

Recommendations for the Community Resilience Initiative: Lessons Learned from Technical Assistance Process for Vulnerability and Climate Adaptation

Contract # C1469
Florida Department of Economic Opportunity

April 21, 2017

This publication was funded in part, through a grant agreement from the Florida Department of Environmental Protection, Florida Coastal Management Program, by a grant provided by the Office for Coastal Management under the Coastal Zone Management Act of 1972, as amended, National Oceanic and Atmospheric Administration Award No. NA14NOS4190053. The views, statements, findings, conclusions and recommendations expressed herein are those of the author(s) and do not necessarily reflect the views of the State of Florida, NOAA or any of their sub-agencies.



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EXECUTIVE SUMMARY

In the fall of 2015, three pilot communities, Escambia County, the City of Clearwater, and the City of St. Augustine, began a process to identify local vulnerabilities to sea level rise and then assess adaptation measures that could address the identified risks. These three communities are involved in the Community Resiliency Initiative Pilot Projects administered through the Florida Department of Economic Opportunity (DEO) and funded by the National Oceanic and Atmospheric Administration (NOAA). This report is intended to convey feedback from the participants (State, consultants, and pilot community stakeholders) as to what aspects of the project could be improved or would be most transferrable for other communities that may participate in similar projects in the future.

This report begins by summarizing activities conducted under Task 1 of the pilot project – the community Coastal Vulnerability Assessment. The knowledge, material and the outputs of Task 1, were leveraged by Task 2 – Adaptation Planning. The three pilot communities went through similar vulnerability assessment processes with varying degrees of community participation and data analysis:

Task 1 – Vulnerability Assessment

- Brief questionnaire provided to points of contact for pilot communities to help inform a kickoff meeting.
- Kickoff meeting to introduce project staff, timeline, expectations, and better understanding of what the pilot communities wanted to assess.
- A facilitated design meeting with each pilot community to allow project stakeholders to identify: sea level scenarios to assess; preferred method(s) of assessment; key sectors/functions of community to analyze; availability of supporting data; prioritization of vulnerability assessments to be performed.
- Presentation of draft vulnerability assessments to be incorporated into vulnerability report.
- Review of draft report by FL DEO and incorporation of feedback from communities that was obtained during the draft vulnerability assessment presentations.
- Final vulnerability report presented to FL DEO and the pilot communities.

Feedback from the pilot communities on the vulnerability assessment process centered on the interaction with the project team and the usefulness of the analysis performed.

Value of Interaction with Project Team (State, Consultants, Community Stakeholders)

- “Our workshops were valuable to me in order to get everyone at the table and hear their own concerns/perspective on how SLR will impact the City.”
- “I thought the amount of meetings was fine and I liked keeping the group small.”
- “There was enough in-person interaction for the risk assessment meetings.”
- Recommendation – “More interim updates between meetings or draft report reviews would be great.”
- Recommendation: “It would probably be of great benefit to work with one community at a time instead of trying to juggle multiple communities at once, as well as having one point of contact for a community.”
- Recommendation – “After the analysis is complete hold a public workshop to get buy in from the community.”

Value of Risk Assessments Performed for the Communities

- “I thought that the creation of the three risk scenarios (nuisance, MHHW and 100-year) in GIS was effective especially when looking at street segments. The street segments is important indicator for utilities and city services that will be impacted.”
- “We found that the sand erosion/accretion map to be highly informative and useful. Since our economy is based on tourism, it’s good to know where we can predict to have to do more or less beach nourishment projects.”
- “We also found that had we had finished floor elevations, the flood maps and data may have been able to provide more of an answer. Even without that data, we still have enough of a starting point that if we were to start collecting other pieces of data we would be able to better utilize what we were provided.”
- “We found the water table/rain fall analysis to not be of much use. We felt that water supply inundation would have been more useful, and how that would potentially affect our groundwater replenishment projects.”

Task 2 – Adaptation Planning focuses on reviewing existing federal, state, and local programs and policy to provide strategy recommendations that focus on the City’s priorities and identified risks. Such strategies are intended to be integrated into existing local planning, policy, and budgeting mechanisms. The process for supporting the communities with adaptation planning is as follows:

Task 2 – Adaptation Planning

- Kickoff meeting to introduce planning staff, timeline, expectations, and identify community concerns.
- A facilitated meeting with each pilot community to educate stakeholder on state and federal policies for adaptation. The second half of the meeting was designed to identify:
 - A common framework for understanding physical and policy options for adapting to sea level rise (SLR);
 - Characterization for particular adaptation issues in terms of their urgency, scale (physical and budgetary), relevance to particular constituencies, and ease or difficulty of address;
 - Strategies suitable for addressing particular adaptation issues.
- Summarize feedback from facilitated meetings.
- Review of draft report by FL DEO and incorporation of feedback from pilots.
- Conference call with consultants, FL DEO, and pilot communities to understand any concerns with the adaptation report and recommendations.
- Final adaptation strategy report presented to FL DEO and the pilot communities.

The pilot communities provided comments on the adaptation planning process primarily related to the kickoff meeting and the facilitated workshops. Once the communities were presented with the draft adaptation planning reports, conference calls were held to gather additional feedback. During the calls, interaction with a broader group of stakeholders provided new insights to community concerns with releasing the adaptation documents as structured in the drafts.

Interaction with Project Team and Utility of the Process

- “The workshop was filled with interesting information specifically it was helpful to discuss the legal aspects of SLR.”
- “The planning document will be used to propose recommendations for the next Comp Plan update.”

- “We did enjoy the meeting with the law school and how well it was facilitated. It was also good that they explained how to break down a state statute into smaller pieces that are easier to understand.”

Community Comments, Concerns, and Suggestions Regarding the Draft Plans and their Recommendations

- Stakeholders new to the process were hoping to get a list of specific structural recommendations that they could seek funding for and start implementing in the near future.
- Report could be structured differently to more clearly identify recommendations.
- The report would be better suited to include any perceived legal opinion as an appendix or otherwise separated from other aspects of the report.
- The report was very thorough and well thought out. However, it would be helpful to more clearly identify items intended to represent the spectrum of legal options and model language versus actual recommendations.

1. SCOPING PROCESS

The three pilot communities had differing concerns going into the project and thus their approaches, priorities, and assessments varied from the beginning. To facilitate the scoping process, a series of activities were performed with each pilot to gather their initial thoughts and engagement of the process. First a call was held with the point of contact to provide an overview of the vulnerability assessment and determine the date for a kickoff meeting. Following the introductory call, each community point of contact was provided a questionnaire for distribution to their stakeholders and a date was set for a formal kickoff meeting to be held in person and/or web-based meeting. The kickoff meeting was intended to further distill what approaches and priorities made the most sense for each community and laid the groundwork for a formal, facilitated workshop. The workshop would then engage the stakeholders directly to understand the point of view of each agency participating (ie public works, planning, economic development, non-profit conservation, etc) and their top concerns as well as the outcomes they hoped the vulnerability assessment and ultimately the adaptation strategies would achieve. A scoring activity helped to narrow down the diverse priorities into those most important and achievable within the timeframe of the project. Following the session, a summary document of the workshops was sent around to each pilot community to verify the consensus that had been reached for the methodologies and activities that would be performed during the vulnerability assessment. The following section identifies what worked and what could have been improved for the scoping process.

What Worked?

Items that facilitated discussion and familiarity were the most productive:

- The iterative process helped participants to understand the nature of the project and understand perspectives of all stakeholders.
- The facilitated discussion helped participants to look at broader areas of concern outside of their area of interest and then narrow priorities to the most appropriate within the constraints of the project.
- Having a project team of mixed backgrounds (scientists, planners, engineers) helped answer stakeholder questions and provide recommendations based on their subject matter expertise.

What Could be Improved?

Suggestions from stakeholders on focusing the teams were as follows:

- While the iterative process was helpful, some participants felt that if there were a way to focus the subject matter prior to in-person meetings, then they could have brought in more stakeholders specific to the task.
- Some of the meetings had participants join remotely. Technological challenges with the equipment (different for each community) made it hard to communicate with attendees. The systems could have been tested prior to the meetings to determine audio and video quality. In-person meetings would be preferred but would require the budgets to account for this need.
- Understanding the availability and quality of the local data would help to identify which information would be best to utilize during the assessment.
- Although pilot communities were presumed to be interested in climate adaptation planning, some participants were a little antagonistic to the process. It would benefit the process to have stakeholders for each community have a consensus on their position/intent towards adaptation efforts to make the best use of limited meeting time.

2. SCOPING TOOLS AND PROCESSES

2.1. *Initial Questionnaire*

To initiate the project, the project team used a questionnaire to learn the City's motivation and goals, existing flood related issues, understanding of sea level rise (SLR), and data assets available for the study. At the project Kickoff Meeting, participants discussed the City's responses and used that information to shape the scope of the discussion during the design meeting.

