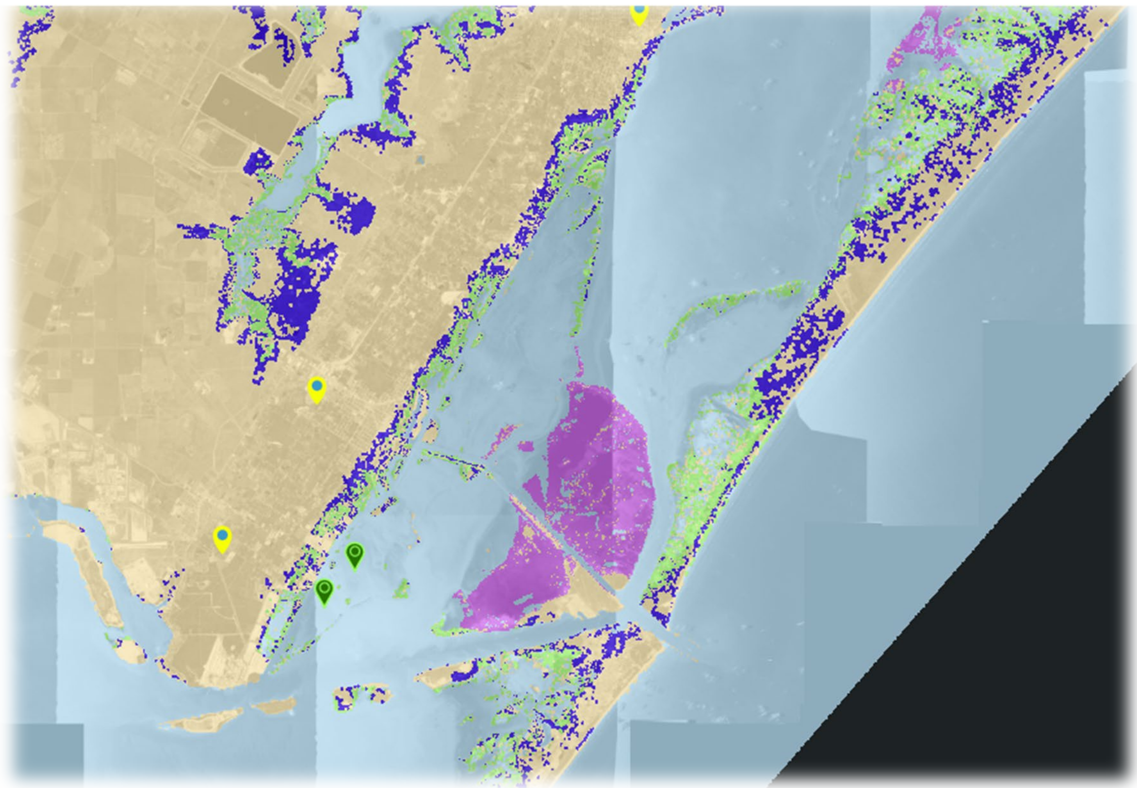
ESLR Coastal Resilience Management Transition Advisory Group Fall 2024 Workshop Report



Report of Activities, Methods, and Results from the
ESLR 2021 Coastal Resilience: Living with Sea Level Rise in the Texas Coastal Bend
Management Transition Advisory Group (MTAG) Meeting
November 12, 2024
Harte Research Institute for Gulf of Mexico Studies

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PI: Dr. James Gibeaut
Co-PI's: Dr. Katya Wowk, Dr. Lihong Su, Dr. Peter Bacopoulos and Dr. Chris Kees

ESLR 2021 Coastal Resilience: Living with Sea Level Rise in the Texas Coastal Bend
Management Transition Advisory Group (MTAG) Workshop
November 12, 2024

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Workshop Summary

The Effects of Sea Level Rise (ESLR) project is a collaboration between the Harte Research Institute (HRI), Louisiana State University (LSU), and The Water Institute. The Fall 2024 workshop held in-person on November 12, 2024, at HRI, was designed to provide updates to the Management Technical Advisory Group (MTAG) on the modeling approaches, products, and outputs of the project. The workshop had the following key goals:

1. Engage with Modeling Results
2. Prioritize Areas for Natural and Nature-Based Features (NNBF)
3. Share Ideas for Localized Data

The meeting began with a welcome and introductions from Dr. Katya Wowk, followed by Dr. Jim Gibeaut's introduction of the project and its co-production approach. The project aligns with the Texas Coastal Resiliency Master Plan (TCRMP) and aims to integrate sea-level rise modeling, utilizing tools such as SLAMM and ADCIRC and is funded through NOAA's NCCOS "Effects of Sea Level Rise (ESLR)" program. Dr. Gibeaut also highlighted LSU's role in this project and how they will incorporate the new Hydro-MEM wetland model, and the project's expected completion by August 2025.

Dr. Diana Del Angel presented the ESLR Concept Model and discussed the goals for assessing sea-level rise vulnerability, particularly wetland changes and water level shifts due to SLR. This session aimed to analyze land cover and wetland scenarios and evaluate the efficacy of Natural and Nature-Based Features (NNBFs) as potential mitigation solutions.

Dr. Gibeaut then provided an update on digital elevation modeling (DEM) efforts to improve Hydro-MEM inputs, using LiDAR and satellite imagery for higher resolution land cover data. Dr. Peter Bacopoulos from LSU presented the WEADS model, which simulates hydrodynamic and ecological interactions, emphasizing the importance of detailed, interval-based modeling for SLR impacts. The model captures marsh dynamics and the feedback between marshes and environmental drivers.

During Data Exploration Activity 1, participants explored water level and land cover changes under SLR scenarios. Discussions revealed concerns about tourism impacts in areas like Corpus Christi and Port Aransas, infrastructure vulnerabilities, sediment loss, and the need for habitat restoration efforts to mitigate the effects of SLR.

Activity 2 focused on wetland changes under SLR scenarios and the role of NNBFs in mitigating these changes. Participants discussed several potential NNBFs for modeling, including using dredged material to restore habitats and raising causeways to protect infrastructure and maintain ecosystem connectivity. Participants voted on potential NNBF's that could be modeled for the next phase of the project.

A post-meeting survey showed that participants were highly satisfied with the workshop and the hands-on activities, especially around the web-based product and the engagement during discussions.

Workshop Objectives

- Refresh on project concept model.
- Engage with modeling results to better understand flood impacts and refine ideas for project outputs, including future flood outputs.
- Prioritize areas for natural and nature-based features and describe potential benefits of such features.
- Share ideas for localized data for infrastructure planning.

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Workshop Attendants

Meredith Darden, Visit CC	Lihong Su, HRI-TAMUCC*
Peter Bacopoulos, LSU*	Evan Turner, TWDB
Kara Coffey, HRI-TAMUCC*	Tony Williams, TGLO TCRMP
Diana Del Angel, HRI-TAMUCC*	Katya Wowk, TWI*
James Gibeaut, HRI-TAMUCC*	Kathryn Keating, TWI*
Jin Ikeda, LSU*	Christine Buckle, NOAA NCCOS
Craig Casper, CC MPO	Katie Swanson, MANERR
Emily Martinez, CBCOG	Sankar Manalilkada Sasidharan, HRI TAMUCC
Clarence Feagin, US Navy	Dijani Laplace, HRI-TAMUCC*
Matthew Mahoney, TxDoT	Mary Baker, CBBEP
Trevor Meckley, NOAA NCCOS	

*denotes affiliation with project team

Description of Meeting Activities and Content

Welcome and Introductions

Dr. Katya Wowk welcomed the MTAG and ESLR team to the meeting. All participants went around the room introducing themselves with name and affiliation. (See Appendix B for Intro Slides)

Dr. Jim Gibeaut opened the meeting by introducing the project, emphasizing its co-production approach, and highlighting its funding source through NOAA's NCCOS "Effects of Sea Level Rise (ESLR)" program. He outlined the project's alignment with the Texas Coastal Resiliency Master (TCRMP). HRI has been involved for about 12 years with the TCRMP efforts, early stages of which were carried out by the Texas GLO Coastal Management Program. Recently, HRI and collaborators have focused on incorporating sea-level rise modeling, utilizing tools like SLAMM and ADCIRC. The current ESLR 2021 project involves a collaboration with LSU, which integrates a new wetland model, Hydro-MEM. The project concludes on August 31, 2025. Findings will contribute to the next version of the TCRMP, with a related meeting planned in Houston.

The group discussed the challenges of measuring land subsidence rates due to limited sensor coverage. Current methods include GPS sensors, field surveys, and interferometric synthetic aperture radar (SAR) from satellites to detect small-scale motion. Variability in subsidence rates along the coast complicates accurate assessment, but SAR technology may help bridge data gaps.

Increased concerns about sea-level rise were noted, partly due to recent storm events that caused flooding and necessitated rescues, particularly in North Beach. Anecdotal reports from boaters and observations from the Coastal Bays and Estuaries program indicate areas now flooding more frequently.

Dr. Gibeaut reiterated the importance of addressing sea-level rise impacts and integrating project outcomes into strategic planning for coastal resiliency.

Dr. Diana Del Angel presented the ESLR Concept Model (Appendix E), which outlines the products generated by the TAMUCC and LSU teams as part of Goal 1. Currently, the project is at Goal 2.1, assessing sea-level rise (SLR) vulnerability. She explained that the day's focus would include outputs from these two goals, specifically comparing HRI land cover with NWI land cover, examining water level changes due to SLR, and analyzing wetland changes. Additionally, the workshop will gather information on potential Natural and Nature-Based Features (NNBF) to inform Goal 2.2, which assesses the efficacy of NNBF solutions.

ESLR Modeling Update: Landcover and Digital Elevation Model

Dr. Jim Gibeaut presented TAMU-HRI's progress on digital elevation modeling (DEM) and land cover classification, highlighting efforts to improve Hydro-MEM inputs (Appendix B). The team aimed to create higher-resolution and updated land cover datasets by integrating LiDAR and satellite imagery (WorldView 2, 2m resolution) through machine learning. The resulting dataset achieves 1m pixel resolution, surpassing the coarser National Wetlands Inventory (NWI) data, which is outdated in some areas. Comparisons showed HRI data with less marsh cover but more dry land than NWI, with similar beach and water classifications. Dr. Gibeaut also discussed addressing vegetation bias in LiDAR data to produce a more accurate DEM, especially in the intertidal zone, essential for wetland projection mapping.

A discussion about data availability addressed incorporating project data into tools like HURREVAC for hurricane evacuations. It was noted that NOAA prioritizes Coastal Change Analysis Program (C-CAP) data updates for 2026, but this project's data is not directly used for evacuation decisions. While evacuation decisions remain the purview of the National Weather Service, similar ESLR projects have informed evacuation-related tools in the past.

ESLR Modeling Update: WEADS Model

Dr. Peter Bacopoulos (LSU) provided an update on hydrodynamic-ecological modeling (see Appendix B for slides). He emphasized the discrete, mesh-based inputs (e.g., ADCIRC triangular points) used to create continuous topographic maps. He explained the two-part Hydro-MEM model, comprising hydrodynamic water modeling and the Marsh Equilibrium Model (MEM), which accounts for feedback between marshes and environmental drivers like sea-level rise. The model captures processes such as marsh elevation growth and berm migration, which simpler bathtub models cannot.

Key points included:

- Modeling sea-level rise and marsh dynamics at 25-year and 10-year intervals, extending to 2120.
- Using tidal datums to model chronic problems like tidal shifts, rather than episodic storm events.
- Biomass curve dynamics, showing marsh preferences for optimal inundation levels.
- ADCIRC's ability to simulate water levels and marsh accretion over time.
- The trade-off between cost and reducing model uncertainty by avoiding the simpler bathtub approach.

Dr. Bacopoulos presented scenarios for vegetation and sea-level changes under various tidal conditions, highlighting the importance of detailed, interval-based modeling.

Data Exploration Activity 1- Water Level and Landcover Data

Dr. Del Angel presented the goals of Activity 1. This exercise involved comparing water levels under sea-level rise scenarios in the Texas Coastal Bend and evaluating two land cover datasets (ESLR Land Cover and NWI). Participants explored inundation layers for present-day and 2070 scenarios, identify water level changes at specific locations, and assess differences in land cover data. Participants took about 45 minutes to explore the data using the ArcGIS online map (see Appendix G).

Figure 1. MTAG participants exploring the online-data during Activity 1.

Activity 1 Discussion

During the discussion participants highlighted critical areas of concern, including sediment loss, infrastructure vulnerabilities, habitat restoration needs, and the economic impacts of SLR on tourism and local businesses. Collaborative efforts, such as beneficial use projects and habitat restoration, are ongoing, but further work is needed to integrate hydrology, erosion, and sedimentation dynamics into planning and policymaking. Discussion points were as follows (see Appendix H: Area of Flood Concern)

- There is potential impact of sea-level rise (SLR) on tourism under the Intermediate-High Scenario, particularly in areas like Corpus Christi and Port Aransas, where beaches are the main draw for visitors. The findings emphasized that SLR poses a significant threat to tourism and local economies, as it diminishes beach areas, the top reason for visitors. Notably, the models did not account for rain or wind effects, only tidal action.
- There is the challenge of public engagement, noting that people won't care about SLR data unless it's tied directly to impacts like flood insurance, business costs, or city-level economic outcomes. Advocated for better ways to translate data into actionable policy decisions.
- One participant observed that areas like Corpus Christi's south and west sides, historically prone to flooding, are exacerbating issues with increased impervious surfaces, reducing sediment influx. This lack of sediment threatens the Nueces Delta and makes current model projections conservative. He emphasized the need to address sedimentation loss and potential habitat degradation.
- Habitat loss was discussed, particularly in the Nueces and Guadalupe Deltas. Although it was noted that there are ongoing beneficial use projects to place material near breakwaters to restore habitats. Five areas in the Nueces Delta are targeted, with some progress already made, but SLR scenarios suggest these habitats could be lost without further action.
- There was mention of frequent flooding at locations like Pier 22 and Yorktown Crossing. The Yorktown bridge, built in the 1950's on mud flats, was not designed for tidal action and faces significant issues, particularly with increased traffic from nearby schools. Infrastructure concerns extend to Mustang Island and other high-traffic areas.

- One participant highlighted Aransas Pass as a flood-prone area that experienced prolonged issues after Hurricane Harvey, including debris accumulation. Routine flooding has impacts on housing, businesses, and infrastructure.
- SLR and habitat loss directly threaten tourism, particularly in areas like North Beach, the marina, and Mustang Island. Suggested raising breakwaters as a priority for mitigation.
- Persistent flooding was reported near Egery Flats on FM 136 and FM 2678 near Rockport and Mission Corridor. It was suggested that these areas, including state-owned parcels south of Rockport, could be potential mitigation sites (Parcels near Palms Harbor). Also mentioned, Texas Water Trade has done some restoration work near Highway 35 and Alligator Lake.
- A discussion of shoreline loss near the Navy base runway stated that there are plans to design natural and nature-based features (NNBF) to stabilize the area long-term. There is a current project taking place at TAMUCC using a wave tank experiment that should yield some recommendations by December. It was highlighted that the area is important bird habitat. Ther is a need for elevated causeways to allow sediment movement and preserve marsh habitats.
- One issue along Corpus Christi Bay is the sediment blockage and habitat loss along Ocean Drive and other areas popular for recreation. There is a need for infrastructure improvements like parking lots for bikers and parasailers. Highlighted the need for improved sediment management and marsh water flow.
- Discussed model limitations were discussed, such as SLAMM's underperformance in capturing erosion, especially on barrier islands. Recommended merging models to improve accuracy. Dr. Gibeaut also noted the difference in detail between HRI and NWI land cover data, advocating for the use of HRI's more detailed datasets. Particularly highlighting the mangroves in Oso Bay.
- Laguna Shores near Red Head Pond and the Intercoastal Waterway, where Flour Bluff Independent School District purchased wetland plots for education and invasive species removal, in partnership with CBBEP.

Data Exploration Activity 2- Wetland Scenarios Under SLR and NNBF's

Dr. Del Angel presented the goals of Activity 2. This activity guided participants to explore wetland changes under two SLR scenarios in the Texas Coastal Bend. Using the projected wetland habitat changes, participants consider the role of Natural and Nature-Based Features (NNBFs) in mitigating impacts, and a discussion followed to develop a list of NNBFs and to vote on which NNBFs should be prioritized for modeling.

NNBF Discussion and Prioritization for Modeling

- Issues with infrastructure, particularly the JFK Causeway and South Padre Island Drive (SPID), which experience significant water coverage.
- Concern about road expansion from two lanes to five lanes without considering the potential flooding impact.
    - Suggestion for nature-based solutions, like marshes with roads, to maintain ecosystem connectivity.
- One participant proposed using NNBF in Port Aransas, specifically the Charlie's Pasture area.
- Another participant mentioned the state-owned area south of Rockport (near Palm Harbor) as a potential site for NNBF.

- Dagger Island was suggested as a location where dredged sediment could be used to restore habitat.
- Dr. Gibeaut highlighted the TCEQ Restore Program there is a restoration priority to protect wetland migratory pathways and suggested using NNBF approaches in areas like Palm Harbor, which may be submerged in the future.
- For a potential NNBF, the areas near Snoopy's and JFK Causeway have high visibility, with frequent flooding during high tide.
    - The flooding of the road above this area, which affects residents and tourists.
    - Another participant mentioned the state-owned land near the causeway, which had no plans for use despite being targeted for further development.
- CBBEP reviews permits for Rookery Islands and construction on sites like Tern Island, Triangle Tree, and Dagger Point.
- Discussion about the possibility of modeling small islands, like the Rookery Islands, to ensure their future viability under sea level rise.
    - Challenges include compaction of dredge material and edge erosion when determining how high to build islands.
- Dr. Del Angel suggested considering broader, community-impact areas beyond standalone islands like the Rookery Islands. Discussion of the possibility to model the island occurred. **Dr.** Bacopoulos suggested it could be possible.
- Dr. Gibeaut asked whether models should account for development in areas like North Beach where marsh development conflicts with existing streets and buildings. The group proposed using different layer colors to indicate these areas.
- Discussion on San Antonio Bay ensued, where marsh development is projected, but the road would likely be covered.
    - Dr. Bacopoulos explained that the hydrodynamic model may not incorporate land that can't be flooded, possibly due to limitations in the model domain or interactions with other models.

Priority NNBF for Modeling

Several NNBFs were considered, including the causeway near Snoopy's, beneficial use of dredged material at Ransom Island and Dagger Point, the causeway near SPID and 361, raising the causeway between North Beach and Portland, the Nueces Delta, and the Mission Corridor.

Participants took turns voting on the NNBFs to be used for modeling. MTAG members voted with blue dots (see Appendix H), while modelers used red dots to ensure the selected NNBF designs were suitable for modeling and would produce reliable results. The NNBFs that received the most votes reflected both their importance to the MTAG and their appropriateness within the model's. These will be explored for modeling in the upcoming months.

Figure 1. MTAG members and modelers voting for NNBF's to model using the ESLR framework.

The group discussed several potential areas for modeling, with a focus on the Snoopy's area and the Highway 361 corridor, which were identified as key for tourism, marsh development, and visibility. Another discussion suggested that combining this area with the proposed expansion of the road on Mustang Island would cover important aspects like business preservation and marsh restoration. Dr. Wowk highlighted other areas of interest, including North Beach, Mustang Island, Nueces Delta, and the Mission Corridor, and emphasized the need to assess feasibility in modeling and for the ESLR team to review if any of these projects are already on the way. Dr. Bacopoulos noted that the Rookery Islands and Intracoastal Waterway may present challenges in visualization due to their size and location. The group also discussed the availability of preliminary data. It was noted that the data is still preliminary but will be accessible via the GRIIDC data repository once finalized.

Closing Remarks and Conclusions

The final comments in the workshop focused on a detailed discussion of the web-based tool. Dr. Wowk prefaced this section by noting that some of the products from earlier ESLR Project ending in 2021 have only recently been incorporated into decision-making processes. Dr. Del Angel presented some of this information (see slides in Appendix B), adding that it still takes time to finalize the tool after feedback has been collected. She mentioned that the web tool was created in 2023 by Christine Buckel, and provided examples of its use in a previous ESLR project:

- A consolidated wastewater treatment facility in Jackson County, where they wanted to understand the level of flooding the facility could endure. The tool helped inform that decision.
- Weeks Bay National Estuarine Research Reserve (NERR), which utilized marsh modeling outputs.
- Educational and outreach materials, which could be applied to the current project as well.

Some last-minute comments suggested that Padre Island National Seashore and the Sea Grant program should be part of the MTAG. One participant noted that the group has done a good job of narrowing their focus, determining who should be responsible for each step. Dr. Wowk expressed her satisfaction that there is genuine interest in using the model, as people have inquired about when the tool will be available for broader use.

Finally, Dr. Ikeda asked Katya and Dr. Del Angel about a potential cost-benefit analysis. Dr. Wowk mentioned that The Water Institute has the capacity to perform one, but it is not currently within the scope of the project.

Post Meeting Evaluation

A brief survey was given to participants before they left the workshop, all participants outside the meeting organizers were invited to respond. Overall, nine participants out of the fifteen responded anonymously (see evaluation questions in Appendix C and results in Appendix D). The results show that participants were generally satisfied with the workshop, reporting high satisfaction with the overall experience, refreshments, presentations, and discussion opportunities. Participants also strongly agreed that the workshop was a good use of their time, increased their knowledge of the project, sea level rise, and habitat changes. Overall comments suggest that participants particularly enjoyed the engagement and conversation around the web-based product and the hands-on activity.

