should expand the communication and coordination with agencies such as FDEP, SFWMD, USGS, U.S. Army Corps of Engineers and other entities that have the resources to fill these gaps. Future analysis related to demographic and socioeconomic information has also been recommended to better plan for adaptation response in an equitable way.

- **Coordination on Capital Improvements.** Vulnerability mapping has identified areas where impacts are expected in the next 20 to 50 years, well within the useful life of many County projects. Annual and multi-year budgeting processes should incorporate this review to ensure that investments are made with a long-term view. It should be noted that adoption of the SLR Report will increase the eligibility and ranking of related County projects in many grant programs. Therefore, projects should be evaluated to determine if a resilience review is required to maximize the project's useful life and ensure that assumptions about SLR impacts are part of the planning process. Full implementation will require that projects subject to the resilience review demonstrate that the SLR Report findings have been incorporated into these projects.

- **Comprehensive Growth Management Plan.** A local government's Comprehensive Plan and Land Development Regulations always provide an opportunity to incorporate resilience planning goals, objectives, policies and regulations. It is important to incorporate the SLR Report recommendations into these documents where appropriate because they provide the decision-making structure for existing and new development projects as well as for County capital improvement and design. Continued coordination between the overall Resilient Martin program, the Comprehensive Plan and the Land Development Regulations will facilitate project reviews that include the best available information related to future climate risk. Goals, objectives and policies may be updated as new data and analysis becomes available. Land Development Regulations should be reviewed and revised concurrent with changes to the Comprehensive Plan. At minimum, a review should be conducted prior to the net Letter of Notification being submitted to the Department of Economic Opportunity as required on or before December 2023 regarding any future Evaluation and Appraisal Report.

- **Funding Strategy.** Funding for resilience is likely to be based on a "layered" approach of traditional and new sources of revenue. Grants have already served an important role in the resilience planning process. Pre- and post-disaster recovery funding sources are also available and many now prioritize resilience planning. Other communities' funding strategies include general obligation or revenue bonding, user fees, non-disaster related grants, State Revolving Loan Funds and incentive-based funding strategies to achieve resilience outcomes. Assessments are also a strategy that is becoming popular because they can capture the differences in the level of adaptation projects necessary which may fluctuate neighborhood to neighborhood based on exposure and risk. Tax increment financing can be another useful tool, especially in the redevelopment context whereby the increase in assessed property value caused by development is used to repay the cost. Impact fees can also be assessed to generate revenue to meet local infrastructure and public facility demands rising as a result of new development. These may include stormwater system upgrades, flood control improvements, road elevation, green infrastructure or open space features that have resilience co-benefits. Finally, pay as you go financing will occur as resiliency concepts are integrated into the traditional capital planning process.

- **Outreach.** As discussed throughout this report, continued outreach is an essential component of a successful resilience effort. The two-way exchange of information allows the County to inform the community of upcoming projects and establish a dialogue in their early planning stages. Information exchanges with the community will provide a better understanding of their priorities and the perceived impact of projects. This information can be incorporated into project planning and construction. Communication should be multi-lingual and include faith-based organizations, nonprofits and community centers. Outreach can also include more accessible hazard data through presentations, web portals, brochures, social media, radio and MCTV broadcasts and other channels. This work can be coordinated with Emergency Management's ongoing public outreach program.

- **Coordination with the Business Community.** All stakeholders must be involved in this resilience conversation, including the business community. Information should be easily accessible by current business owners as well as those contemplating a move to the county. Business owners must be aware that Martin County is preparing for a resilient future, understand the value and become part of that process. The importance of this planning, including the strong linkages between resilience and disaster planning, should clearly show how this strategy can achieve multiple goals simultaneously. According to FEMA, nearly 40% of small businesses never reopen their doors following a flood disaster.

- **Inclusive Adaptation Planning.** Resilience communication by Martin County must include its diverse population. It is important to identify the most effective ways to connect with vulnerable communities and businesses about climate change preparedness and to identify the resources that would provide the best benefit. Recommendations also suggest an increased emphasis on education, training and resources as a resilience strategy.

- **Intergovernmental Coordination.** The County should maintain and expand the lines of communication that have been developed with municipalities and others conducting resilience work in the South Florida region. Since the County also owns, maintains and operates infrastructure and assets within municipal boundaries, discussion and agreement on SLR planning will be important to these partnerships. Joint efforts could include data collection, project planning, funding, grants and overall implementation.

- **Federal, State, Regional Government Partnerships.** It will be in the County's best interest to continue and enhance its relationships with federal, state and regional partners and track the evolving landscape of governance structures, new rules and policies and funding opportunities. As these agencies develop new tools to collect and model data, they enhance the County's efforts in planning and outreach, policy and regulatory development. As the state's climate response and governance structure evolves, the County can continue to benefit from its work products and grant opportunities. The process of developing and implementing the SLR Report will put the County in a leadership position to take advantage of these relationships and opportunities.

- **Responsibilities, Structure and Staffing.** As the process of implementing the SLR Report begins, it will be important to assess the County's financial, organizational and staffing structure to achieve success. Responsibility for implementation will need to be a cross departmental collaborative process. The internal collaboration that has occurred thus far has been extensive and must continue through regularly scheduled meetings. Not all recommendations will require new, dedicated funding mechanisms, instead many recommendations can be implemented through work that is planned but can be modified to incorporate SLR assumptions into the design for new projects. Capital project and asset management information should be generated in a

way that can be incorporated into future analysis related to vulnerability. This effort has shown that the County's data sets are far ahead of many other local governments in Florida, however there is always room for improvement.

- **Monitoring/Reporting/Updating.** The SLR Report includes 48 recommendations, some of which require new data or information for implementation. The subsequent analysis can help the County identify and implement the best future actions. Successful SLR Report implementation will require monitoring and reporting to County administration, the County Commissioners and the public. The County's new Resilient Martin website provides an excellent opportunity to track and monitor implementation of the SLR Report. Additionally, internal collaboration prior to the launch of the annual budgeting process will help align capital project review. An SLR Report update should be provided to the County Commission prior to the beginning of the annual budget process. This will help manage the SLR Report's implementation and keep completion of the recommendations on track. Finally, the vulnerability assessment should be updated or expanded as needed to address new resilience attributes not previously considered. This update should occur no less than every 3 to 5 years.

▶ **APPENDIX A.** LIST OF RECOMMENDATIONS

COUNTY ASSETS & INFRASTRUCTURE: TECHNICAL VULNERABILITY ANALYSIS	
RECOMMENDATION	TIMELINE
1. Add vulnerability or flood risk factor into capital projects.	**Short**
2. Consider project life and relationship to sea level rise and flood risk in capital projects.	**Short**
3. Expand overall vulnerability assessment to include erosion rates, shoreline elevation, impacted stormwater discharge and commercial area metrics.	**Medium**
4. Make infrastructure retrofits and maintenance projects more resilient.	**Short**
5. Improve stormwater vulnerability analysis to factor in more data about structures, drainage basins, storage capacity and rainfall.	**Medium**
6. Enhance sea level rise modeling to link surge from hurricanes, precipitation and shorelines.	**Long**
7. Undertake modeling that relates surface water, groundwater and impacts to septic tanks and water supply wells.	**Medium**
8. Complete property level risk analysis with NFIP data.	**Short**
9. Expand information and coordination on sea level risk impacts to transportation systems	**Short**
10. Use more detailed information related to elevations to determine road impacts from sea level rise.	**Medium**
11. Analyze individual at-risk facilities and assets to prioritize adaptation measures.	**Medium**
12. Incorporate property level building elevations into vulnerability analysis.	**Short**
13. Use vulnerability information in emergency management planning and project priorities.	**Short**
14. Collaborate with SFWMD to understand their coastal structure adaptation projects and relationship to County drainage.	**Short**

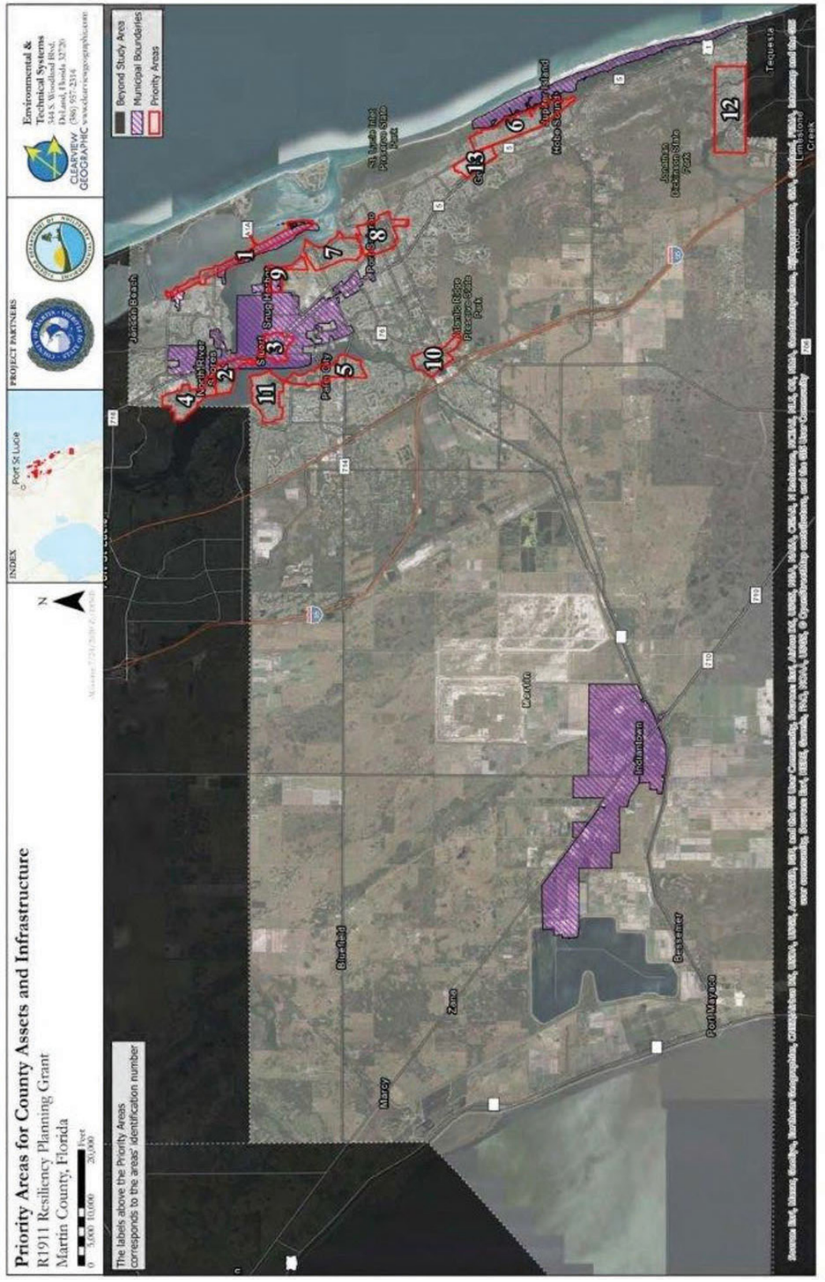
15. Create complete dataset on hazardous materials use or storage impacts by future flood risk.	**Medium**
16. Use “pilot” projects to help inform feasibility of adaptation measures.	**Ongoing**
17. Link CRA stormwater planning with vulnerability information.	**Short**
18. Determine if public open spaces can accommodate enhanced stormwater management benefits.	**Short**
19. Link ongoing sanitary sewer conversions with sea level rise vulnerability analysis.	**Short**
COUNTY ASSETS & INFRASTRUCTURE: ECONOMIC ANALYSIS	
20. Analyze future flood damage and economic impact to properties.	**Short**
21. Update previous economic analysis related to adaptation strategies.	**Short**
22. Determine costs and funding sources for adaptation.	**Short**
COUNTY ASSETS & INFRASTRUCTURE: POLICY DEVELOPMENT	
23. Review Comprehensive Plan and Code for linkages with recommendations in the SLR Report.	**Short**
24. Integrate sea level rise projections into Comprehensive Plan and Design elements of Code.	**Medium**
COUNTY ASSETS & INFRASTRUCTURE: AGENCY OR STAKEHOLDER COORDINATION	
25. Update the BOCC annually on Resilient Martin.	**Ongoing**
26. Coordinate vulnerability work with the municipalities.	**Medium**
COUNTY ASSETS & INFRASTRUCTURE: CRS IMPROVEMENT	
27. Track citizen Request for Service (RFS) related to alleviating flood impacts and achieve CRS credits.	**Short**
28. Adopt Watershed Management Plan for CRS submittal.	**Short**
29. Complete repetitive loss analysis for CRS submittal.	**Short**
30. Determine if analysis in CRS for levee or dam structures is beneficial.	**Short**