The questionnaire asked the following eight questions:

1. What do you want the community to get out of the coastal resilience vulnerability and adaptation study?
2. Should the study focus on a particular geography of the community, such as a downtown or area targeted for redevelopment? If so, please describe.
3. Should the study focus on particular infrastructure (e.g. due to aging, proximity to hazard, etc.)? If so, please describe.
4. Has the community discussed planning scenarios in relation to adaptation planning?
5. Are there particular timelines (e.g. the master planning time frame) that are of interest?
6. What data do you have about the community to help characterize the built environment and natural assets?
7. Studies of this type typically involve leadership from the departments responsible for emergency management, public works, and planning. Who from the community do you anticipate being key points of contact from your community (provide name, phone, and email)?
8. Stakeholder engagement will be a key to long-term success for any of the initiatives developed during this process. Please list who you perceive as stakeholders to this project.

2.2. *Design Meeting*

The purpose of the design meeting was to frame the problems faced by the City with respect to coastal resilience, and to identify analysis products that would support the adaptation planning process. The design meeting also served as a forum to discuss and identify the flood event types and SLR scenarios for use the vulnerability assessment with the City representatives. The breakout sessions during the January design meetings revealed a number of key issues, identified by attendees representing the City and the Florida DEO. Discussion also served to identify additional datasets that could be leveraged to assess issues. A synopsis of the design meeting follows, with a full summary provided in Appendix B.

Priority issues included:

- Realistic options for adapting the city's historical resources to SLR.

- Realistic options for adapting the city at large while also managing aging infrastructure.
- Understanding tipping points for when facilities and buildings will be compromised.
- Positioning the city to obtain funding for planning (master planning, capital improvement planning).

Subsequent to the design meeting, the research team contacted the designated personnel and collected the data described during the meeting. This data augmented basic geospatial data already supplied by the community. Based on the issues identified, data holding and initial data exploration, the team refined the problem statement and developed a proposed approach, which is described in Section 2.3. As processes for 2.2 and 2.3 are fairly intertwined, the feedback and recommendations are combined below 2.3.

2.3. Work Plan

Task 1 of the overall study effort focused on performing a vulnerability and risk assessment to assess the community's potential impacts from SLR. The design meeting, as described in the preceding section, included facilitated breakout sessions to gain an understanding of the pilot's goals and concerns, which informed the problem statement. Discussion also focused on establishing the SLR scenarios and flood conditions for the study effort. The flood conditions and SLR scenarios decided on from that discussion is presented in the following section and thus not repeated here. From the design meeting, the study team developed a work plan to address the key items identified during the design meeting breakout sessions. A draft work plan was circulated to the pilot communities for feedback. The study team finalized the work plan to accommodate feedback and then initiated the vulnerability assessment. The assessments presented in this report reflect this process.

What Worked?

- The questionnaire was effective to communicate initial thoughts to the consultants ahead of the Design Meeting.
- The Design Meeting allowed participants the chance to discuss very specific concerns as well as communitywide priorities.
- Community staff was able to work with stakeholders from other disciplines/departments to understand challenges of their peers.
- Stakeholders were able to reach consensus on assessments to prioritize.
- Pilot communities were presented with examples from other parts of the country to have an understanding of how others have approached the issues.

What Processes Could be Improved?

- As noted earlier, it was hard for remote participants to effectively communicate.
- It was hard for communities to decide the best option when considering constraints of project (funding and schedule). Should they request the resources for one or two items to be studied in-depth or so do high-level assessments for 5-10 sectors?
- The communities liked the multi-disciplinary panel (planning, emergency management, coastal science, and engineering) of consultants. However, it would be helpful to add an economic/grants-focus to the panel.
- The schedule was compressed due to items outside the project team's control. Participants noted that it would be beneficial to have more time to review drafts of documents and presentations to provide additional feedback.

3. MAPPING OF SEA LEVEL RISE CONDITIONS

One of the first activities for each pilot community to reach consensus on was the approach to mapping and assessing sea level rise (SLR). Facilitated sessions with the communities focused on explain the latest estimations of SLR as well as the uncertainties associated with the most accepted models. Additionally, once the communities determined which curve/scenario was most appropriate to their planning needs, they needed to identify what time horizons to focus on and how they would represent that in their assessments (rounded to the nearest foot, range, etc).

3.1. *What was the Process for Mapping Sea Level Rise?*

The first step for mapping SLR was to establish SLR scenarios in consultation with the community during the design meeting. The results for the three communities were as follows:

- **City of St Augustine:** The community preferred an incremental water level approach - where existing water level conditions are raised at specified increments from present day to the highest NOAA SLR projection considered. Two future time-frames were considered for the bases of the SLR projections. A relatively short-term horizon approximately 30 years from today (2045), and a relatively long-term horizon 70 years from today (2085).
 - o Key benefit of this approach to the community was that these two time horizons **enabled them to relate vulnerability results to the life cycle of municipal plans and infrastructure.**
 - o The city also chose to assess impacts at every half-foot to determine elevations that would **trigger “tipping points” for action.**
 - o The city focused on three coastal flood event types including tidal, nuisance the 1% annual chance flood.
- **City of Clearwater:** The design meeting established a preference for representative short-, moderate-, and long-term values with short-term value providing a “no regrets” planning elevation.
 - o Key benefit of this approach was that the vulnerability results **provide representative elevations that decision makers could utilize for land use and design guidelines.**
 - o The approach allowed the City to look an array of scenarios while utilizing data consistent with the Tampa Bay Climate Science Advisory Panel.
 - o The City identified the coastal flood types of interest as the nuisance flood as well as the 100-yr and 500-yr recurrence interval floods.
- **Escambia County:** Two future time-frames were considered for the bases of the SLR projections. A relatively short-term horizon approximately 30 years from today (2045), and a relatively long-term horizon 70 years from today (2085). These time horizons relate to municipal planning (short-term) and critical infrastructure planning (long-term). The two time horizons were then further broken down to account for low, medium, high, and highest projections from the USACE and NOAA SLR curves. Feedback from the community participants was that they preferred to be fully transparent about the range of uncertainty in the future projections. The decision was made to create mapping information and perform the vulnerability assessment using exact values from each for the two future time horizons, in lieu of representative values.

- Key benefit is that by focusing on two time horizons, the **community simplifies the decision-making framework within planning**. It also provides **transparency and clarity by identifying specific elevations** per current available science.
- The community selected tidal, the 1% annual chance flood, and the 0.2% annual chance flood to evaluate.

3.2. How will Vulnerability to Flooding (Area Inundated) Change with Sea Level Rise?

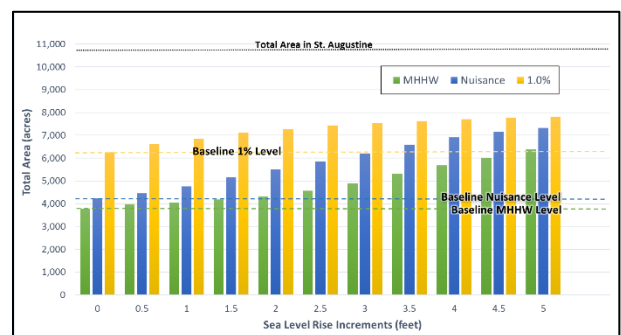
SLR increases water elevations relative to land, resulting in larger and deeper floods. Vulnerability to these future conditions varies by each flood type and local land elevations. The mapping layers produced for each flood type and SLR scenario were reviewed to gain a better understanding of how each flood type would change with SLR. The graphics chosen to convey the results went through an iterative feedback with the communities. The information was presented to them at a final vulnerability meeting to understand what was easily understood and what may have been confusing for the participants; knowing that they would need to incorporate these into other internal documents and communicate out to additional stakeholders. The final report to each community reflected the feedback received from each group. The original graphics and their captions/explanations are provided within each community’s vulnerability report.

City of St. Augustine:

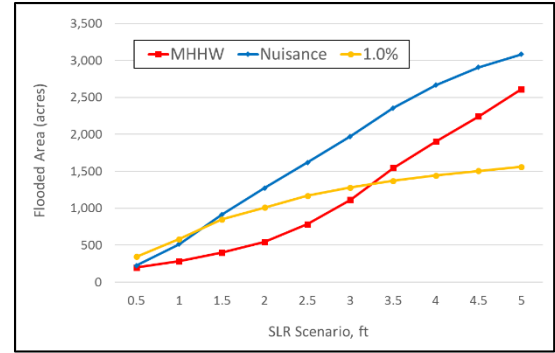
Area (acreage) impacted under the three scenarios of MHHW, nuisance flooding, and 1% annual chance floodplain was assessed. Acreage was calculated at the ½-foot intervals as chosen by the city and then compared relative to each event’s existing baseline. Of note in the city, nuisance flooding grows the fastest, followed by MHHW, and then the 1% annual chance floodplain.