Appendix A: Workshop Agenda

ESLR Coastal Resilience: Living with Sea Level Rise in the Texas Coastal Bend
Management Transition Advisory Group (MTAG) Meeting
November 12th, 2024
8:30 am- 3:00 PM

Harte Research Institute for Gulf of Mexico Studies
6300 Ocean Drive, Corpus Christi, Texas 78412
Conference Room 127

Project goal: Enhance resilience planning in the Coastal Bend using enhanced marsh modeling techniques to better understand potential impacts and the benefits that may be achieved using natural and nature-based features.

Project objectives:

- Improve and adapt the existing coupled hydrodynamic-marsh model to the Texas Coastal Bend
- Assess sea level rise (SLR) vulnerabilities and the efficacy of natural and nature-based features (NNBF) using the appropriate marsh evolution models
- Co-produce knowledge and products through collaboration with the Management Transition Advisory Group (MTAG) for modeling and assessing SLR resiliency in the region

Workshop Objectives:

- Refresh on project concept model.
- Engage with modeling results to better understand flood impacts and refine ideas for project outputs, including future flood outputs.
- Prioritize areas for natural and nature-based features and describe potential benefits of such features.
- Share ideas for localized data for infrastructure planning.

Meeting Agenda

Time	Item
8:30	Arrive and sign in (breakfast provided)
9:00	Welcome, Icebreaker, and refresh on Project Concept Model
9:30	Presentation: Model Tides & Validation
10:00	BREAK
10:15	Activity: Scenario Based Exploration Activity
11:15	Facilitated Discussion of Scenario Based Exploration
12:00	Lunch (Provided)
1:00	Activity: Natural and Nature-Based Features
2:00	Break
2:15	Discussion on Data Output Types and Tool Needs
2:45	Final Thoughts and Next Steps
3:00	Adjourn

*coffee, tea and water will be provided throughout the meeting.

Appendix B: Presentations

Wowk, Gibeaut, Del Angel Slides:

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Context

- The Texas General Land Office publishes the TCRMP which identifies coastal vulnerabilities and strategies to address them.
- HRI models the impacts of SLR and storm surge for the TCRMP using SLAMM and ADCIRC models.
- NOAA's Effects of SLR (ESLR) Program funds research for (1) describing coastal vulnerability, (2) determining benefits of Natural and Nature Based Features (NNBF), and (3) predicting effects of SLR.
- LSU developed and applied new SLR modeling techniques (Hydro-MEM) under the ESLR program.
- HRI, LSU, and TWI are partners on this newly funded ESLR project with the following goals:

Lost Salt and Brackish Wetlands
Surviving Salt and Brackish Wetlands
Gained Salt and Brackish Wetlands

NCCOS | NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

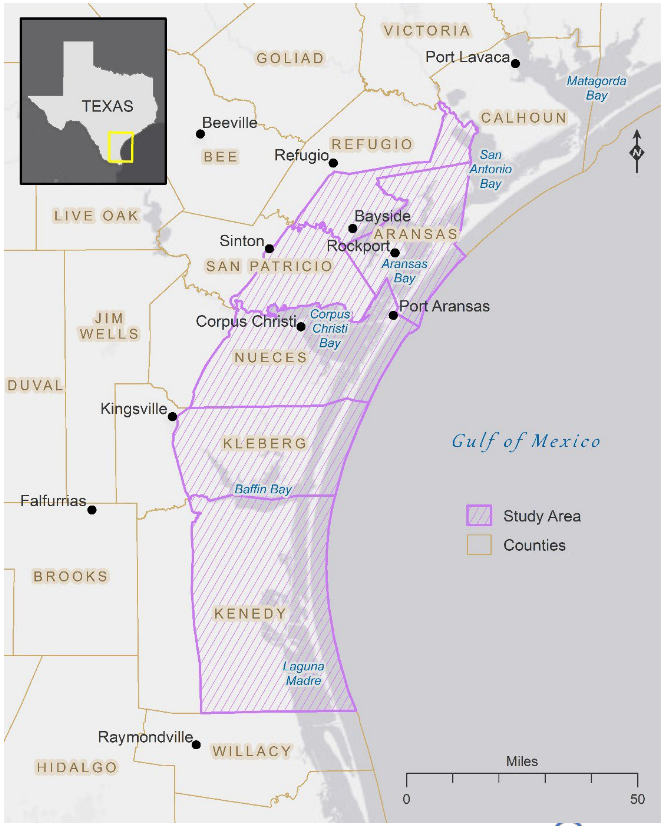
SCIENCE SERVING COASTAL COMMUNITIES

The Effects of Sea Level Rise (ESLR) Program

Texas A&M University Corpus Christi | HARTE RESEARCH INSTITUTE FOR GULF OF MEXICO STUDIES — LSU Center for Coastal Resiliency — THE WATER INSTITUTE OF THE GULF

Goals

- Improve and adapt Hydro -MEM to the Texas Coastal Bend
  - Improve bare-Earth elevation model
  - Develop detailed model mesh
  - Improve data/modeling of marsh vertical accretion
- Assess SLR vulnerabilities and NNBF efficacy using Hydro-MEM and SLAMM as appropriate
  - Model SLR effects with and without NNBF
- Form a collaborative MTAG and co -produce a knowledge base for modeling and assessing SLR resiliency in the region



November 2024 MTAG Overview

OBJECTIVES & AGENDA

Objectives

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- Engage with modeling results to better understand flood impacts and refine ideas for project outputs, including future flood outputs
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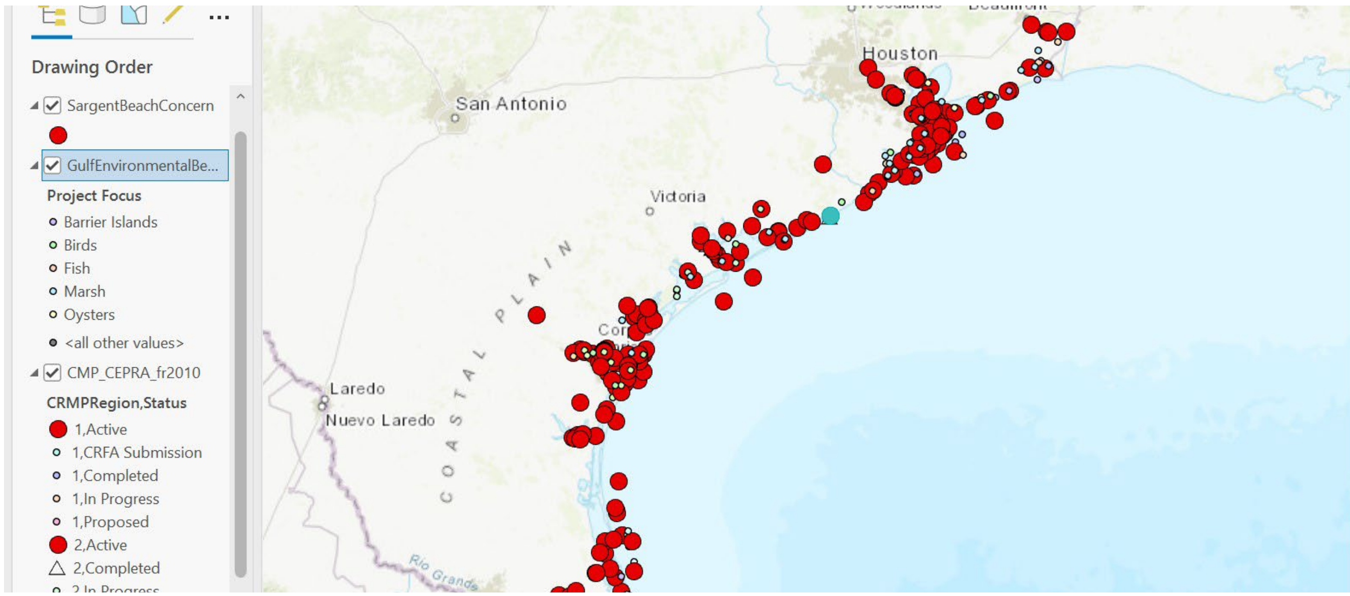
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GulfEnvironmentalBe...
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Barrier Islands
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Fish
Marsh
Oysters
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CRMPRegion,Status
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1,CRFA Submission
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Houston
San Antonio
Victoria
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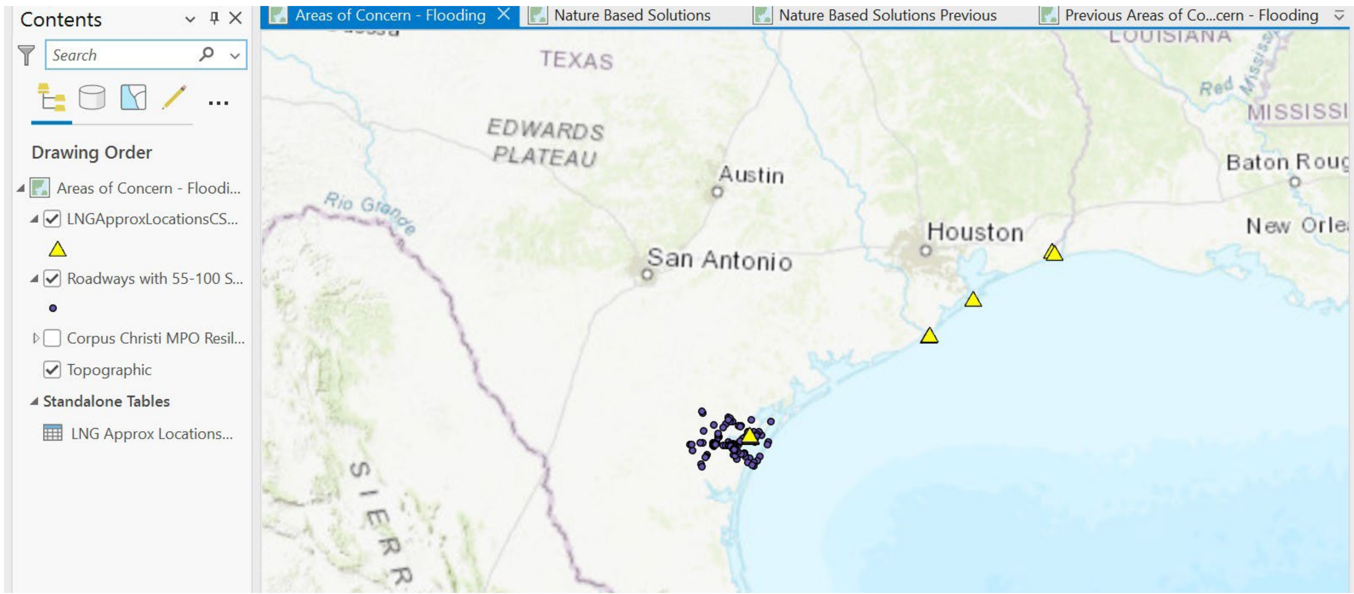
Nuevo Laredo
COASTAL PLAIN



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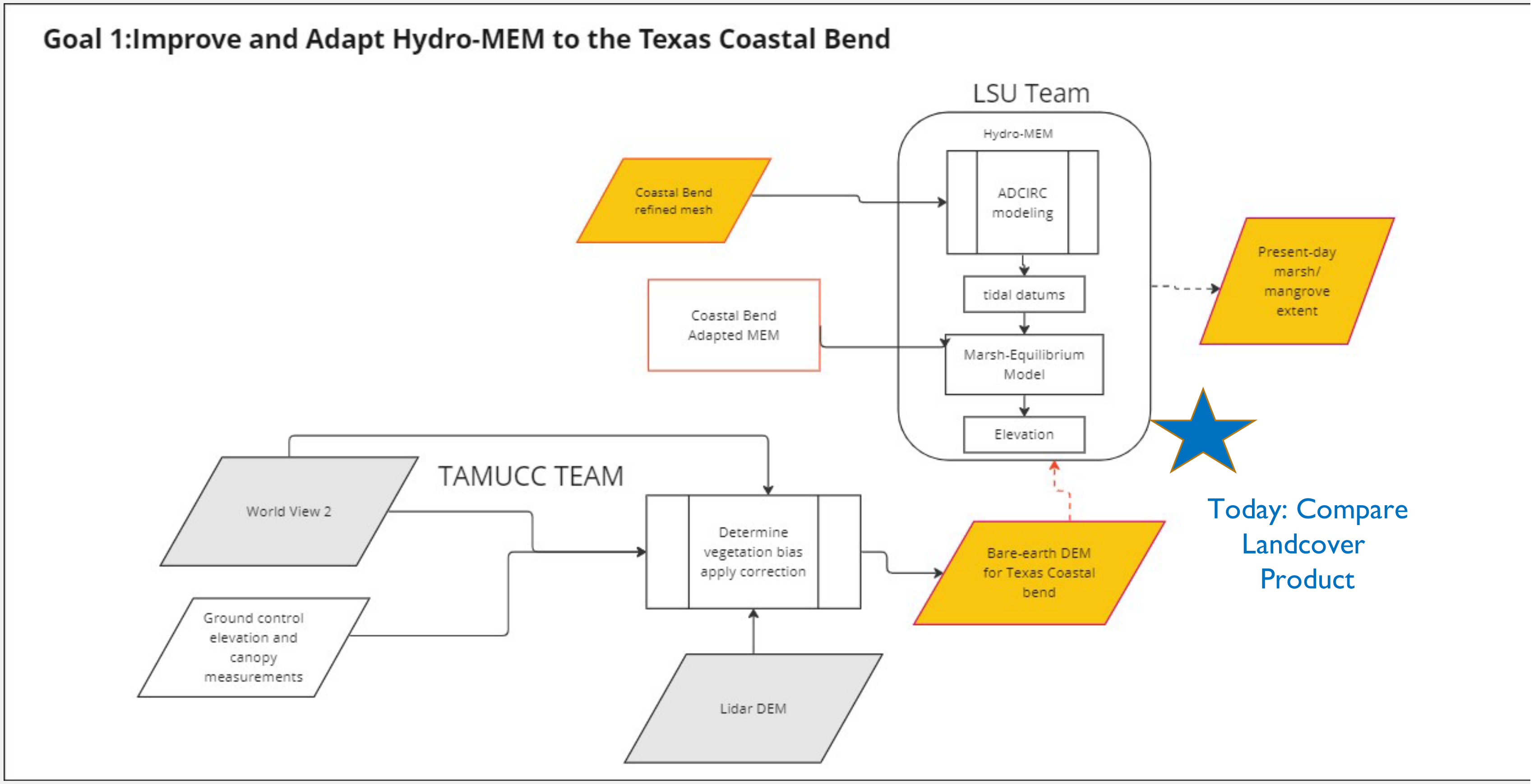
ESLR Components - Today



Today: Compare Landcover Product

ESLR Components Continued – Past MTAG Discussion

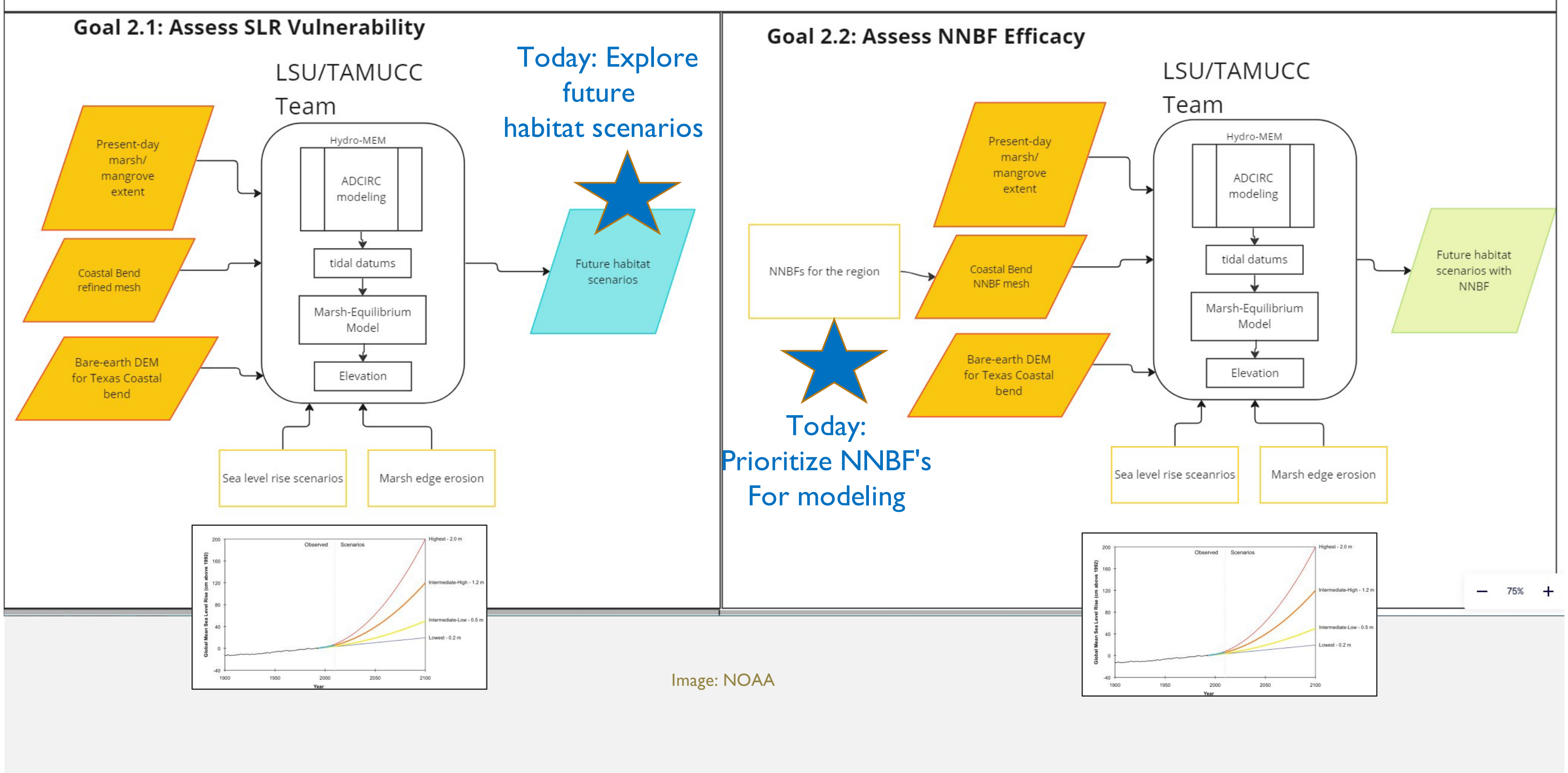
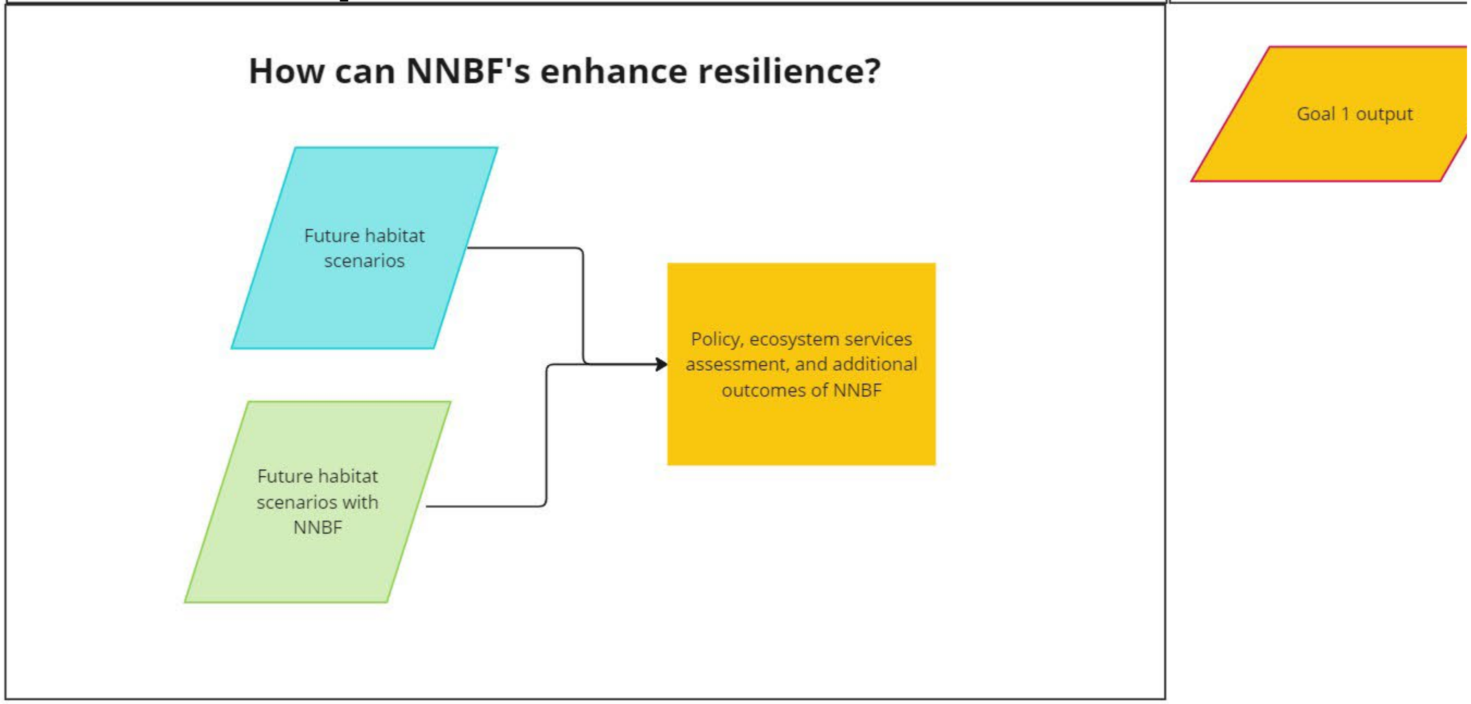
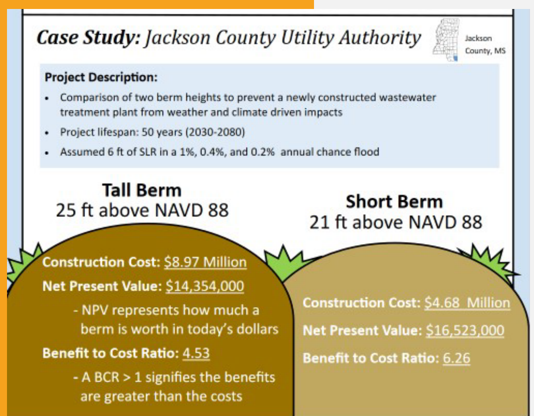


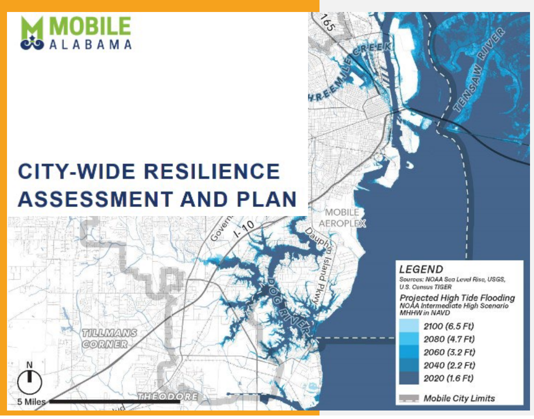
Image: NOAA

ESLR Components: End Goal



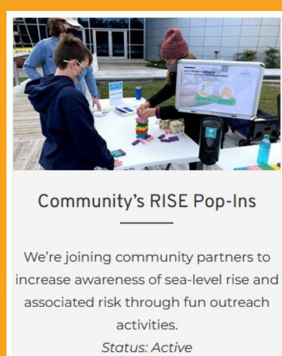
EXAMPLE DATA USE





- **Building Consolidated Wastewater Treatment Facility**
  - Jackson County Utility Authority wanted to build a consolidated wastewater treatment facility
  - Used future high tide to assess potential **facility locations**
  - Used future storm surge to inform **design** of protective berm
- **Resilience Planning in Coastal Cities**
  - Multiple municipalities have used changes in expected high tide footprint to inform resilience assessments and planning
  - This includes informing infrastructure decisions, land use decisions, and proactive government activities with dual benefits (e.g., parks, water access).

