RESTORE Funded Priorities List 3b
Project Proposal Planning Sheet and Guidance

The Florida Department of Environmental Protection is seeking project proposals for consideration of RESTORE Act funds to be distributed as grants to governmental entities and non-governmental organizations for Funded Priorities List 3b programs in Florida. Please submit your project proposal using the portal at https://survey.alchemer.com/s3/6527856/Deepwater-Horizon-Project-Portal. This sheet may be used to plan proposal information before entering information directly into the portal via the website. You may copy and paste the information for submittal through the portal. The Department will notify through GovDelivery and the Deepwater Horizon Program website when the portal is open. Once open, the Department will accept proposals for at least 30 days. Project proponents are strongly advised to become familiar with RESTORE FPL 3b Program FAQs before using this form. Required items marked with a red asterisk "*".

Florida FPL 3b Program: Gulf Coast Resiliency Program (GCRP) *

Project Details

Project Sponsor: Santa Rosa County *

Project Title: Navarrre Beach Utilities Living Shoreline Construction *

Existing DWH Portal ID Number: (*if applicable*) Click or tap here to enter text.

RESTORE Planning Framework Technique(s): * (*Select all that apply within the selected FPL 3b program*)

☒GCRP-Protect Natural Shorelines
☐GCRP-Land Acquisition
☐THRP-Restore Hydrologic Connectivity
☐THRP-Restore Natural Salinity Regimes
☐THRP-Land Acquisition
☐WQIP-Reduce Excess Nutrients and other Pollutants to Watersheds-Stormwater Management
☐WQIP-Reduce Excess Nutrients and other Pollutants to Watersheds-Erosion and Sediment Control
☐WQIP-Reduce Excess Nutrients and other Pollutants to Watersheds-Sediment Reduction
☐WQIP-Reduce Excess Nutrients and other Pollutants to Watersheds-Land Acquisition
☐WQIP-Reduce Excess Nutrients and other Pollutants to Watersheds-Non-potable Reuse

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RESTORE Comprehensive Plan Goal: Note: The portal will populate the Comprehensive Plan Goal automatically based on FPL 3b Program selected above. For your convenience, the goals are also listed here.

GCRP-Enhance Community Resilience

Use the space below to describe how the proposed project will address the comprehensive plan goal. (2,500 character limit)

Santa Rosa County proposes to construct a living shoreline along 1400 linear feet of a severely eroded coastal property located on Santa Rosa Sound in the Pensacola Bay Estuarine Watershed. The project will construct a natural resource-based living shoreline protection system to prevent and reduce the impacts of large storm surge events on estuarine processes and improve the environmental value of the shoreline. The shoreline is part of the 316-acre county owned property that has the Navarre Beach Utilities complex on 50 acres with critical infrastructure providing utilities for all of Navarre Beach property owners with the remainder 260 acres being natural lands. This project will address in the comprehensive plan Objective 1: Restore, Enhance, and Protect Habitats by the design of the Navarre Beach Utilities living shoreline to include features that restore, enhance, and protect the extent, functionality, resiliency, and sustainability of estuarine, wildlife, and marine habitats within the 1400 linear feet and seaward of the living shoreline. In addition to, this project includes in the design of the living shoreline Objective 4: Restore and Enhance Natural Processes and Shorelines to enhance ecosystem resilience, sustainability, and natural defenses through the restoration of a natural coastal and estuarine processes.*

RESTORE Comprehensive Objective: *Note: The portal will populate the Comprehensive Plan Objective automatically based on FPL 3b Program selected above. For your convenience, the objectives are also listed here.*

GCRP-Promote Community Resilience

Use the space below to describe how the proposed project will address the comprehensive plan objective. (2,500 character limit)

The Navarre Beach Utilities property located directly on Santa Rosa Sound has the Waste Water Treatment Plant on the northern facing shore, that due to erosion is in jeopardy of being compromised. On the eastern facing shore of the Waste Water Treatment Plant site the erosion has compromised a storage building with the back of the building falling off into the surrounding waters. The erosion of the northern and eastern shore has been documented to be occurring since 1970 through an analysis of aerials through the year 2019. See attachment one section titled Navarre Beach Utilities Timeline.
This project is in support of Santa Rosa County's two current existing projects to promote the use of living shorelines instead of armoring and vertical seawalls on county, commercial and residential owned coastal properties. Santa Rosa County's approach has been to collect data on county owned coastal properties processes in the upper Escambia Bay to design and construct a 780 linear foot living shoreline at the county owned Floridatown park in addition to, collect data on coastal processes in the lower Pensacola Bay system of Santa Rosa Sound to design and construct a 500 linear foot living shoreline at the county owned Navarre Park. This 1400 linear foot living shoreline supports Objective 6: Build and sustain Gulf Coast communities' capacity to adapt to short- and long-term natural and man-made hazards, particularly increased flood risks associated with sea-level rise and environmental stressors. Promote ecosystem restoration that

enhances community resilience through the re-establishment of non-structural, natural buffers against storms and flooding and enhances community resilience through the re-establishment of non-structural, natural buffers against storms and flooding. *

Project Description: Provide a description of the project that includes each of the following: anticipated environmental benefits, environmental stressor(s) being addressed, general location, estimated cost, approximate timeline, partners, and other information that might be needed to provide the reader with a full understanding of the project. *(5,000 character limit)*

Santa Rosa County received a federal planning grant of $250,000 from the National Fish and Wildlife Foundation 2022 Emergency Coastal Resilient Fund to address the ongoing coastal erosion at the Navarre Beach Utilities shoreline. The NFWF grant portion of the project will be to design the living shoreline and will be accomplished in a one year period, anticipated to start in October 2022 and end in October 2023 to reach a 90% design phase. During this time the project will conduct monitoring and data collection of the hydrographic and geomorphic features that effect the 1400 linear feet of the shoreline. This will produce an assessment and a numerical model representative of the Navarre Beach Utilities shoreline and surrounding bathymetry so that a non-structural natural buffer living shoreline can be designed and engineered by 90% to be resilient against the rapid coastal erosion occurring and hurricane storm surge events.

Timeline and budget costs for this proposed project in this specific Restore proposal:
November 2023 – January 2024 using the completed 90% design phase to apply for state and federal permits. $100,000
February 2024-February 2025 100% Design Plans fully engineered will be completed, state and federal permits to be issued. No Cost
February 2025-December 2025 Implementation of Construction of fully designed, engineered and permitted 1400 linear foot living shoreline. Current costs for the installation of living shorelines range up to $2,000 per linear foot of treatment. Therefore, $2,000 x 1400 linear feet is $2,800,000
*

Is the proposed project identified in a federal, statewide, or regional plan or has a vulnerability assessment been performed for Coastal Resiliency-focused projects? Check all that apply. *Note: If you did not select Gulf Coast Resiliency Program, the option to select vulnerability assessment will not be visible.*

☐Project is not identified in an existing plan or vulnerability assessment.

- ☐Basin Management Action Plan (BMAP)
- ☐Florida Trustee Implementation Group (FL-TIG) Restoration Plan
- ☐Minimum Flow Level (MFL)
- ☐Gulf Environmental Benefit Fund (GEBF) Restoration Strategy
- ☐State Expenditure Plan (SEP)
- ☐Surface Water Improvement Management (SWIM) Plan
- ☐Other (Please describe)
- ☒Vulnerability Assessment has been completed (Coastal Resiliency Program only)

If yes, use the space below to provide the name of plan(s) and link, or details on the vulnerability assessment that was performed (if available). *Note: The portal will omit this space if "project is not identified in an existing plan" is checked above.*

In March 2021 Santa Rosa County completed the Resilience to Future Flooding Vulnerability Assessment to inform decision making by the Santa Rosa County Florida BOCC. This vulnerability assessment took several factors that contribute to flood vulnerability and numerous data sets were collected which fit into four categories: environmental, social, physical/built environmental and economic impacts. With the assistance of a Steering Committee of local subject matter experts, data sets were ranked according to importance when considering flood vulnerability. The three top-ranked variables were: Repetitive Loss Structures, Base Flood Elevation, and Social Vulnerability Index.This Navarre Beach Utilities property was analyzed for vulnerability to flooding using the Flood Vulnerability Index:Ranked on a scale from 0-5 with 0 being no risk and 5 being severe riskVulnerability Score: 4.33.Vulnerability Breakdown for Navarre Beach Utilities SiteOverall Rank: 4.33 / 5.00. Please see attachment 2.

Project-specific Methods: Describe the methods to be used in the project, and the reasons that the methods were selected.

All methods should be justified using best available science (provide citations); and methods may also be justified by other reasons (e.g., cost-effectiveness, technical feasibility).

Address how the chosen methods support project resiliency, or the extent to which the project is vulnerable to applicable climate risks under varying future scenarios, including but not limited to sea level rise, alterations in rainfall patterns, and/or potential increases in hurricane intensity. Consider how such risks might affect the benefits and duration of the project.

Include any design or other measures taken to mitigate climate risks and increase resiliency. *(5,000 character limit)*

Living shorelines are a method of stabilizing the shoreline. Living shorelines are encouraged in the Pensacola Bay estuary as an alternative to traditional hardened erosion control structures such as bulkheads or rip rap. Living shorelines may be placed adjacent to traditional stabilization techniques. Living shoreline methods involve planting of native vegetation and/or the installation of green infrastructure. Green infrastructure consists of materials, such as oyster shell, that promote the health and growth of the native ecosystem and help to maintain the land and water connection. *

Does the project require ongoing operation and maintenance? ☐Yes ☒No

For projects that will require ongoing operation and maintenance, describe the project sponsor's capacity to manage the proposed project, as strong operation and management capabilities, including financial resources, will be needed to assure the long-term success of the project. This is not intended to discourage participation by small or disadvantaged communities. *Note: The portal will omit this space if "no" is selected above for ongoing operation and maintenance. (1,500 character limit)*

Click or tap here to enter text.