- The acreage of areas inundated was presented several ways to convey the results:

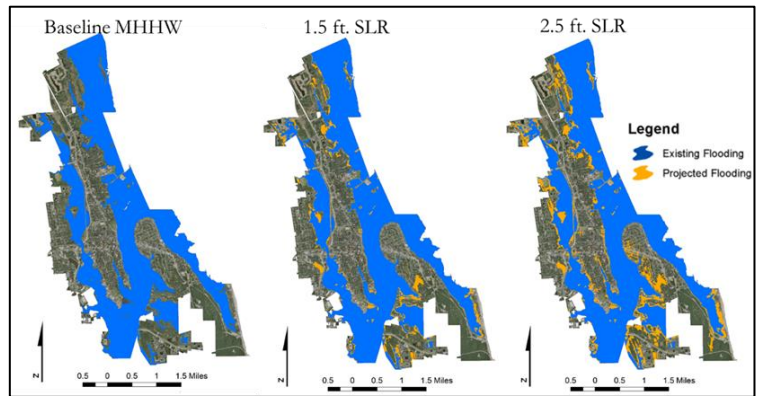
- Combined bar chart with baselines for each flood event - This helped show the potential growth in acreage related to each type of flood event. Also, a line representing all area within the county was later added to the chart which helped illustrate the percent of community acreage susceptible per each event.



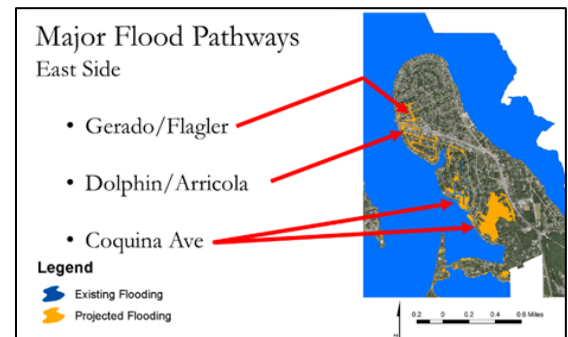
- Line-graph identifying the change in acres inundated – The line chart was utilized to help show the rate of increased inundation per each event. This made it easy to show that nuisance flooding grew the fastest and where the tipping points for this metric occurred illustrated by the slope change.



- Maps of area impacted – For each scenario, maps were also very effective to help visualize what geography within the community would be at risk. The data behind the maps could be utilized to visualize all scenarios but for the sake of a concise document, several key scenarios were mapped and presented within the vulnerability report itself.



Additionally, the City was provided with graphics that **identified the major pathways for flood inundation**. These helped to illustrate where the most vulnerable areas within the City are helped to provide focus on where investments should/should not be made.

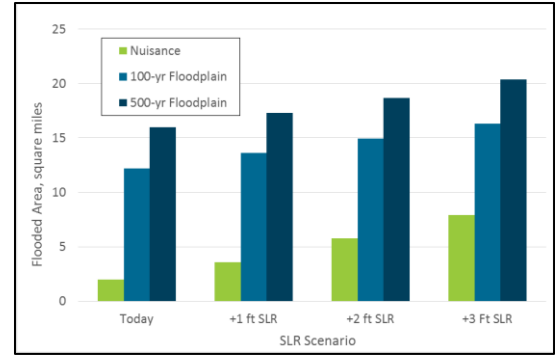


City of Clearwater

Area (square miles) impacted for the +1, +2, and +3 foot scenarios for each flood type chosen by the city (nuisance, 100-yr floodplain, and 500-yr floodplain) was evaluated. As Clearwater has shoreline on two sides (Gulf of Mexico and Tampa Bay), some of the graphics were chosen to highlight areas of importance on both shores.

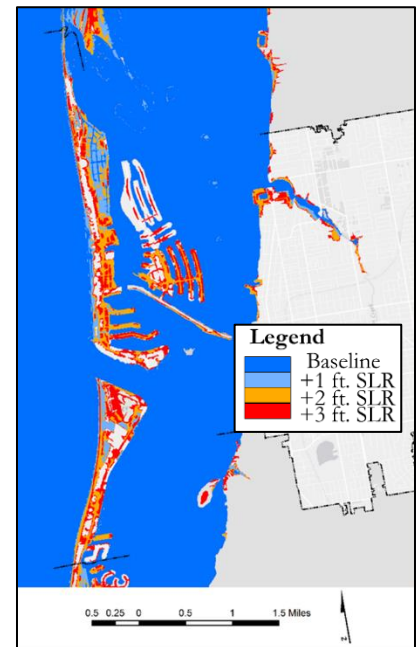
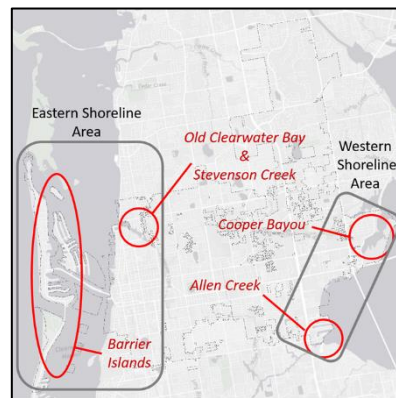
- The areas of increased inundation were presented as follows for Clearwater:

- Combined bar chart each flood event by the +1, +2, and +3 scenarios - This helped show the potential growth in square miles inundated related to each type of flood event. This style of chart also made it easy to visualize that the area inundated by nuisance flooding will increase approximately three-fold while the other flood types have a fairly linear progression as SLR gets higher.



- Maps of area impacted - The map coverages for the City’s vulnerability to future flooding were broken out into two areas, including the western shoreline (Gulf of Mexico, Clearwater Harbor and St. Joseph Sound shorelines) and the eastern shoreline (Old Tampa Bay shoreline).

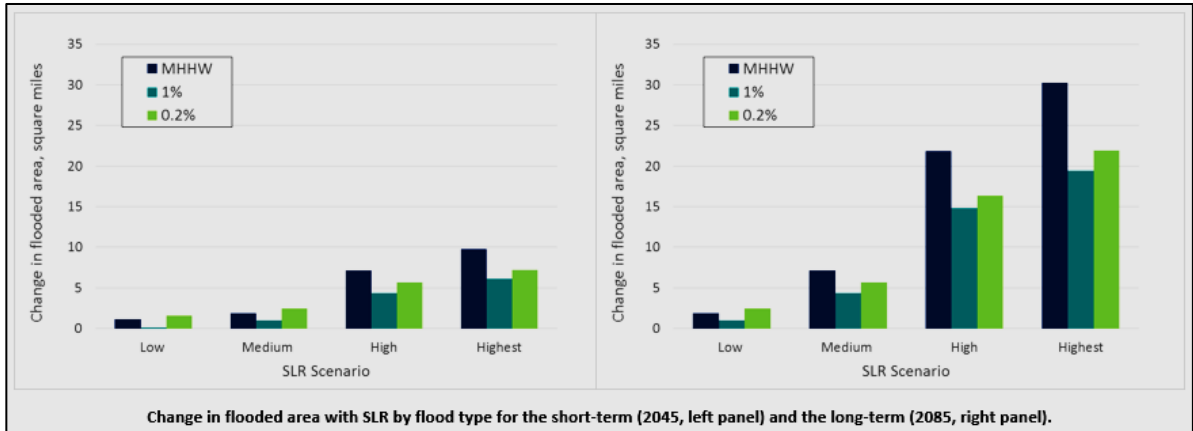
Additionally, a high-level “hot-spot” graphic was provided to illustrate those particular areas of interest where the most inundation was occurring on the two shorelines. This helped focus the discussions that occurred during the meetings.



Escambia County

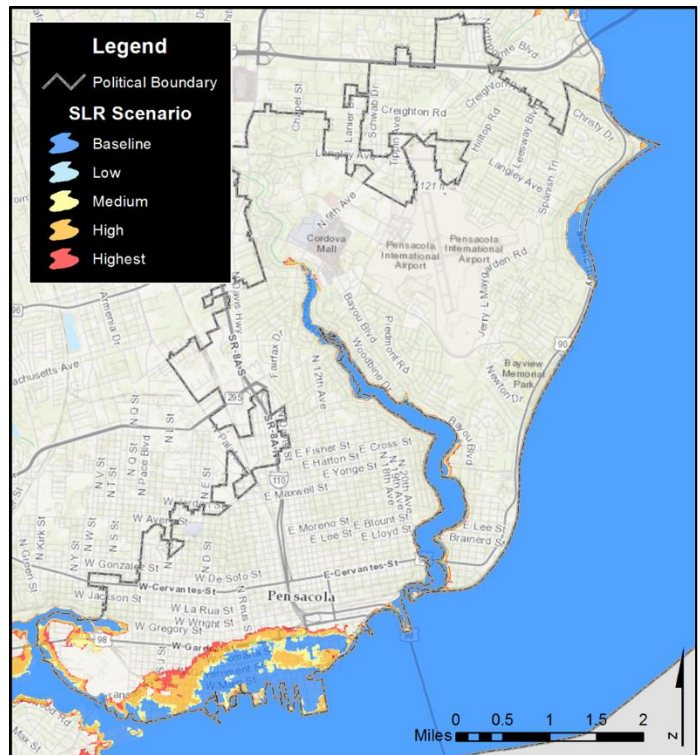
Area (square miles) impacted in the short-term (Year 2045) and the long-term (Year 2085) for each flood type chosen (MHHW, 1% annual chance, 0.2% annual chance) was identified during the assessment. The fact that this assessment was countywide meant the geographic scale for mapping was considerably different than the cities and less clear to illustrate vulnerabilities. Additionally, the topography in the county is significantly different (more elevation and vertical relief) than the other two pilots and so the county is fairly insulated from impacts at the shore but areas along the rivers going inland could experience different effects.