LAND DEVELOPMENT	
31. Ensure debris management policies reduce impacts to stormwater functions.	**Short**
32. Increase stormwater management requirements on parcels.	**Medium**
33. Develop a list of feasible property owner adaptation strategies and revise Code, if necessary, to facilitate implementation.	**Medium - Long**
34. Better link building elevation information and inundation mapping for property owners to reduce risk in new constructions and retrofits.	**Medium**
35. Review, update or develop policies to protect historic structures from future flood risk.	**Medium**
36. Increase the minimum elevation of buildings (freeboard) in at risk locations.	**Short**
37. Pursue and develop programs that help property owners adapt their properties to mitigate future flood risk.	**Short**
NATURAL RESOURCES	
38. Promote rainwater harvesting to increase on site retention of flood water for beneficial reuse.	**Short**
39. Increase utilization of passive green infrastructure projects (such as swales and retention areas) by partnering to develop list of project types and feasible implementation through permits and Code.	**Short**
40. Contribute vulnerability information to regional discussions on land and water resource protection.	**Short**
41. Model sea level rise impacts to changing habitats.	**Medium**
42. Integrate coastal information into vulnerability assessment.	**Medium**

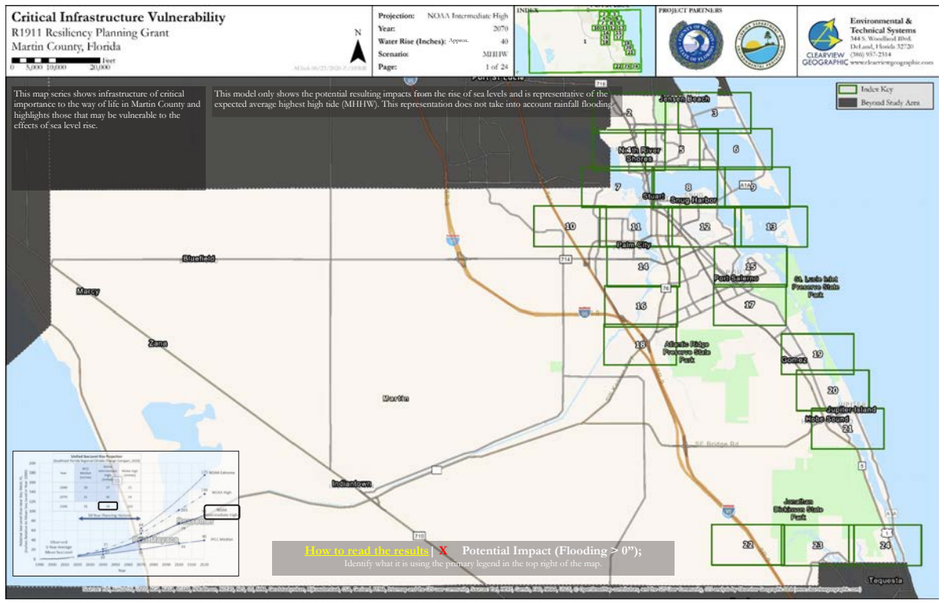
SOCIOECONOMIC	
43. Increase communications with the business community on Resilient Martin.	**Short**
44. Improve community discussions on the projected impacts of climate change on the County..	**Ongoing**
45. Exchange vulnerability information with asset owners throughout the County such as hospitals and the Martin County School District.	**Short**
46. Specifically target socially and economically vulnerable populations in community outreach activities.	**Ongoing**
47. Coordinate vulnerability information with Department of Health.	**Ongoing**
48. Enhance regional vulnerability discussions through providing vulnerability data to the Regional Planning Counci.	**Short**

▶ **APPENDIX B.** PRIORITY LOCATIONS MAP

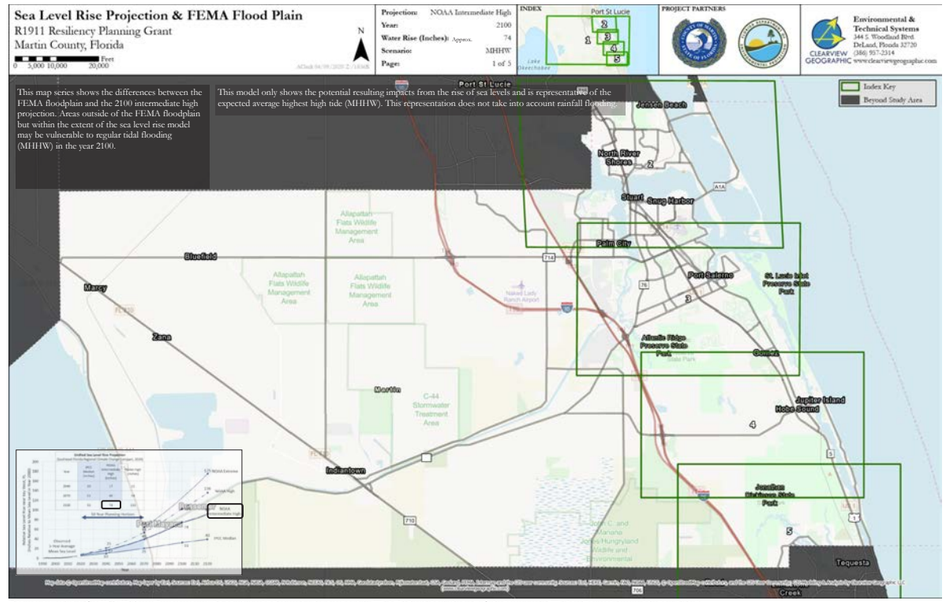
The entire map series can be found at http://bit.ly/MapSeries



▶ **APPENDIX C.** MAP SERIES INDEX KEYS



This map series was designed for a 11 (h) x 17 (w) paper. Pages or page areas with minimal elements in the legend may have gaps in available GIS data. Additional data collection and verification is recommended. GIS data and its associated representation is provided as-is.



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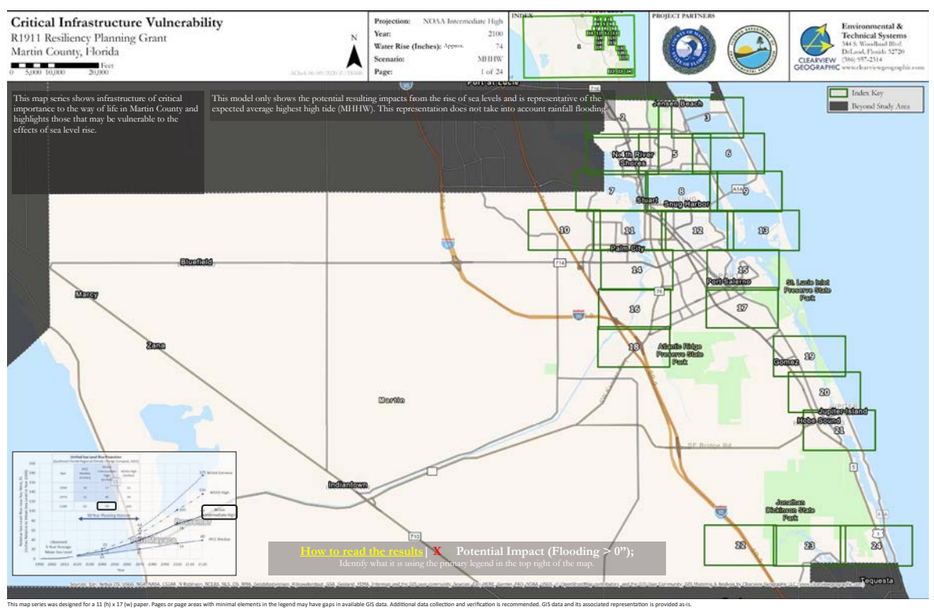

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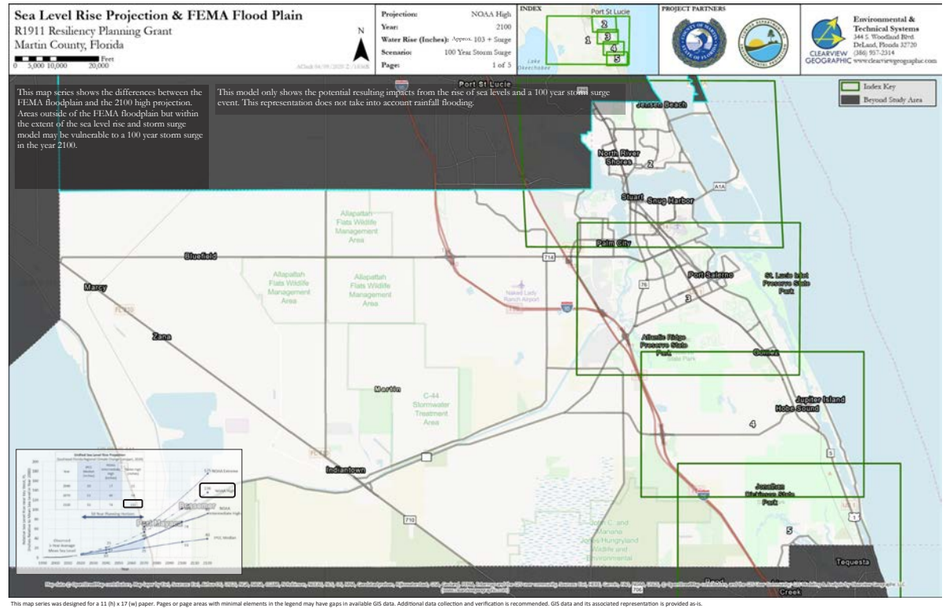