Project-specific Risk: Using best available science, summarize risks and uncertainties associated with the overall project, along with proposed measures to mitigate such risks and uncertainties. In general, risks and uncertainties should be considered in both the near- and long-term, and with respect to the anticipated lifespan of the proposed project. *(5,000 character limit)*

Coastal marsh habitats such as is located at the Navarre Beach Utilities Living shoreline site are at risk due to sea level rise, increased storm intensity, coastline development, and shoreline hardening. Living shorelines are a powerful tool to proactively protect estuarine shorelines. The design of this shoreline is in an excellent position to take advantage of living shorelines to protect and restore its salt marshes and improve coastal resilience. Living shorelines can protect land from erosion and provide several additional ecosystem benefits. Living shorelines create essential habitat by promoting marsh and oyster growth, buffer boat wakes and wave energy, sequester carbon, and, depending on the materials used, filter pollutants from the water. Natural marshes and those with constructed living shorelines have been shown to offer better shoreline protection than bulkheads during storm events (Gittman et al., 2014). In addition to storm protection, living shorelines that have a salt marsh in its design buffer against the threat of sea level rise. As sea level rises, salt marsh heights will naturally increase; therefore, the salt marsh persists as natural, growing breakwaters which adjust to the change in tidal elevation (e.g., Rodriguez et al., 2014). These benefits enhance the health and resilience of our coasts while also providing natural protection for property on adjacent uplands. Any risks and uncertainties associated with the overall project will be mitigated by the numerical model of the shoreline that will use the bathymetric and wave processes to design the living shoreline from the planning grant from NFWF to address the following:

- Data review and analysis;
- Development and calibration of hydrodynamic model;
- Development and calibration of wave transformation model;
- Assessment of extreme (defined as having a 25-yr return period) current condition; and
- Assessment of extreme (defined as having a 25-yr return period) wave condition.

The adoption of the 25-yr return period is consistent with the expected life span (25 years) of the coastal resilient infrastructure, which will comprise of nature and nature-based solutions. *

Project Support: Indicate the level of public support, if known, and/or the potential for socio-economic benefits or unintended adverse impacts that may affect public support for the project. *(1,500 character limit)*

The region encompassing the project area on Santa Rosa Sound has been impacted by multiple natural disasters, including Hurricane Sally (2020} and Tropical Storm Fred (2021). Events such as these, together with long-term sea-level rise, have contributed to erosion of estuarine littoral habitats and increased risk on the part of coastal communities. The proposed project will benefit Santa Rosa Sound, within the Pensacola Bay System watershed, and protect critical infrastructure for Santa Rosa County and Navarre Beach. Furthermore, this effort will help implement key recommendations from the Northwest Florida Water Management District's Pensacola Bay System Surface Water Improvement and Management plan, updated in 2017 with support of the NFWF Gulf Environmental Benefit Fund. As such, the Northwest Florida Water Management District supports this proposal and looks forward to working with Santa Rosa County as a partner. This proposed project will work with as a partner with the Perdido Pensacola Bay Estuary Program (PPBEP) to achieve its goals of enhancing community resilience, reducing sedimentation, restoring and protecting fish and wildlife habitat within the Pensacola Bay Estuary. As the PPBEP works toward the implementation of its first Comprehensive Conservation and Management Plan (CCMP) it strives to build lasting partnerships through collaborative projects like this to address proactive comprehensive resilient initiatives , future storm events coupled with sea level rise will continue to increase the risk of critical infrastructure failure and loss of the estuarine littoral zone.

Funding Request

Amount of RESTORE funds requested for project planning (e.g., Engineering, Design, Permitting): Enter “$0” if the project is fully designed and permitted, or if no FPL3b funds are requested for project planning. Additional information may be requested if funds are requested for implementation. 0 *

Amount of RESTORE funds requested for project implementation (e.g., Construction, Land acquisition): Enter “$0” if the project will use RESTORE funds for planning activities only**:** $2,900,000 *

Is it anticipated that the project will include leveraging? ☐Yes ☒No ☐Undetermined

If yes, provide information on leveraging opportunities below. If multiple sources of leveraged funding are anticipated, provide information for each source of leveraged funding. See the FAQs document for an explanation of the types of leveraging. Only funds designated as Co-funding are factored into the total cost of the project*. Note: The portal will omit this space unless the response is checked yes to the leveraging question above.*

Source	Name of agency organization providing leveraging opportunity	Amount of leveraged funds	Type of leveraged funds	Status of leveraged funds
1	Click or tap here to enter text.	Click or tap here to enter text.	Choose an item.	Choose an item.
2	Click or tap here to enter text.	Click or tap here to enter text.	Choose an item.	Choose an item.
3	Click or tap here to enter text.	Click or tap here to enter text.	Choose an item.	Choose an item.

Briefly describe the leveraged funding opportunities identified above. Provide context If specific information is known about project components that will be or have been funded through leveraging opportunities: *(750 character limit)*

Click or tap here to enter text.

Total estimated cost of project: $2,900,000 *

Proposed Project Readiness to Proceed

Status of Project Design*: ☒Not Started/Not Applicable ☐30% ☐60% ☐90% ☐100%

Status of implementation project permitting/environmental compliance. *Note: The options below will only be visible in the portal if the funding request above includes funds for implementation. Leave blank in this planning sheet if the funding request is for planning projects only.*

☒Not Started
☐Permit Applications Submitted
☐Some Permits Approved
☐All Required Permits Approved

Proposed project start date: November 2023 *

Proposed project end date: February 2025 *

List any information regarding the design, permitting, or timing of the project that may be useful to the reviewer.

Timeline and budget costs for this proposed project in this specific Restore proposal:
November 2023 – January 2024 using the completed 90% design phase to apply for state and federal permits. $100,000
February 2024-February 2025 100% Design Plans fully engineered will be completed, state and federal permits to be issued. No Cost

February 2025-December 2025 Implementation of Construction of fully designed, engineered and permitted 1400 linear foot living shoreline. Current costs for the installation of living shorelines range up to $2,000 per linear foot of treatment. Therefore, $2,000 x 1400 linear feet is $2,800,000

Proposed Project Location

Indicate the county and watershed where the project will primarily be implemented or administered. If the project will occur in more than one county or watershed, please provide narrative details in the space at the end of this section.

County: *Note*: *Only counties marked with a "*" are eligible for funding under the Gulf Coast Resiliency Program.* Santa Rosa* *

HUC-8 (cataloguing unit) Watershed: A mapping tool is available to assist with locating hydrologic unit code (HUC-8) watershed information. Watersheds that are not eligible for Gulf Coast Resiliency Program are noted in the pick list. (Choctawhatchee-Escambia) Florida Panhandle Coastal (Pensacola Bay) *

Can the project be considered a "regional project", meaning it will be implemented in more than one county, municipality, water management district, or a combination thereof?*

☐Yes ☒No ☐Undetermined

Provide a brief narrative description of location of the project.

The Navarre Beach Utilities property is located on Santa Rosa Sound, which is in between Gulf Breeze Peninsula and the Santa Rosa Island located on the Gulf of Mexico. Santa Rosa Sound (SRS), located in the Pensacola Bay System (PBS), extends from Choctawhatchee Bay to Pensacola Bay and opens to the Gulf of Mexico at Fort Pickens. Location with Section, Township and Range : 32 2S 26. Street location, 8660 GULF BLVD NAVARRE BEACH *

Additional Information

Will the project provide benefit to, or be located within a state-designated financially disadvantaged community?* *Check all that apply.* Rural Economic Development Initiative

(REDI) communities are described in Chapter 288.0656, Florida Statutes, (F.S.). Fiscally Constrained County is defined in 218.67(1), F.S.

☐ REDI. If checked, provide the name of the community(s) within the associated Rural Area of Economic Opportunity: Click or tap here to enter text.

☐ Fiscally Constrained County per 218.67(1), F.S.

☐ Yes, another designation by State (describe): Click or tap here to enter text.