- The areas of increased inundation were presented as follows for Escambia.
 - Side-by-side combined bar chart for the 2045 and 2085 scenarios - This helped show the potential growth in square miles inundated related to each type of flood event per each SLR projection curve and time horizon. This visualization made it easy to see that there are limited



increases in areas expected to be inundated in the short term. However, should the long-term high- or highest scenarios occur, there will be a significant increase to the area inundated for all three flood types.

- Maps of areas impacted – As noted above, the countywide scale of assessment was challenging to convey impacts. To help communicate the results, a series of maps was created to visualize the three flood types and two time horizons at different geographic scales. These included a series of countywide maps, a series of maps for downtown, and a series of maps for the southern county and coastline. As with the other counties, the maps were helpful to facilitate discussions during the stakeholder meetings.



3.3. Additional Sea Level Rise Metrics Requested by Pilot Communities

Beyond the identification of what SLR scenarios, time horizons, and flood types to evaluate, the pilots had specific concerns that they wanted to further investigate as data and project constraints allowed. In some cases, the pilots allocated the resources to more robust asset assessment as opposed to a unique SLR metric. These assessments are itemized below along with the value it provided to the community.

St. Augustine

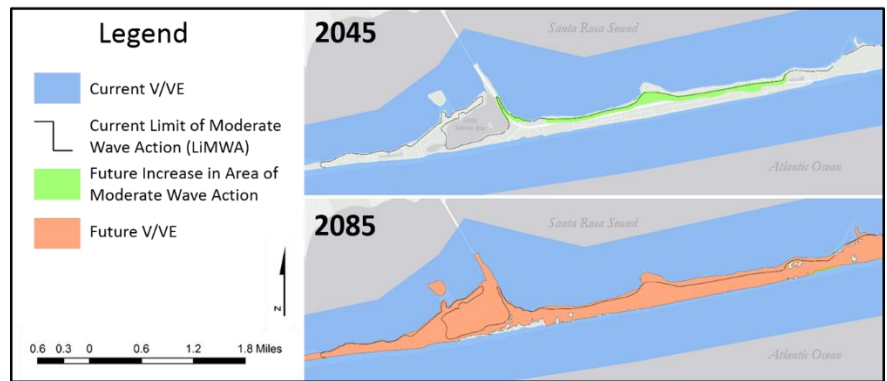
Changes in flood frequency – this assessment was performed to understand how SLR will affect flood frequencies, which were characterized using recurrence intervals. Changes in recurrence intervals were calculated using a tool developed for the Federal Transit Administration. For example, if SLR increases by 2-feet above the existing condition we can expect the 100-yr event to become a 5-yr event.

Reductions in recurrence intervals under SLR scenarios.										
Existing Recurrence Interval, years; (Percent annual chance)	SLR Increment, feet above existing condition									
	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
	Estimated Recurrence Interval, years									
10 (10%)	4	2	1	1	1	1	1	1	1	1
50 (2%)	16	5	2	1	1	1	1	1	1	1
100 (1%)	71	50	16	5	2	1	1	1	1	1
500 (0.2%)	334	223	149	100	71	50	16	5	2	1

Escambia County

Change in future wave hazard zones

– the study included an assessment of how the location of coastal wave hazard zones would change in response to SLR. Proactive management of building requirements in such areas could help mitigate future storm damages. Outputs of the wave hazard modeling included GIS coverages delineating changes to the VE Zone and Limit of Moderate Wave Action (LiMWA). Notable changes in the VE Zone and LiMWA were limited to the southern portion of Escambia County. An example of one of the areas assessed is shown above.



4. VULNERABILITY ASSESSMENT

The objective of the vulnerability assessment was to identify infrastructure impacted by sea level rise (SLR) scenarios and to summarize key impacts. Geospatial data holdings varied per each pilot community and each community had their own focus areas and SLR scenarios which impacted how the assessment was conducted and reported/visualized. The overview and comparison of each pilot is presented below.

St. Augustine

Component	Metrics
Roads	<ul style="list-style-type: none"> Percent of network affected by scenario Days inundated for road segments
Infrastructure	<ul style="list-style-type: none"> Bridges, Water/Wastewater
Historic Resources	<ul style="list-style-type: none"> Structures impacted
Archaeological Resources	<ul style="list-style-type: none"> Percent of archaeological zone or cemetery affected by scenario
Groundwater impacts	<ul style="list-style-type: none"> Local and regional response to SLR

Clearwater

Component	Metrics
Roads	<ul style="list-style-type: none"> Percent of network affected by each flood type and SLR scenario combination
Buildings	<ul style="list-style-type: none"> Change in number of buildings exposed to flooding from each event type and SLR scenario
Bridges	<ul style="list-style-type: none"> Bridges impacted by flooding from each event type and SLR scenario
Facilities	<ul style="list-style-type: none"> Structures exposed (fire stations, schools, and wastewater treatment facilities) to flooding from each event type and SLR scenario
Groundwater Impacts	<ul style="list-style-type: none"> Local and regional response to SLR

Escambia

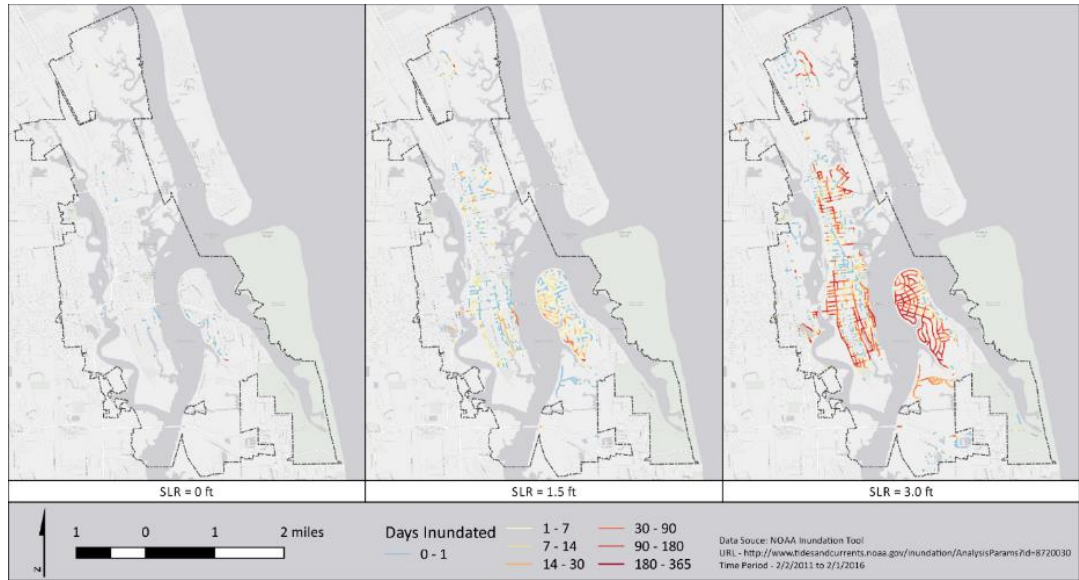
Asset	Information Analyzed for Each Asset
Parcels	<ul style="list-style-type: none"> Number of vulnerable parcels
Roads	<ul style="list-style-type: none"> Miles of network affected
Bridges	<ul style="list-style-type: none"> Bridges impacted
Community Facilities	<ul style="list-style-type: none"> Identified vulnerable structures

4.1. Road and Bridge Vulnerability Assessment

In all three communities, the road network was assessed to identify vulnerability per each SLR scenario. This provided the opportunity to evaluate these risks slightly differently per community. In each community, the vulnerability was communicated via tables, graphs, and maps to quantify and visualize the impacts.

St. Augustine – Road network assessment using NOAA inundation tool approach

In St. Augustine, the road network was first segmented into small, discreet segments. Each segment was assigned an elevation from the Digital Elevation Model in the GIS framework. Future flood vulnerability as well as the frequency and duration of flooding was assessed using the NOAA inundation tool. This resulted in a look-up table of expected flood frequency and duration by SLR increment. The final step of the analysis

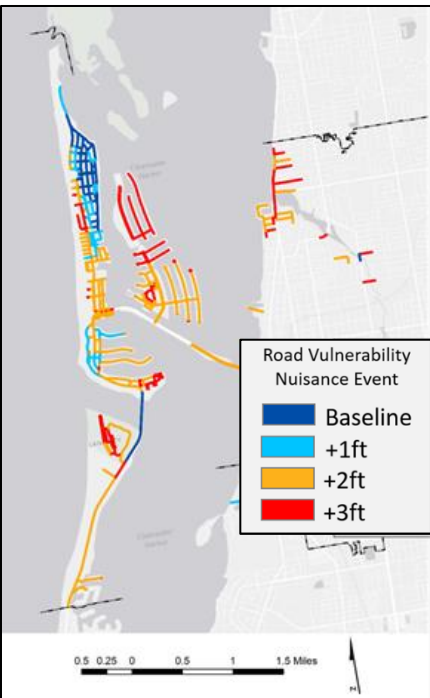


was to relate the table to road segments. Road segments were selected by location using the nuisance flood extent polygons and then attributed with flood frequency values. The amount of roads (length and percent of total) in the community subject to nuisance flood frequency were then

summarized by SLR increment. Further information on aspects of the approach is provided within the St. Augustine Vulnerability Report. City staff indicated that the assessment is an important indicator for utilities and city services that will be impacted.