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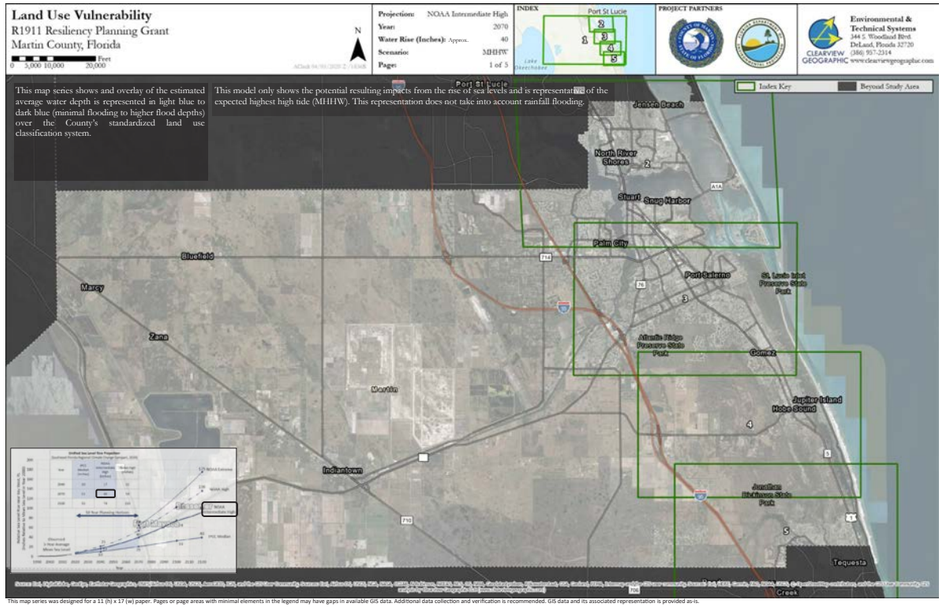
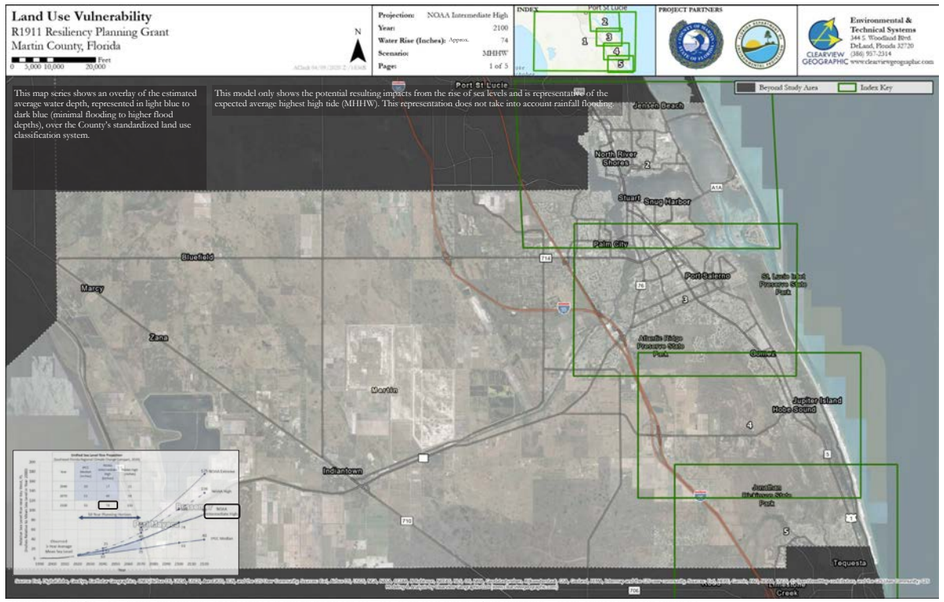

Land Use Vulnerability
R1911 Resiliency Planning Grant
Martin County, Florida
Projections: NOAA Intermediate High
Year: 2070
Water Rise (Inches): Approx. 40
Scenario: MHHW
Page: 1 of 5
INDEX
PROJECT PARTNERS
Environmental & Technical Systems
344 S. Woodland Blvd.
DeLand, Florida 32720
(386) 957-2314
CLEARVIEW GEOGRAPHIC www.clearviewgeographic.com
This map series shows and overlay of the estimated average water depth is represented as light blue to dark blue (minimal flooding to higher flood depths) over the County's standardized land use classification system.
This model only shows the potential resulting impacts from the rise of sea levels and is representative of the expected highest high tide (MHHW). This representation does not take into account rainfall flooding.
Index Key
Beyond Study Area
Port St Lucie
Jensen Beach
North River Shores
Stuart
Sewall's Point
Rocky Point
Hobe Sound
Bessey Creek
Palm City
Port Salerno
St. Lucie Inlet Preserve State Park
Bluefield
Murphy
Zeus
Martin
Indiantown
Jupiter Island
Hobe Sound
Jonathan Dickinson State Park
Tequesta
Loxahatchee River
Lake Okeechobee
This map series was designed for a 11 (h) x 17 (w) paper. Pages or page areas with minimal elements in the legend may have gaps in available GIS data. Additional data collection and verification is recommended. GIS data and its associated representation is provided as-is.