☒ No, or Not Applicable

Contact Information

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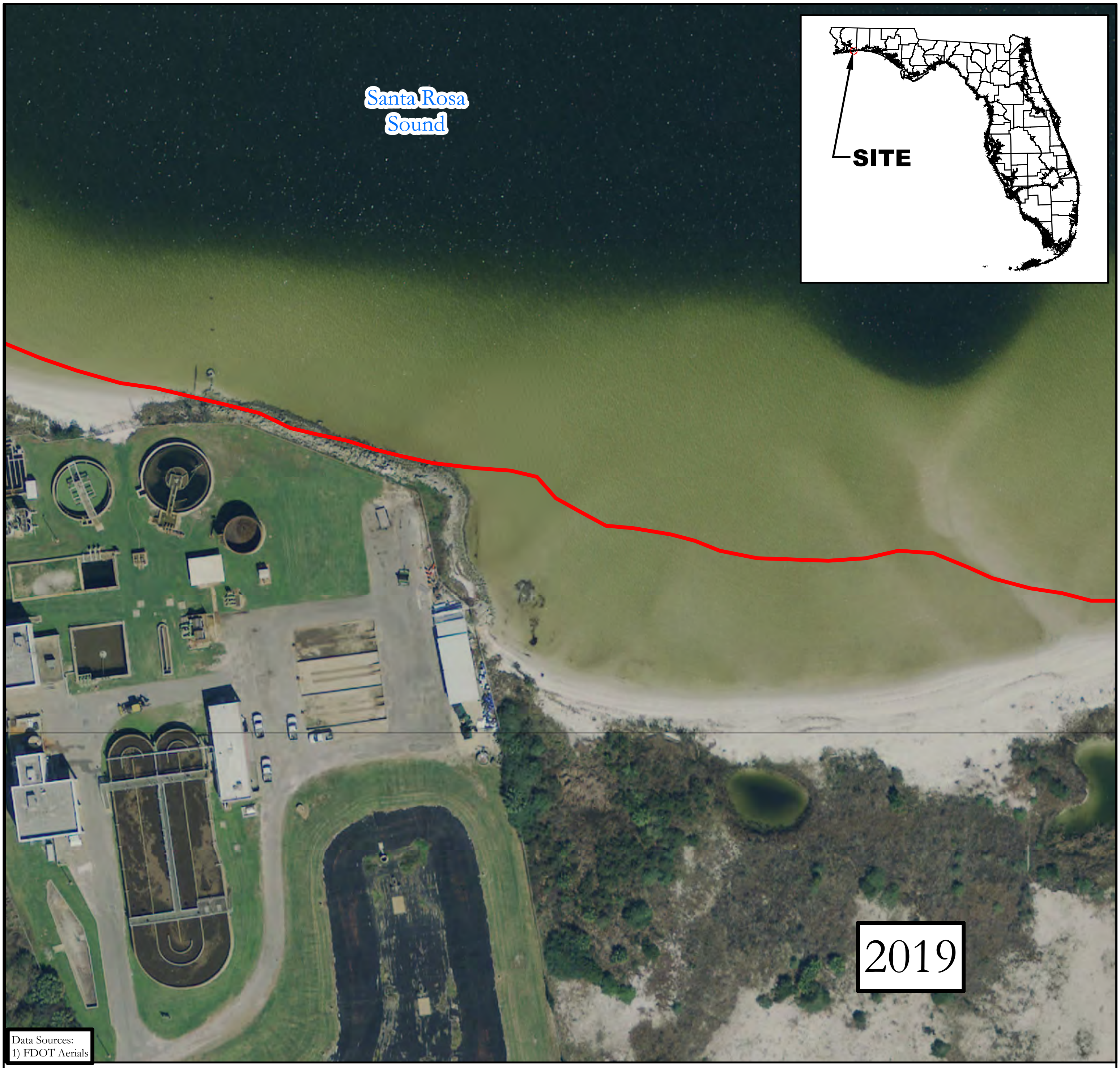
City:	Milton *
Zip:	32583 *
Phone:	850-776-5938 *
Email:	shelleya@santarosa.fl.gov *

Optional: You may upload up to 3 documents with your submission. Each file can be up to 50 megabytes in size. If you have larger files, the files can be split in to multiple, smaller files or you can coordinate transmission of uploads by contacting Restoration.Projects@dep.state.fl.us. Extensions allowed are: pdf, zip, png, gif, jpg, jpeg, doc, xls, docx, xlxs, pdf, txt, mov, mp3, and mp4.

Please visit the RESTORE FL3b portal at
https://survey.alchemer.com/s3/6527856/Deepwater-Horizon-Project-Portal
to submit your proposal.



1970 Shoreline

0 50 100 200
Feet

Navarre Beach WWTP

Santa Rosa County, Florida

N
W E
S

File Location: \\FLDEP1\tech_cad\Counties_GIS\Santa_Rosa\Navarre_Beach_WWTP\GIS\Navarre Beach Timeline\Navarre Beach Timeline.aprx
Date Saved: 2/6/2020 10:18 AM
Map Created By: GW Stelter


≤ 1.00
≤ 2.00
≤ 3.00
≤ 4.00
≤ 5.00
Navarre Beach Utility Property
Vulnerability Breakdown for
Navarre Beach Wast Water Treatment Facility
Overall Rank: 4.33 / 5.00
Repetitive Flood Loss Rank: 5
Base Flood Elevation Rank: 5
CDC Social Vulnerability Index Rank: 3 (0.3934)

C. Final Report

PROJECT OVERVIEW

This project produced a county-wide vulnerability assessment model as well as a resilience story map and web application, to inform decision making and create public awareness about localized flooding in Santa Rosa County. The project followed the first two steps of the Florida Adaptation Planning Guidebook: (1) Context Development and (2) Vulnerability Assessment. To supplement the context development, a needs assessment was completed to identify programmatic, planning, resource, and other needs specific to building coastal resilience as well as to identify ongoing resilience efforts within county departments and community stakeholders. Final deliverables include a needs assessment and data collection and a vulnerability assessment model.

BACKGROUND

Santa Rosa County, one of the fastest-growing counties in Florida, is heavily affected by extreme weather and climate-related hazards. Situated in the Northwest panhandle of Florida, the county has over 81 miles of rivers and streams and 100 miles of tidally affected shoreline. According to the county's Local Mitigation Strategy, all geographic locations within the county are vulnerable to one or more of the following natural hazards: flooding, severe storms and lightning, tornadoes and waterspouts, wildfire, heatwaves and drought, winter storms and freezes, erosion, and tsunamis and rogue waves. With 12.3% of the parcels in Santa Rosa County located within the 100-year, 500-year, or velocity hazard flood zones, the county is particularly vulnerable to flooding. Annually, there is at least one incidence of localized flooding in Santa Rosa County. Older subdivisions are especially vulnerable to these flood events as they were not built-in accordance with current lot grading and finished floor elevation requirements and lack appropriate drainage infrastructure.

Santa Rosa County has been included in 13 disaster declarations since 2004. Flood problems that occur in the county can be attributed to riverine, coastal surge, overland sheet flow, and ponding. In many areas of the county, infrastructure has not been upgraded to meet increasing population growth, thus contributing to urban runoff, and exacerbating localized flooding. While the County is aware of many historical flood events, previously, the communities in northwest Florida have not engaged in future climate conversations.

Santa Rosa County recently partnered with national and regional stakeholders through the National Association of Counties (NACo) Coastal Resilience Team Challenge. Through this training opportunity, a multidisciplinary team was formed and identified several needs to build coastal resilience. These needs include: 1) a needs analysis and vulnerability assessment to show the county staff, community, and elected officials where they stand in terms of resiliency to future flooding, 2) to identify what resilience measures are already in place, and 3) to determine what else needs to happen to create a more resilient future. Through the NACo opportunity and subsequent Sea Grant facilitated Community Resilience Index workshop, the team identified that a “one-stop-shop” to capture information on existing and needed resilience efforts would be an indispensable structure for county staff and valuable communication and education tool for residents and businesses. Additionally, public engagement opportunities are needed to facilitate flood risk discussions with residents, local businesses, and other stakeholders.

This project positions the communities within Santa Rosa County to be more resilient to future flooding by producing a county-wide vulnerability assessment model to inform decision making and creating a resilience story map and web application, valuable public information tools. The project will follow the first two steps of the Florida Adaptation Planning Guidebook: (1) Context Development and (2) Vulnerability Assessment. To supplement the context development, a needs assessment will be completed to identify programmatic, planning, resource, and other needs specific to building coastal resilience as well as to identify ongoing resilience efforts within county departments and community stakeholders.

Our county-wide vulnerability assessment takes into consideration socio-ecological factors that are needed to gain an understanding of what populations, habitats, and land uses may be at risk of inundation and increased flooding from sea level rise. An assessment of vulnerabilities will provide the basis to continue planning for adaptation strategies and implementation strategies and to encourage economic and infrastructure development in the right place considering compatible uses. The vulnerability assessment will be presented as an online web application.

LITERATURE REVIEW

Methodology varies from article to article; however, our ongoing literature review reveals a few techniques and recommendations for weighting the GIS data layers and tables pertaining to various physical and social aspects of flood vulnerability, also known as indicators. The following paragraphs summarize and compare the methodology that may be considered by the steering committee during the critical stage of weighting the indicators for best results in the vulnerability model**.** Further research and literature reviews are ongoing at this stage so that a more detailed weighting strategy may be formed.

Indicators of flood vulnerability and community resilience to flood related natural disasters may not all be considered equal in a multi-criteria GIS model such as the one proposed in this study. The weights or indices assigned to a data component in a spatial model will have great impact on the spatial patterns of vulnerability, which in turn will influence the decisions that are made with the model results, thus making it a critical step (Papathoma-Köhle et al. 2019, 2). Weighting strategies depend on several factors including:

- Goals or focus of the study
- Expertise and experience of the researchers
- Quality of data available

Wang et al (2011) depicts the role that weighting plays in their flood vulnerability multi-criteria GIS model that created 5 different risk levels in a Central China study area (Wang et al. 2011, Fig 2., 3468).

This workflow incorporates expert opinion as the primary component of evaluating and weighting their model criteria. Other strategies may be less subjective, such as the PVA-3 and PVA-4 techniques explained in Kohle's article on the contrast and comparison of how weights affect model results (Papathoma-Köhle et al. 2019, 2). The PVA-3 method assigns weights to indicators based on past records of flood events and utilized a linear weighted combination, while the PVA-4 method assigned importance to layers based on questionnaire results from experts (Papathoma-Köhle et al. 2019, 3).

The model results for these methods differed significantly in that spatial zones of high, medium, and low risk to tsunami impact changed in certain areas. This led decision makers to draw different conclusions based on which result set they were viewing (Papathoma-Köhle et al. 2019, 7).