EXAMPLE DATA USE



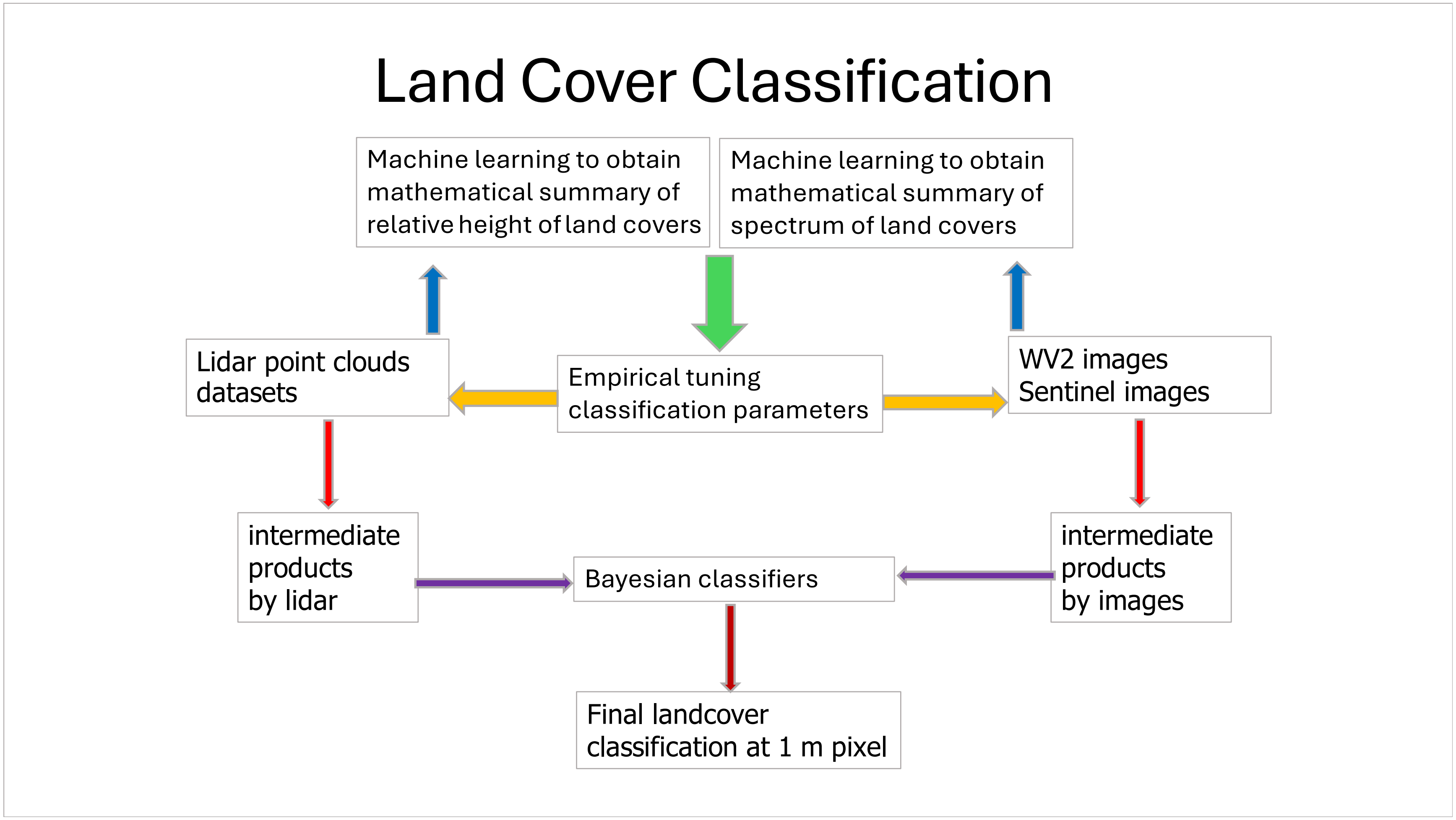
- **Weeks Bay NERR Management Plan**
  - Updating the plan of how to best steward the land they manage
  - Used marsh modeling outputs to assess and chart specific activities using the RAD framework

- **Education and Outreach Products**
  - Both flood risk and change in marsh health/extent information
  - Used by state and local government; non-profits; boundary spanners; non-profits; community-based organizations; etc.
  - Developed into wide ranging products across a myriad of conversations – requires comfort and familiarity
  - Use of local-scale data enhanced quality and efficacy of communication efforts

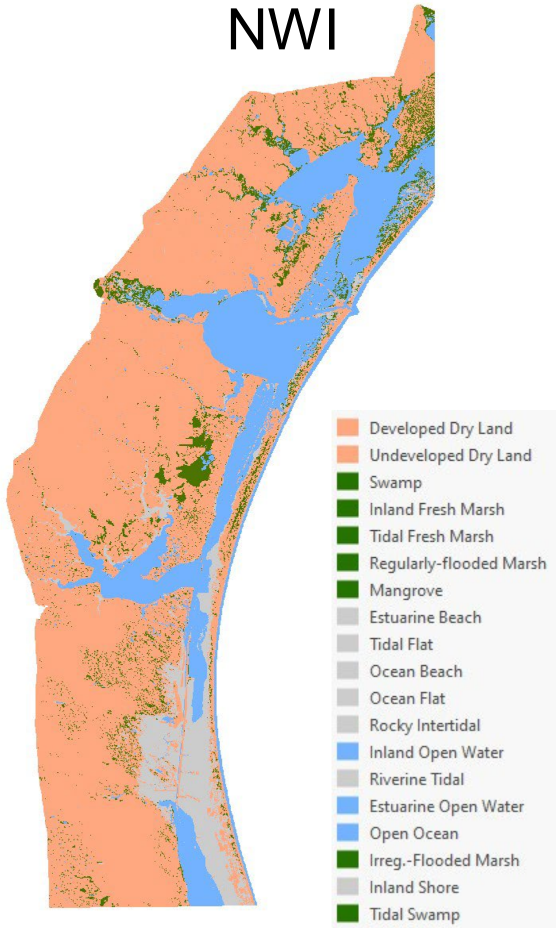
HOW COULD USE THESE DATA?

- Which of these examples resonated with you?
- What situations do you have where these types of data could be useful?
- Who isn't here that might be able to use these data?
- What outputs/accessibility would you need?
  - GIS layers of flood extent/marsh future?
  - Interactive dashboard?
  - Simple infographics describing the science background?

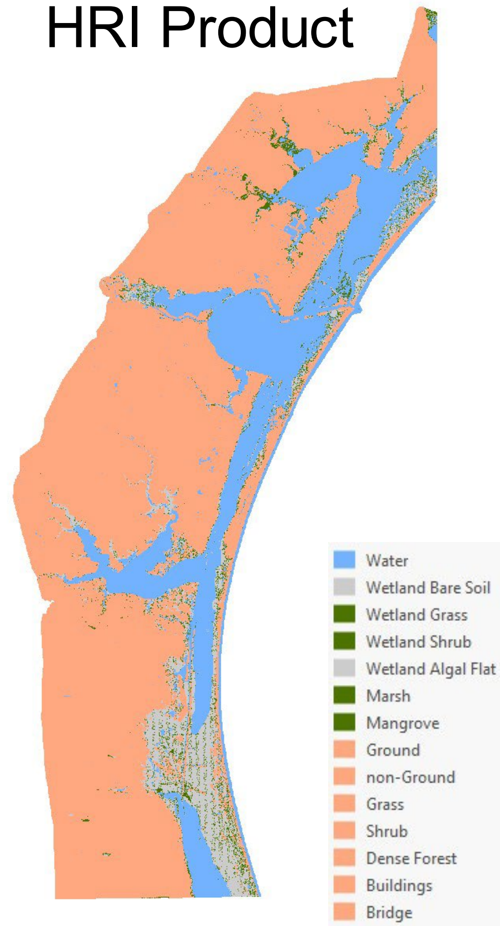
Gibeaut TAMUCC Slide:



NWI



HRI Product



NWI vs HRI Product

NWI

class	count	description
1	286809756	Developed Dry Land
2	6149281173	Undeveloped Dry Land
3	25899585	Swamp
5	436657146	Inland Fresh Marsh
6	800064	Tidal Fresh Marsh
8	99391134	Regularly-flooded Marsh
9	6846426	Mangrove
10	515726103	Estuarine Beach
11	196856532	Tidal Flat
12	4299222	Ocean Beach
13	5967534	Ocean Flat
14	10764	Rocky Intertidal
15	64735758	Inland Open Water
16	1216209	Riverine Tidal
17	1829448115	Estuarine Open Water
19	100930782	Open Ocean
20	68730681	Irreg.-Flooded Marsh
22	24121275	Inland Shore
23	402696	Tidal Swamp

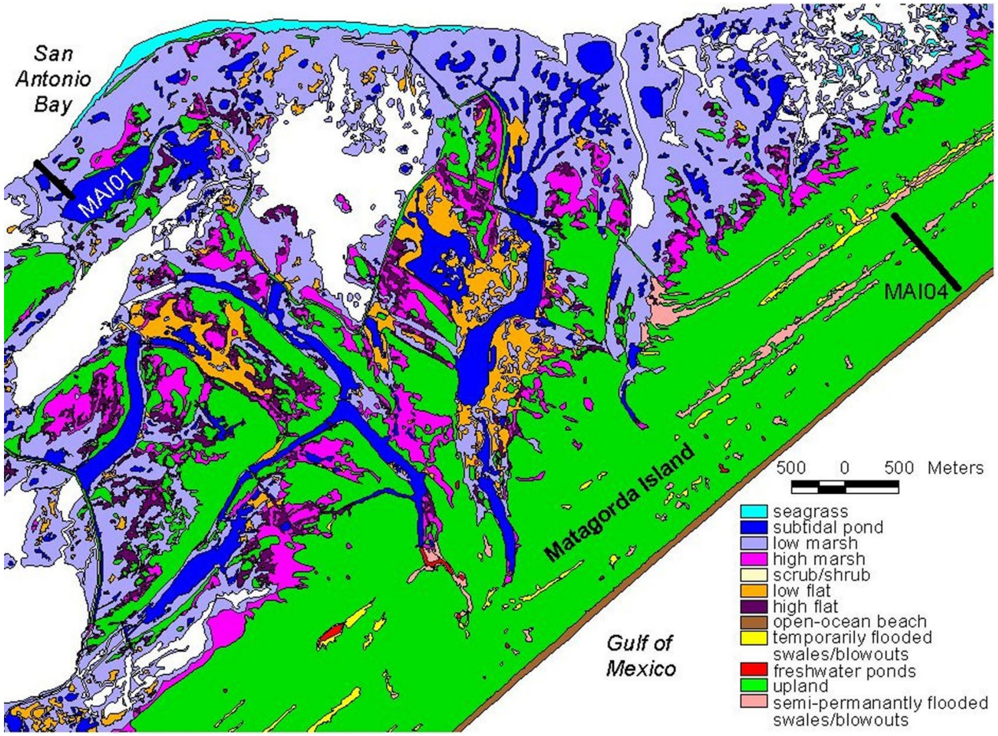
re-class	%
Dry land	65.55
Marsh	6.51
Beach and flat	7.37
Water	20.32

HRI Product

%	re-class
68.51	Dry land
2.94	Marsh
7.15	Beach and flat
21.40	Water

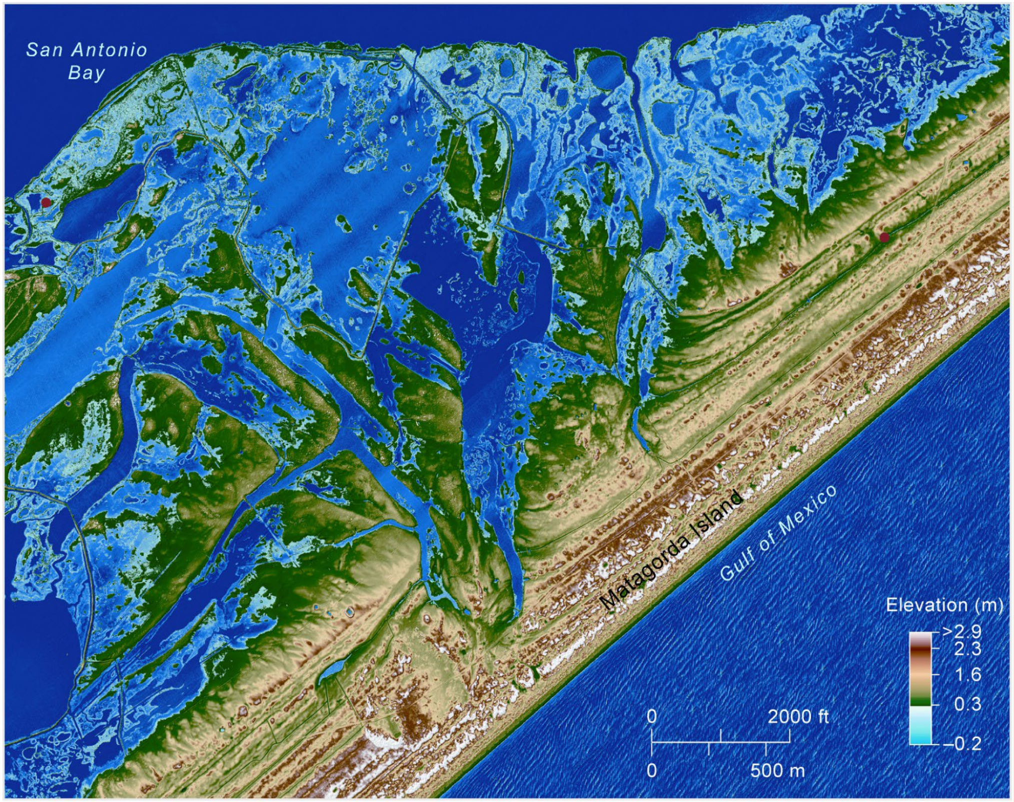
description	count	class
Water	2098491439	1
Wetland Bare Soil	519354946	2
Wetland Grass	95615089	3
Wetland Shrub	45553870	4
Wetland Algal Flat	181980455	5
Marsh	102431002	7
Mangrove	44574761	8
Ground	4160043024	12
non-Ground	206460698	13
Grass	1025652200	14
Shrub	318204356	15
Dense Forest	966082094	16
Buildings	40038136	17
Bridge	405756	21

Habitat Classification Map From Color IR Photography



Data from White et al., 2002

1 – Meter Lidar Digital Elevation Model



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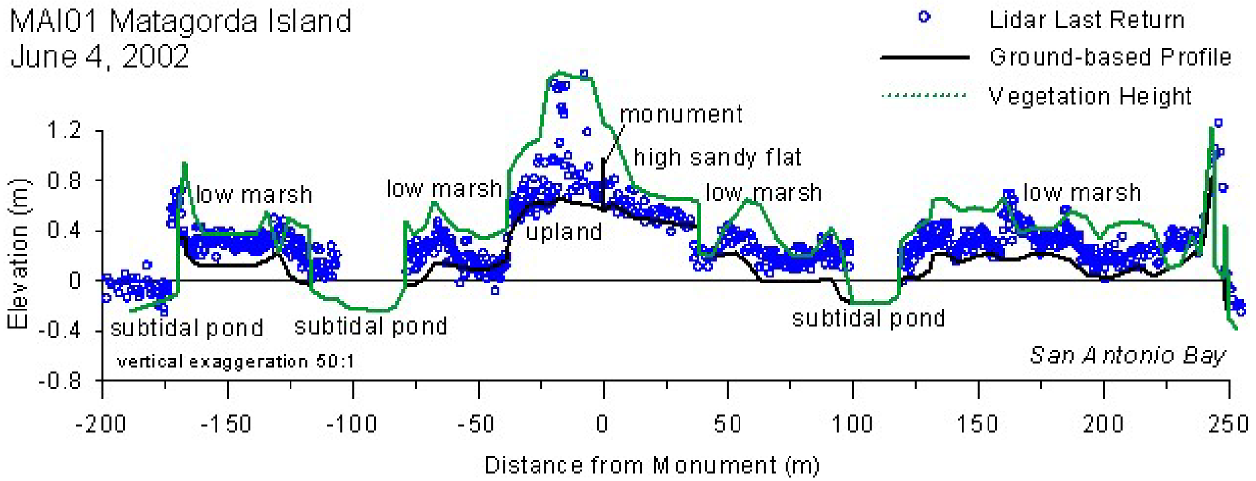
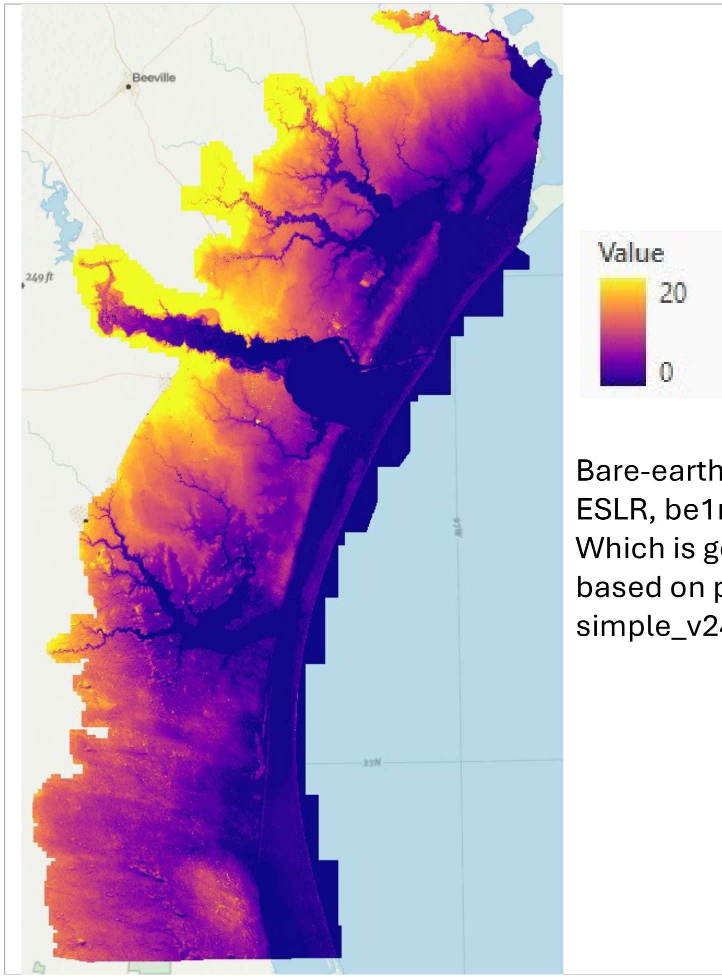
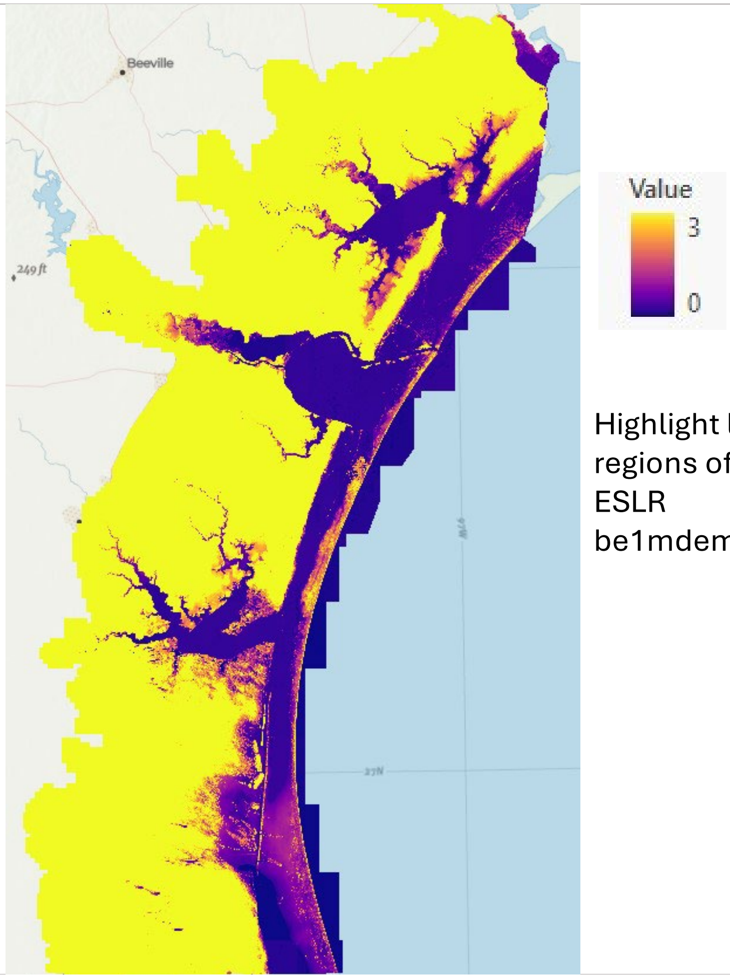
Ground and Lidar Profiles