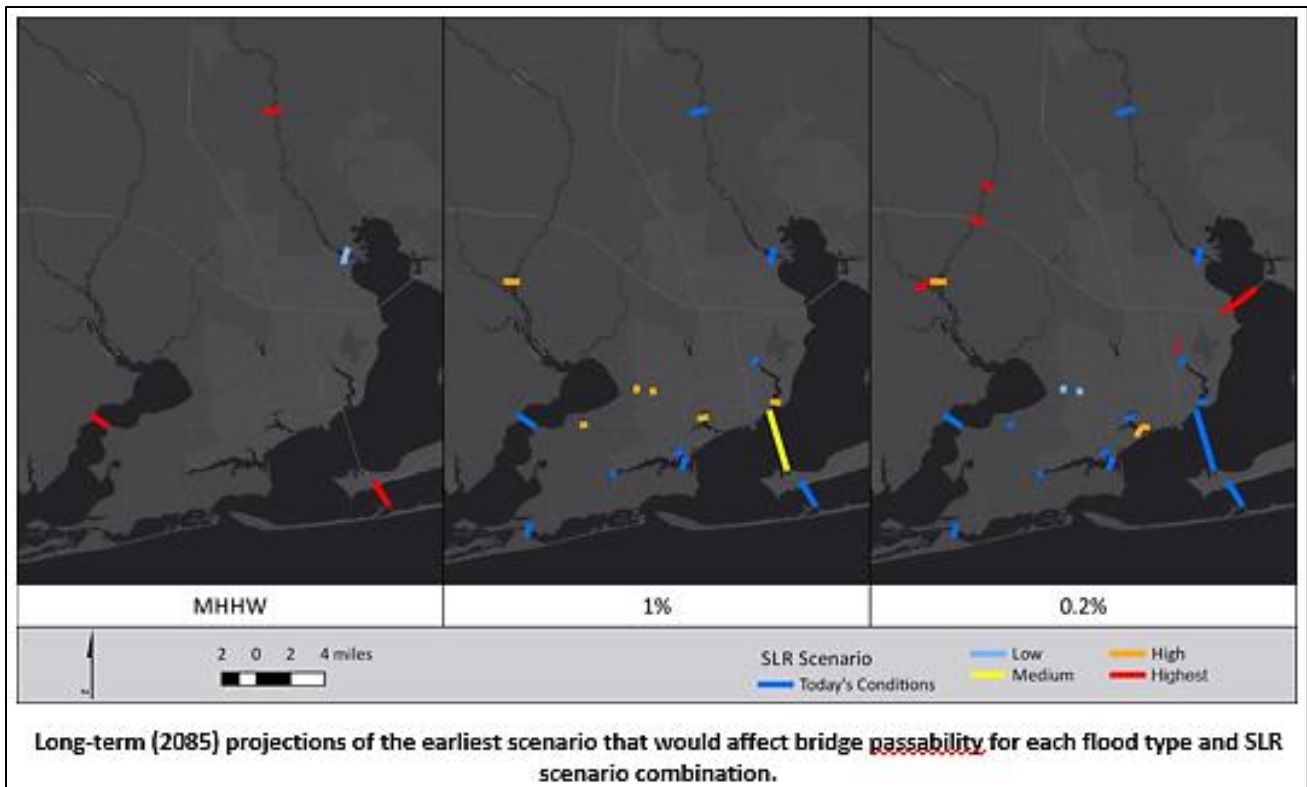
Clearwater – Road network assessment using overlay approach

The city road GIS network centerline coverage was segmented into small, discreet lengths. The length of each individual segment varied on local complexity of the roads but no segment was longer than 100 ft. The road segments were then intersected with the flood extents mapped for each SLR scenario and the total length of road affected in each scenario was summarized. A limitation of this approach is that elevated road segments, typically bridges, are classified as vulnerable due to position within the flood coverage. The maps helped to show that vulnerability is concentrated on Clearwater Beach Island and back lying areas, expanding from a relatively limited area along the sound side of Clearwater Beach Island to the southern half of the island as well as the other islands in St. Joseph sound with increasing SLR.



Escambia County – Bridge passability under various scenarios

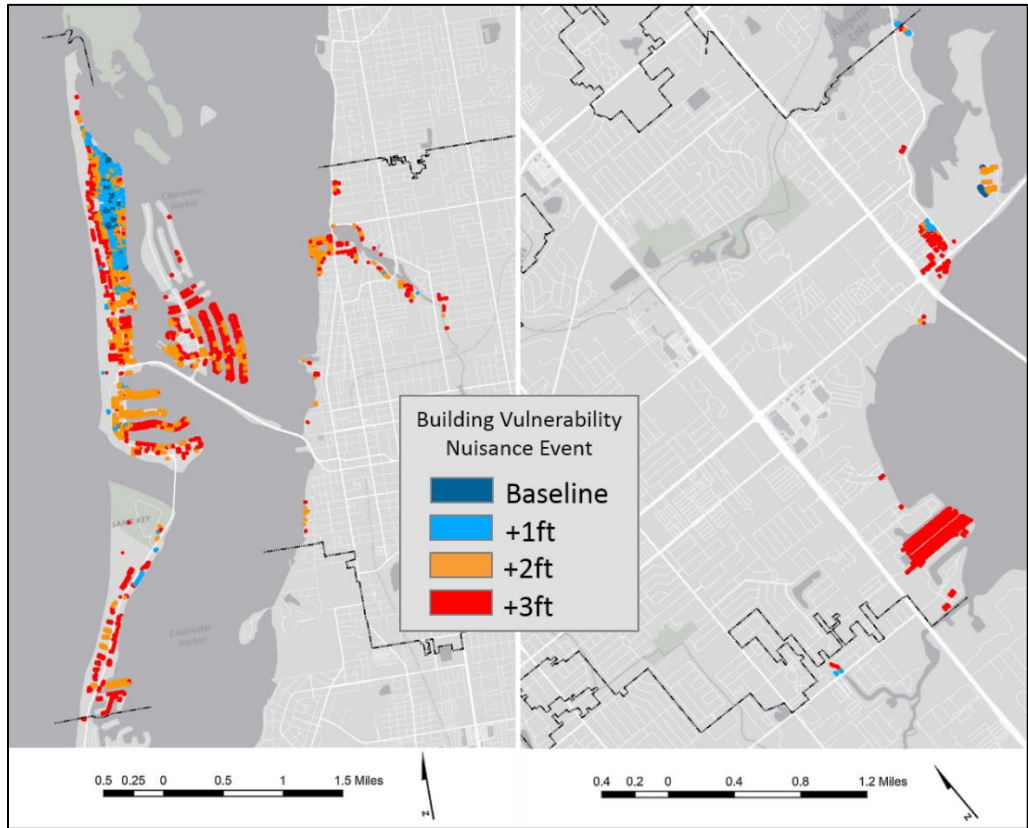
Bridge vulnerability to the different flood hazard types with SLR was evaluated in order to identify potential issues with bridge passability under future conditions. It should be noted that bridge deck elevation data was not provided as part of this study. Bridges could appear “vulnerable” if a simple overlay of the floodplain and bridge location were performed without consideration to deck height. To limit potential misclassification, the vulnerability of bridges was determined by inspecting the floodplain extents and bridge approaches. When bridge approaches were inundated by a particular flood type and SLR scenario, the bridge was deemed to have limited passability.