Many of the articles reviewed did not include specific information on the weights they applied to indicators, or the methods they used to arrive at those numbers. Wang et al. (2011) summarizes how they categorized the data components, assigned relevance each category, and then assigned weights to each layer within that group (Wang et al. 2011, Table 4, 3478). This table may serve as a template for the steering committee for how to organize, rank, and weight the data components. Kohle included a similar table of final weights, however it is noted that tsunami indicators would be different from flood vulnerability or other types of hazard risk assessments, thus making their specific indices inapplicable to this project.

Based on the literature reviewed so far, it is recommended that the steering committee choose a strategy or technique for assigning weights that best suits their expertise and data resources, and that is supported by the literature. The next step will then be to design a hierarchy of categories and subcategories of importance, followed by specific indicator weights for best practice. As stated above, the literature review continues as more information on weighting strategies is desired. The table below shows some of the key variable indicators used by specific sources of literature.

Source	Variable indicators used
Papathoma-Köhle et al. 2019	Building Material, number of floors, surroundings (e.g., vegetation), building use
Smith, et al. 2016	Population Distribution (raster), road Network Weighted with Traffic Count Data (raster), Flood Zones
Wang, et al 2011	Population/demographic data, transportation and land cover e.g., cropland via high Resolution Terrain data
Pricope, et al. 2019	Demographic, housing, social, and economic data tables, TIGER/Line files, Floodplain zone, Base Flood Elevation (BFE) & Finished Floor Elevation (FFE), Building Extent (Polygon)

Table 1 - Criteria for Flood Vulnerability Model per Literature Review

STEERING COMMITTEE

A steering committee was formed to gain an understanding of what populations, habitats, and land uses may be at risk of increased flooding from sea level rise, assess vulnerability to help guide future mitigation dollars and continued planning for adaptation strategies, and to help guide and encourage economic and infrastructure development in the right place considering compatible uses. In doing so, this committee ranked data sets of four categories: environmental, social, physical/built environment, and economic impacts. According to importance when considering flood vulnerability, the three top ranked variables were: Repetitive Loss Structures, Base Flood Elevation, and Social Vulnerability Index.

Steering Committee Members:

Cynthia Cannon, City of Pensacola

Brad Baker, Santa Rosa County Emergency Services

Darryl Beaudreau, The Nature Conservancy

Christian Wagley, Healthy Gulf

Beth Fugate, Florida Department of Environmental Protection

Daniel Hahn, Santa Rosa County School Board

METHODS

With these three factors chosen, a model was created to identify and score areas of vulnerability. These factors were ranked on a scale from 0-5, with 0 being no risk and 5 being severe risk. Each quarter mile square of the county received scores based on its Social Vulnerability Index, Repetitive Loss Structures, and Base Flood Elevation. These 3 scores were then weighted against one another equally to create an overall vulnerability score for each area. The final vulnerability scores, also ranked 0-5, are an average of the three factors.

Workflow Contextualization

Drawing from the literature review and considering the process outlined by ESRI (2020) and others we can generalize a process weighted suitability that we can apply to the flood vulnerability modeling (Fig. 1). This process takes us from problem identification through results analysis.

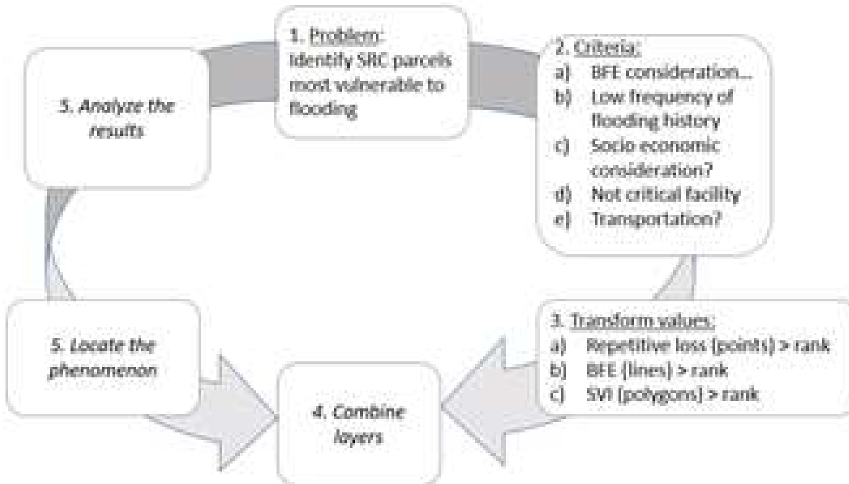


Fig. 1 - Broad overview of steps to suitability modeling (Esri 2020)

We created a flowchart to consider how the input risk/vulnerability layers might move through the process of creating a flood vulnerability map (Fig. 1). Also, we consider the uses and users of the model that we are developing. This was important in isolating the scale at which the analysis was to be done. Fig. 2 presents a unified modeling language (or UML) use-case diagram that considers a sample of stakeholders who would benefit from and utilize the flood model. For instance, the Santa Rosa County (SRC) GIS department would typically be tasked with mapping the areas of risk at the scale of parcel or building footprints. SRC Permitting would consider these maps in their decisions about what building permits to approve. Whereas, at differing scales SRC Planning officials would utilize these maps to inform area zoning decisions.

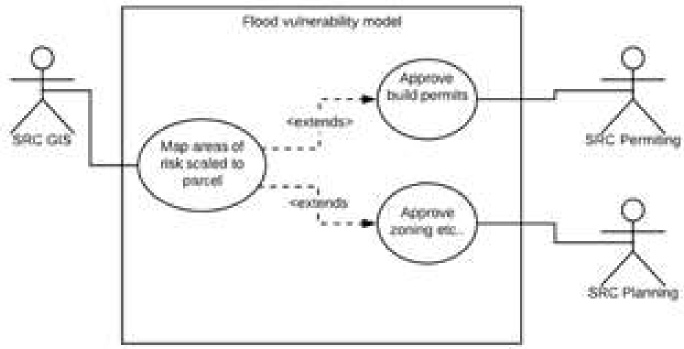


Fig. 2 UML use-case diagram

With a solid understanding of how the flood model results are to be used, we were then able to consider the data processing workflow (Fig. 3). This flowchart only considers some of the key datasets that will be used in the final model. Of significance here is that we were able to work out how the input layers would move through the flood vulnerability mapping process and how they would relate to each other spatially. Note that in this process visualization we are considering how we will be relating the different data models of points and polygons and, ultimately, assigning them a weight factor.

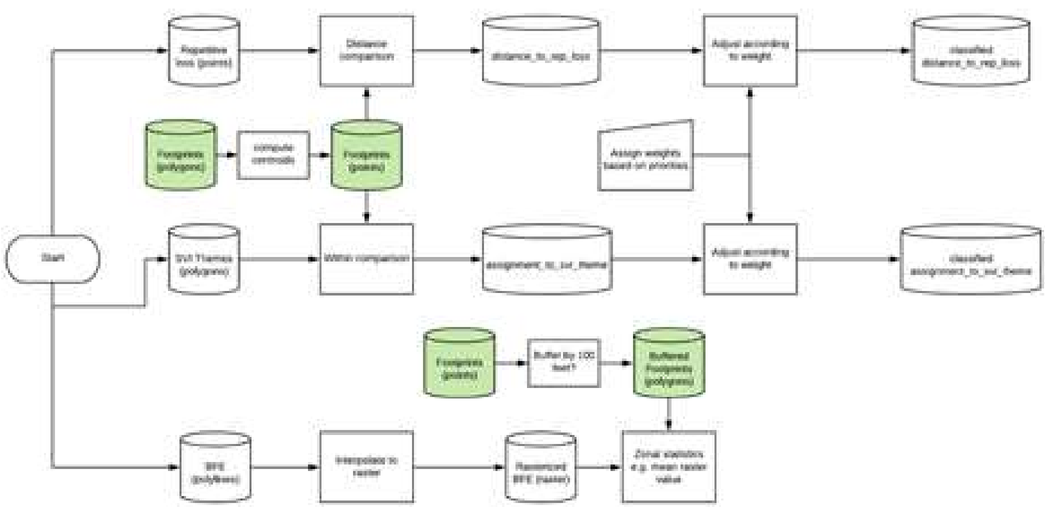


Fig. 3 - Flowchart of flood vulnerability process

Flood Model Architecture

Heirs et al (2002), Wang et al (2009), Smith et al (2013), Rincon et al (2018) all use a grid/raster overlay approach to produce their models. Specifically, Rincon et al (2018) lays out a pretty good approach for the grid overlay/weighted suitability model approach: "*Each of the criteria maps was transformed to the corresponding projected coordinate system (NAD_1983_UTM_Zone_17N) and converted to raster format. In addition, all the maps were reclassified in a scale from 1 to 5, using the Reclassify Tool in ArcMap, where 1 refers to very low (e.g., low flood risk), and 5 is a very high level of flood risk*". Also, of note is that they use a 5m-by-5m spatial resolution for this grid overlay. For our model we chose 1320ft by 1320ft or a quarter mile. It is important to know that this number can be adjusted as it is simply an input parameter into our final model as you will see.

Initial Database Setup

The initial database was prepared and populated by the GIS department at Santa Rosa County. The name of this geodatabase is DataCleanUp.gdb. In the process of design/developing a geodatabase and flood vulnerability model, this data is being copied into a new database called SRCFloodVulnerability.gdb, which follows the below standard naming scheme. Since automation is a long-term goal for this project, it will be helpful to standardize the names of the datasets. For this, we can use acronyms and hyphens with common naming for specific types of datasets. For instance, the repetitive loss structure (RLS) dataset will be "rls," and building footprints will be "bf." When running a process on a dataset, we will add to the name in a standard way appropriate to the actions taken, such as rls_near_net, which we will see is the result of running the Generate Near tool.