Land Use Vulnerability
R1911 Resiliency Planning Grant
Martin County, Florida
Projections: NOAA Intermediate High
Year: 2100
Water Rise (Inches): Approx. 74
Scenario: MHHW
Page: 1 of 5
INDEX
PROJECT PARTNERS
Environmental & Technical Systems
344 S. Woodland Blvd.
DeLand, Florida 32720
(386) 957-2314
CLEARVIEW GEOGRAPHIC www.clearviewgeographic.com
This map series shows an overlay of the estimated average water depth, represented in light blue to dark blue (minimal flooding to higher flood depths), over the County's standardized land use classification system.
This model only shows the potential resulting impacts from the rise of sea levels and is representative of the expected average highest high tide (MHHW). This representation does not take into account rainfall flooding.
Beyond Study Area
Index Key
Port St Lucie
Jensen Beach
North River Shores
Stuart
Sewall's Point
Rocky Point
Hobe Sound
Bessey Creek
Palm City
Port Salerno
St. Lucie Inlet Preserve State Park
Bluefield
Murphy
Zeus
Martin
Indiantown
Jupiter Island
Hobe Sound
Jonathan Dickinson State Park
Tequesta
Loxahatchee River
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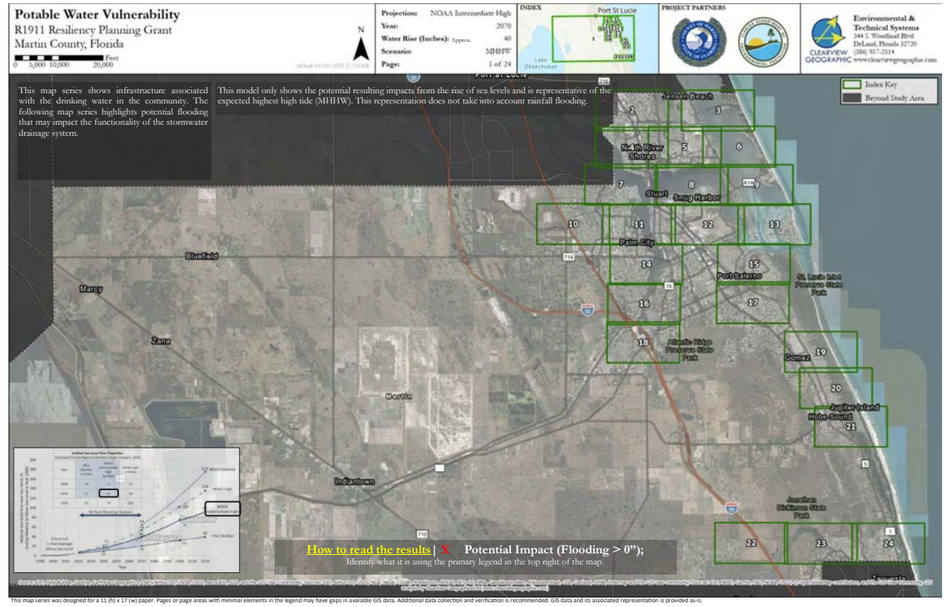
Potable Water Vulnerability
R1911 Resiliency Planning Grant
Martin County, Florida
Projections: NOAA Intermediate High
Year: 2070
Water Rise (Inches): Approx. 40
Scenario: MHHW
Page: 1 of 24
INDEX
PROJECT PARTNERS
Environmental & Technical Systems
344 S. Woodland Blvd.
DeLand, Florida 32720
(386) 957-2314
CLEARVIEW GEOGRAPHIC www.clearviewgeographic.com
This map series shows infrastructure associated with the drinking water in the community. The following map series highlights potential flooding that may impact the functionality of the stormwater drainage system.
This model only shows the potential resulting impacts from the rise of sea levels and is representative of the expected highest high tide (MHHW). This representation does not take into account rainfall flooding.
Index Key
Beyond Study Area
How to read the results | X Potential Impact (Flooding > 0"); Identify what it is using the primary legend in the top right of the map.
Port St Lucie
Jensen Beach
North River Shores
Stuart
Sewall's Point
Rocky Point
Hobe Sound
Bessey Creek
Palm City
Port Salerno
St. Lucie Inlet Preserve State Park
Bluefield
Murphy
Zeus
Martin
Indiantown
Jupiter Island
Hobe Sound
Jonathan Dickinson State Park
Loxahatchee River
Lake Okeechobee
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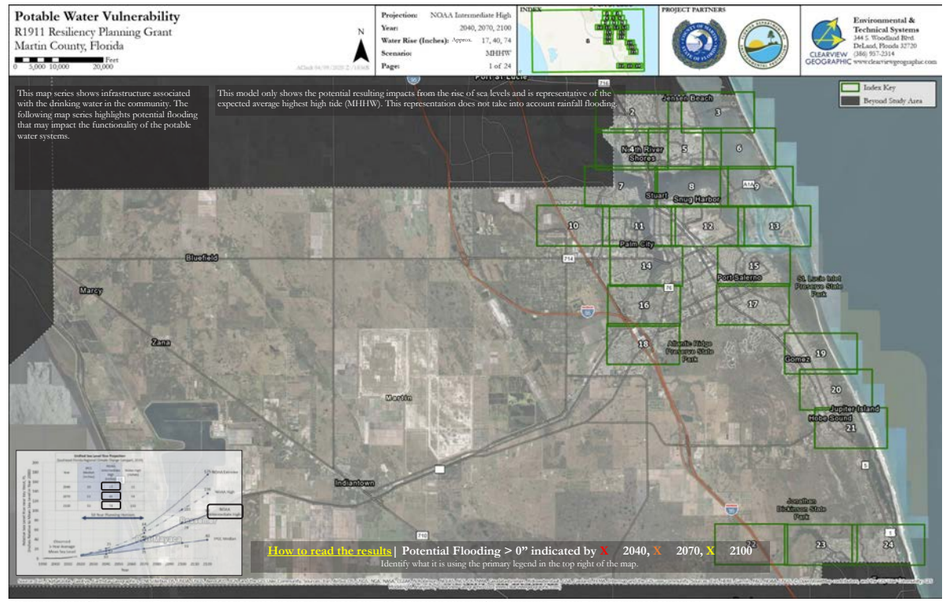
Potable Water Vulnerability
R1911 Resiliency Planning Grant
Martin County, Florida
Projections: NOAA Intermediate High
Year: 2040, 2070, 2100
Water Rise (Inches): Approx. 17, 40, 74
Scenario: MHHW
Page: 1 of 24
INDEX
PROJECT PARTNERS
Environmental & Technical Systems
344 S. Woodland Blvd.
DeLand, Florida 32720
(386) 957-2314
CLEARVIEW GEOGRAPHIC www.clearviewgeographic.com
This map series shows infrastructure associated with the drinking water in the community. The following map series highlights potential flooding that may impact the functionality of the potable water systems.
This model only shows the potential resulting impacts from the rise of sea levels and is representative of the expected average highest high tide (MHHW). This representation does not take into account rainfall flooding.
Index Key
Beyond Study Area
How to read the results | Potential Flooding > 0" indicated by X 2040, X 2070, X 2100
Identify what it is using the primary legend in the top right of the map.
Port St Lucie
Jensen Beach
North River Shores
Stuart
Sewall's Point
Rocky Point
Hobe Sound
Bessey Creek
Palm City
Port Salerno
St. Lucie Inlet Preserve State Park
Bluefield
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Martin
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Jupiter Island
Hobe Sound
Jonathan Dickinson State Park
Loxahatchee River
Lake Okeechobee
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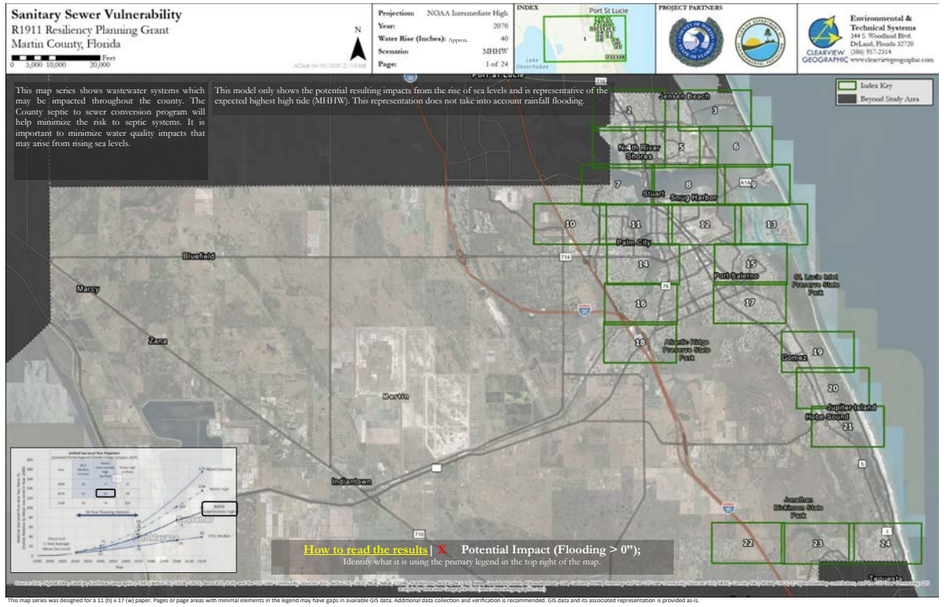
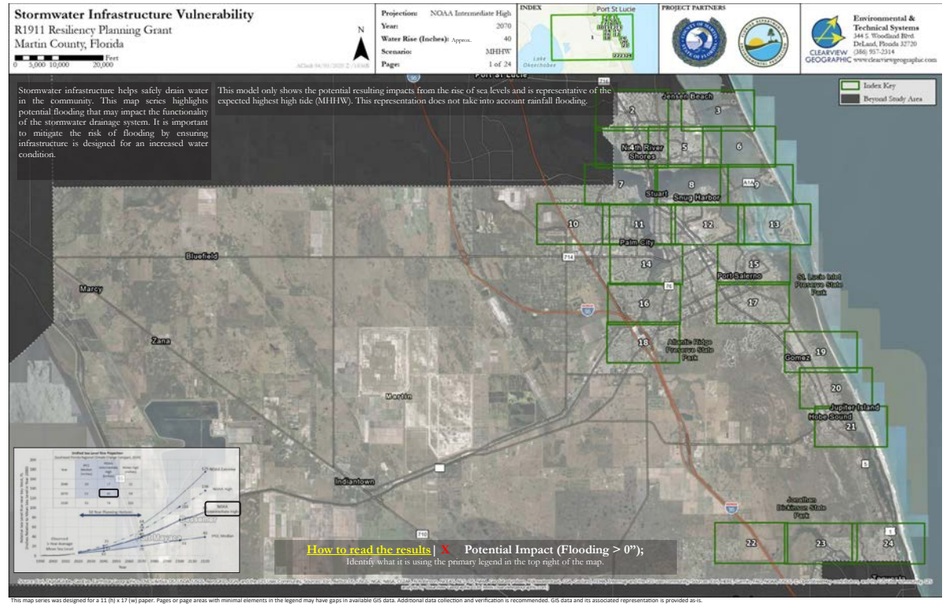

Sanitary Sewer Vulnerability
R1911 Resiliency Planning Grant
Martin County, Florida
Projection: NOAA Intermediate High
Year: 2040, 2070, 2100
Water Rise (Inches): Approx. 17, 40, 74
Scenario: MHHW
Page: 1 of 24
INDEX
PROJECT PARTNERS
Environmental & Technical Systems
344 S. Woodland Blvd.
DeLand, Florida 32720
(386) 957-2314
CLEARVIEW GEOGRAPHIC www.clearviewgeographic.com
This map series shows wastewater systems which may be impacted throughout the county. The County septic to sewer conversion program will help minimize the risk to septic systems. It is important to minimize water quality impacts that may arise from rising sea levels.
This model only shows the potential resulting impacts from the rise of sea levels and is representative of the expected highest high tide (MHHW). This representation does not take into account rainfall flooding.
Index Key
Beyond Study Area
How to read the results | Potential Flooding > 0" indicated by X 2040, X 2070, X 2100
Identify what it is using the primary legend in the top right of the map.
This map series was designed for a 11 (h) x 17 (w) paper. Pages or page areas with minimal elements in the legend may have gaps in available GIS data. Additional data collection and verification is recommended. GIS data and its associated representation is provided as-is.