Example of Escambia County Bridge Vulnerability

4.2. How will Sea Level Rise Impact Building or Parcel Vulnerability?

Building flood exposure to the different flood hazard types was evaluated in order to identify how the number of buildings would change under the sea level rise scenarios. Building finished floor elevation data was not provided and vulnerability is simply attributed to cases where the building or parcel lies within each particular flood extent layer. Feedback from participants indicated that lowest-floor elevations with the structures is something that they would like to obtain in order to better assess risk. Depth-damage analysis would provide further information on potential impacts to these flood conditions. Due to this data gap, depth of flooding, or depth-damage analysis were not assessed. Given this, results below should be evaluated in the context that

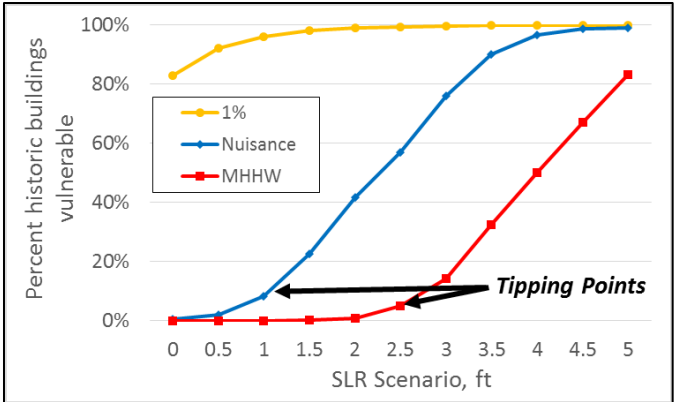


although these buildings may be exposed to flooding around the structure, waters may not be entering the structure at lower SLR scenarios. The graphic to the left is a representation of the building vulnerability for Clearwater under the nuisance type for the +1, +2, and +3 scenarios. This analysis could also be combined with the road and bridge assessment to identify how many people could be isolated if roads are inundated or bridges deemed not passable.

4.3. How will Sea Level Rise Impact Archeological Resources and National Register Historic District Vulnerability?

This assessment was performed specifically for St. Augustine but is a growing concern with coastal communities across the country. In St. Augustine, there are approximately 2,550 historic structures. Exposure was evaluated against each flood type and scenario by using a GIS overlay approach, where the mapped floodplain extents were overlaid on top of the historical structures - this methodology is described in more detail in the St. Augustine vulnerability report.

Although already known to be extremely susceptible to the 1% annual chance event, the assessment of SLR increases relative to the nuisance and MHHW types illustrates further vulnerability particularly at the 1-foot and 2.5 foot increases.

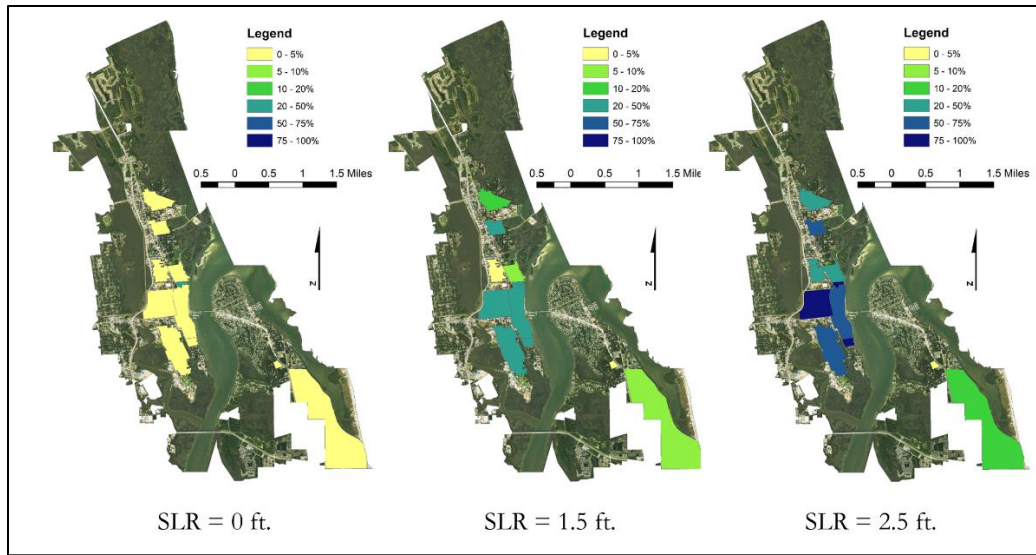


St. Augustine’s historic districts have negligible vulnerability to a nuisance event, as defined by this study, under today’s conditions. Vulnerability quickly increases as SLR raises water levels 1.5 ft over existing conditions. Maps were also provide to help illustrate the percentage of each district expected to be inundated

under the various scenarios. As the City’s economy is almost exclusively driven by tourism to these areas of town, these maps and data analytics will help the city in future planning discussions with their Historic

Architectural Review Board, elected officials, and the public.

In addition to the analysis of the historic district, the city’s team requested support for understanding the risk of their archeological resources.



An assessment was performed using archeological zones provided by the City. Using the elevation of those locations and the various surge scenarios, each zone was evaluated to identify the percentage of the zone impacted at each 1/2-foot interval. These results were mapped and also charted to help the community prioritize areas to protect or mitigate from the effects of sea level rise.

Many archeological zones and cemeteries experience large, sudden jumps in extent of flooding, which are likely a result of archeological resources with fairly uniform elevations; once a threshold elevation is reached, the majority of area is vulnerable to inundation.

Percentage of inundated area in St. Augustine archeological zones with nuisance flooding plus SLR. Row becomes blue when zone is completely inundated.

Zone	Sea Level Rise Increment (Feet)										
	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Zone I A	3%	7%	16%	26%	38%	60%	81%	94%	97%	97%	97%
Zone I B	6%	10%	17%	30%	47%	62%	71%	82%	96%	100%	
Zone I C	29%	32%	36%	55%	69%	79%	86%	91%	94%	95%	97%
Zone I D	38%	43%	52%	58%	66%	72%	78%	86%	93%	98%	100%
Zone I E	79%	80%	81%	84%	87%	89%	92%	94%	96%	99%	100%
Zone II A	10%	12%	15%	27%	41%	54%	70%	84%	97%	99%	100%
Zone II B	58%	65%	79%	96%	100%						
Zone II C	1%	3%	11%	22%	31%	42%	61%	90%	100%		
Zone II D	0%	3%	9%	18%	33%	39%	50%	73%	88%	100%	
Zone II E	0%	0%	0%	9%	27%	56%	90%	96%	99%	100%	
Zone II F	0%	0%	0%	23%	82%	100%					
Zone II G	40%	41%	42%	43%	44%	47%	48%	67%	84%	97%	99%
Zone II H	0%	28%	33%	36%	41%	49%	53%	57%	61%	65%	69%
Zone III A	8%	10%	19%	32%	44%	58%	70%	79%	90%	97%	99%
Zone III B	26%	28%	32%	38%	41%	45%	49%	53%	56%	59%	65%
Zone III C	5%	5%	6%	9%	12%	16%	19%	23%	28%	33%	37%
Zone III D	53%	56%	59%	62%	66%	70%	72%	75%	79%	82%	84%

4.4. How will Sea Level Rise Impact Critical Infrastructure?

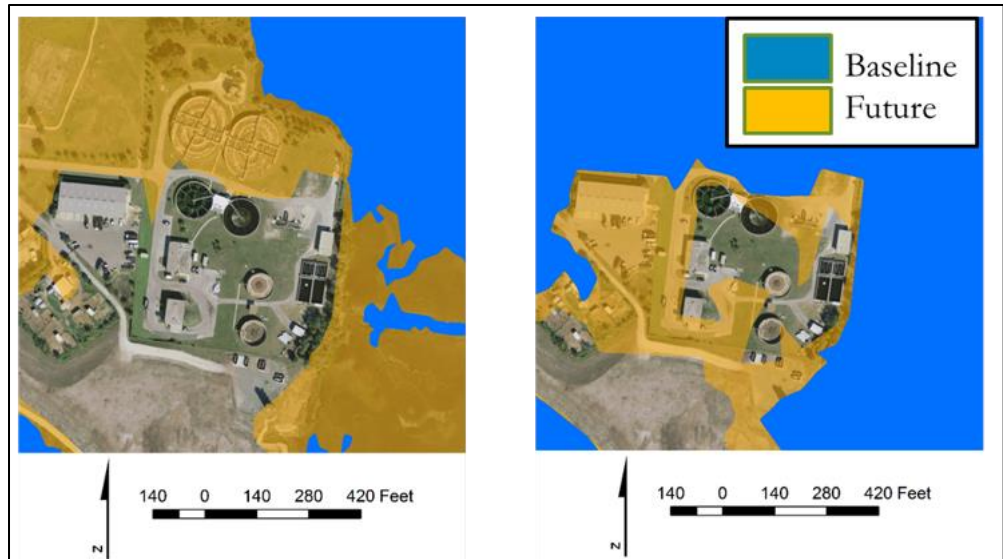
Each community provided sites of specific concern that were to be mapped. The results were reported a little differently for each pilot based on the quality of the data and facilities’ exposure to the various scenarios. The following section describes some of the differences in assessment per each community.

St. Augustine

The St. Augustine team decided to study the vulnerability of water and wastewater treatment facilities to different flood hazard types with SLR in order to identify key SLR flood elevation thresholds that begin to significantly impact facility structures. Flooded water treatment facilities face a threat of contamination due to saltwater intrusion and flood waters impairing infrastructure.

Wastewater treatment facilities that are frequently inundated may experience structural damages that lead to

releases of untreated waste. Flood damage would be costly to both types of facilities in terms of threat to public health and financial loss.



Clearwater

The Clearwater assessment was not focused on any specific pieces of infrastructure, particularly because most are known to be away from the high-risk areas. However, schools, fire stations, and water treatment and pollution control facilities were evaluated for their exposure to the various scenarios and flood types.