Model Design

To prepare to run the model a process of generating an overlaying grid (a fishnet) is carried to a specific extent, the boundary of Santa Rosa County in this case (Fig. 4). After a fishnet is created, it is clipped to the boundary accordingly. Finally, the clipped fishnet feature is converted to a point feature, which will be more optimal for analysis within the model.

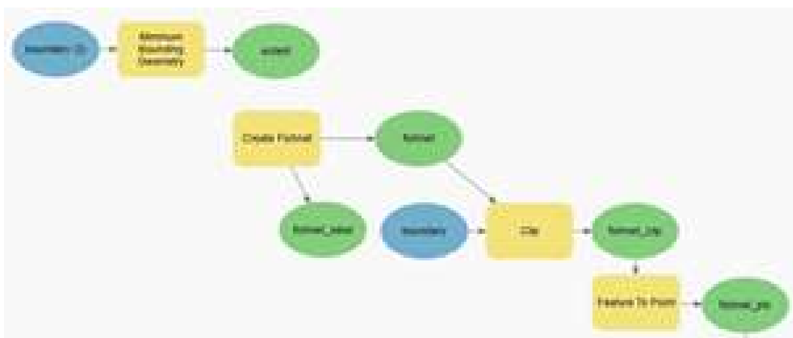


Fig. 4 - Model setup process

The final model consists of three instances of ModelBuilder within Esri’s ArcGIS Pro software. The three models correspond to the criteria variables that we analyzed based on feedback from key stakeholders.

The model that was designed was implemented in three different ModelBuilder instances and using three of those high preference variables, base flood elevation (BFE), social vulnerability index (SVI), and repetitive loss of structure (RLS) records. It is important to note that these three variables are coming from three different domain areas, landscape, cultural/economic, and historical (BFE, SVI, and RLS). The models are described below. We are also providing Python scripts exported with those same models that should facilitate any automation efforts in the future.

Repetitive Loss of Structure (RLS)

RLS was ranked high by the key stakeholders as an important factor in determining the risk of flood. RLS is any insurable building that has had two or more claims of $1,000 or more paid by the National Flood Insurance Program within any ten-year period since 1978. This data is stored as point locations that are a record of locations (building structures) that have had flood-related losses in the past. In Fig 5 below, the green dot represents a RLS record and the pink polygons are building footprints.

Fig. 5 - Example RLS record

For the purposes of the model, the GIS team decided that that specific distance to a recorded RLS incident was not as important for the model as general nearness. This is to say that intersecting the RLS point with the fishnet would be sufficient to associate the risk for the model. Fig 6 below shows the actual steps implemented in the *ModelBuilder* instance.

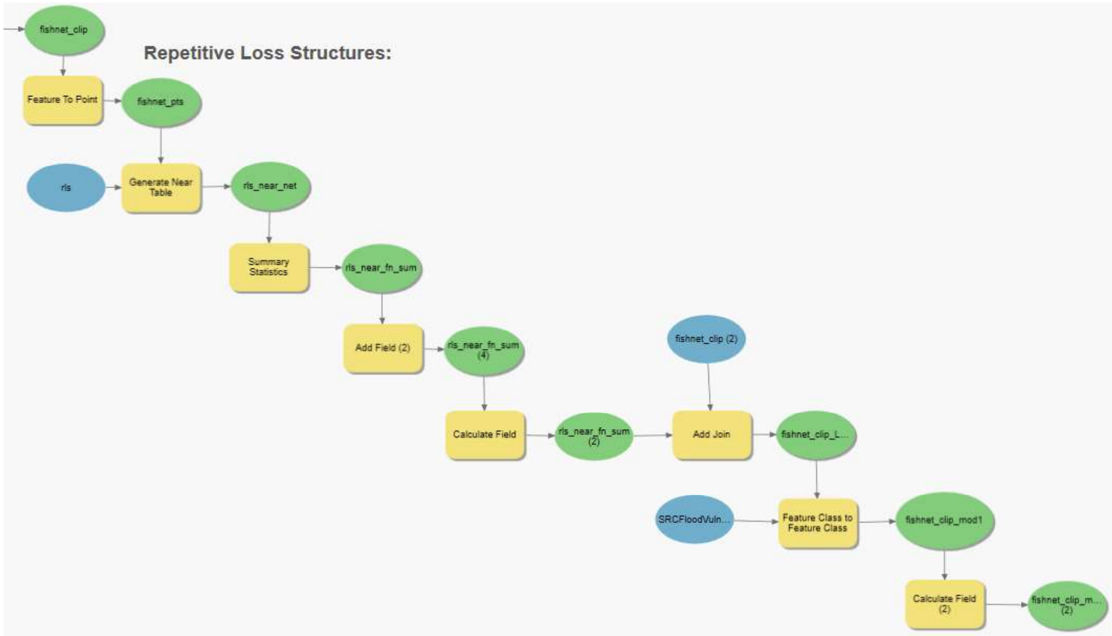


Fig. 6 - RLS Model setup

First, the fishnet grid is converted to the centroid (or center points). It is computationally easy to compare points to points. Next the *Generate Near Table* tool was run to create a record of which RLS points were within a certain distance, 5,280 feet, in this case, keeping a count number of points as a variable. Next a summary (*Summary Statistics*) is computed, and a new column/field is used to store these values. Next a weight value (*rls_wgt)* is calculated using the following logic illustrated in a Python script:

def cal_wgts (ct):

rank_val = 0

if (ct == 1):

rank_val = 1

if (ct == 2):

rank_val = 2

if (ct == 3):

rank_val = 3

if (ct == 4):

rank_val = 4

if (ct > 4):

rank_val = 5

return rank_val

The logic of this script, which was implemented in a *Field Calculator* tool, is easily adjusted, and interpreted. Finally, the resulting features are joined back to the original fishnet, *fishnet_clip,* grid bringing over the weight value accordingly. This join results in a second feature class, *fishnet_clip_mod1*.

Base Flood Elevation (BFE)

BFE was also ranked high by the key stakeholders as an important factor in determining the risk of flood. BFE identifies the expected height of flood waters in high-risk areas. BFE lines are polylines of cross sections along the centerline of rivers and waterways with an elevation value that indicates the depth of flooding. FEMA articles have shown that a structure should be built above its BFE depth. The polylines are of different lengths, angles, and depth values with no apparent pattern other than following waterway centerlines. The structures are points scattered throughout with varying proximity to the lines, but rarely touching them, therefore making it difficult to determine a structure's BFE.

Fortunately, the GIS team at Santa Rosa County had already taken efforts to associate the BFE lines to the combined flood zones with the BFE lines (likely an interpolation), resulting in polygons instead of a polyline dataset. For the purposes of the flood model, we first broke this field out into a separate field (*bfe_bool*) that indicates whether the polygon contains a BFE elevation or not. Note that if we wanted to, we could assign a value depending on the actual BFE value, but we are going with the Boolean for now. To do this we can strip out the elevation from the string within the label field. Since the highest elevation in the county is around 400ft, we will take all the 9999 values as outside of a BFE value. Fig 7 below shows the steps implemented in the *ModelBuilder* instance:

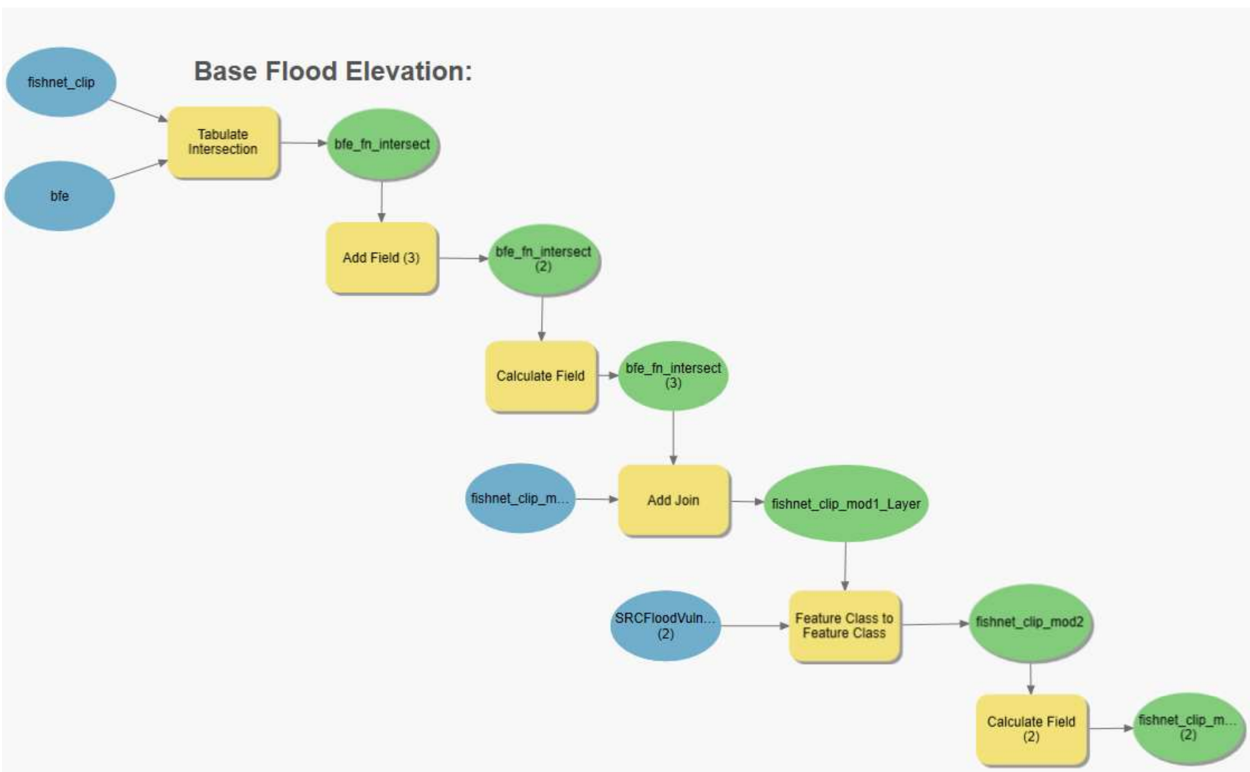


Fig. 7 - BFE Model setup

Computation of this variable starts with running the *Tabulate Intersection* tool comparing the *bfe* dataset (polygons). This resulted in a table of intersections between the fishnet grid and the cases where there were BFE polygons with a positive Boolean value. Next, the percentage of overlap between the BFE polygon and the fishnet grid was considered in computing a weight value (*bfe_wgt)* using the following logic implemented with Python:

```
def calc_wgts (pct):
rank_val = 0
if (pct < 20):
rank_val = 1
if (pct > 20) & (pct < 40):
rank_val = 2
if (pct > 40) & (pct < 60):
rank_val = 3
if (pct > 60) & (pct < 80):
rank_val = 4
if (pct > 80):
rank_val = 5
return rank_val
```