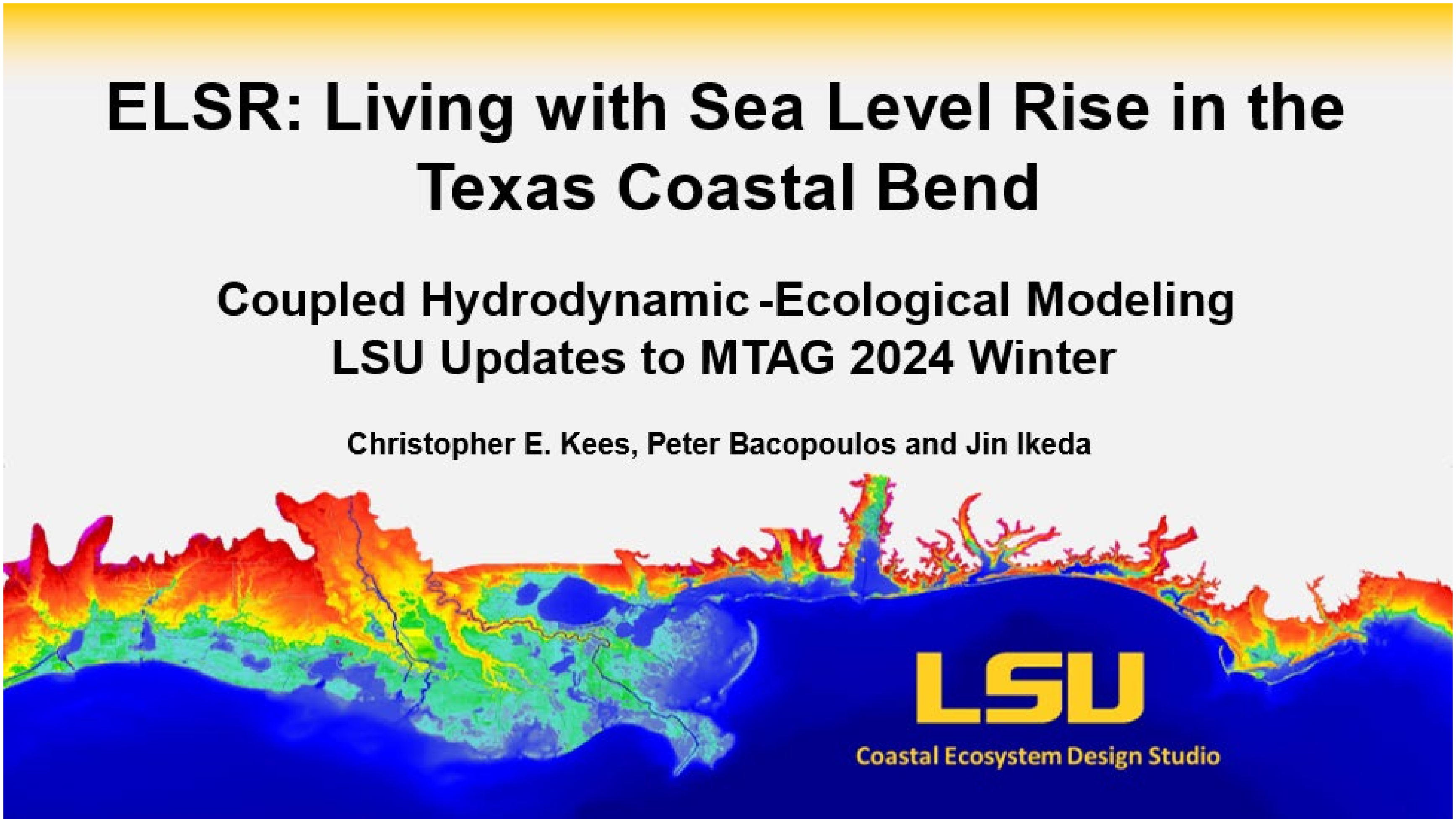


Bare-earth DEM of ESLR, be1mdemv3, Which is generated based on previous simple_v24_keptv22



Highlight lower regions of the ESLR be1mdemv3

Bacopoulos LSU Slides:

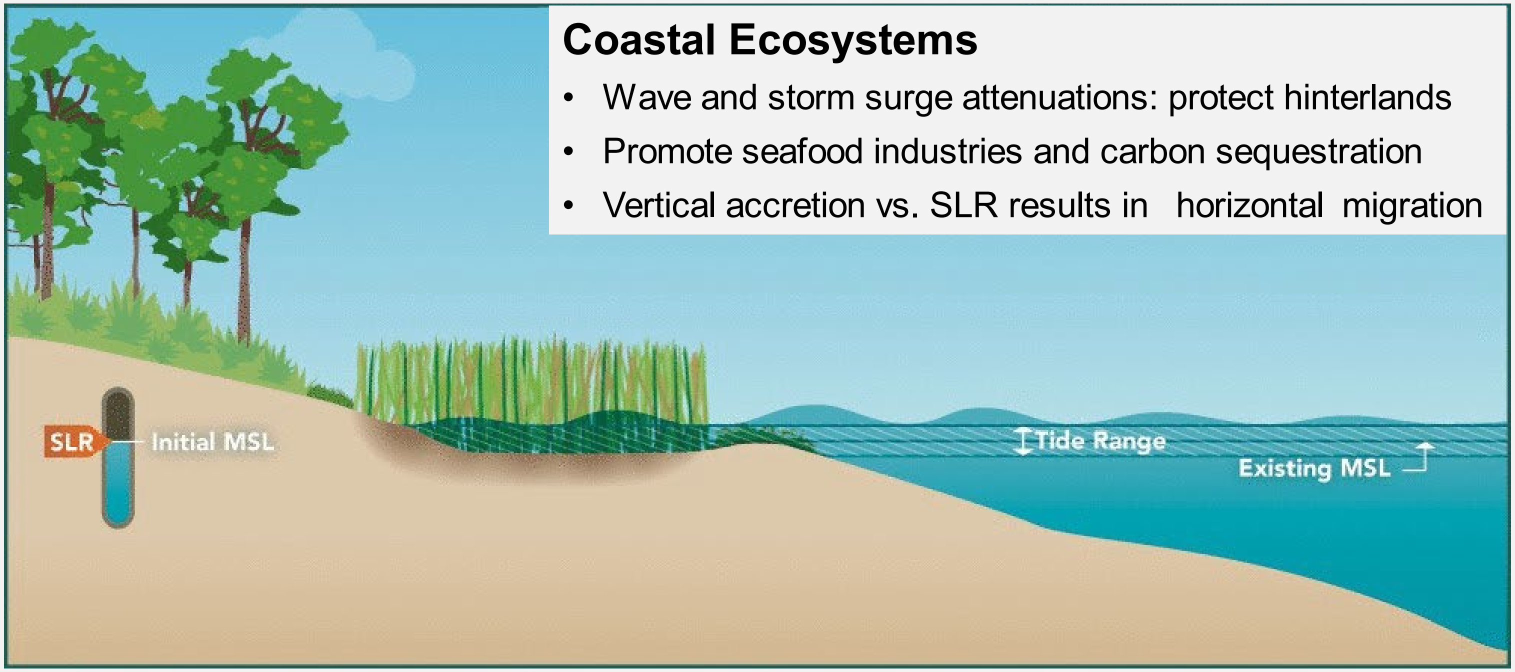


Coastal ecosystem functions and resilience to SLR

Q: How coastal ecosystems respond to SLR and their resiliency?

Coastal Ecosystems

- Wave and storm surge attenuations: protect hinterlands
- Promote seafood industries and carbon sequestration
- Vertical accretion vs. SLR results in horizontal migration



Recapitulate the last MTAG meeting in 2024 Summer

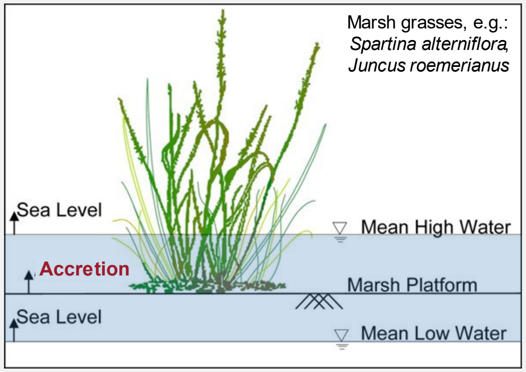
2024 Summer

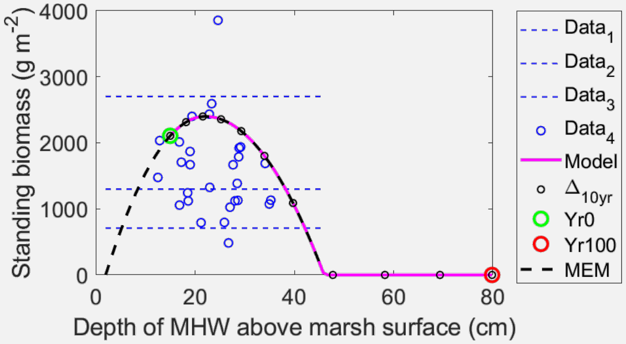
- Parameterization of ecological models for the Texas Coastal Bend ecosystem, focusing on marshes and mangroves.
- Long-term hydrodynamic -ecosystem simulations under an intermediate SLR scenario, with evaluations at 25 -year intervals.

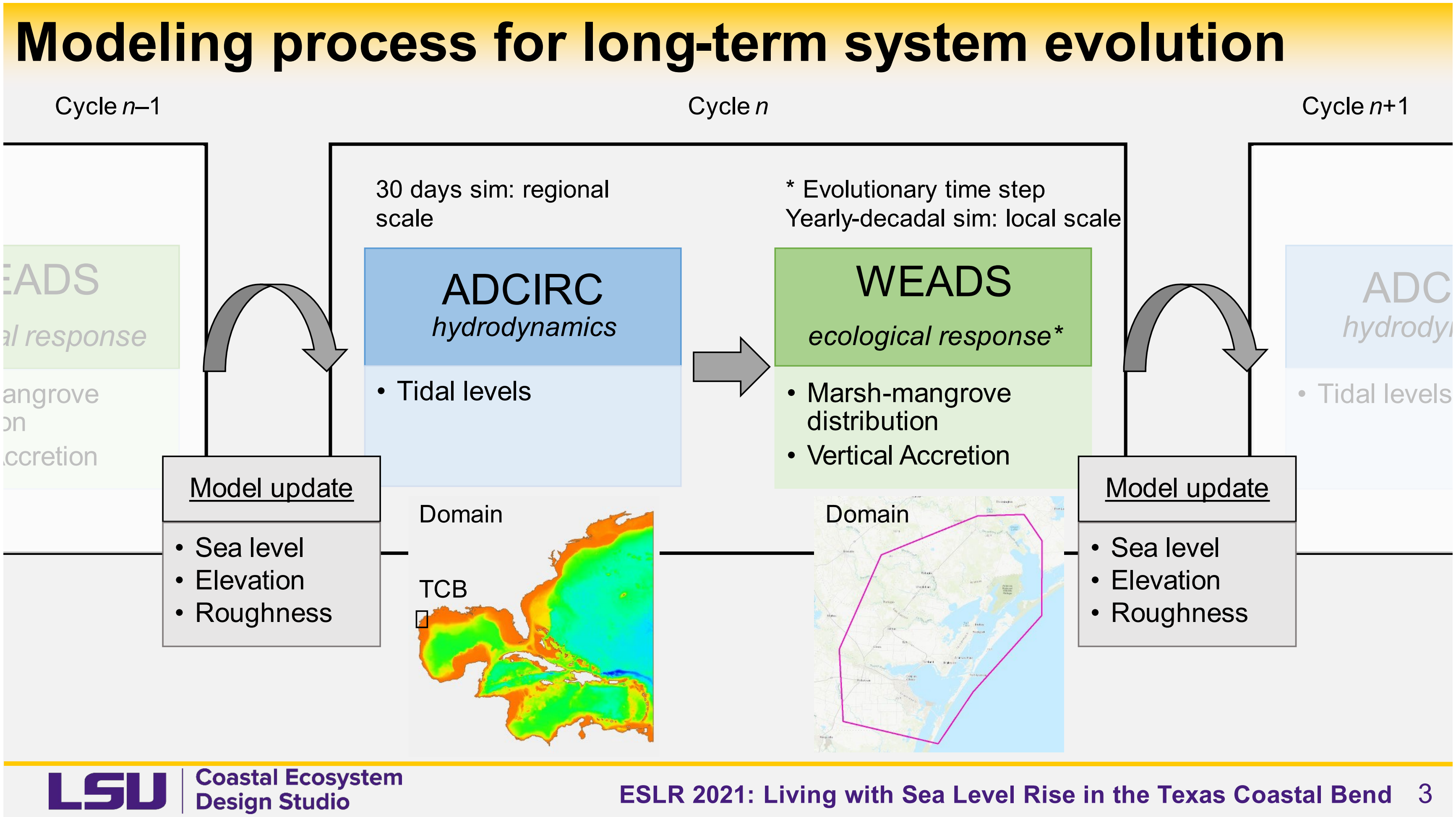
2024 Winter (Updates)

- Use two SLR scenarios (Int -Low and Int -High).
- Decrease time step for long -term hydrodynamic - ecosystem simulations.
- **Provide tidal inundation changes under SLR.**

Biomass productivity for salt marshes

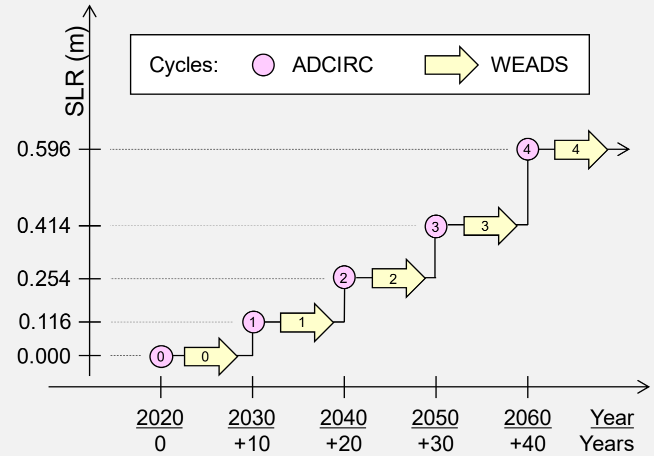





Modeling process for long-term system evolution
Cycle n–1
Cycle n
Cycle n+1
30 days sim: regional scale
* Evolutionary time step
Yearly-decadal sim: local scale
ADCIRC
hydrodynamics
• Tidal levels
WEADS
ecological response*
• Marsh-mangrove distribution
• Vertical Accretion
Model update
• Sea level
• Elevation
• Roughness
Domain
TCB
Domain
Model update
• Sea level
• Elevation
• Roughness
Coastal Ecosystem Design Studio
ESLR 2021: Living with Sea Level Rise in the Texas Coastal Bend 3

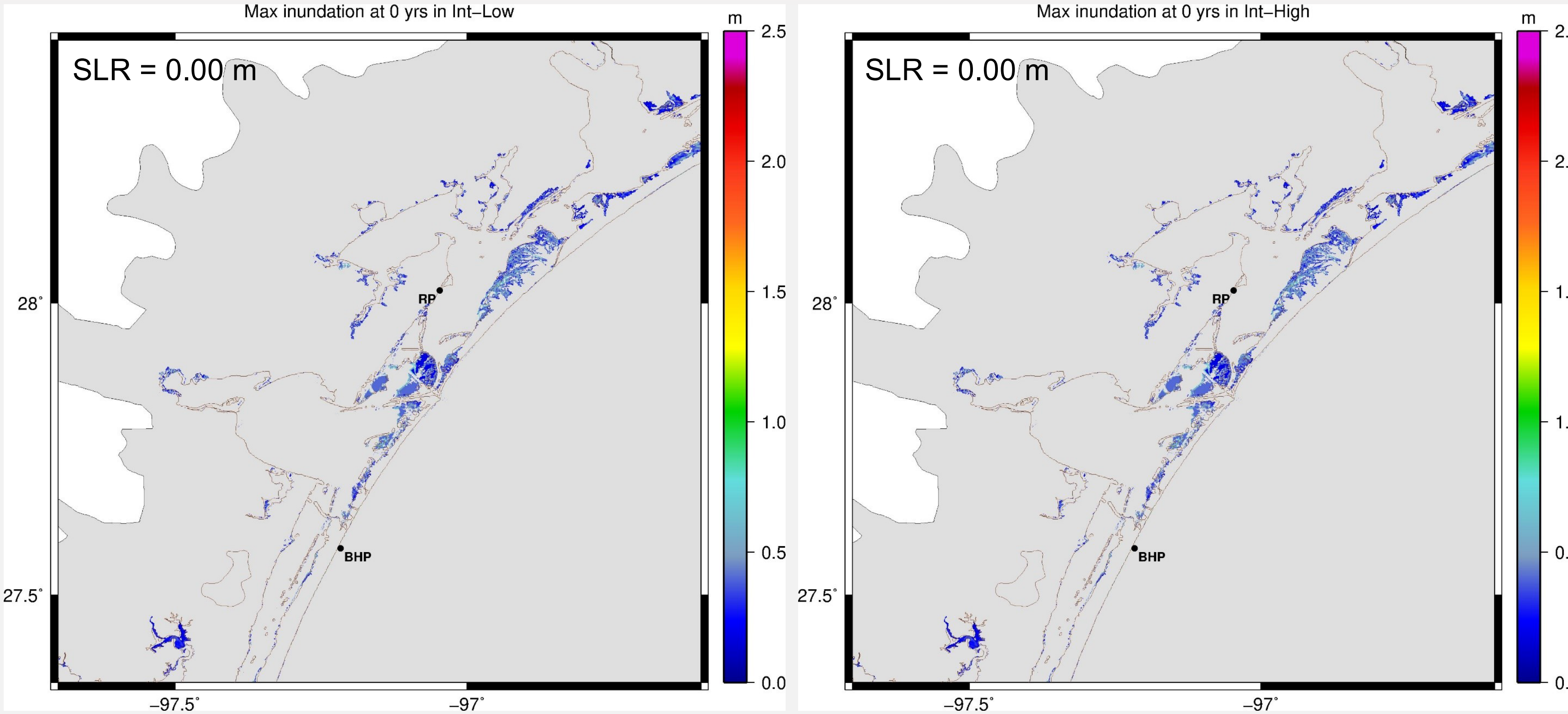
Sea level projections and model runs

		SLR projections [m] (Sweet et al., 2022)				
Year	Years	Low	Int-Low	Int	Int-High	High
2020	0	0.000	0.000	0.000	0.000	0.000
2030	10	0.069	0.078	0.102	0.116	0.140
2040	20	0.141	0.163	0.221	0.254	0.312
2050	30	0.217	0.255	0.357	0.414	0.516
2060	40	0.297	0.354	0.510	0.596	0.752
2070	50	0.380	0.460	0.680	0.800	1.020
2080	60	0.467	0.574	0.866	1.027	1.320
2090	70	0.557	0.694	1.070	1.276	1.652
2095 (Interp)	75	0.604	0.758	1.180	1.412	1.834
2100	80	0.651	0.822	1.290	1.547	2.016
2110	90	0.748	0.956	1.528	1.840	2.412
2120	100	0.849	1.098	1.782	2.156	2.840
2130	110	0.953	1.247	2.053	2.494	3.300