Escambia County

The Escambia stakeholders wanted to understand the infrastructure at two levels. The first was an overlay assessment of emergency facilities (police, fire, EMS, hospitals) and educational facilities. This information was reported back to the team in narrative and chart form.

Summary of emergency facility exposure to each flood type and SLR scenario.

Emergency Facilities	MHHW		1%		0.2%	
	2045	2085	2045	2085	2045	2085
Escambia County EMS Station 13		Highest	Today	Today	Today	Today
Escambia County EMS Station 14				Highest	High	Medium
Innervity Point Fire Station 8				High	Low	Medium
NAS Fire & EMS Station 1			High	Medium	Today	Today
NAS Fire & EMS Station 2			High	Medium	Today	Today
NAS Fire & EMS Station 3			High	Medium	Today	Today
NAS Fire & EMS Station 4			High	Medium	Today	Today
NAS Fire & EMS Station 5			High	Medium	Today	Today
Pensacola State College Police Dept.						High
Perdido Key Fire Department			Today	Today	Today	Today
Warrington Fire District						Highest

The county also wanted to have a separate assessment that was a further look at cumulative impacts and critical issues with the existing stormwater system. Specifically, the research team focused on the following tasks to achieve this objective:

- Identify historical and existing stormwater standards.
- Discuss changes in tailwater over the historical record.
- Project changes in tailwater due to sea level rise and precipitation.

Results were provided based on literature review of current stormwater documents relative to SLR projections and spatial overlays. The lack of detailed structure information within the inventory, such as invert elevations, limited the assessment.

4.5. Aquifer and Water Table Changes

A high-level assessment changes to the aquifer and water table were performed for the Cities of St. Augustine and Clearwater. A literature review was performed to address the groundwater impact component of the vulnerability assessment. This review included examination of local hydrogeological studies to understand the local and regional hydrogeological setting, identified mechanisms for saltwater intrusion, and consider how the water-table might respond to sea level rise. Feedback from the communities was that this assessment was too generalized to be of particular value. Stakeholders commented that an in-depth qualitative analysis of anticipated changes in the water table would require a long-term groundwater-level monitoring network in the surficial aquifer system in order to construct a spatially distributed estimated water table surface that could serve as a baseline from which to forecast future scenarios. The City of Clearwater is looking at some exploratory wells which could be utilized to better model and forecast water-table response. Further feedback from stakeholders indicated that “water supply inundation would have been more useful, and how that would potentially affect our groundwater replenishment projects”.

4.6. Future Changes to Precipitation

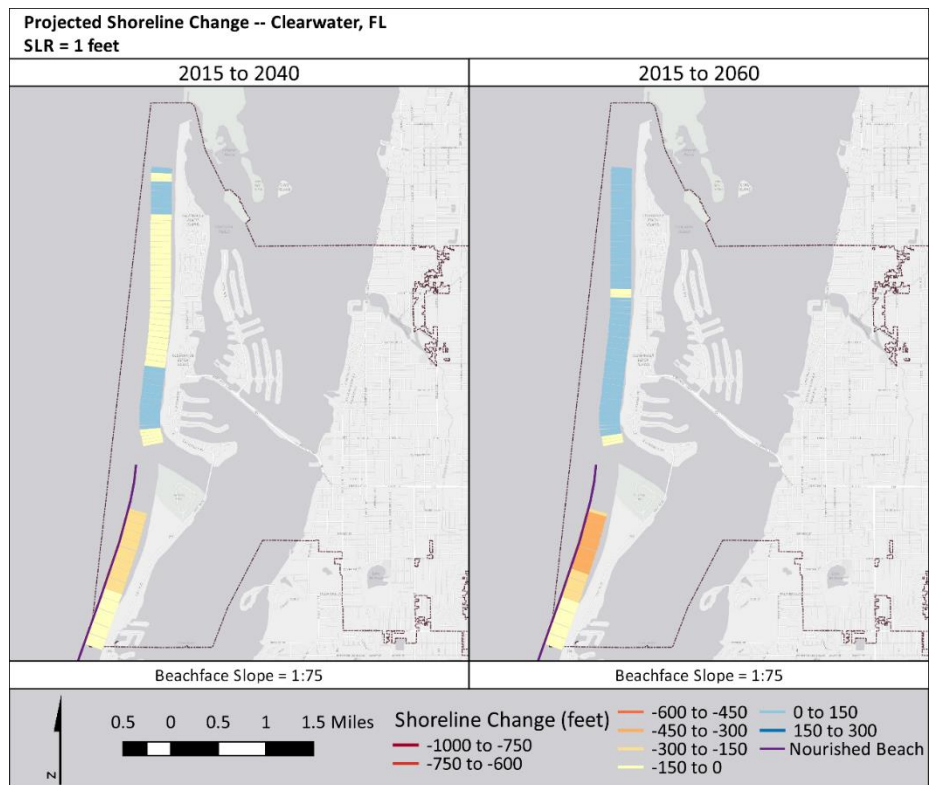
Escambia County understood that their coastal exposure is not that great and thus wanted to approximate future changes to precipitation to address potential stormwater design changes. Historical and projected changes in future precipitation were reviewed at the local and national levels in order to evaluate potential changes in frequency of heavy rainfall events. Overall, the projected changes are relatively small and within the bounds of the error of the historical data. These results indicate that it is not likely that a significant change in rainfall intensity will occur. It is important to note that these estimates may be conservative given that the statistically downscaled precipitation data used in this analysis does not fully capture the impact of changes in tropical cyclone activity. This portion of the study is focused on projecting changes using a consistent framework, which this dataset allowed the research team to do. In other words, the focus of this analysis was on the relative changes between the historical period and the future projection.

It was conveyed to the community that although the projected increases in rainfall may not appear all that large, they may still impact design criteria. This is also confirmed by the Storm Water Advisory Team’s Executive Summary Report (2015). For example, the current 24-hour 100-year design value is about 14 inches, which is based on outdated rainfall recurrence statistics from the US Weather Bureau’s TP40 report in 1963. That value is about 15% less than the Atlas 14 value (and 33% less if we use the upper bound of the Atlas 14 estimate of 20.9 inches). This suggests there may be a benefit to update standards to incorporate NOAA Atlas 14, which also includes the added benefit of uncertainty estimates unlike many past rainfall recurrence atlases such as the commonly used US Weather Bureau’s TP40.

4.7. Gulf Shoreline Response

For the City of Clearwater, the Gulf of Mexico shoreline was evaluated to estimate how existing shoreline change rates may respond to increasing sea levels. Shoreline response was evaluated only for the Gulf of Mexico shoreline of the barrier islands; the backside of the barrier island, mainland bay shorelines and shorelines along Tampa Bay were not studied. The analysis approach required historical shoreline change rates as an input; these data were only available for the Gulf shorelines. The historical rates, in combination with other geologic parameters, were used to project and estimate future trends and magnitudes of shoreline change in response to SLR. A full technical explanation of the approach is provided in the City of Clearwater Vulnerability Assessment.

Projected shoreline changes for the 1, 2 and 3 ft SLR scenarios were mapped. The vulnerability report includes additional results from the shoreline change calculations made using three separate representative slopes for the offshore profile (50:1, 75:1, and 100:1) under each SLR scenario and time horizon combination. The figures depict results for the 75:1 slope that represents the average amount of change between the three cases. In general, slopes steepen from the north to the south. The city’s team indicated that the results of this section of the report were “highly informative and useful. Since our economy is based on tourism, it’s good to know where we can predict to have to do more or less beach nourishment projects.”



5. ADAPTATION PLANNING

In the fall of 2016, the pilot communities each participated in separate adaptation workshops facilitated by Columbia Law School's Sabin Center for Climate Change Law, St Thomas University – School of Law, and Dewberry. The workshops served several interwoven objectives, including:

1. Developing a common framework for understanding physical and policy options for adapting to sea level rise (SLR);
2. Clarifying political and regulatory circumstances relevant to adaptation efforts;
3. Characterizing particular adaptation issues in terms of their urgency, scale (physical and budgetary), relevance to particular constituencies, and ease or difficulty of address;
4. Identifying types of strategies—and in some instances, specific strategies—suitable for addressing particular adaptation issues.

Following the day-long workshops, summary documents identifying key concerns and preliminary decisions were provided to the stakeholders. Below are some of the key takeaways from the communities relative to the objectives above.

5.1. Physical and policy objectives for adapting to sea level rise

The communities provided their concerns for presenting these elements to elected officials as well as pockets of influential residents/businesses within their community. Additionally, the interplay between levels of federal, state, local, and quasi-governmental groups adds to the challenges of consensus and future implementation as indicated below. Generally speaking, the three communities agreed that this framework for responding to SLR vulnerability involves either (1) protecting current land uses and patterns of activity in vulnerable areas (protect), (2) reducing vulnerabilities by modifying those uses and patterns (accommodate), or steering clear of vulnerabilities by (3) moving existing people and structures (retreat) or (4) deciding against development (avoid).