Finally, the resulting features are joined back to the original fishnet grid, *fishnet_clip,* bringing over the weight value accordingly. This join results in a second feature class, *fishnet_clip_mod2*.

Social Vulnerability Index (SVI)

SVI was also ranked high by the key stakeholders as an important factor in determining the risk of flood within the social category. The SVI data comes from the Centers for Disease Control and Prevention (CDC) to identify vulnerable populations based on Socioeconomic Status, Household Composition and Disability, Minority Status and Language, and Housing

Type and Transportation. Within this data, we focused on the variable entitled *rpl_theme1,* which is recorded at the scale of census tracts (polygons) in a percentile that is indicative of vulnerability to disasters such as flooding. Fig 8 below shows the steps implemented in the *ModelBuilder* instance:

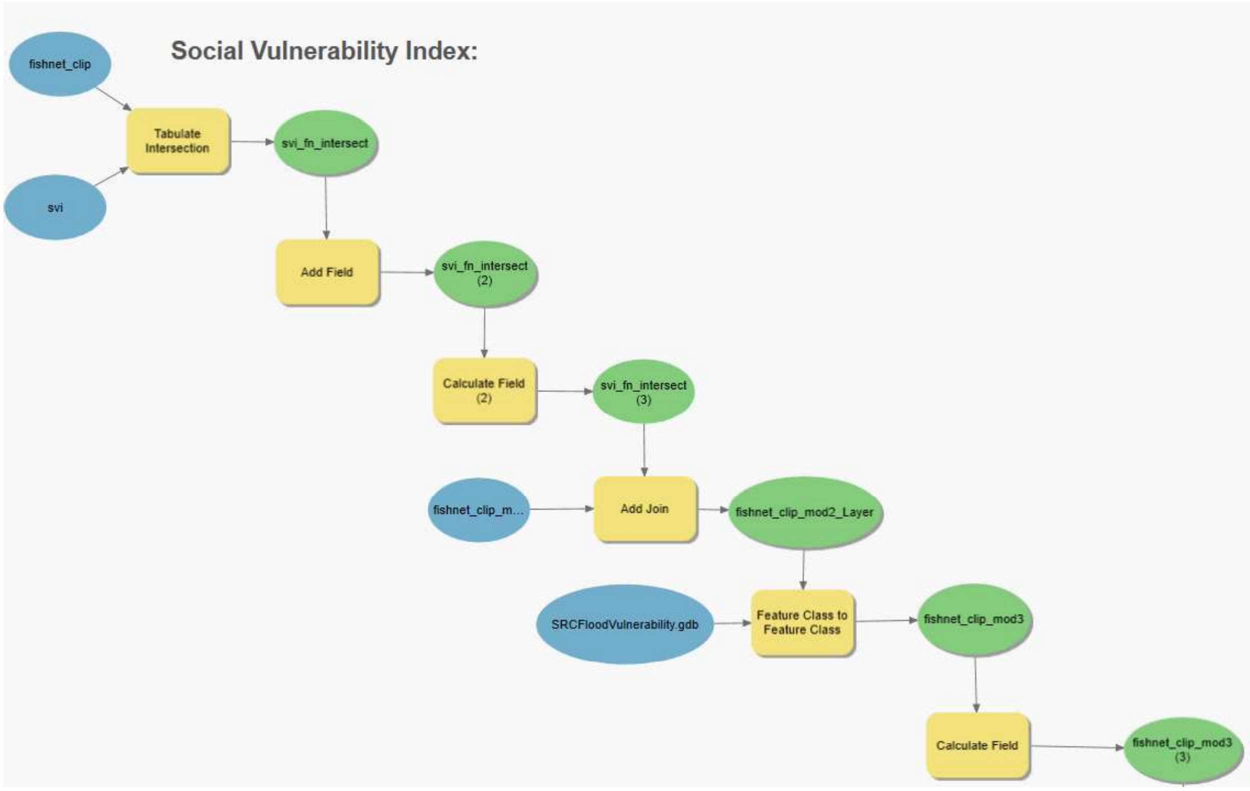


Fig. 8 - SVI Model setup

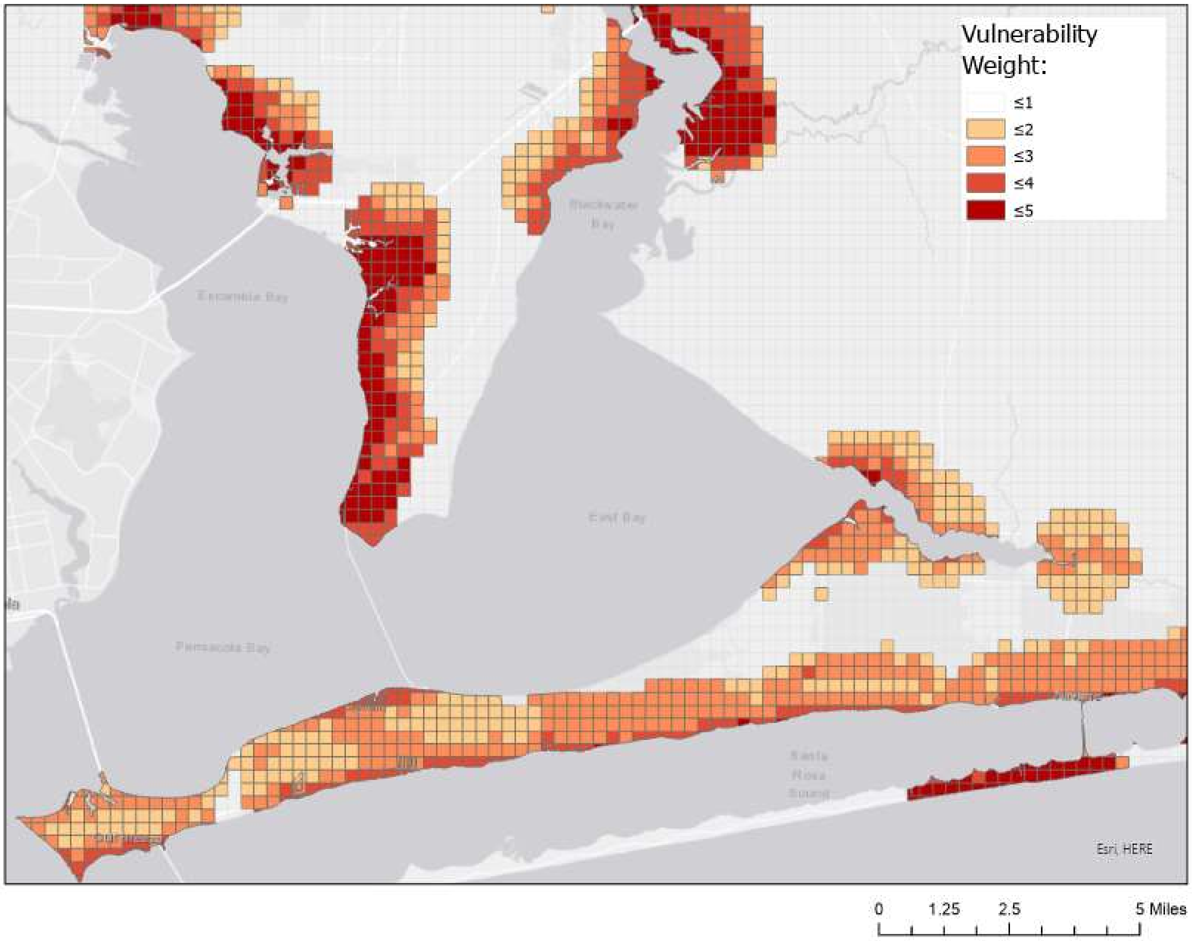
Computation of this variable starts with running the *Tabulate Intersection* tool which compares the SVI polygons to the overlap that they have with the fishnet grid. However, we are not only interested in the case of an overlap but the value of the overlapping variable (*rpl_theme1)*, which is also a percentage value. Therefore, in the logic of the calculating field, Python is a bit more nuanced as it considers both the overlap of the census tract with the fishnet grid and also the percentage of the socioeconomic concern for the given tract. The currently implementing Python logic is as follows:

```
def cal_wgts (pct, overlap):
    rank_val = 0
    if (pct > .10) & (overlap > 50):
        rank_val = 1
    if (pct > .15) & (pct < .30) & (overlap > 50):
        rank_val = 2
    if (pct > .30) & (pct < .45) & (overlap > 50):
        rank_val = 3
    if (pct > .45) & (pct < .60) & (overlap > 50):
        rank_val = 4
    if (pct > .60) & (overlap > 50):
        rank_val = 5
    return rank_val
```

Following the calculation of this weight variable a similar logic using a join and a resulting third feature class, *fishnet_clip_mod3*, is carried out within the model.