Stormwater Infrastructure Vulnerability
R1911 Resiliency Planning Grant
Martin County, Florida
Projection: NOAA Intermediate High
Year: 2070
Water Rise (Inches): Approx. 40
Scenario: MHHW
Page: 1 of 24
INDEX
PROJECT PARTNERS
Environmental & Technical Systems
344 S. Woodland Blvd.
DeLand, Florida 32720
(386) 957-2314
CLEARVIEW GEOGRAPHIC www.clearviewgeographic.com
Stormwater infrastructure helps safely drain water in the community. This map series highlights potential flooding that may impact the functionality of the stormwater drainage system. It is important to mitigate the risk of flooding by ensuring infrastructure is designed for an increased water condition.
This model only shows the potential resulting impacts from the rise of sea levels and is representative of the expected highest high tide (MHHW). This representation does not take into account rainfall flooding.
Index Key
Beyond Study Area
How to read the results | X Potential Impact (Flooding > 0");
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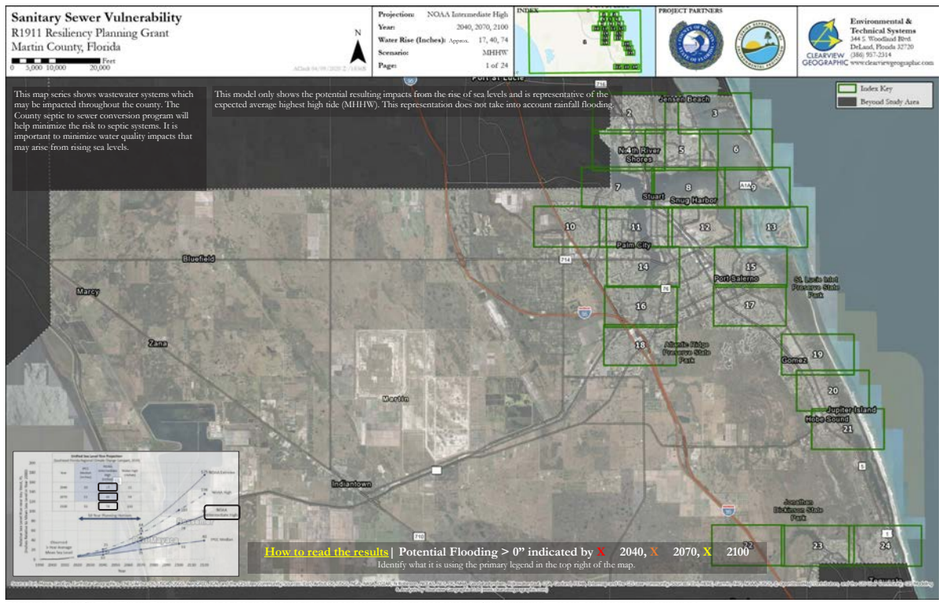
Sanitary Sewer Vulnerability
R1911 Resiliency Planning Grant
Martin County, Florida
Projection: NOAA Intermediate High
Year: 2040, 2070, 2100
Water Rise (Inches): Approx. 17, 40, 74
Scenario: MHHW
Page: 1 of 24
INDEX
PROJECT PARTNERS
Environmental & Technical Systems
344 S. Woodland Blvd.
DeLand, Florida 32720
(386) 957-2314
CLEARVIEW GEOGRAPHIC www.clearviewgeographic.com
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This model only shows the potential resulting impacts from the rise of sea levels and is representative of the expected average highest high tide (MHHW). This representation does not take into account rainfall flooding.
Index Key
Beyond Study Area
How to read the results | Potential Flooding > 0" indicated by X 2040, X 2070, X 2100
Identify what it is using the primary legend in the top right of the map.
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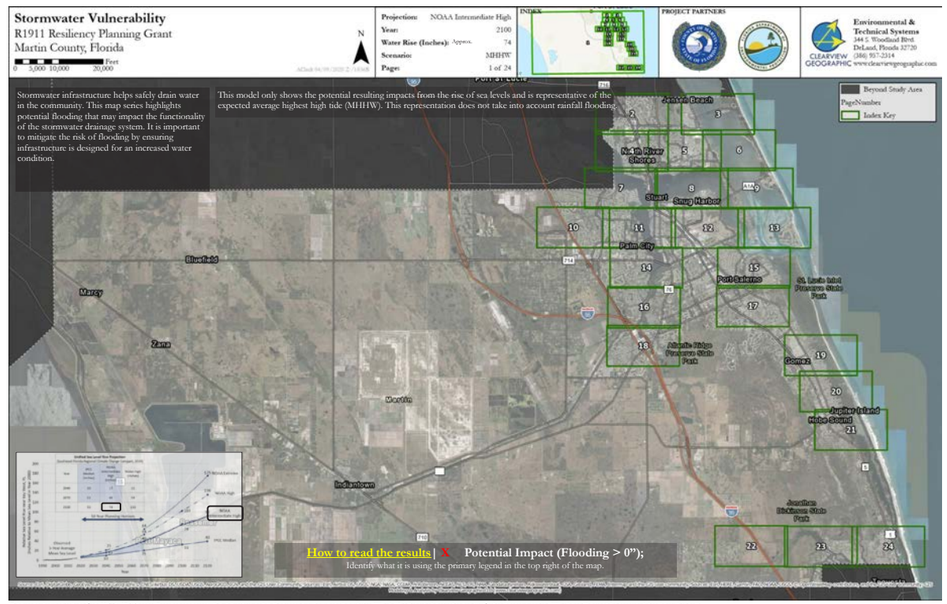
Stormwater Vulnerability
R1911 Resiliency Planning Grant
Martin County, Florida
Projection: NOAA Intermediate High
Year: 2100
Water Rise (Inches): Approx. 74
Scenario: MHHW
Page: 1 of 24
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PROJECT PARTNERS
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(386) 957-2314
CLEARVIEW GEOGRAPHIC www.clearviewgeographic.com
Stormwater infrastructure helps safely drain water in the community. This map series highlights potential flooding that may impact the functionality of the stormwater drainage system. It is important to mitigate the risk of flooding by ensuring infrastructure is designed for an increased water condition.
This model only shows the potential resulting impacts from the rise of sea levels and is representative of the expected average highest high tide (MHHW). This representation does not take into account rainfall flooding.
Beyond Study Area
PageNumbers
Index Key
How to read the results | X Potential Impact (Flooding > 0");
Identify what it is using the primary legend in the top right of the map.
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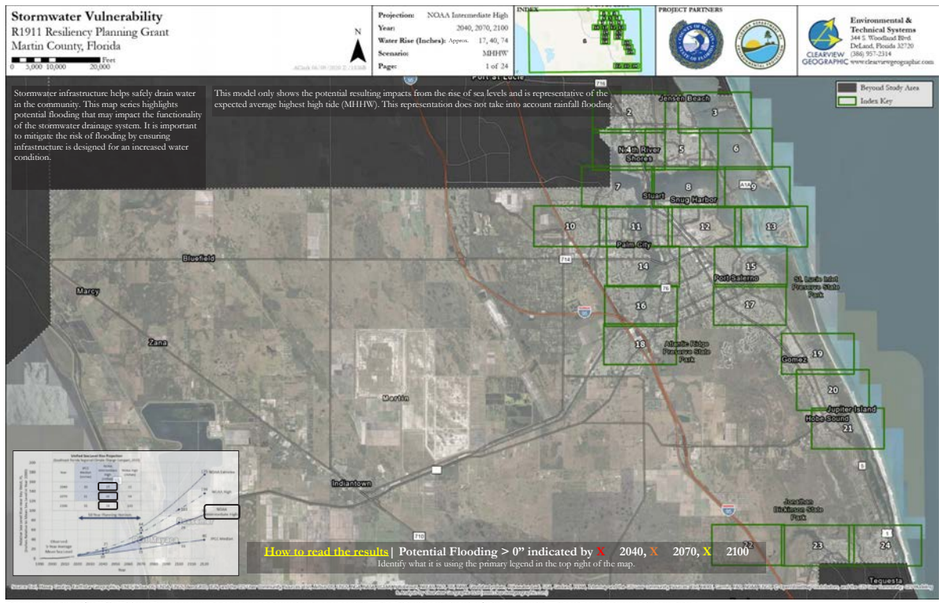
Stormwater Vulnerability
R1911 Resiliency Planning Grant
Martin County, Florida
Projection: NOAA Intermediate High
Year: 2040, 2070, 2100
Water Rise (Inches): Approx. 17, 40, 74
Scenario: MHHW
Page: 1 of 24
PROJECT PARTNERS
Environmental & Technical Systems
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DeLand, Florida 32720
(386) 957-2314
CLEARVIEW GEOGRAPHIC www.clearviewgeographic.com
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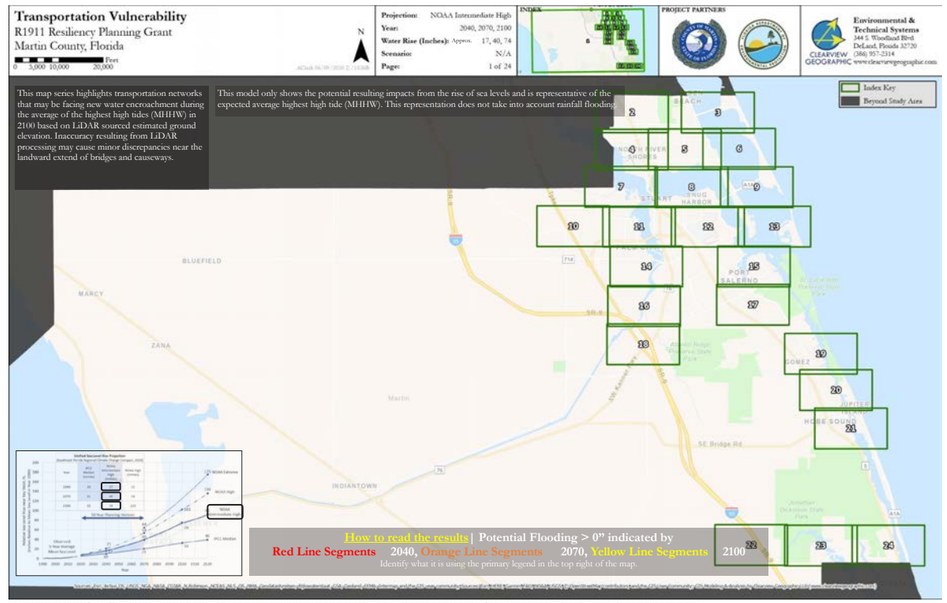
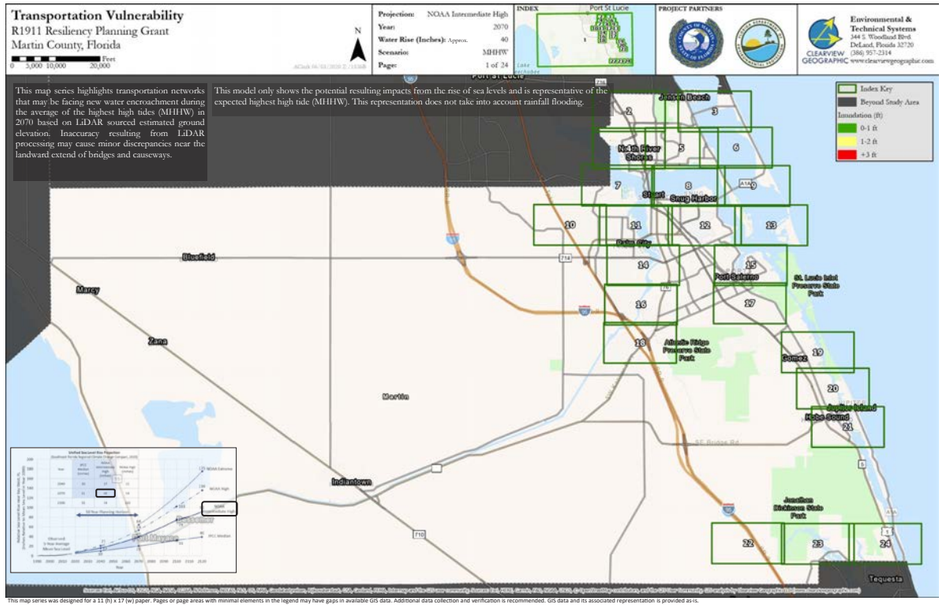
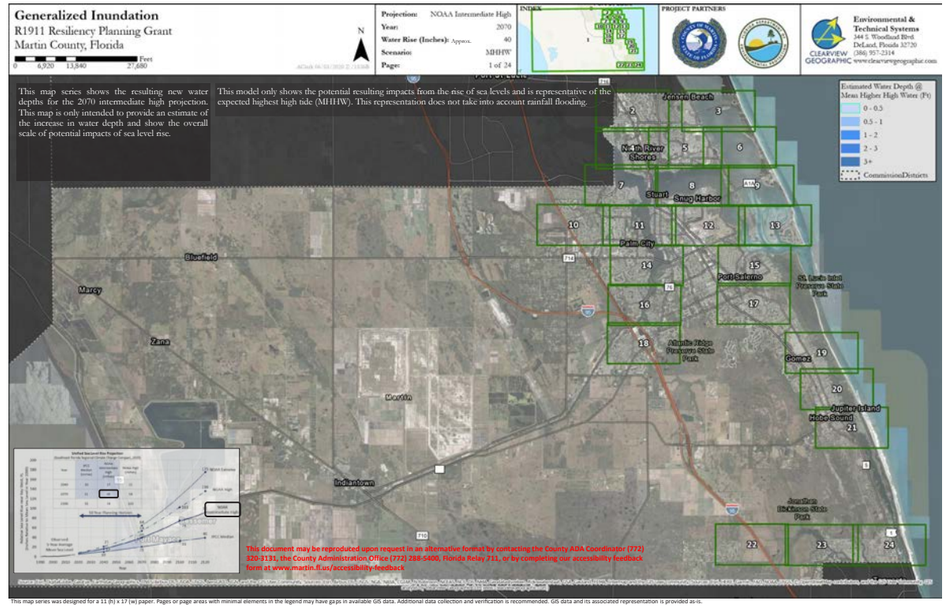
This model only shows the potential resulting impacts from the rise of sea levels and is representative of the expected average highest high tide (MHHW). This representation does not take into account rainfall flooding.
Beyond Study Area
Index Key
How to read the results | Potential Flooding > 0" indicated by X 2040, X 2070, X 2100
Identify what it is using the primary legend in the top right of the map.