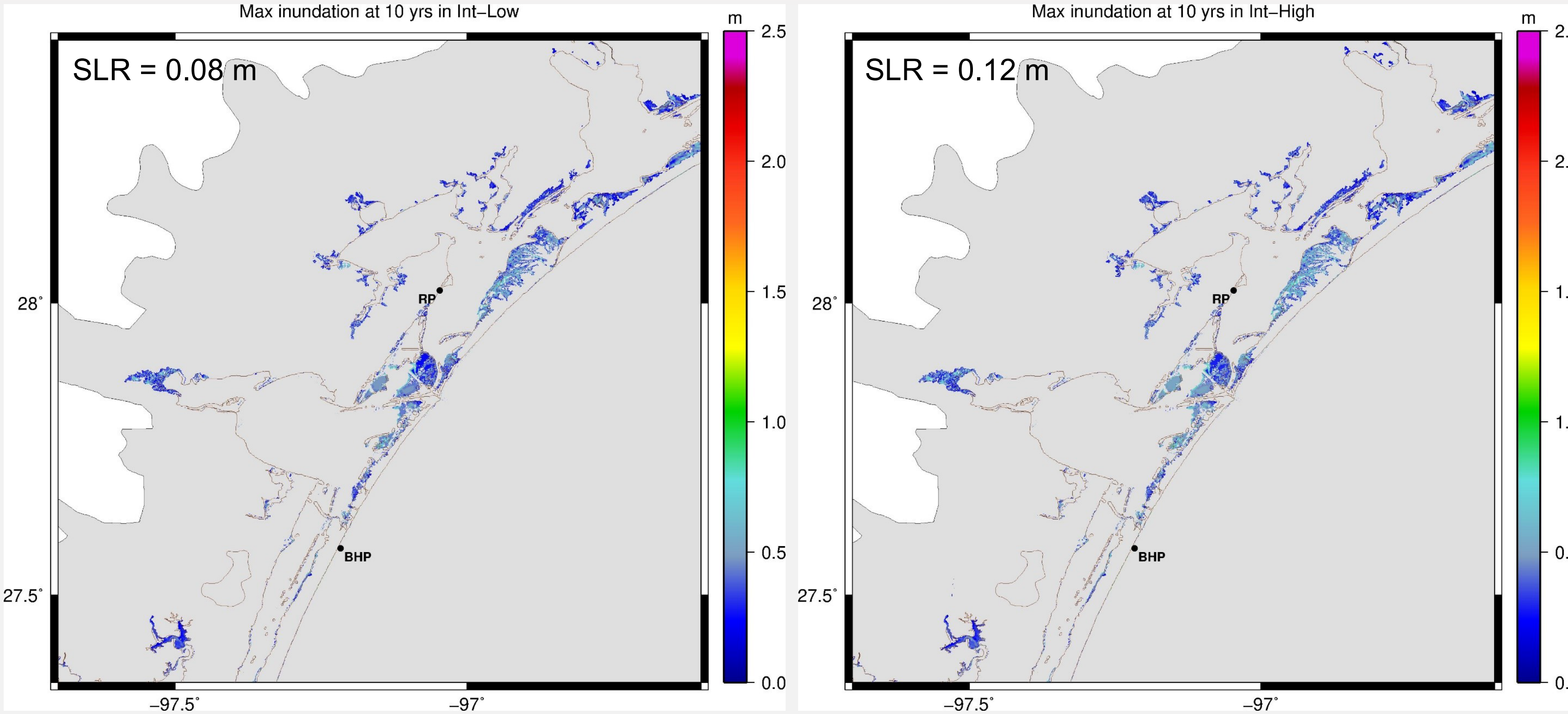


SLR: Increase sea-surface height in all ADCIRC nodes and run tidal simulations

Max tidal inundation depth at 0 yrs (2020)



Max tidal inundation depth at 10 yrs (2030)



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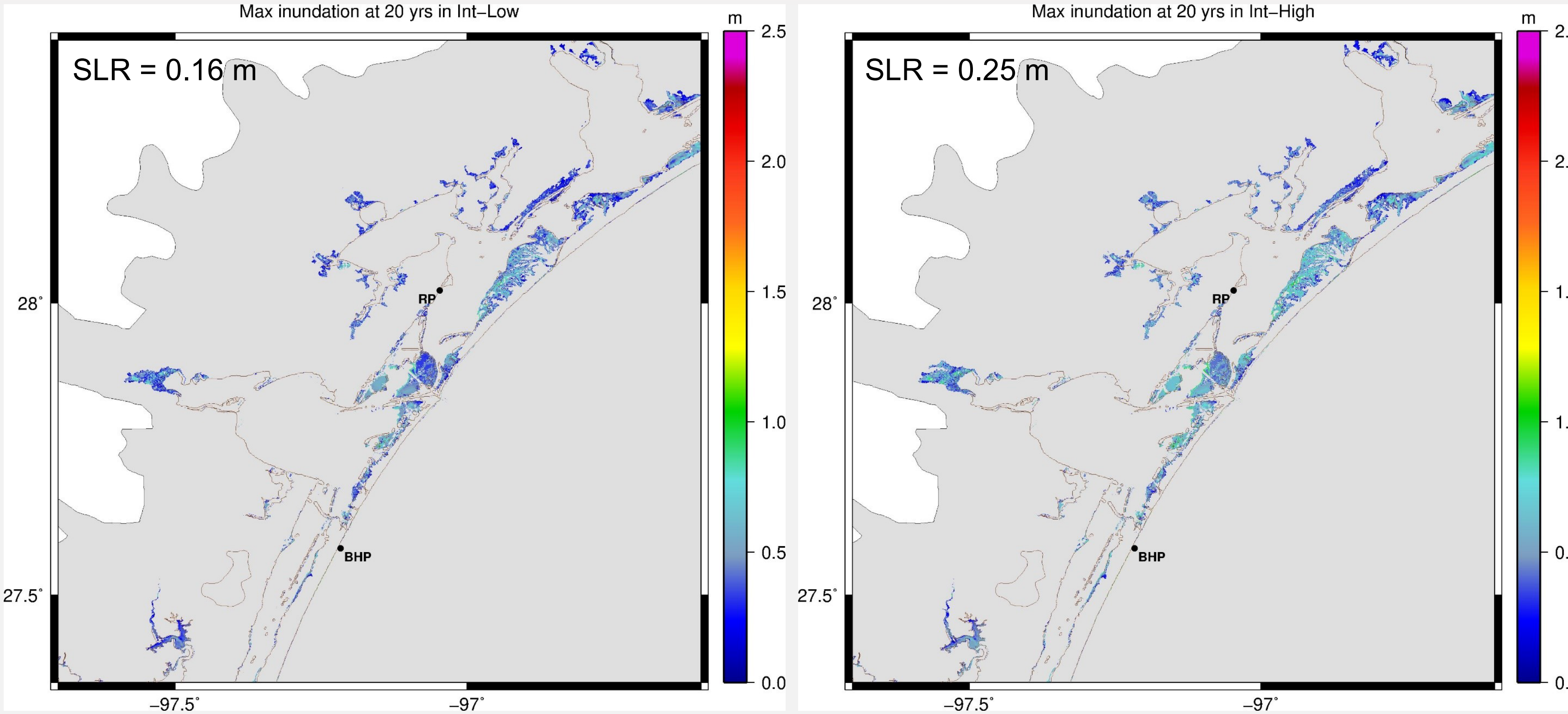
Max tidal inundation depth at 20 yrs (2040)



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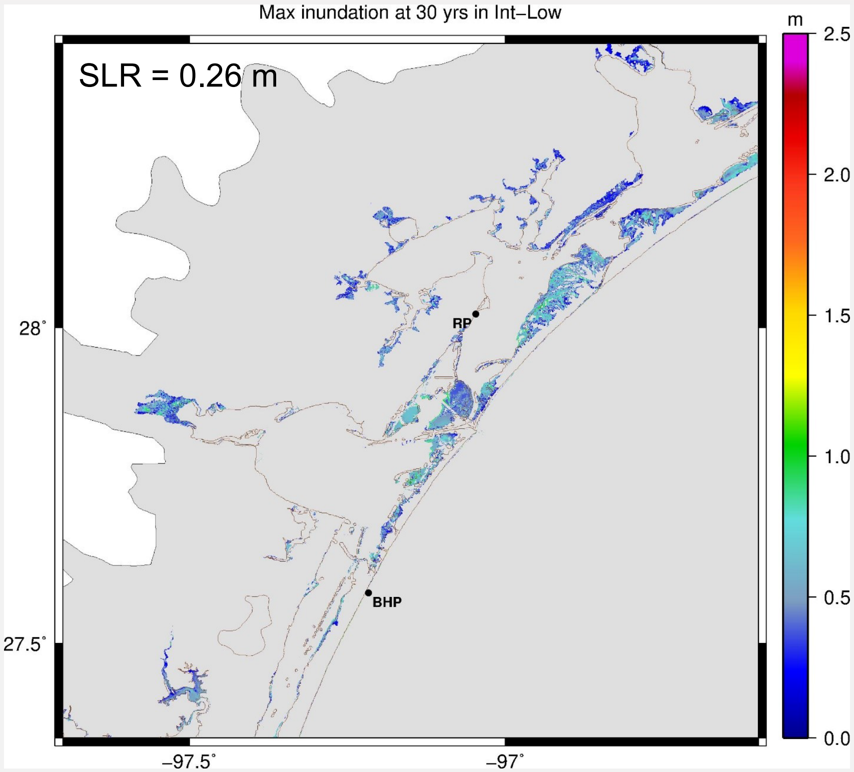
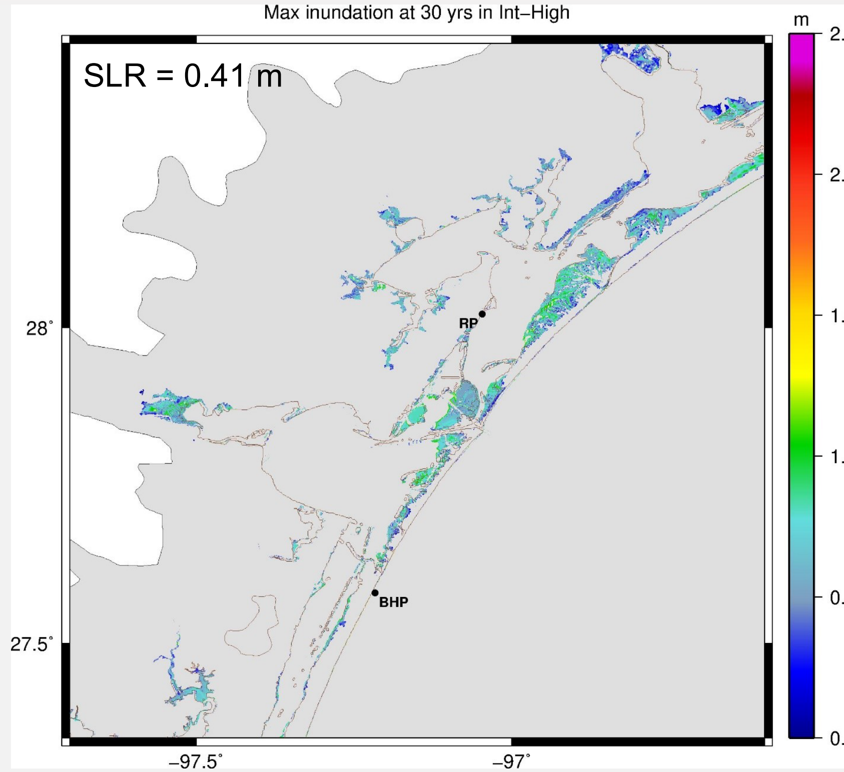
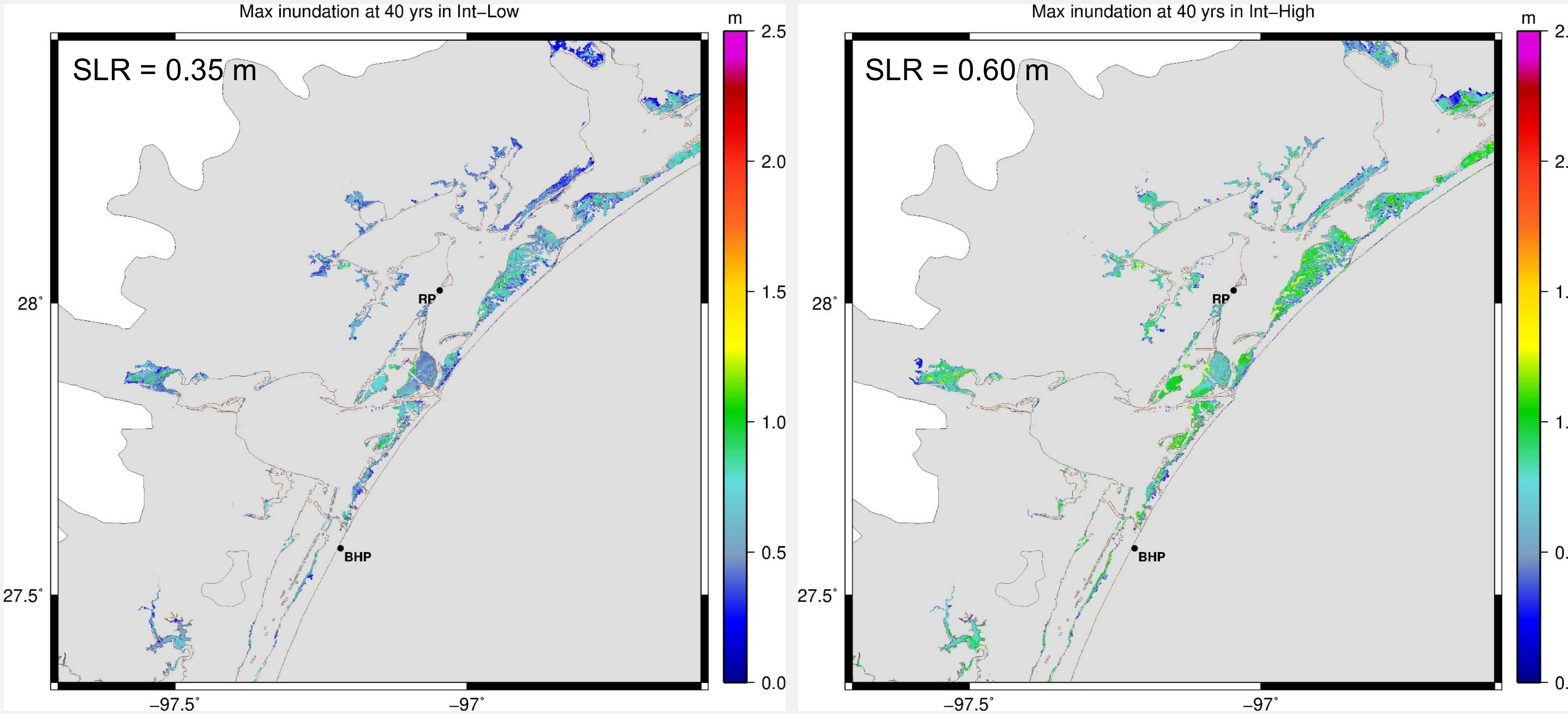
Max tidal inundation depth at 30 yrs (2050)

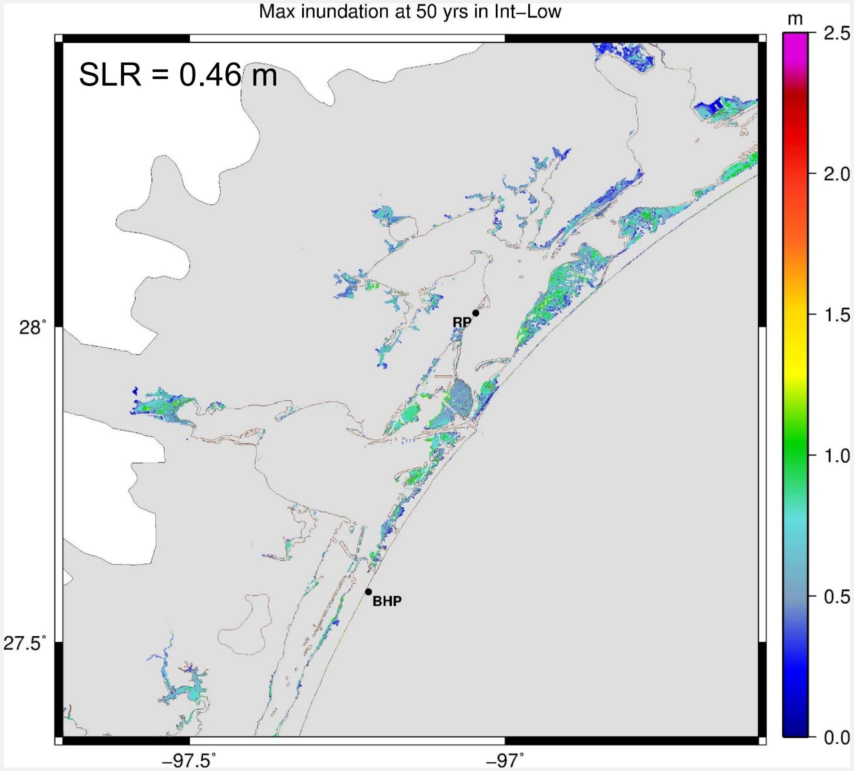


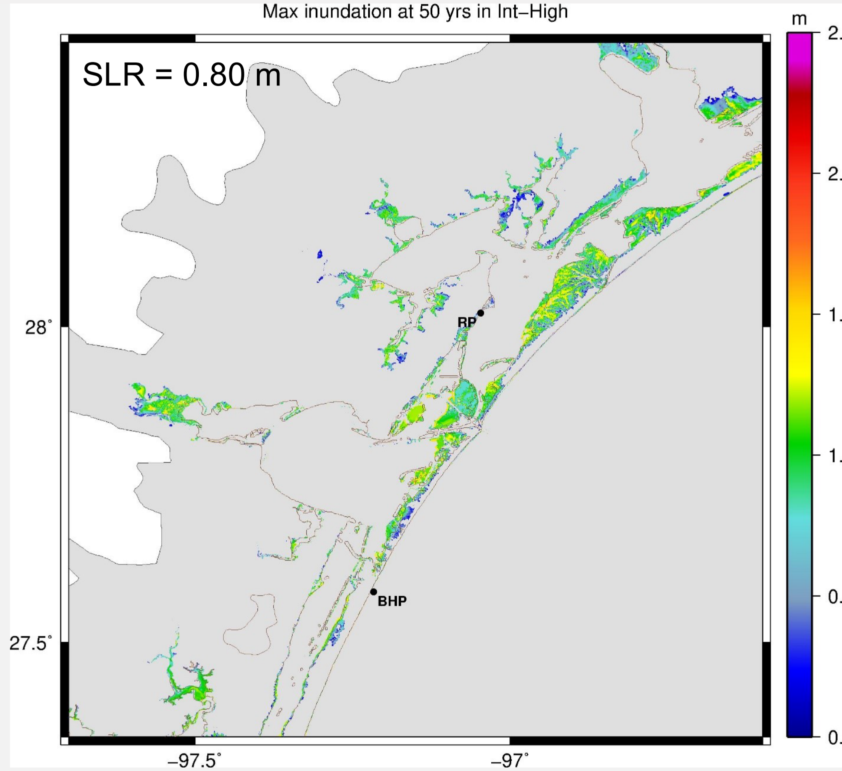


Max tidal inundation depth at 40 yrs (2060)

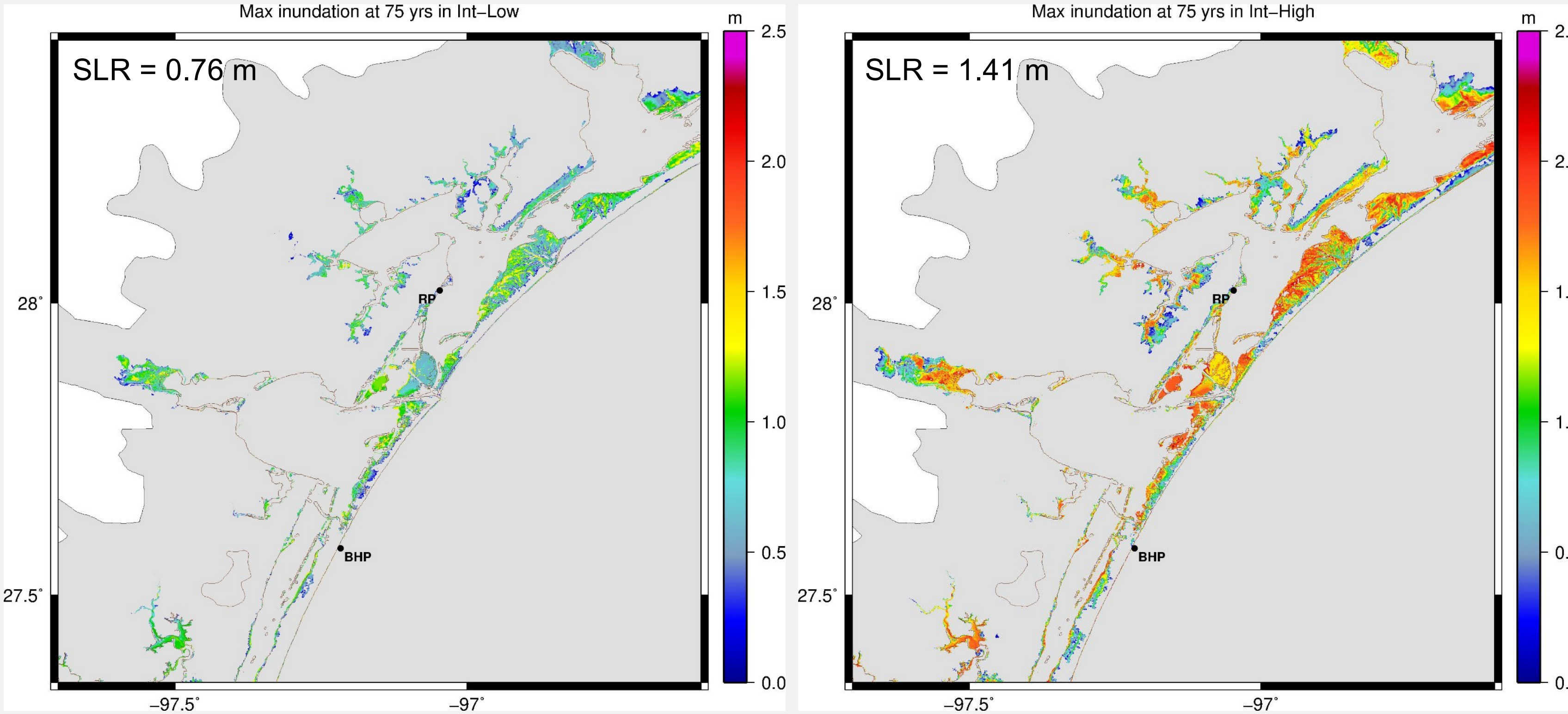


Max tidal inundation depth at 50 yrs (2070)