Weighted Variable Computation.

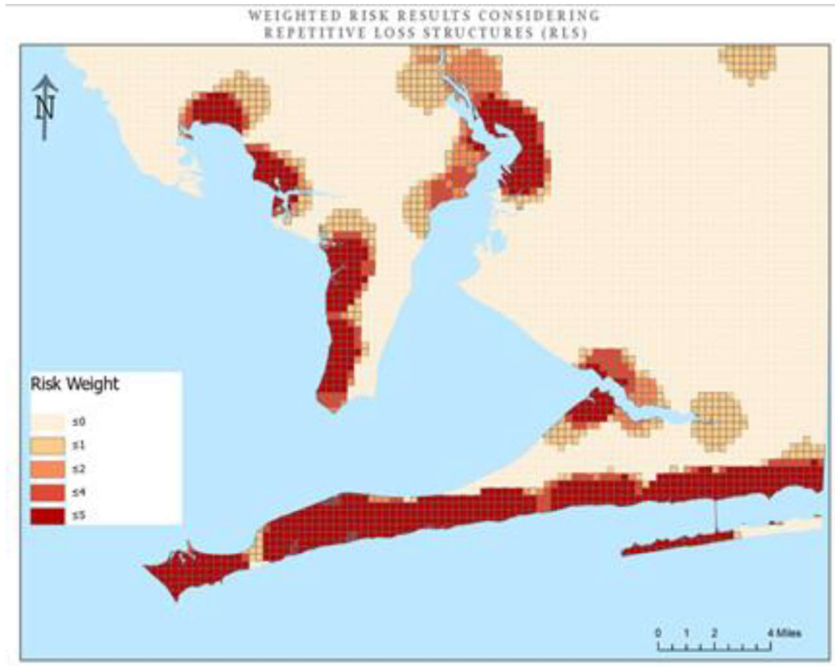
While we are using only three variables, it is easy to see how additional variables can be added and computed. Furthermore, the calculation of a final weighted variable can be carried out. If you are using an equal distribution weighting, it would be a matter of applying the following formula within the *Field Calculator* tool: (!bfe_wgt! + !svi_wgt! + !rls_wgt!)/3. The weights can be adjusted accordingly to alternative specifications. However, with equal weighting and a manual break classification, the final map will look like:



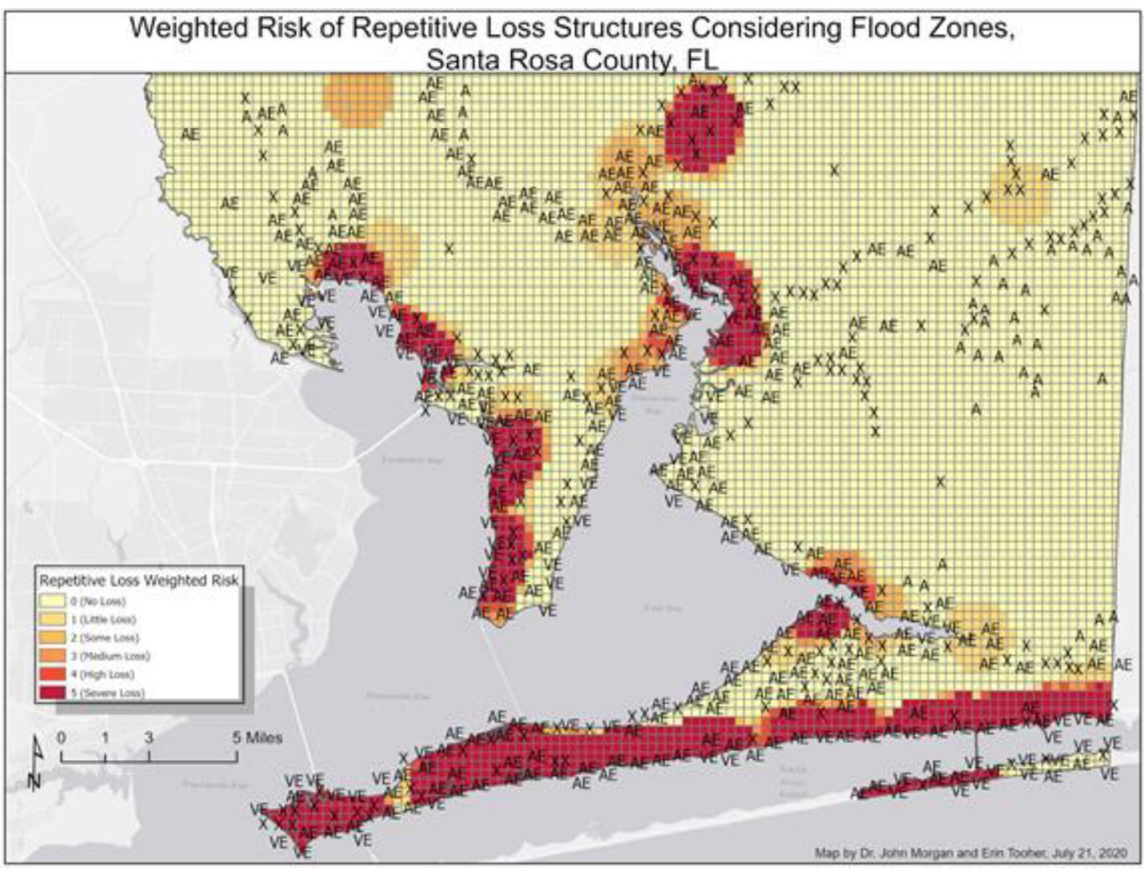
Map 1 - Weighted flood vulnerability map

Model Validation

With the weight field calculated we can use a graduated color map to compare the results to a validating data source such as flood zones. This map is the result of running through the initial model setup just using the RLS points. The original criteria are that a grid cell be within a quarter of a mile of a RLS point. When multiple RLS points are within that distance, a sum of five for a maximum value are counted. When combined with other risk factors, a weighting will be applied accordingly. The three maps below show some early validation steps taken.



Map 2 - Weighted Risk of Repetitive Loss Structures Considering Flood Zones at county scale for Santa Rosa County, Florida



Map 3. Specific Examination of Coastal Area of Santa Rosa County, Florida with regards to Weighted Risk of Repetitive Loss Structures Considering Flood Zones

Chart 1 below depicts the percentage of flood zone by area in square feet per RLS weight (0-5), where a weight of zero indicates no repetitive loss to structures within a given fishnet grid square and a weight of five denotes severe repetitive loss to structure in each fishnet grid square. Note that the highest percentage of loss, regardless of Repetitive Loss Weighted Risk, corresponds to DFIRM Flood Zone X.