Transportation Vulnerability
R1911 Resiliency Planning Grant
Martin County, Florida
Projection: NOAA Intermediate High
Year: 2040, 2070, 2100
Water Rise (Inches): Approx. 17, 40, 74
Scenario: N/A
Page: 1 of 24
PROJECT PARTNERS
Environmental & Technical Systems
344 S. Woodland Blvd.
DeLand, Florida 32720
(386) 957-2314
CLEARVIEW GEOGRAPHIC www.clearviewgeographic.com
This map series highlights transportation networks that may be facing new water encroachment during the average of the highest high tides (MHHW) in 2100 based on LiDAR sourced estimated ground elevation. Inaccuracy resulting from LiDAR processing may cause minor discrepancies near the landward extend of bridges and causeways.
This model only shows the potential resulting impacts from the rise of sea levels and is representative of the expected average highest high tide (MHHW). This representation does not take into account rainfall flooding.
Index Key
Beyond Study Area
How to read the results | Potential Flooding > 0" indicated by
Red Line Segments 2040, Orange Line Segments 2070, Yellow Line Segments 2100
Identify what it is using the primary legend in the top right of the map.


Transportation Vulnerability
R1911 Resiliency Planning Grant
Martin County, Florida
Projection: NOAA Intermediate High
Year: 2070
Water Rise (Inches): Approx. 40
Scenario: MHHW
Page: 1 of 24
PROJECT PARTNERS
Environmental & Technical Systems
344 S. Woodland Blvd.
DeLand, Florida 32720
(386) 957-2314
CLEARVIEW GEOGRAPHIC www.clearviewgeographic.com
This map series highlights transportation networks that may be facing new water encroachment during the average of the highest high tides (MHHW) in 2070 based on LiDAR sourced estimated ground elevation. Inaccuracy resulting from LiDAR processing may cause minor discrepancies near the landward extend of bridges and causeways.
This model only shows the potential resulting impacts from the rise of sea levels and is representative of the expected highest high tide (MHHW). This representation does not take into account rainfall flooding.
Index Key
Beyond Study Area
Inundation (ft)
0-1 ft
1-2 ft
+3 ft


Generalized Inundation
R1911 Resiliency Planning Grant
Martin County, Florida
Projection: NOAA Intermediate High
Year: 2070
Water Rise (Inches): Approx. 40
Scenario: MHHW
Page: 1 of 24
PROJECT PARTNERS
Environmental & Technical Systems
344 S. Woodland Blvd.
DeLand, Florida 32720
(386) 957-2314
CLEARVIEW GEOGRAPHIC www.clearviewgeographic.com
This map series shows the resulting new water depths for the 2070 intermediate high projection. This map is only intended to provide an estimate of the increase in water depth and show the overall scale of potential impacts of sea level rise.
This model only shows the potential resulting impacts from the rise of sea levels and is representative of the expected highest high tide (MHHW). This representation does not take into account rainfall flooding.
Estimated Water Depth @ Mean Higher High Water (Ft)
0 - 0.5
0.5 - 1
1 - 2
2 - 3
3+
CommissionerDistricts
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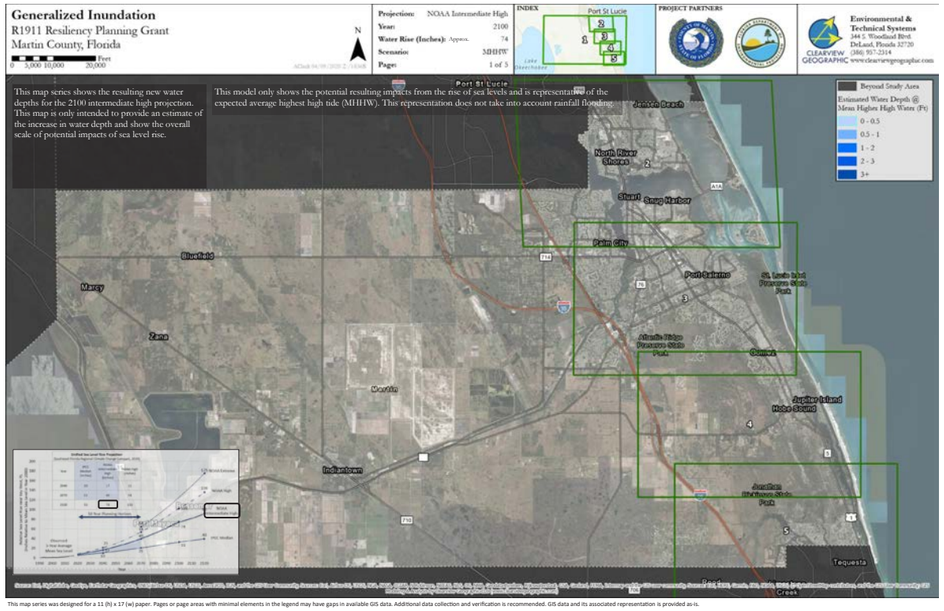

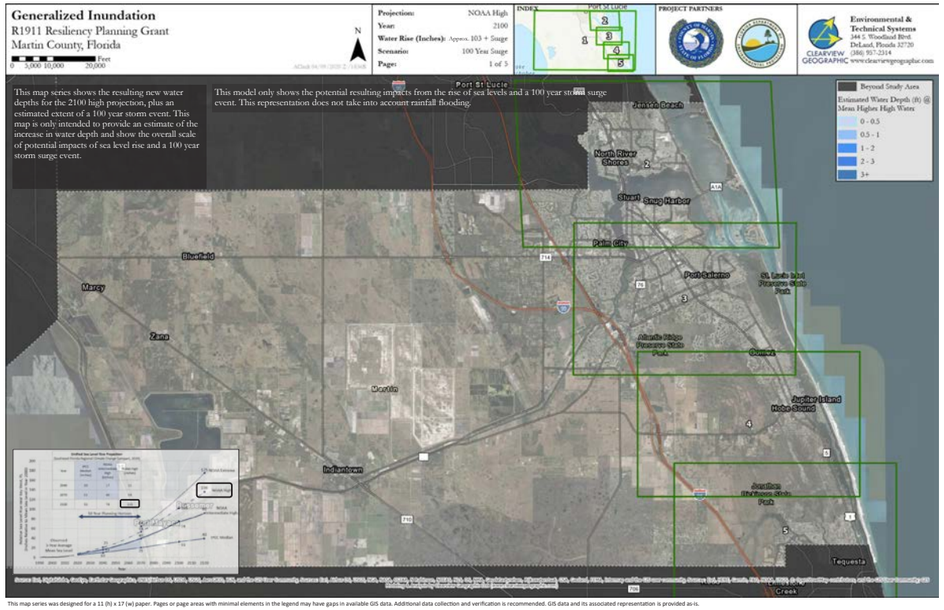

▶ APPENDIX D. ENDNOTES

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[ii] https://toolkit.climate.gov/content/glossary

[iii] https://www.usgs.gov/faqs/what-difference-between-global-warming-and-climate-change-1?qt-news_science_products=0#qt-news_science_products

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[v] https://www.usgs.gov/faqs/what-difference-between-global-warming-and-climate-change-1?qt-news_science_products=0#qt-news_science_products

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MARTIN COUNTY BOARD OF COUNTY COMMISSIONERS

2401 SE MONTEREY ROAD
STUART, FLORIDA 34996

MARTIN.FL.US/**RESILIENCE**

Connect with us

BCC MEETING DATE: March 23, 2021
AGENDA ITEM: DEPT-6

MARTIN COUNTY, FLORIDA
SUPPLEMENTAL MEMORANDUM

TO: Honorable Members of the Board of County Commissioners **DATE:** March 16, 2021

VIA: Taryn Kryzda
County Administrator

FROM: Kathy FitzPatrick, Coastal Engineer

REF: 21-0490
SUBJECT: **SUMMARY OF THE RESILIENCE PROGRAM'S - SEA LEVEL RISE REPORT**

Staff requests this supplemental Final Presentation and Final Report to be added to the above Agenda Item.

TK/kf
Attachment

RESILIENT MARTIN

SEA LEVEL RISE REPORT

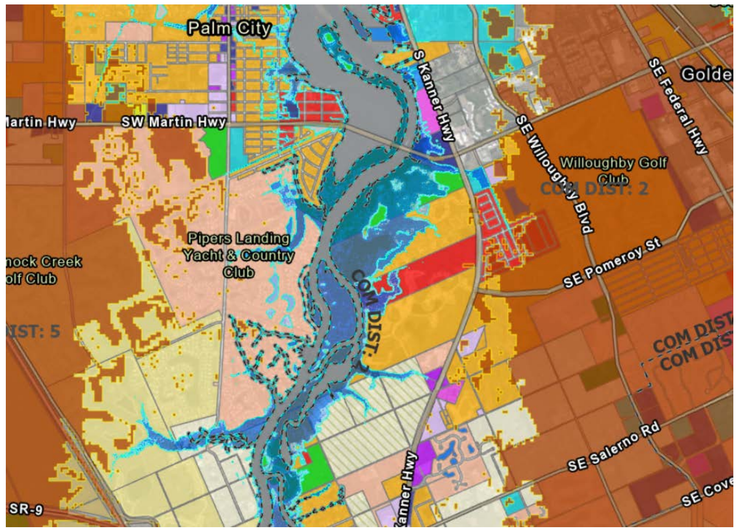
RESILIENT
MARTIN

REPORT FOCUS

COMMUNITY IMPACTS

MODELING AND MAPPING FUTURE WATER CONDITIONS FROM SALTWATER INUNDATION

- To assess potential vulnerability
- Community level impacts
- Focused on 2070



INFRASTRUCTURE FUNCTION

- In-depth consideration of future conditions
- Location and extent of flooding
- Project prioritization
- Focus on health and safety

PHASE 1 (CM933)

PHASE 2 (R1911)