Max tidal inundation depth at 75 yrs (2095)



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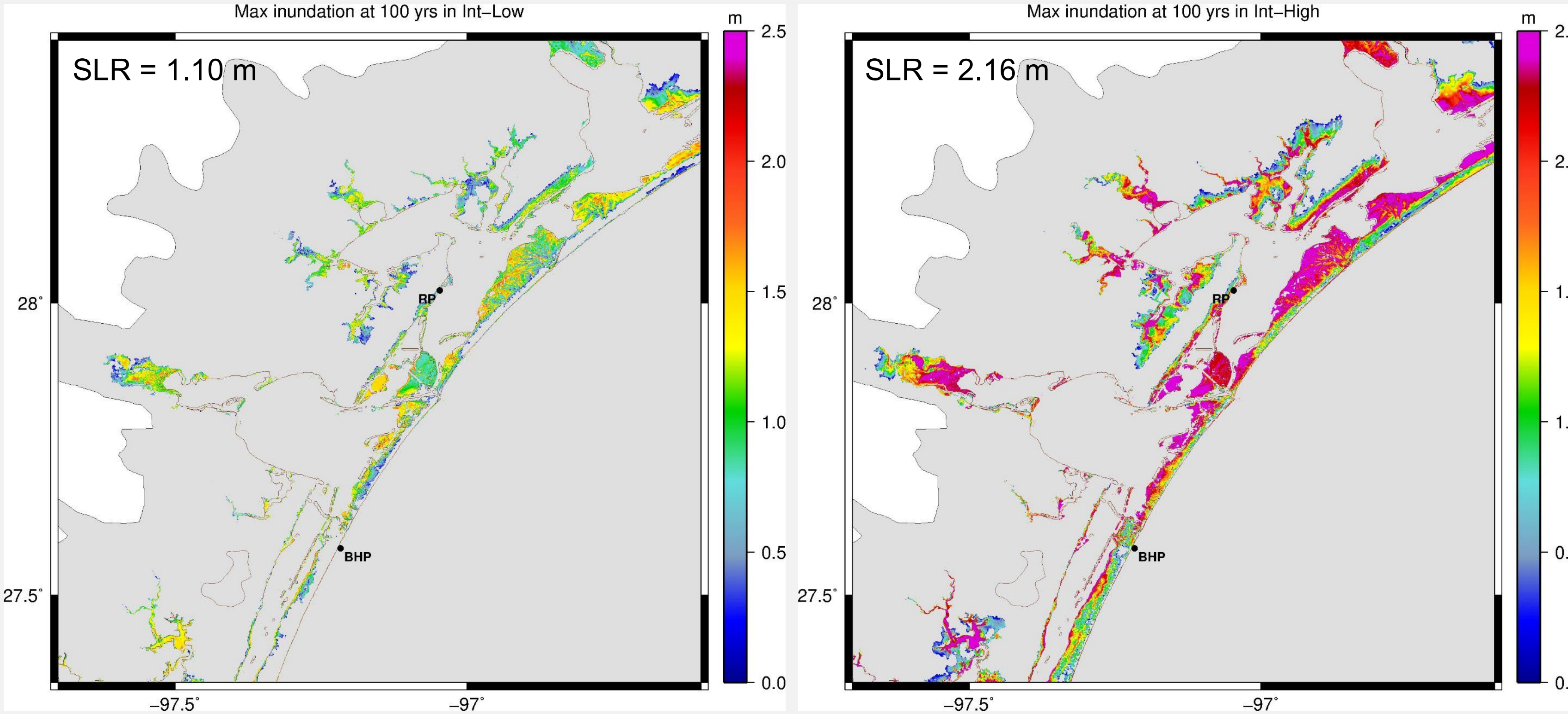
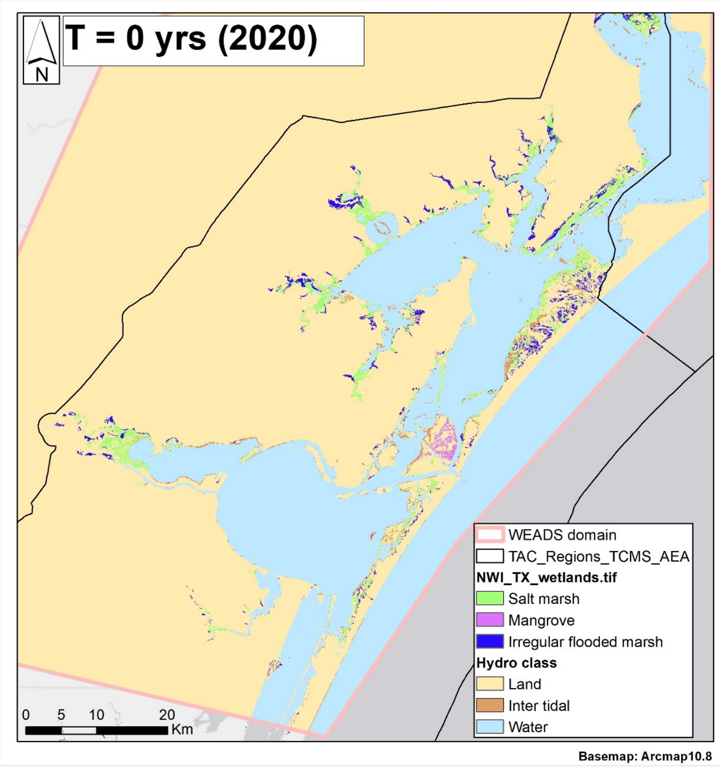
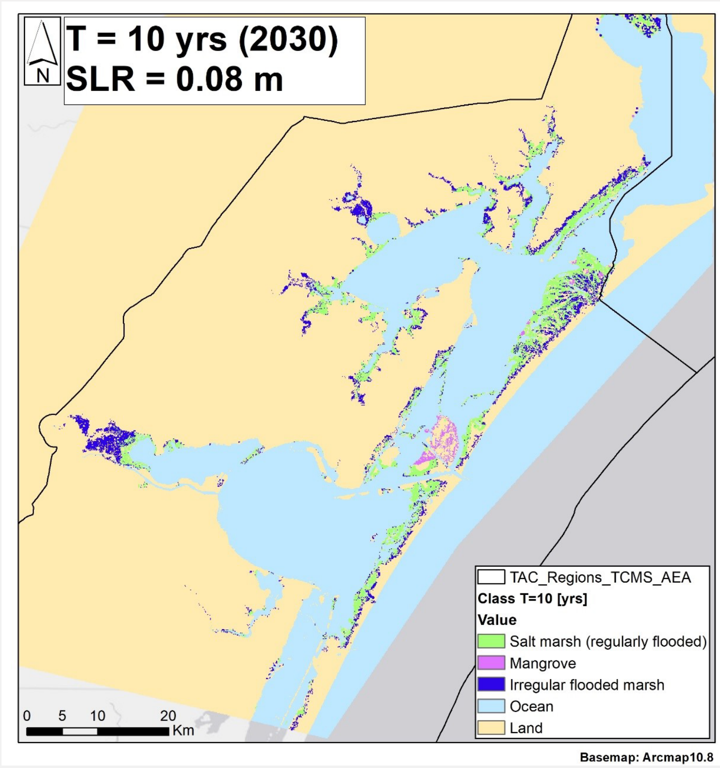
Max tidal inundation depth at 100 yrs (2120)

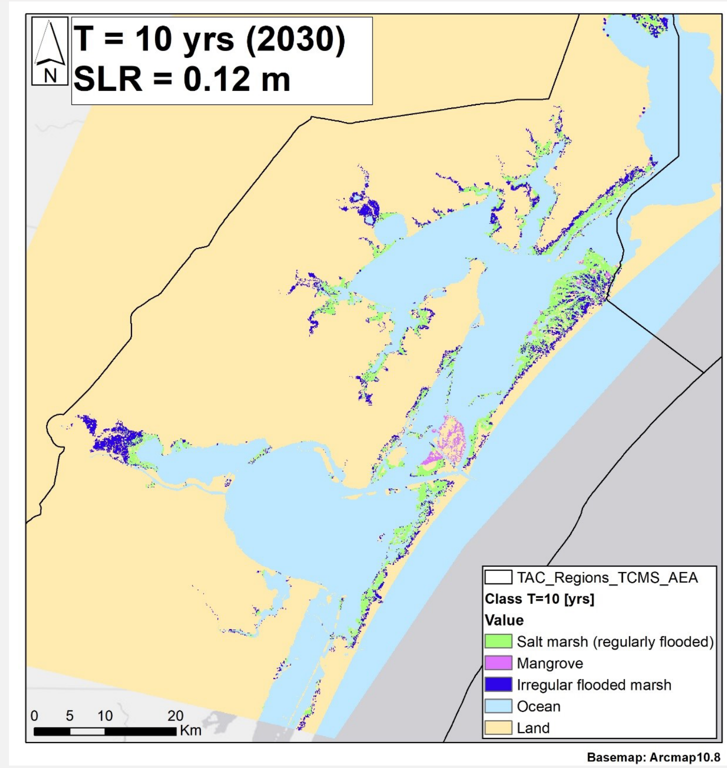


Vegetation map at 0 yrs (2020) : NWI vegetation map

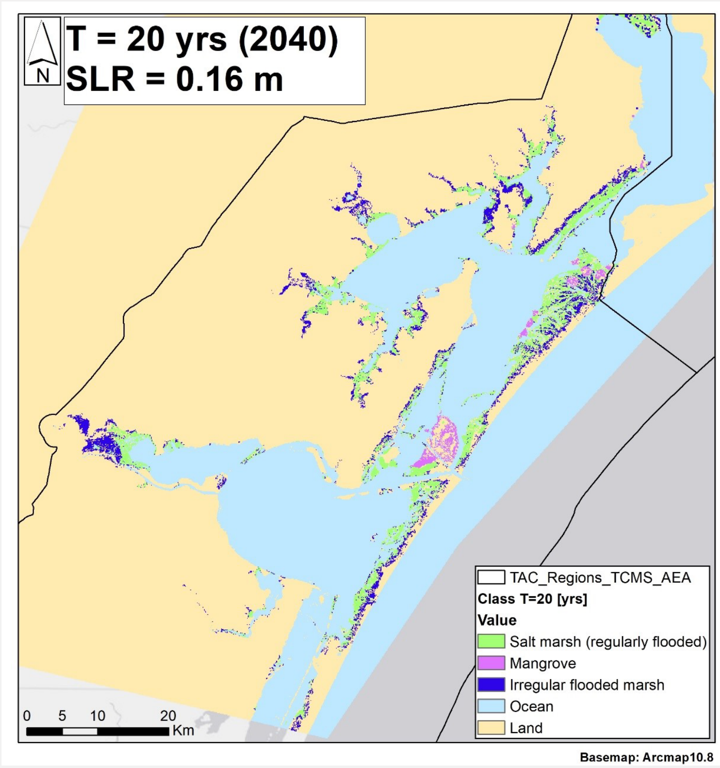


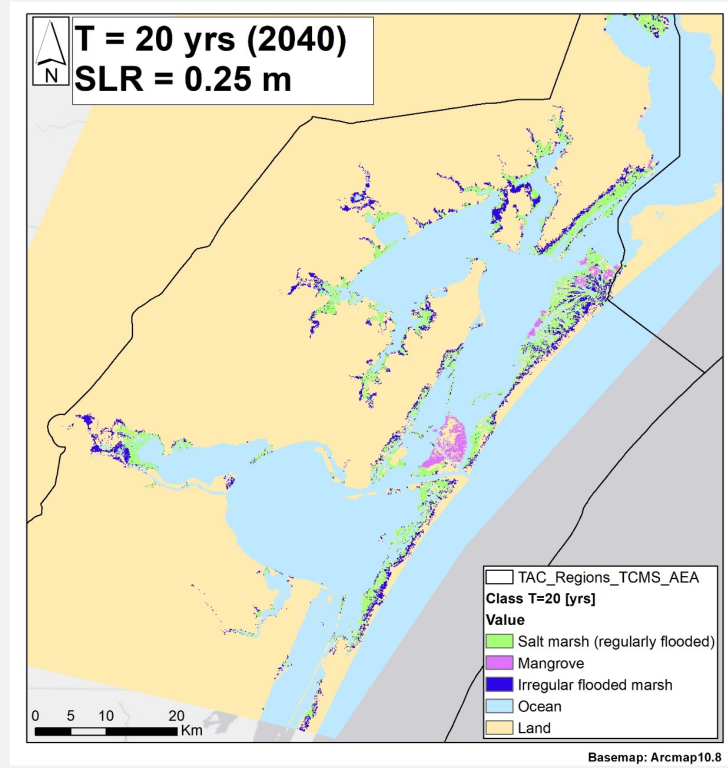
Vegetation map at 10 yrs (2030)





Vegetation map at 20 yrs (2040)





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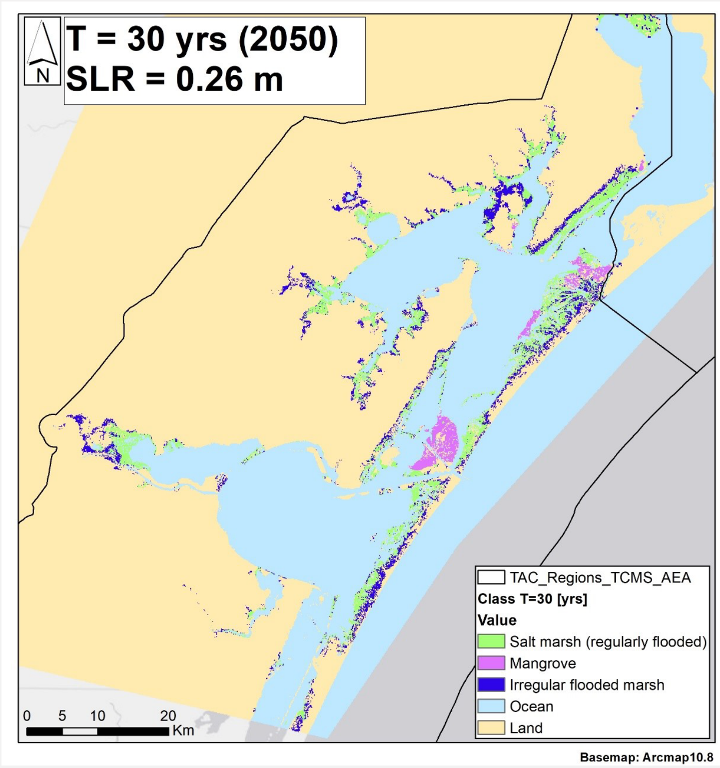
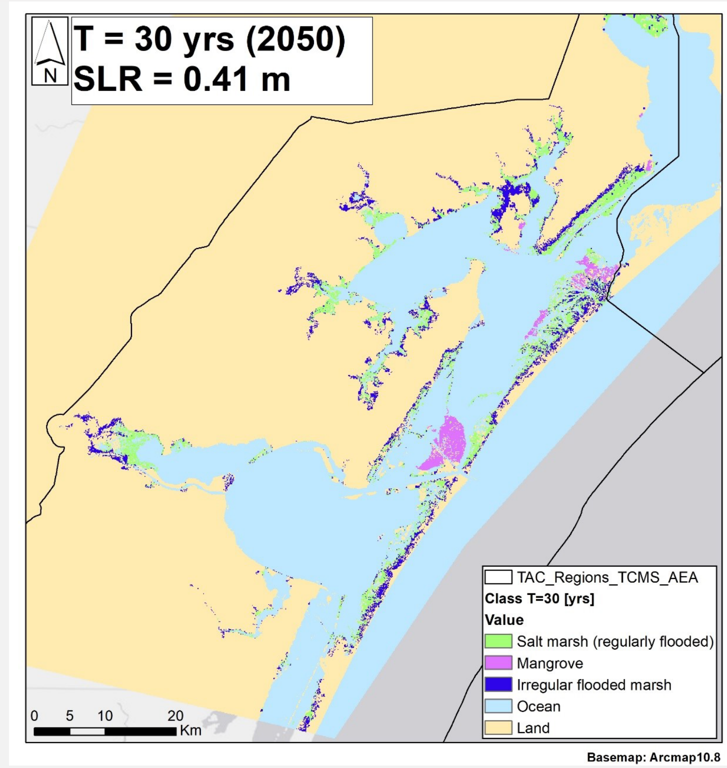
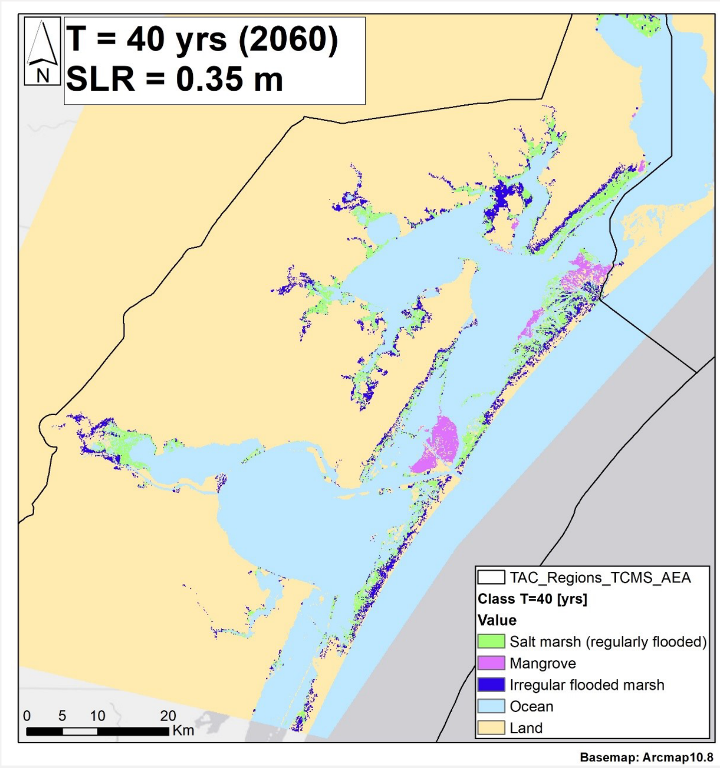
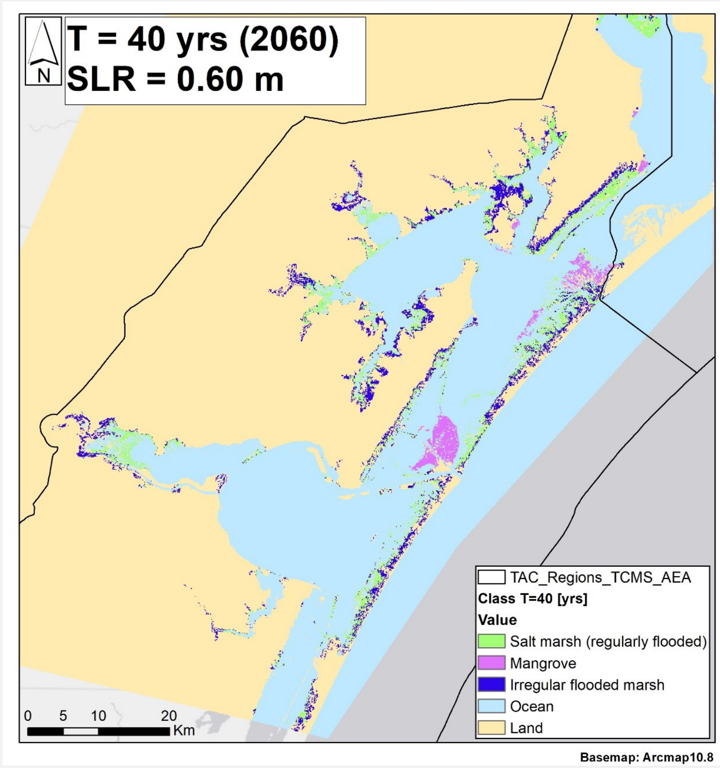
Vegetation map at 30 yrs (2050)





Vegetation map at 40 yrs (2060)