5.2. Clarifying political and regulatory circumstances relevant to adaptation efforts

In discussions with pilot communities, these were some fairly candid conversations about what they see as obstacles and mechanisms to further SLR strategies. A point of note brought up by St. Augustine stakeholders is that their residents' attachment to the City and its historical integrity could lead to a greater acceptance and tolerance for living with these new MHHW conditions; i.e. Residents may accept that portions of their land flood weekly or even daily. Some of the activities of St Augustine and Clearwater are highlighted below. Escambia County's lower vulnerability to SLR limited this discussion during the workshop. The County did note that there is cooperation with the City of Pensacola for most development activities but that there could be opportunities to collaboratively enhance resilience planning for the two communities.

St. Augustine

Efforts to make the city's historic buildings less vulnerable by elevating or relocating them would unravel significant aspects of the city's historic fabric and would be difficult to accomplish besides, as those buildings are largely unsuitable for either elevation or complete removal to a different location. Those circumstances are likely to limit residents' and council members' responses to calls for prudent steps toward adaptation—specifically, accommodation measures in the near term and at least partial retreat in the longer term. Notably,

sharply rising property values are currently compounding this collision between enthusiasm for investing in St. Augustine as it is today and investing in adaptation. The City also noted the challenges of colliding regulatory authorities such as the FL Department of Transportation, FEMA, and the Historic Architectural Review Board, to name a few.

City of Clearwater

The Clearwater stakeholders itemized some of their particular concerns and challenges to overcome. Some of the more salient aspects are as follows:

- Political:
 - likely intransigence from hotel and condo owners, especially on the barrier island, to restrictions on current development;
 - optics and messaging challenges owing to climate change skepticism;
 - doubts about flood insurance's prudence;
 - general preference for hard protective measures over alternatives;

- Regulatory:
 - State agencies will generally defer to localities' adoption of adaptation-oriented provisions in disaster recovery, development, and re-development planning elements;
 - current comprehensive plan sunsets in 2018;
 - patchwork jurisdiction with Pinellas County (85% is Clearwater; 15% Pinellas) means collaboration is necessary for enforcement, programmatic changes, and sometimes grant requests in stormwater management and water quality contexts;
 - cost-benefit analysis sometimes but not always required for project evaluation;
 - projects and maintenance efforts that affect one another, and whose effects are heightened in a context of more frequent flooding, are often not coordinated;
 - maintenance budgets respond in somewhat ad hoc fashion to changes owing to sea level rise;
 - TMDLs developed pursuant to statewide consent decree give control plan development and implementation priority;
 - "substantial improvement" criteria in flood zones currently provides a loophole for avoiding code compliance;
 - high Community Rating scores but currently no freeboard requirement for structures in flood zones.

5.3. Identified focus areas for adaptation and discussion of potential strategies (workshop objectives 3 and 4)

Objectives three and four from the workshops became intertwined discussions so they will be covered together here. The second half of the workshops had participants identify all of the areas that were of concern relative to measures and implementation. The meeting facilitators went through a process to focus the issue area, then specific issues within the topic, and ultimately potential responsive strategies. The table below is meant to indicate the priority issue areas for each community and the breadth of discussion. The specific issues and detailed responses are available via the Adaptation Plan for each community.

Workshop Issue Areas and Discussion

Community	Issue Area	Specific Issues Identified	Potential Responses Discussed
City of St Augustine	Stormwater and Wastewater Management	5	5
	Flood Insurance and Freeboard	2	3
	Historical and Archeological Resources	3	4
	Roads and Bridges	3	3
	Disaster Recovery	5	6
	Justifying Adaptation Measures	4	5
City of Clearwater			
	Stormwater Management	7	8
	Flood Insurance and Freeboard	5	4
	Coastal Management	1	1
	Wastewater Management	2	3
	Roads and Bridges	2	2
	Disaster Recovery	3	3
	Justifying Adaptation Measures	2	2
Escambia County			
	Coastal Management	2	2
	Flood Mapping and Disaster Recovery	2	4
	Stormwater Management	4	7
	Justifying Adaptation Measures	3	3

5.4. Products and Intended Use of Adaptation Deliverables

Early on in the process, stakeholders identified that a true adaptation “plan” would not be feasible to get accomplished within the timeline of the project. Thus each community was asked how to best deliver information and results to enable further action. All three communities identified that it would be helpful to have a standalone document in a format that could have specific elements cut and paste directly into other planning documents and updated as needed. The adaptation draft reports were received with mixed reviews. At first, communities provided minimal feedback upon receipt of the draft adaptation reports. The FL DEO facilitated conference calls with the pilots to encourage additional feedback on the draft products. Calls were then held with two of the three pilots as Escambia County was not able to provide feedback before the

deadline provided to the contractors. The pilots provided more detail on how they may want to utilize the documents provided to them as follows:

- Communication/educational tool for elected officials and public
- Help set a guidance framework for future resilience activities (range of policy options, look at implementation consistent with local codes, etc)
- Provide a better understanding of Florida statutes related to future flood conditions
- Start building the case for future actions

The pilot community stakeholders understood and helped guide the direction of the project with an understanding of budget and timelines. Following the delivery of draft adaptation planning documents, the pilot community stakeholders began to show the products to other interested parties in their communities that had not been part of the process from the outset. It was clear that these outside stakeholders had some further expectations as to what would constitute adaptation planning. It would be helpful for future communities to maybe have a fact sheet or some other tool to help outside entities understand the work that had been decided upon by each community and what priorities they chose to receive assistance with relative to the planning process.

5.5. Evaluation of Draft Adaptation Deliverables by Communities

The list of items below focuses on the key comment items provided either in email or phone communications with the consultants and FL DEO. The list is not exhaustive but covers the items reported as most helpful and most contentious by the stakeholders.

City of Clearwater

- Inclusion of model language was helpful.
- City officials were hoping for a list of recommended projects. The community is in process of evaluating a potential tax and having a list of projects and potential costs would have helped them look at allocation of funds/resources.
- The recommendations could have been better communicated as they were embedded within larger narrative discussions.
- City Council members are

City of St Augustine

- The report provided a thorough analysis of potential policy actions.
- Some language within the document appeared to reflect more of a legislative opinion than a recommendation. The City would like any legal analysis/opinion to be separate from other general policy narrative.
- The document could be reorganized to better indicate what is meant to convey the spectrum of policy options and how that relates to an actual recommendation.
- The document loosely implies that the City would limit private property development rights. The City has not determined how it will manage adaptation in coastal areas but it does not want to imply that the City would limit private development.
- The ongoing updates to FEMA flood maps complicate issues and coordination is needed to understand how potential expansion or shrinking of the special flood hazard areas would impact the public discussion relative to adaptation planning.

5.6. Additional Adaptation Planning Recommendations to FL DEO

Localities are well positioned to identify the vulnerabilities to which adaptation is necessary. They are also uniquely well-informed about how best to set priorities for addressing those vulnerabilities. However, leadership from a statewide authority like DEO, the Department of Environmental Protection, or the Department of Transportation is critical to the success of adaptation to sea level rise in Florida. Statewide leadership can facilitate coordinated and potentially synergistic efforts among multiple localities. It can take pressure off of local officials who might otherwise face insurmountable political hurdles. And it can help make useful information, expertise, and funding accessible to those in need of it in a way that individual localities generally cannot do. This leadership role is even more critical now, as the federal government agencies that have served these centralizing roles to date are being directed away from further engagement. Consistent with these essential objectives, DEO should:

- Create an online database that shares the experiences of Florida localities already engaged in adaptation planning and implementation. In contrast to databases maintained by the Georgetown Climate Center and the Climate Adaptation Knowledge Exchange, a Florida-specific database would provide Florida localities with a manageable volume of resources, all of which reflect efforts to contend with similar challenges in the same legal and policy context. DEO might consider collaborating with the Southeast Florida Regional Climate Compact in this effort, as the Compact has already established a database of this sort.
- Create a web portal that makes available technical information such as building codes, stormwater and wastewater equipment specifications, and disaster mitigation plans that have been shown to be especially effective in the face of rising seas and strengthening storms. Locating resources (or even just links to resources) like these in one place in an organized way would facilitate not just access but also comparisons of technical approaches across jurisdictions.

6. CLOSING

This document was intended to provide direction to the State of Florida's Department of Economic Opportunity as they look to support additional communities with similar vulnerability and adaptation processes. Throughout the text, potential improvements to the process are identified along with salient discussion points provided by the pilot community stakeholders over the course of the project. For process related items, suggestions focus on how meetings are facilitated, interactions with the communities, and the manner in which technical information is best represented to stakeholders in maps, graphics, and discussion. The additional lessons learned mentioned throughout the document focus on key topical discussions with stakeholders as well as comparing the approaches from community to community to help Florida DEO compare and contrast the activities. The information contained within this document as well as the additional project deliverables (Vulnerability Report for each community, Adaptation Report for each community, community presentations, lessons learned appendices, meeting minutes, and meeting summaries) provide future participants a comprehensive base of information and approaches to build upon.