Figure 1: Stages of Stormwater Infrastructure Failure due to Sea Level Rise

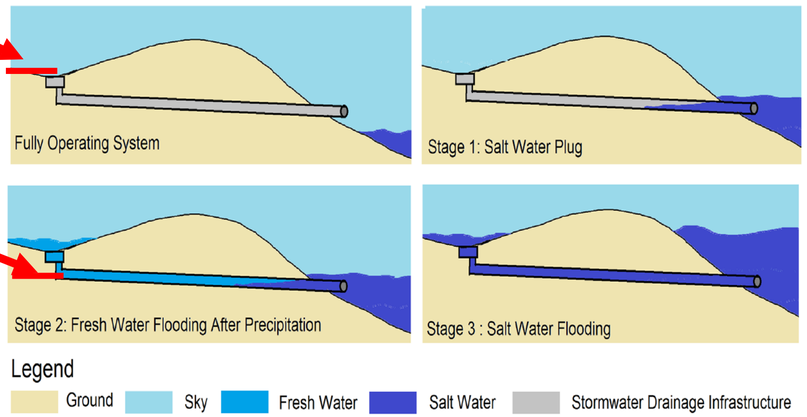
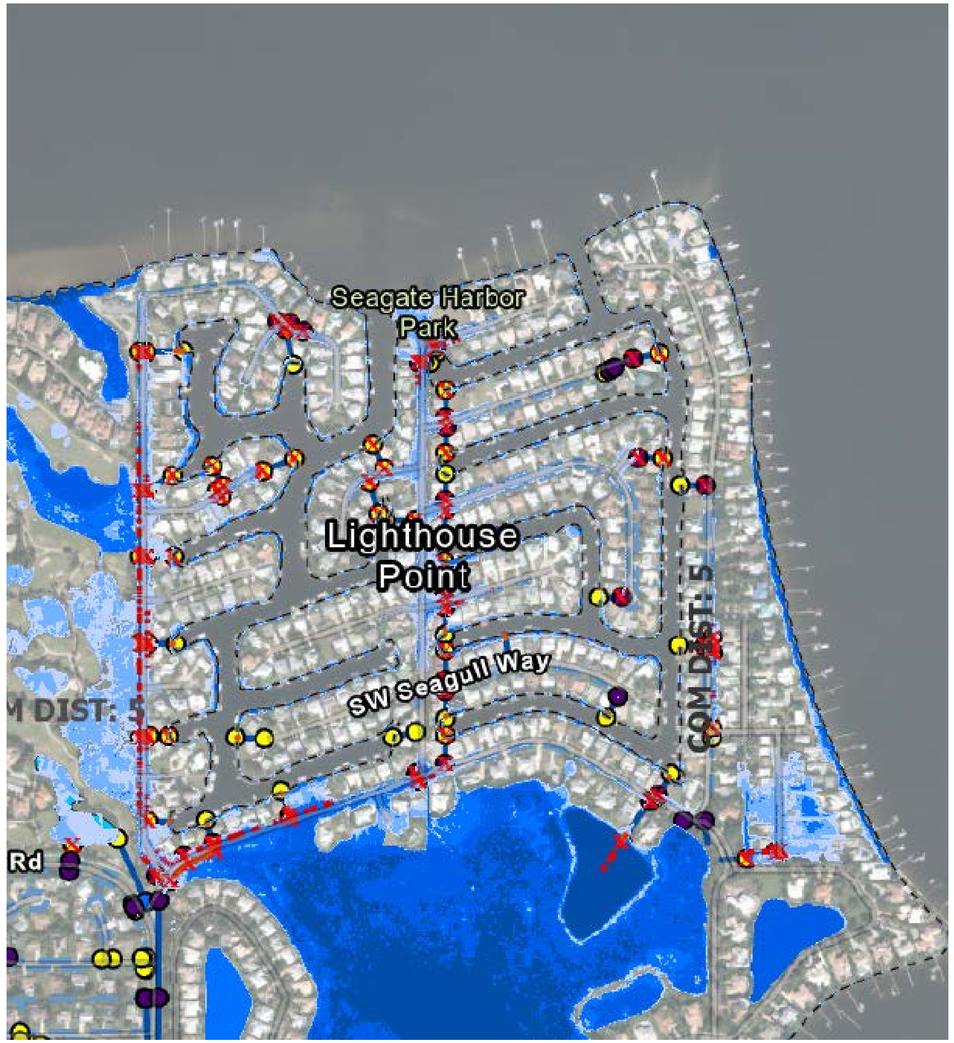
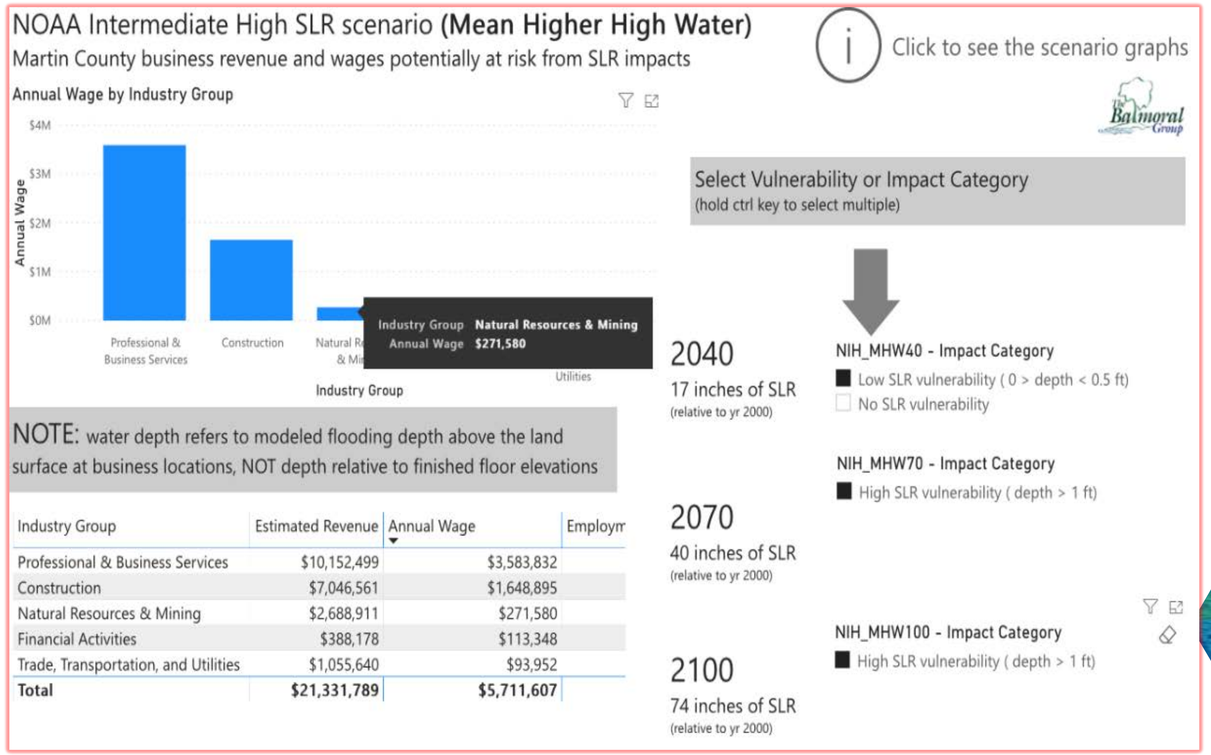


Figure By Emily Niederman



ECONOMIC ANALYSIS



Industry Group	Estimated Revenue	Annual Wage	Employm
Professional & Business Services	$10,152,499	$3,583,832	
Construction	$7,046,561	$1,648,895	
Natural Resources & Mining	$2,688,911	$271,580	
Financial Activities	$388,178	$113,348	
Trade, Transportation, and Utilities	$1,055,640	$93,952	
Total	**$21,331,789**	**$5,711,607**	

DATA DASHBOARD: MARTIN.FL.US/ECONVULNERABILITY

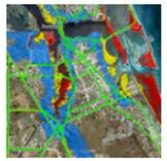
TOOLS YOU CAN USE

MAPS

NOAA Coastal Flood Exposure Mapper

NOAA's Coastal Flood Exposure Mapper enables users to explore maps that show people, places, and natural resources exposed to coastal flood hazards and create a collection of maps to share and communicate about flood exposure.

Flood Zones Map
Perform a property search via the county's Flood Zones Map to find out which flood zone your home or property is located in.



Storm Surge Map
View local areas which may potentially be inundated with storm surge, or whose evacuation routes may be impacted by storm surge.

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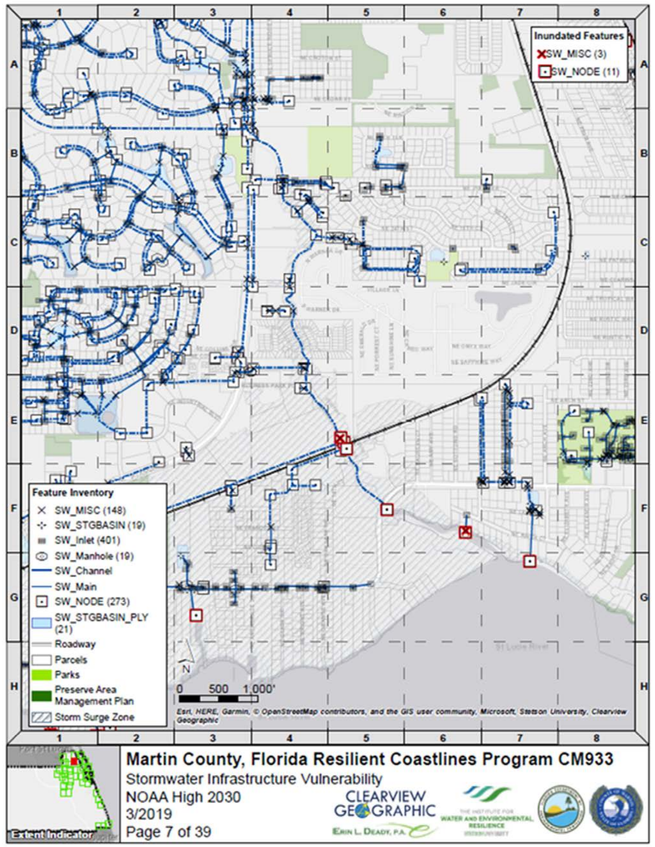
MARTIN

HOW DO WE USE THIS INFORMATION?

PLANNING AND PRIORITIZATION



- Vulnerability Analysis
- Linkages to Capital Improvement Program
- Project Siting & Construction
- Project Selection & Prioritization
- Comprehensive Planning
- CRS Rating Improvement
- Watershed Planning
- Shoreline Maintenance and Protection

INFORMATION SHARING

WHAT IS RESILIENCE?

OUR RESILIENCE PLAN

SEA LEVEL RISE REPORT

...rate at which Martin County residents face impacts from sea level rise is increasing along with the severity of those impacts. The County is developing response plans to address current flooding issues as well as future impacts from predicted sea level rise.

This report provides a brief background on climate change and sea level rise, explains the goals and analysis employed to develop the report and contains examples of both individual sector and overall economic impacts. Recommendations and links to actual work products are also provided in the report.

Sea Level Rise Report

SEA LEVEL RISE VULNERABILITY

These maps will show the potential sea level rise (SLR) in Martin County and the infrastructure that could possibly be impacted at 2070, 2100 and 2100 plus a 100 year storm.