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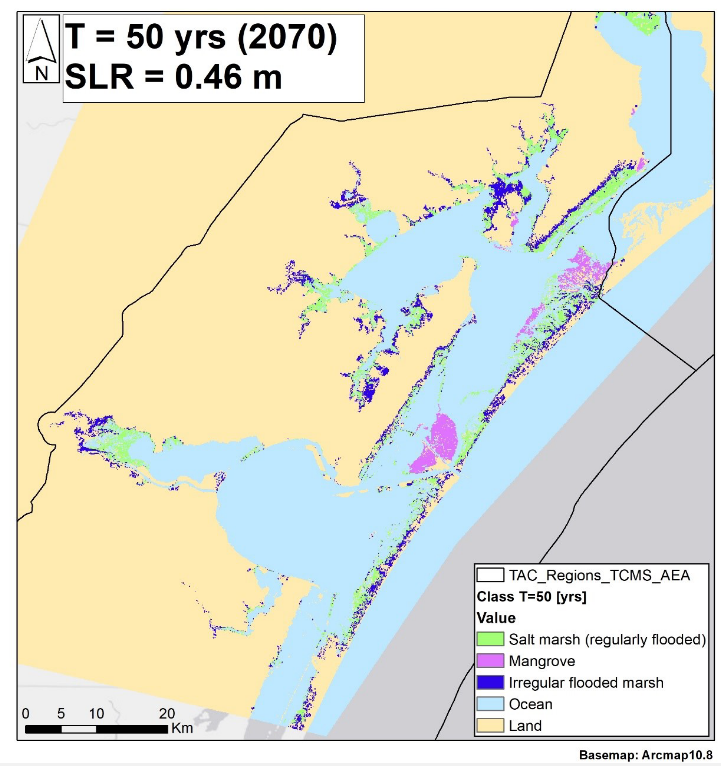
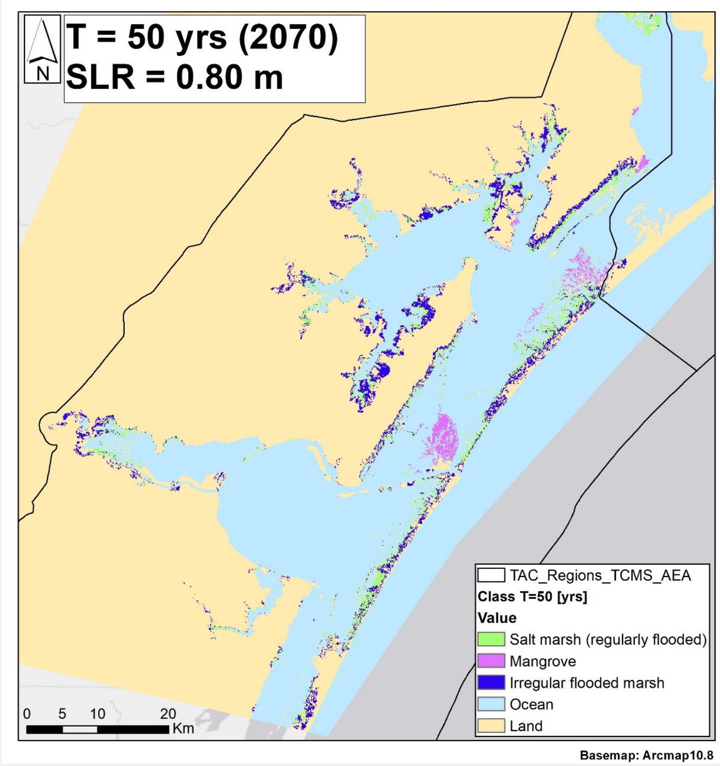
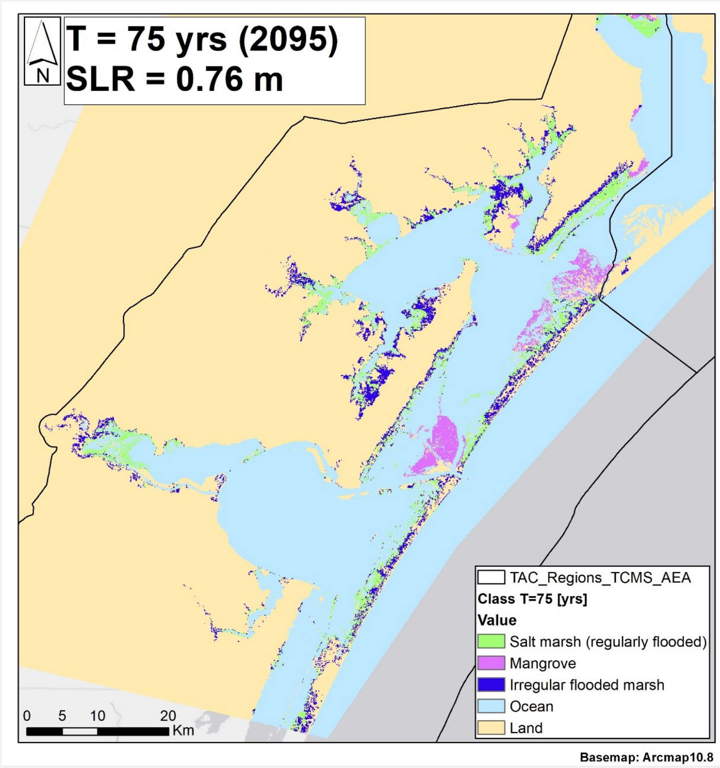
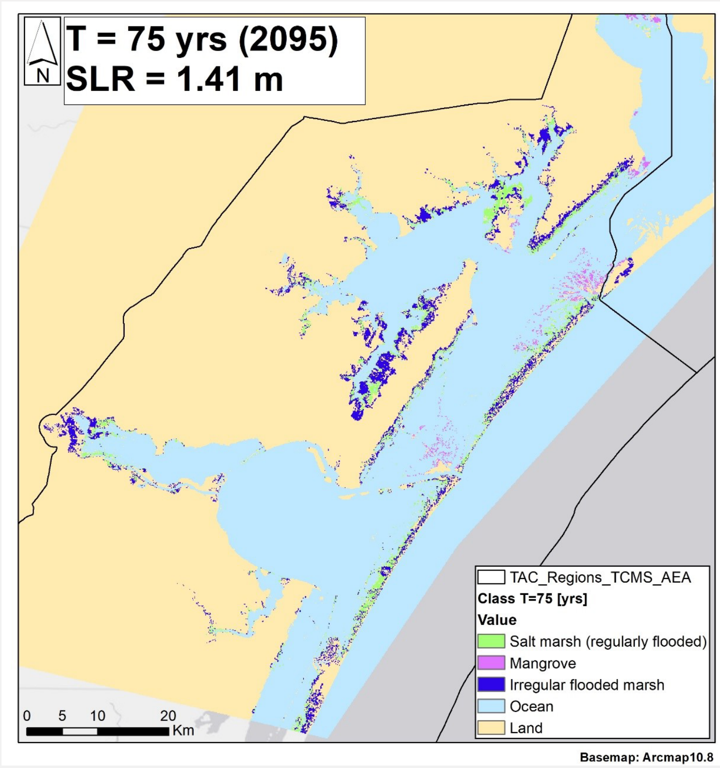
Vegetation map at 50 yrs (2070)



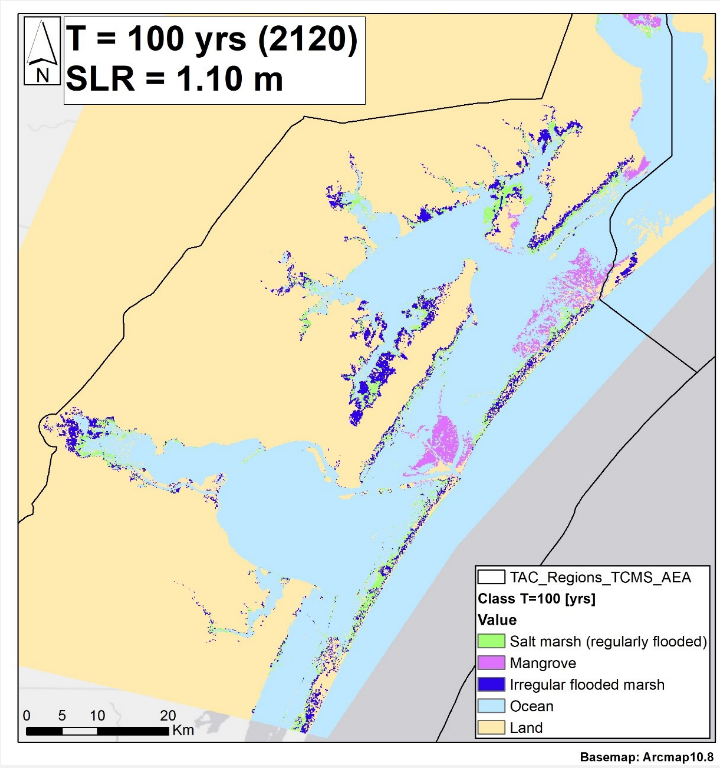


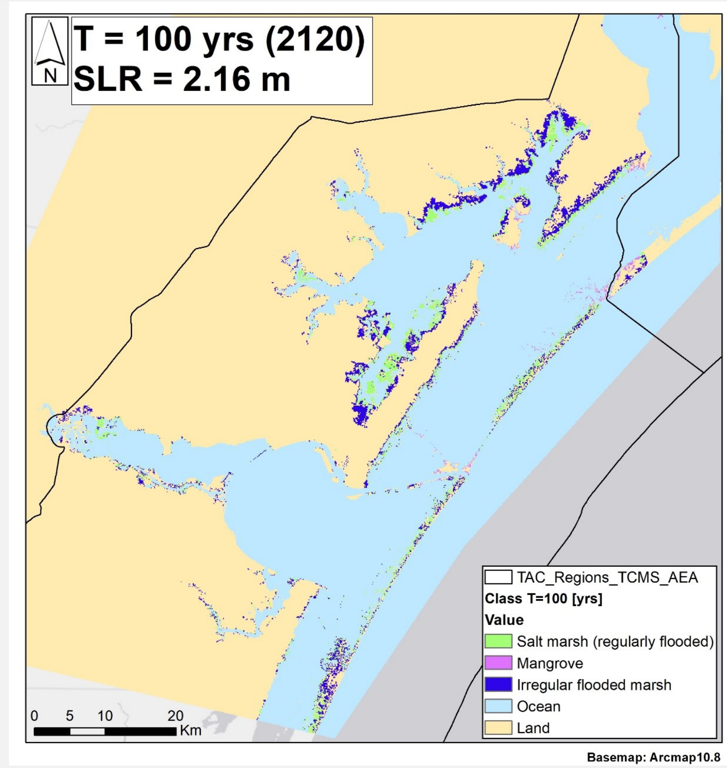
Vegetation map at 75 yrs (2095)





Vegetation map at 100 yrs (2120)





Texas Coastal Bend: Mitigation effect on elevation by vegetation

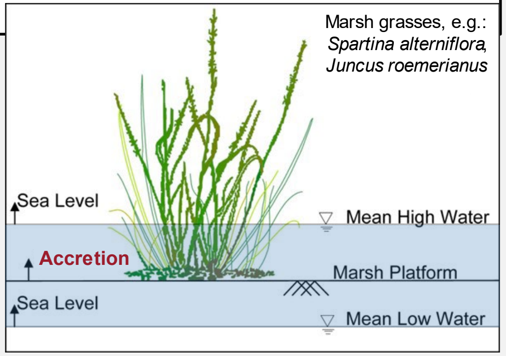
❑ Vegetation Survivability

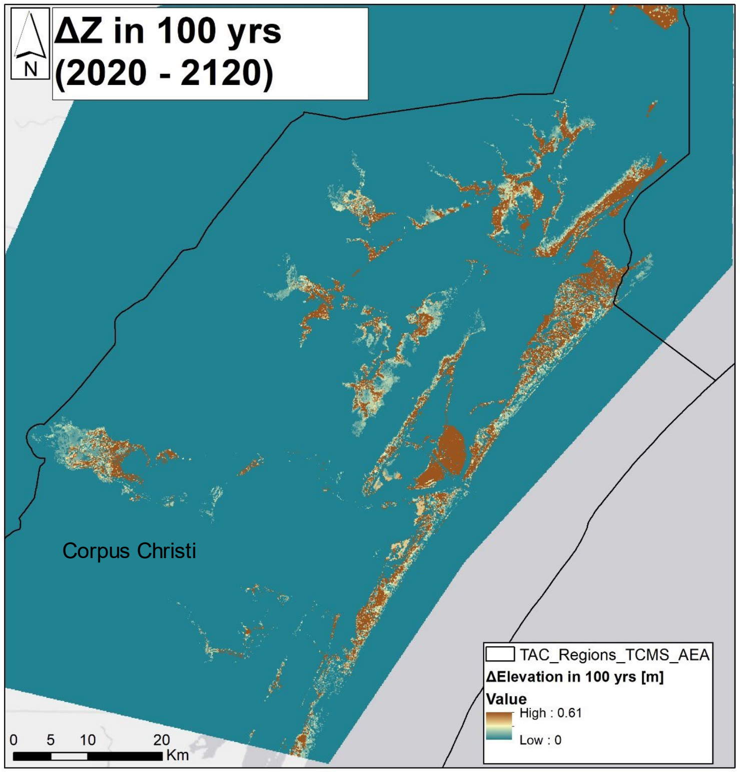
✓ Coastal vegetation cannot withstand intermediate SLR scenarios (SLR > Accretion)

✓ However, horizontal migration is likely possible inside bays (e.g., Int-Low case)

❑ Mitigation effect by vegetation

✓ Vegetation can accumulate up to 0.6 m depositions, which mitigates SLR effects compared to no-vegetation (e.g., Int-Low case)





Basemap: Arcmap10.8

References

Local parameterizations

Data1-3: Comeaux et al. (2012) and Weaver and Armitage (2020)

Data4: Rezek et al. (2017)

- Comeaux, R. S., Allison, M. A., and Bianchi, T. S. (2012). "Mangrove expansion in the Gulf of Mexico with climate change: Implications for wetland health and resistance to rising sea levels." Estuarine, Coastal and Shelf Science, 96, 81-95
- Rezek, R. J., Lebreton, B., Sterba-Boatwright, B., and Beseres Pollack, J. (2017). "Ecological structure and function in a restored versus natural salt marsh." PLOS ONE, 12, doi: 10.1371/journal.pone.0189871
- Weaver, C. A., and Armitage, A. R. (2020). "Above- and belowground responses to nutrient enrichment within a marsh-mangrove ecotone." Estuarine, Coastal and Shelf Science, 243, 106884

Appendix C. Post Meeting Survey

Workshop Evaluation

Living with Sea Level Rise in the Texas Coastal Bend Workshop

November 12th, 2024

1) Please provide your thoughts on the following aspects of today's workshop

	Very Dissatisfied	**Dissatisfied**	**Neutral**	**Satisfied**	**Very Satisfied**
Workshop Content	1	2	3	4	5
Workshop Format	1	2	3	4	5
Workshop Pace	1	2	3	4	5
Workshop Time Length	1	2	3	4	5
Level of Detail Provided	1	2	3	4	5
Workshop Location	1	2	3	4	5
Opportunities to provide input	1	2	3	4	5
Opportunities to communicate my needs	1	2	3	4	5
Opportunities to ask questions	1	2	3	4	5
Knowledge and Communication skills of presenters	1	2	3	4	5
Refreshments	1	2	3	4	5
Overall workshop experience	1	2	3	4	5

2) Please provide your thoughts about the following aspects of today's workshop:

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Don't know**
This workshop was a good use of my time	1	2	3	4	5	DK
This workshop increased my understanding of this project	1	2	3	4	5	DK
This workshop clearly increased my knowledge about sea level rise	1	2	3	4	5	DK
This workshop clearly increased my knowledge about habitat changes under sea level rise	1	2	3	4	5	DK
This workshop increased my knowledge about modeling capabilities and constraints for this project	1	2	3	4	5	DK
I learned something that I will apply to my current or future work	1	2	3	4	5	DK

3) What did you like most about the workshop? Please explain.

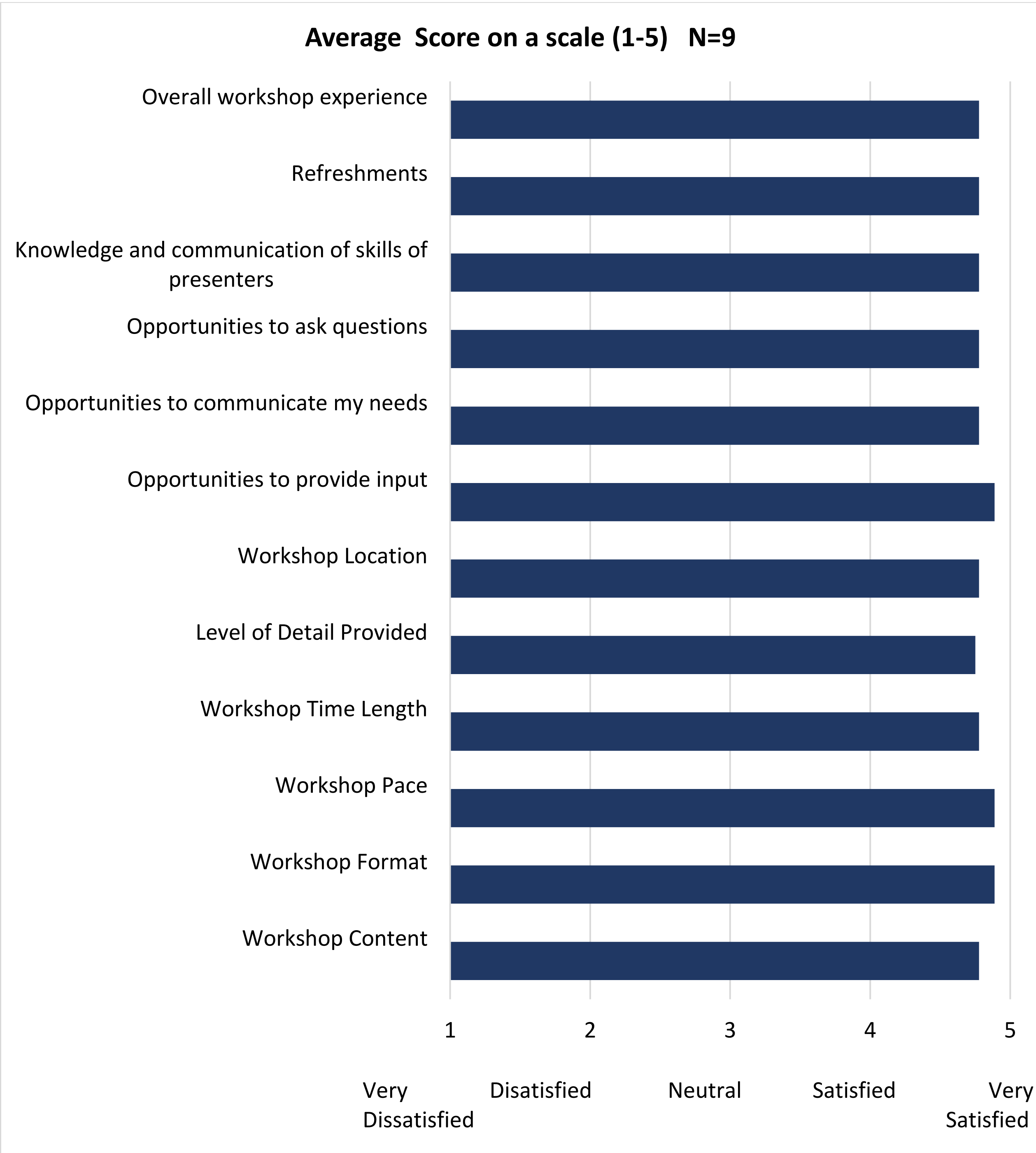
4) What aspect of this workshop was least useful to you? Please explain.

5) What improvements would you recommend in this workshop?