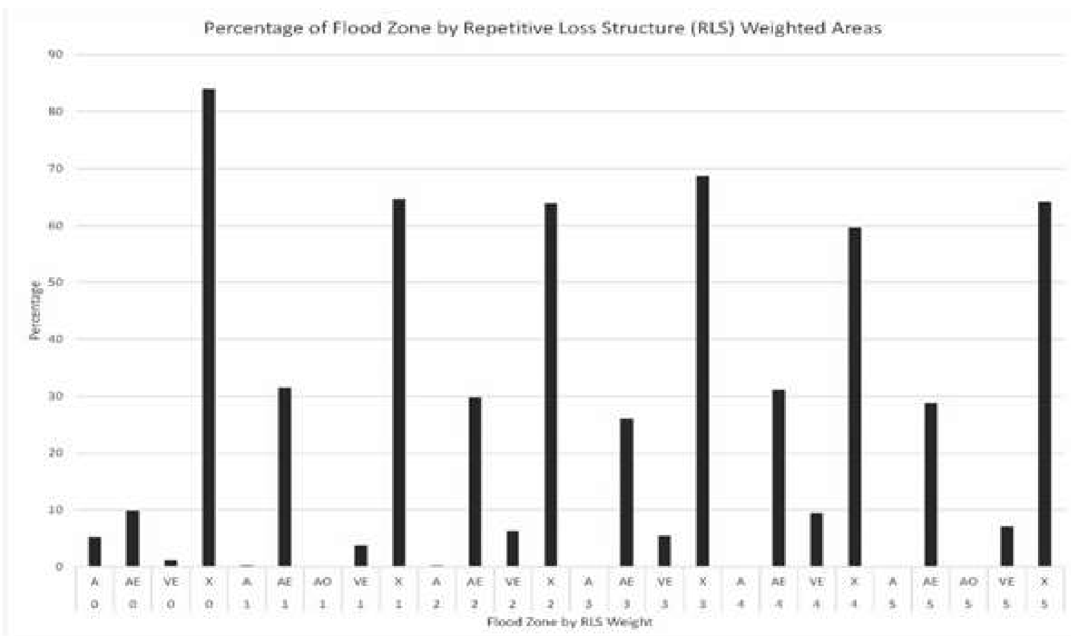
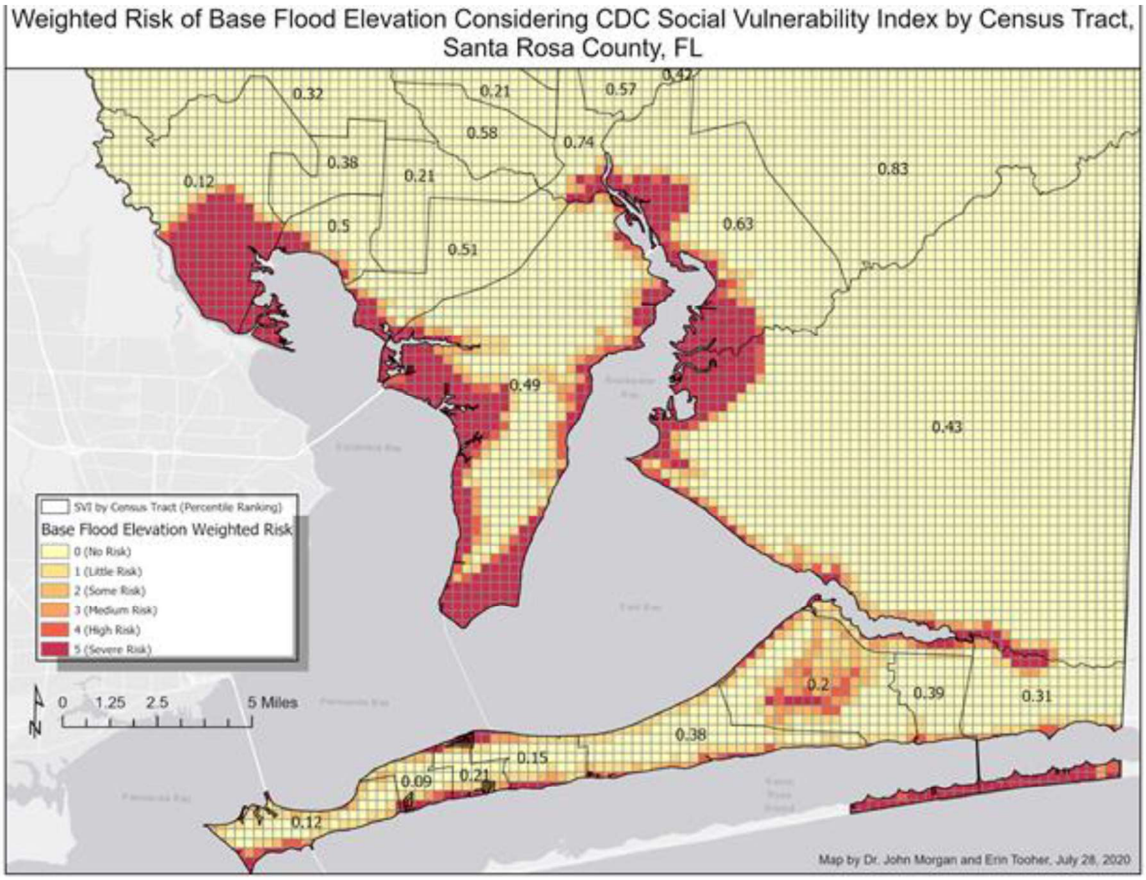


Chart 1 - Flood zone by area in square feet per RLS weight (0-5)



Map 4. Examination of Coastal Area of Santa Rosa County, Florida with regards to Weighted Risk from Base Flood Elevation Considering Social Vulnerability

Finally, the following table depicts each census tract for Santa Rosa County, Florida, with regards to Base Flood Elevation Risk (0 = no risk through 5 = severe risk) where the lower the SVI percentile ranking value, the lower the risk for social vulnerability. For example, a census tract with an SVI percentile ranking of 0.09 is at lower risk for social vulnerability in comparison to a census tract with an SVI percentile ranking of 0.49. Census tract polygon boundaries are marked in black borders and labeled with their SVI percentile ranking. The Base Flood Elevation weighted risk data layer is placed over these boundaries and a tabulate intersection geoprocessing function was run in ArcPro to calculate the percentage in square feet of each census tract by Base Flood Elevation Risk. Since this data is rather extensive, the following table summarizes these percentages better than any bar, scatterplot, or pie chart can. This tabular data has been visually displayed in Map 4 above.

Social Vulnerability Index (Percentile ranking)	BFE Risk (value)	BFE Risk	PERCENTAGE
0.09	0	No risk	48.3
0.09	1	Little risk	23.0
0.09	2	Some risk	8.1
0.09	3	Medium risk	3.5
0.09	4	High risk	5.6
0.09	5	Severe risk	11.5
0.12	0	No risk	57.3
0.12	1	Little risk	9.0
0.12	2	Some risk	2.0
0.12	3	Medium risk	1.6
0.12	4	High risk	2.6
0.12	5	Severe risk	27.5
0.15	0	No risk	51.7
0.15	1	Little risk	23.3
0.15	2	Some risk	5.7
0.15	3	Medium risk	7.3
0.15	5	Severe risk	12.0
0.16	0	No risk	95.1
0.2	0	No risk	37.7
0.2	1	Little risk	25.2
0.2	2	Some risk	15.0

0.2	3	Medium risk	11.4
0.2	4	High risk	6.2
0.2	5	Severe risk	4.5
0.21	0	No risk	94.0
0.21	1	Little risk	2.5
0.21	2	Some risk	1.4
0.21	3	Medium risk	0.3
0.21	5	Severe risk	1.8
0.31	0	No risk	64.3
0.31	1	Little risk	10.7
0.31	2	Some risk	1.4
0.31	3	Medium risk	4.5
0.31	4	High risk	2.4
0.31	5	Severe risk	16.7
0.32	0	No risk	95.0
0.38	0	No risk	75.0
0.38	1	Little risk	16.0
0.38	2	Some risk	4.2
0.38	3	Medium risk	2.0
0.38	4	High risk	1.8
0.38	5	Severe risk	1.0
0.39	0	No risk	69.0
0.39	1	Little risk	5.5
0.39	2	Some risk	2.1
0.39	3	Medium risk	1.7
0.39	4	High risk	3.0
0.39	5	Severe risk	18.6

0.42	0	No risk	100.0
0.43	0	No risk	89.8
0.43	1	Little risk	2.8
0.43	2	Some risk	1.1
0.43	3	Medium risk	0.9
0.43	4	High risk	1.0
0.43	5	Severe risk	4.4
0.49	0	No risk	48.3
0.49	1	Little risk	11.9
0.49	2	Some risk	4.5
0.49	3	Medium risk	4.5
0.49	4	High risk	4.2
0.49	5	Severe risk	26.5
0.5	0	No risk	63.8
0.5	1	Little risk	7.3
0.5	2	Some risk	5.2
0.5	3	Medium risk	3.2
0.5	4	High risk	0.0
0.5	5	Severe risk	20.5
0.51	0	No risk	82.7
0.51	1	Little risk	3.0
0.51	2	Some risk	1.0
0.51	3	Medium risk	1.8
0.51	5	Severe risk	11.5
0.57	0	No risk	100.0
0.58	0	No risk	100.0
0.63	0	No risk	98.0

0.63	1	Little risk	0.3
0.63	2	Some risk	0.2
0.63	3	Medium risk	0.1
0.63	4	High risk	0.1
0.63	5	Severe risk	1.3
0.74	0	No risk	80.3
0.74	1	Little risk	2.2
0.74	2	Some risk	3.4
0.74	3	Medium risk	3.0
0.74	4	High risk	1.5
0.74	5	Severe risk	9.6
0.83	0	No risk	100.0

CIVIC WORKSHOP

Twenty-one colleagues from the two-county area participated in two and a half-day virtual UF/IFAS Community Voices/ Informed Choices (CIVIC) training. This UF/IFAS Extension initiative builds capacity for communities to work toward enhanced quality of life leading to solutions directed at local challenges. The facilitation training consisted of situation analysis, facilitative listening skills, situation analysis, meeting management, establishing parameters of the conversation and process agenda development. The training concluded with a public input meeting to introduce the Santa Rosa County Flood Vulnerability assessment model to 26 community members.

Participants of the meeting contributed insight and questions concerning flooding issues in Santa Rosa County. Follow-up with 2 participants led to increased use of Extension materials and 1 participant followed-up with a letter to the commissioners with suggestions to increase future resiliency in Santa Rosa County. A follow-up survey will be sent to participants in early 2021. In addition, copies of the Facilitator's Guide to Participatory Decision Making by Sam Kaner were distributed to all attendees of the training.

VIRTUAL PUBLIC PRESENTATION

On October 29th, 2020, the Resilience to Future Flooding team held a public meeting via Zoom moderated by Joy Hazell from the University of Florida CIVIC group. We had over 50 citizens attended the online meeting. The event lasted about an hour and a half and included a presentation of the vulnerability assessment web application as well as a question-and-answer session with the public.

WEB APPLICATION / STORYMAP

A Web-App was created with the data from the Flood Vulnerability Model. This allows community members to search addresses and discover if they are in a vulnerable area based on the three ranked factors. The Web-App was included in a publicly published Story Map explaining the details, results, and future uses of the project to the community.

APPLICATIONS

Santa Rosa County will use the vulnerability assessment data and analysis to identify vulnerable areas and develop appropriate plans. From developing an Adaptation Action Plan, to evaluating benefits of nature-based projects in Santa Rosa

County, this model provides detailed information staff can use to obtain funds and address vulnerability.

Existing implementation projects using nature-based solutions to address coastal erosion in Santa Rosa County are the Floridatown Living Shoreline and the Oyster Shell Recycling Program. Using information gathered by the model, these projects can move forward with new insight of development strategies and engineering solutions.

In the future, this model can provide insight into various other areas of interest. The weight of factors can be modified to reflect the target study, providing new information about the relationships between SVI, RLS, and BFE. Moving forward, sea level rise can be included into the model to help identify and protect future vulnerable areas in Santa Rosa County.

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