2070 SLR VULNERABILITY MAP

2100 SLR VULNERABILITY MAP

2100+100 SLR VULNERABILITY MAP

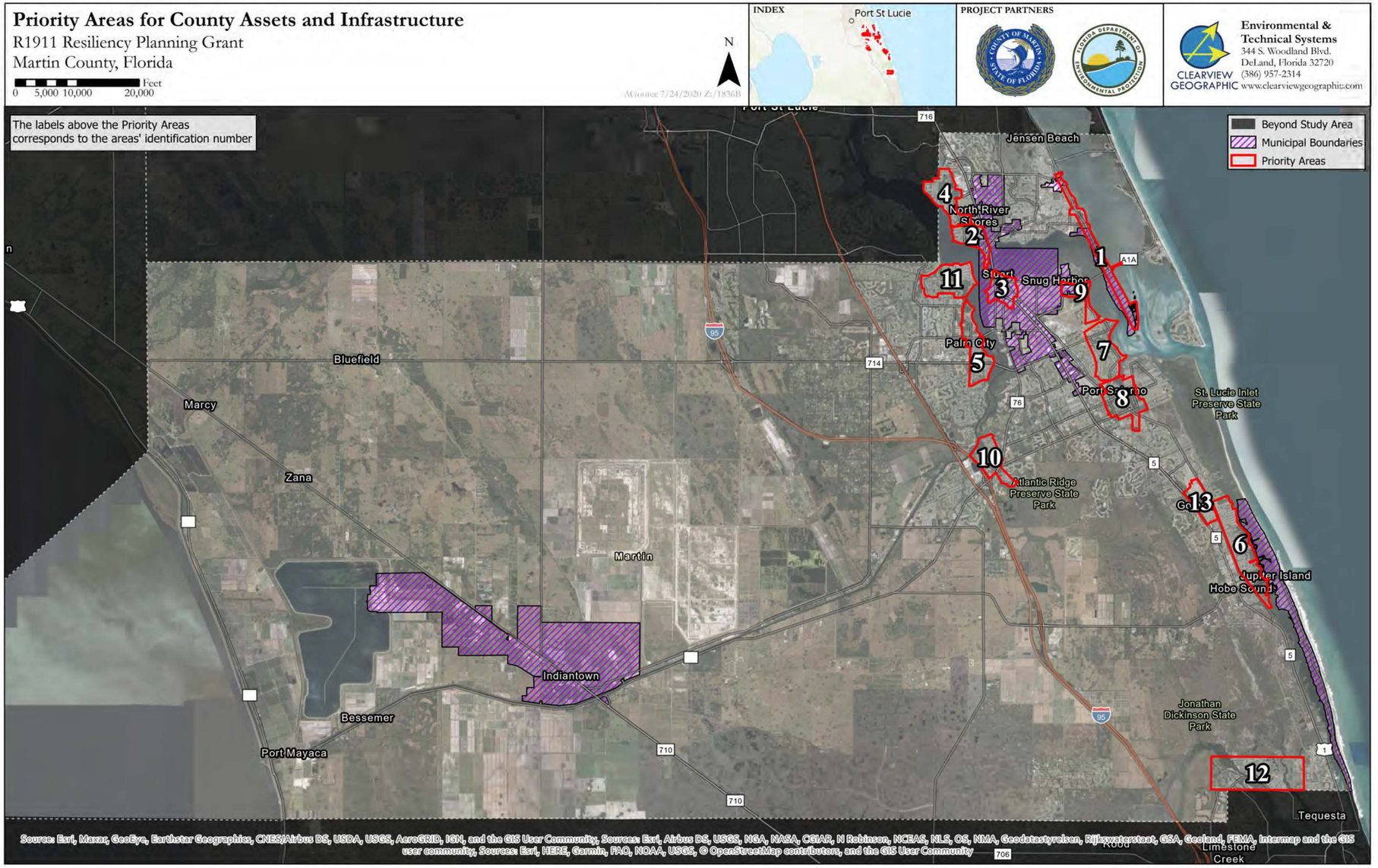
BY THE NUMBERS

4820	21	161	16
Waterfront Parcels	Miles of Beaches	Miles of Shoreline	Current Projects

MAPS

Coastal Flood Exposure

PRIORITY AREAS FOR COUNTY ASSET AND INFRASTRUCTURE

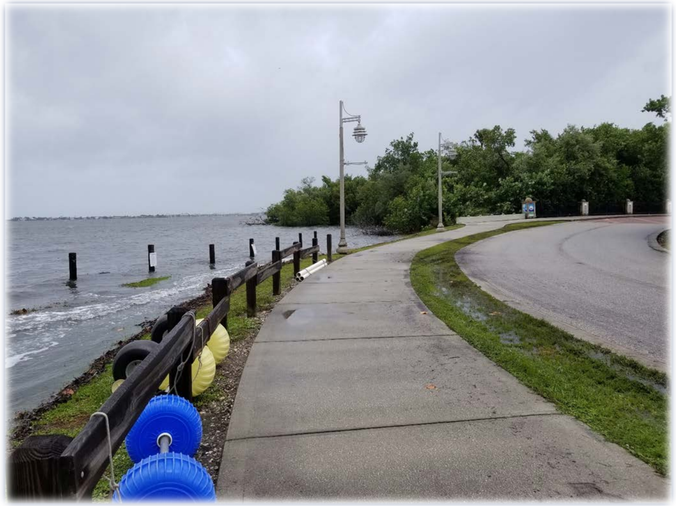


ADAPT AND MITIGATE FOR FLOOD RISK

SE COVE POINT RD
SEPTEMBER 22, 2020
2PM

SE MERRITT WAY UNDER WATER SIGN
SEPTEMBER 22, 2020

MITIGATE SHORELINE IMPACTS



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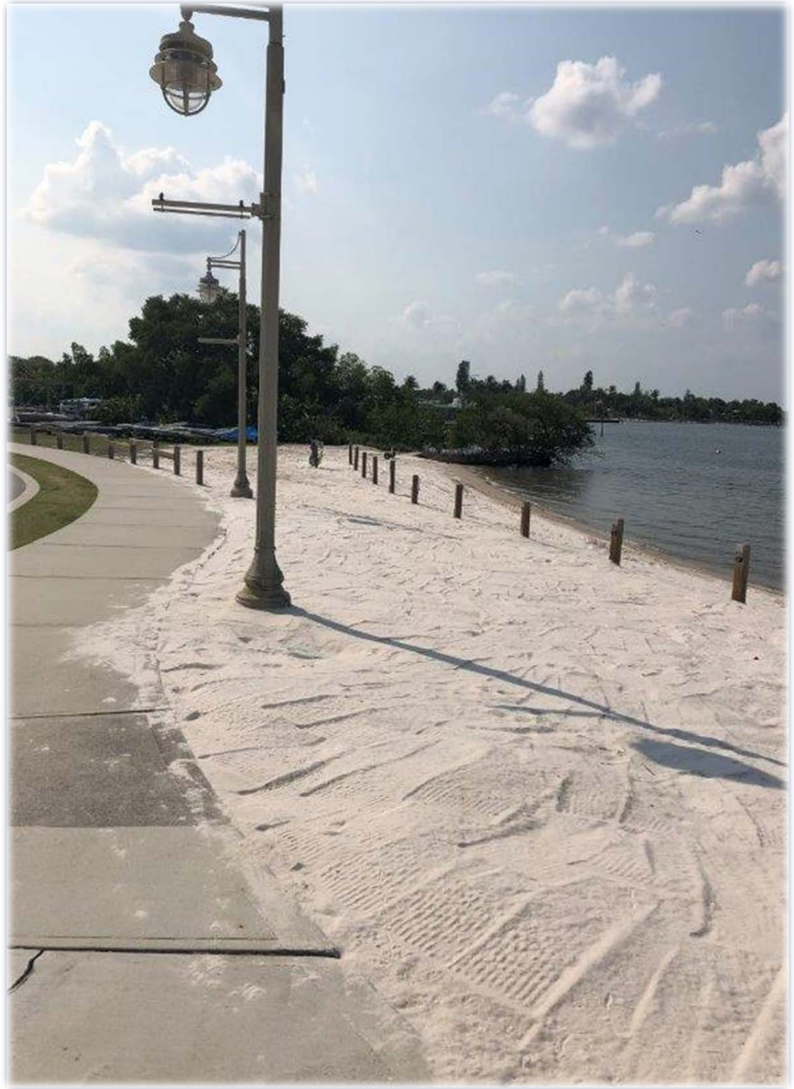
IMPACTS

AND

RESTORATION



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MARTIN

WHAT'S NEXT?

RESILIENT MARTIN RECOMMENDED ACTIONS

The SLR Plan includes 48 recommendations grouped into 4 main areas:

1. County Assets & Infrastructure
2. Land Development
3. Natural Resources
4. Socioeconomic

The recommendations also indicate an implementation mechanism which may include the need for additional data or analyses.

Specific County procedures are identified where feasible.

A projected timeline is established:

- Short (1-5 years)
- Moderate (5-10 years)
- Long (10+ years)

Martin County Sea Level Rise Plan Implementation Recommendations	
RECOMMENDATION	**TIMELINE** (Short:1-5yrs, Medium: 5-10yrs, Long: 10+yrs)
COUNTY ASSETS & INFRASTRUCTURE: TECHNICAL VULNERABILITY ANALYSIS	
1. Add vulnerability or flood risk factor into capital projects.	Short
2. Consider project life and relationship to sea level rise and flood risk in capital projects.	Short
3. Expand overall vulnerability assessment to include erosion rates, shoreline elevation, impacted stormwater discharge and commercial area metrics.	Medium
4. Make infrastructure retrofits and maintenance projects more resilient.	Short
5. Improve stormwater vulnerability analysis to factor in more data about structures, drainage basins, storage capacity and rainfall.	Medium
6. Enhance sea level rise modeling to link surge from hurricanes, precipitation and shorelines.	Long
7. Undertake modeling that relates surface water, groundwater and impacts to septic tanks and water supply wells.	Medium
8. Complete property level risk analysis with NFIP data.	Short
9. Expand information and coordination on sea level risk impacts to transportation systems.	Short
10. Use more detailed information related to elevations to determine road impacts from sea level rise.	Medium
11. Analyze individual at-risk facilities and assets to prioritize adaptation measures.	Medium
12. Incorporate property level building elevations into vulnerability analysis.	Short
13. Use vulnerability information in emergency management planning and project priorities.	Short
14. Collaborate with SFWMD to understand their coastal structure adaptation projects and relationship to County drainage.	Short
15. Create complete dataset on hazardous materials use or storage impacts by future flood risk.	Medium
16. Use “pilot” projects to help inform feasibility of adaptation measures.	Ongoing
17. Link CRA stormwater planning with vulnerability information.	Short
18. Determine if public open spaces can accommodate enhanced stormwater management benefits.	Short
19. Link ongoing sanitary sewer conversions with sea level rise vulnerability analysis.	Short
COUNTY ASSETS & INFRASTRUCTURE: ECONOMIC ANALYSIS	
20. Analyze future flood damage and economic impact to properties.	Short
21. Update previous economic analysis related to adaptation strategies.	Short
22. Determine costs and funding sources for adaptation.	Short
COUNTY ASSETS & INFRASTRUCTURE: POLICY DEVELOPMENT	
23. Review Comprehensive Plan and Code for linkages with recommendations in the Resilient Martin Plan.	Short
24. Integrate sea level rise projections into Comprehensive Plan and Design elements of Code.	Medium

RECOMMENDATIONS

1. Initiate the development of guidance documents for adaptation action strategies that include (but are not limited to):
   a. Develop engineering standards for resilient project development
   b. Assess the viability of exfiltration trench/soil storage as water levels rise
   c. Design criteria for living shoreline/seawall
   d. Develop a methodology to determine expected impacts to stormwater management as groundwater levels change
2. Initiate amendment(s) to the Comprehensive Growth Management Plan to improve resilience with emphasis on the Shoreline Protection Zone.
3. Include a resilience review for future Capital Improvement Projects that fall within the vulnerable areas as depicted in the SLR Report, using criteria that includes resilient engineering standards as they become available.
4. Approve the Resolution to Initiate Text Amendments to the Comprehensive Growth Management Plan