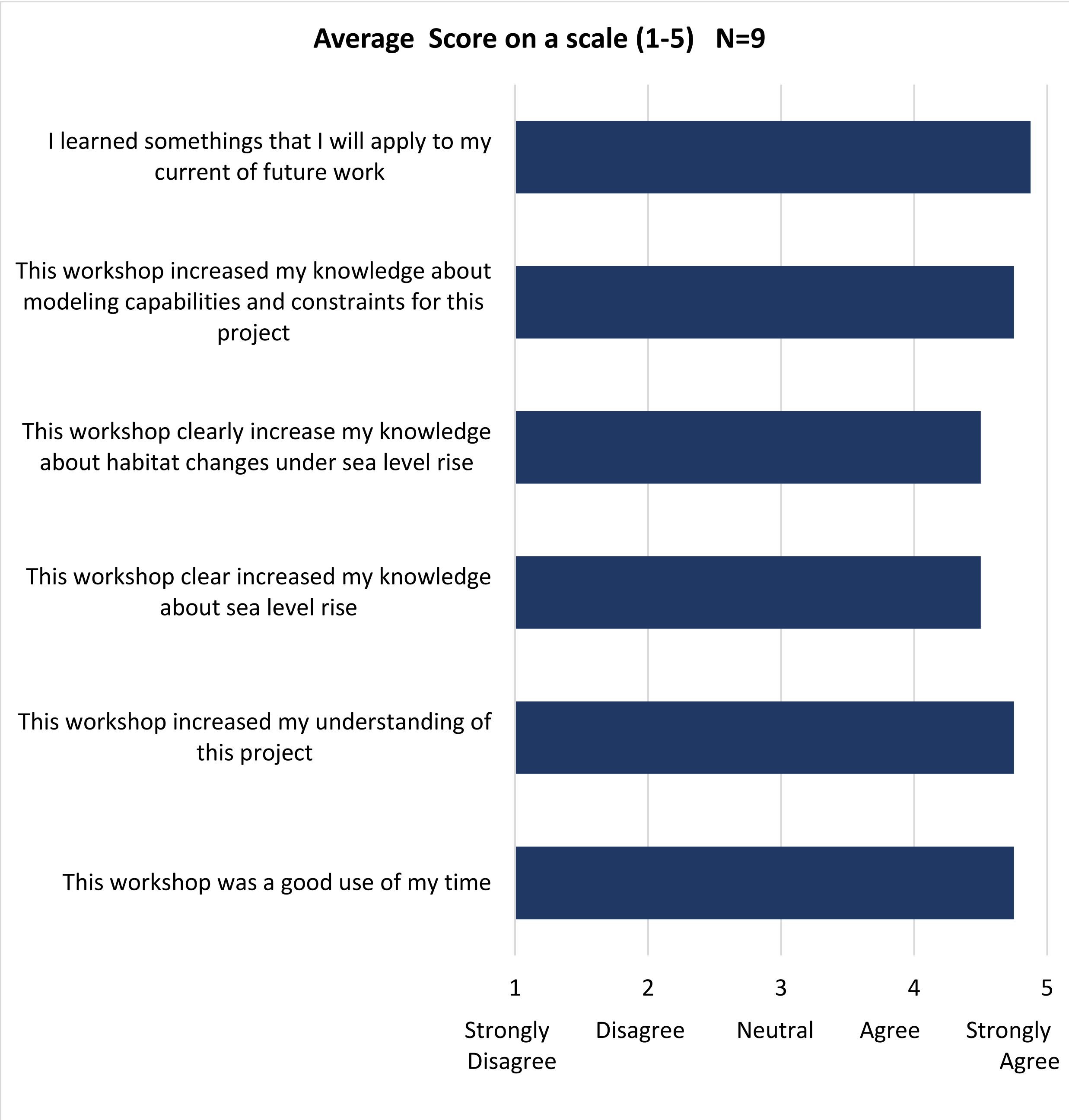
6) What questions, if any, do you have because of participating in this workshop?

Appendix D. Evaluation and Participant Feedback

1. Please provide your thoughts on the following aspects of today's workshop



2.Please provide your thoughts about the following aspects of today's workshop:



3. What did you like most about the workshop? Please explain.

Progress
Activities
The web portal and exploring sea level rise and land cover for the TX [Coastal bend} …?
Great engagement and conversation, clearly well facilitated to make participants comfortable
Using the product and identifying priority areas into project updates
The transparency of the researchers
The conversations and interactions of the members

4) What aspect of this workshop was least useful to you? Please explain.

Activities
N/A
Some of the fine scale info about modeling techniques wasn't directly useful to my future use of the tool
Hard to say, seemed very productive

5) What improvements would you recommend in this workshop?

N/A
If projects are ever really narrowed down, breakout groups may be helpful
N/A - soda

6) What questions, if any, do you have because of participating in this workshop?

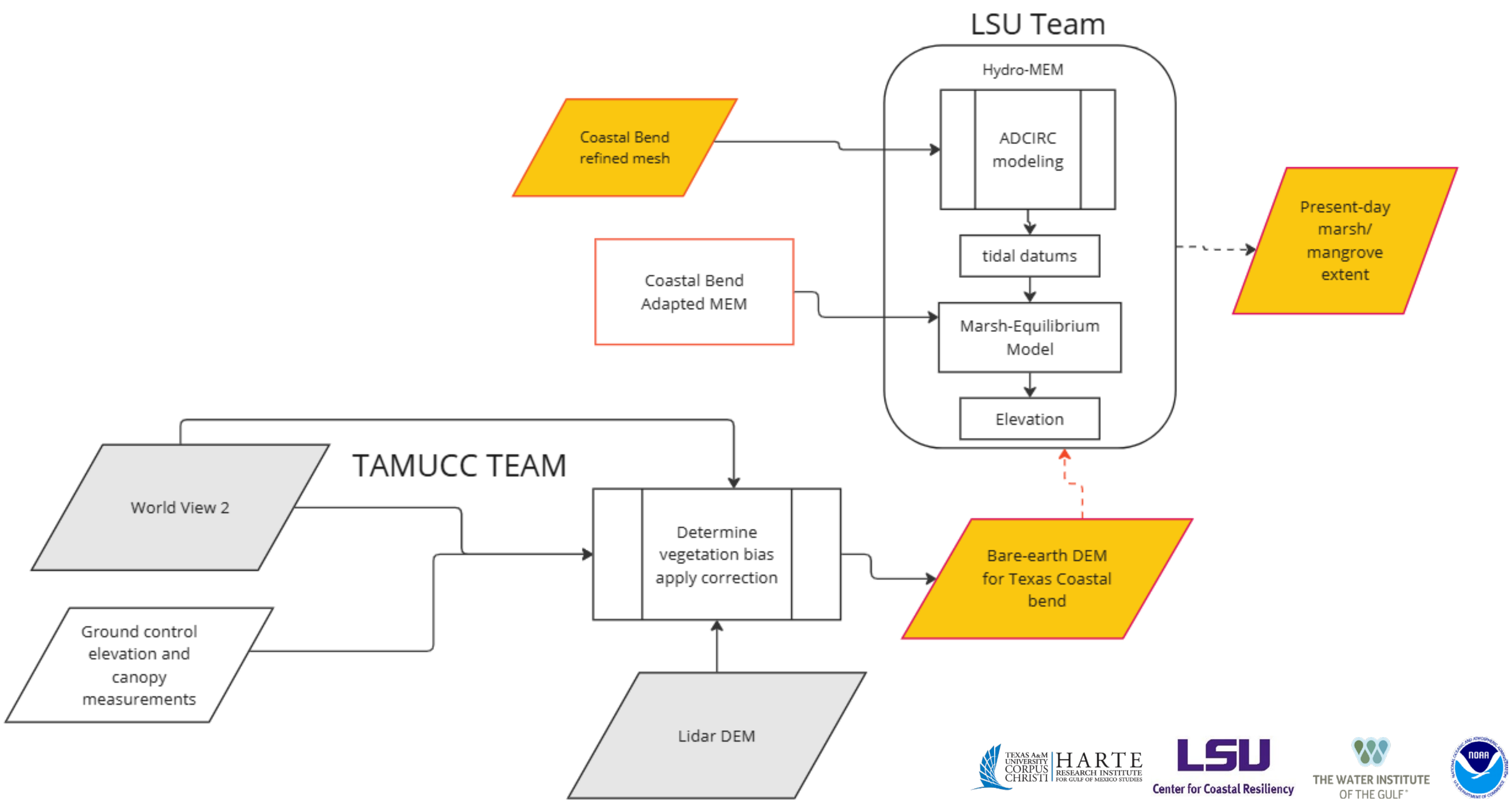
N/A
N/A

Appendix E: Project Concept Model

Living with Sea Level Rise in the Texas Coastal Bend: Project Concept Model

Nov 12, 2024

Goal 1:Improve and Adapt Hydro-MEM to the Texas Coastal Bend



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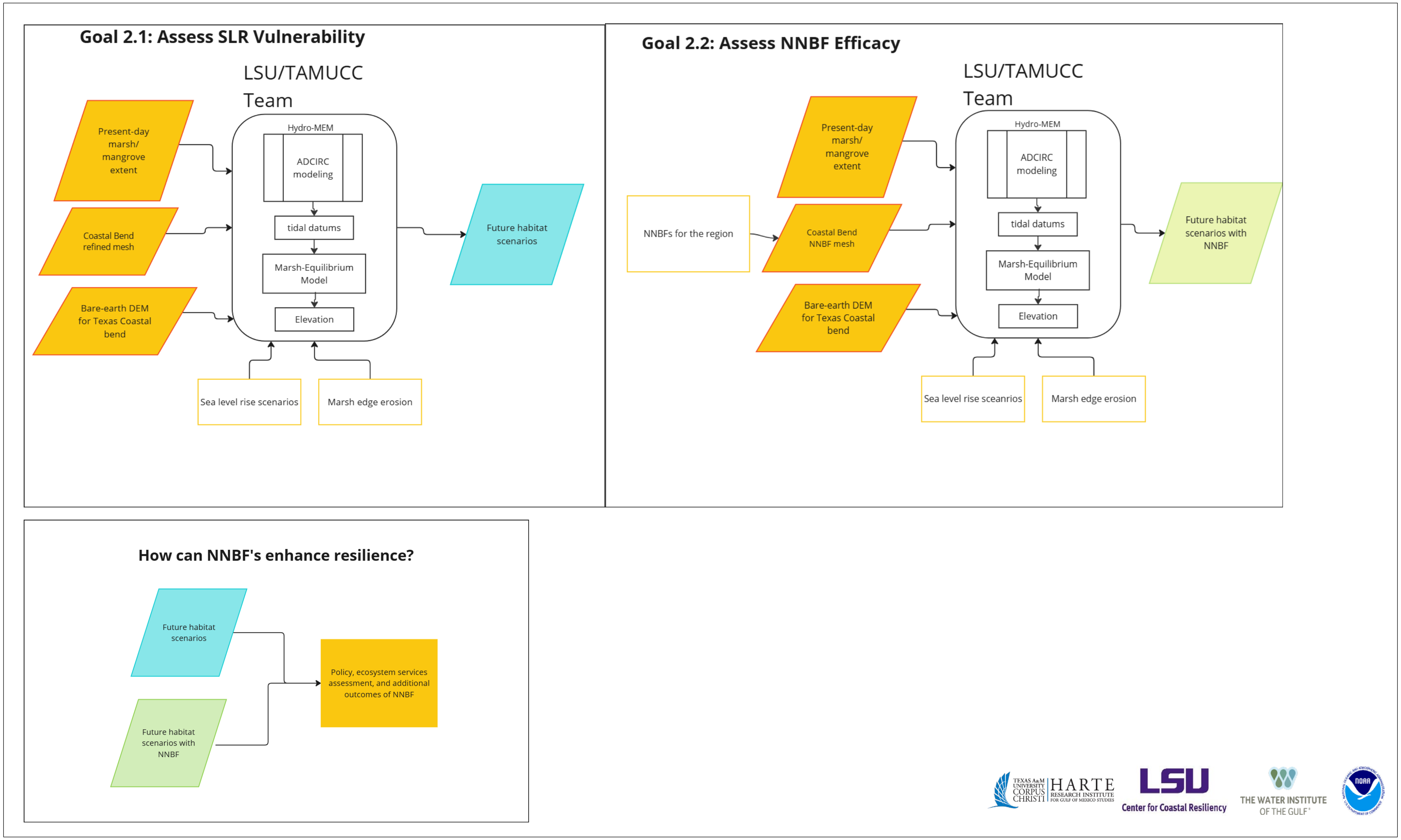


Goal 2.1: Assess SLR Vulnerability
LSU/TAMUCC Team
Present-day marsh/ mangrove extent
Coastal Bend refined mesh
Bare-earth DEM for Texas Coastal bend
Hydro-MEM
ADCIRC modeling
tidal datums
Marsh-Equilibrium Model
Elevation
Future habitat scenarios
Sea level rise scenarios
Marsh edge erosion
Goal 2.2: Assess NNBF Efficacy
LSU/TAMUCC Team
NNBFs for the region
Present-day marsh/ mangrove extent
Coastal Bend NNBF mesh
Bare-earth DEM for Texas Coastal bend
Hydro-MEM
ADCIRC modeling
tidal datums
Marsh-Equilibrium Model
Elevation
Future habitat scenarios with NNBF
Sea level rise sceanrios
Marsh edge erosion
How can NNBF's enhance resilience?
Future habitat scenarios
Future habitat scenarios with NNBF
Policy, ecosystem services assessment, and additional outcomes of NNBF

Appendix F: Workshop Activity

Activity Sheet 1 – Exploring Sea Level Rise & Land Cover for the Texas Coastal Bend

Objective

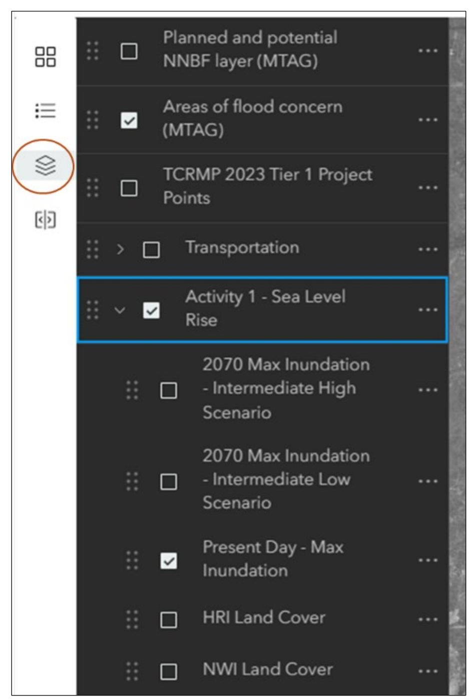
This activity will guide you through a comparison of water levels under sea level rise (SLR) in the Texas Coastal Bend and a comparison of two land cover products—ESLR Land Cover (HRI) and National Wetlands Inventory (NWI). Layers to be explored:

1. **Present Day – Max Inundation**
2. **2070 Max Inundation- Intermediate Low Scenario**
3. **2070 Max Inundation- Intermediate High Scenario**
4. **Areas of flood concern (MTAG)**
5. **HRI Land Cover**
6. **NWI Land Cover**

Through this exercise, you'll:

- Identify changes in water level at a chosen location.
- Compare projected changes across different locations.
- Compare the two land cover datasets.

Instructions



Step 1: Pick a Location of Interest

1. Visit https://bit.ly/3CpVbMs to view the map for the Texas Coastal Bend area.
2. Select a specific location of interest using the **Areas of flood concern (MTAG)** layer or search tool.
3. Navigate to this location using your mouse (*see reference sheet*).

Step 2: Observe Present Day Water Levels

1. Expand the Activity 1- Sea Level Rise Group Layers. *See image* →
2. Turn on the **Present Day – Max Inundation** layer to view current maximum water extent. *See image* →
3. Note any key features in this area that might be impacted by water changes, such as buildings, parks, or habitats.

Step 3: Evaluate Projected Water Levels for the year 2070

1. Enable the **2070 Max Inundation- Intermediate Low Scenario** layer.
   - Observe changes in the maximum water extent from the present day. *Toggle the Map Legend* →
   - Record the change in extent, *use the measuring tool* as needed to record distances.
2. Switch to the **2070 Max Inundation- Intermediate High Scenario** layer.
   - Observe and record further changes. Compare them to the **Intermediate Low** scenario.

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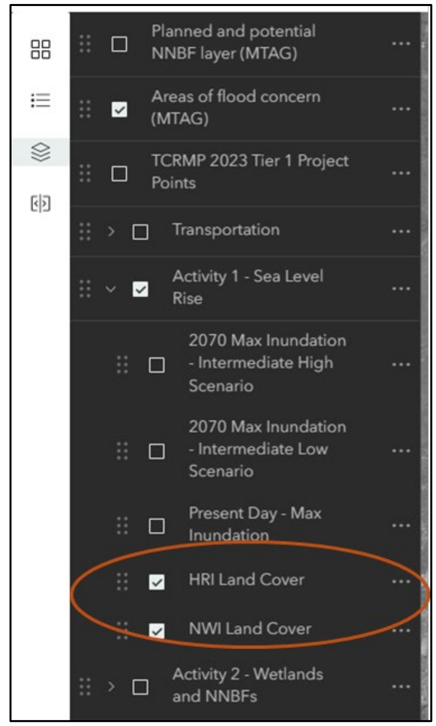
Step 4: Compare Land Cover Products (ESLR and NWI)

1. Enable the **HRI Land Cover** and the **NWI Land Cover** layers. *See image* →
2. Navigate to a location of interest,
3. Use the Swiper Widget (*see Quick Reference Sheet*) to toggle between layers.
4. Use the Map Legend to explore landcover.
5. **Record Your Observations**:
    - Describe any differences in the classification or delineation of wetland types or other land cover between the ESLR and NWI products.
    - Based on your knowledge and experience, consider which product appears more accurate or useful.
    - Note any additional land cover categories or details that stand out in one product versus the other.
    - What are the main differences you noticed between the ESLR and NWI land cover products?



Step 5: Compare with Neighboring Sites

1. Select 2-3 neighboring sites and repeat Steps 2-4 for each.
2. Record observations, noting which areas show the highest vulnerability to SLR and which remain relatively unaffected.
3. Discuss the reasons for differences between sites. Consider factors like elevation, proximity to the shoreline, or natural barriers.
4. Did the comparison change your level of concern for the different sites?

Step 6: Discuss Potential Community Impacts

1. Reflect on the implications for your chosen location and neighboring sites under different SLR scenarios.

2. Looking at previous areas of flood risk concern – are you more or less concerned about this flood risk area?

3. Are there new areas you would like to identify?

4. Discuss potential impacts on the local community, including:
    - **Infrastructure and Housing**: Which areas or buildings might be flooded or require adaptation?
    - **Ecology**: Are there natural habitats, wetlands, or recreational areas at risk?
    - **Economy**: How might local businesses, tourism, or property values be affected?

5. Do you envision using water-level products in your work? What do you like about them? Do you have suggestions for the best way to provide this information?

Activity Sheet 2 – Exploring Wetland Changes under Sea Level Rise in the Texas Coastal Bend

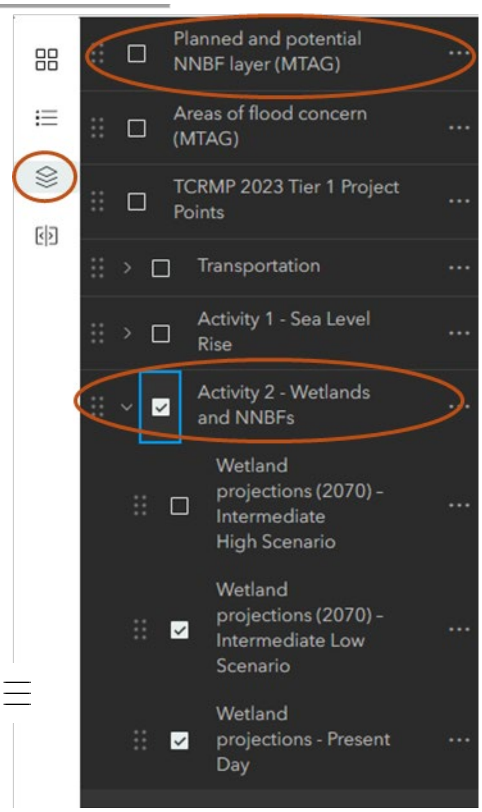
Objective

This activity will guide you through analyzing two land cover products—ESLR Land Cover (TAMUCC) and National Wetlands Inventory (NWI)—and exploring wetland changes under two sea level rise (SLR) scenarios in the Texas Coastal Bend using the following datasets:

1. **Wetland projections - Present Day**
2. **Wetland projections (2070) Intermediate Low Scenario**
3. **Wetland projections (2070) Intermediate High Scenario**
4. **Planned and potential NNBF layer (MTAG)**

Through this exercise, you'll:

- Analyze projected wetland habitat changes under SLR scenarios.
- Consider Natural and Nature-Based Features (NNBFs) for mitigating future impacts and cast a vote for NNBFs that should be prioritized for modeling.



__Instructions__

Step 1: Pick a Location of Interest

1. Visit https://bit.ly/3CpVbMs to view the map for the Texas Coastal Bend area.
2. Select a specific location of interest, you may use the location of **Planned and potential NNBF layer (MTAG)**. Also, consider selecting an area that has significant wetland habitats or is near coastal communities, as these areas are more vulnerable to SLR. Navigate to this location using your mouse (*see reference sheet*).

Step 2: Explore Wetland Changes under Sea Level Rise Scenarios

1. Expand the __Activity 1- Sea Level Rise__ Group. *See image* →
2. Enable the **Wetland projections - Present Day** and **Wetland projections (2070) Intermediate Low Scenario** layers.
3. Use the Swiper Widget (*see Quick Reference Sheet*) to toggle between layers.
4. Use the Map Legend to explore wetland changes
   - Observe and record any changes in wetland habitats from the Present Day scenario, focusing on areas where wetland extent is reduced or changed.
5. Finally, enable **Wetland projections (2070) Intermediate High Scenario**. Note: be sure to disable the previous scenario. Repat Step 2.
   - Record any significant shifts in wetland habitat type, location, or extent under this higher SLR scenario.

6. On the space below, reflect on the wetland changes you observed under the two SLR scenarios:
    - Are the changes in wetland habitats consistent with your knowledge of the Texas Coastal Bend?
    - How do these projections align with other research, reports, or observations you have about this region's wetlands?
    - Identify any surprising or notable discrepancies between these projections and your understanding of the system.
    - How do projected wetland habitat changes vary under the two SLR scenarios, and what implications might these changes have for local ecosystems and communities?
    - Considering these scenarios, are you interested in exploring additional scenarios that will become available by the end of the project?

Step 3: Identify and Suggest NNBFs

- Consider areas where significant wetland changes are projected under SLR. You may use the **Planned and potential NNBF** layer as reference:
    - Could Natural and Nature-Based Features (NNBFs) such as living shorelines, or wetland restoration help mitigate future changes?
    - Make a list of NNBFs that are planned or could be planned or implemented in the Texas Coastal Bend to reduce SLR impacts on wetland habitats and communities.

Step 4. Vote for NNBFs to Prioritize:

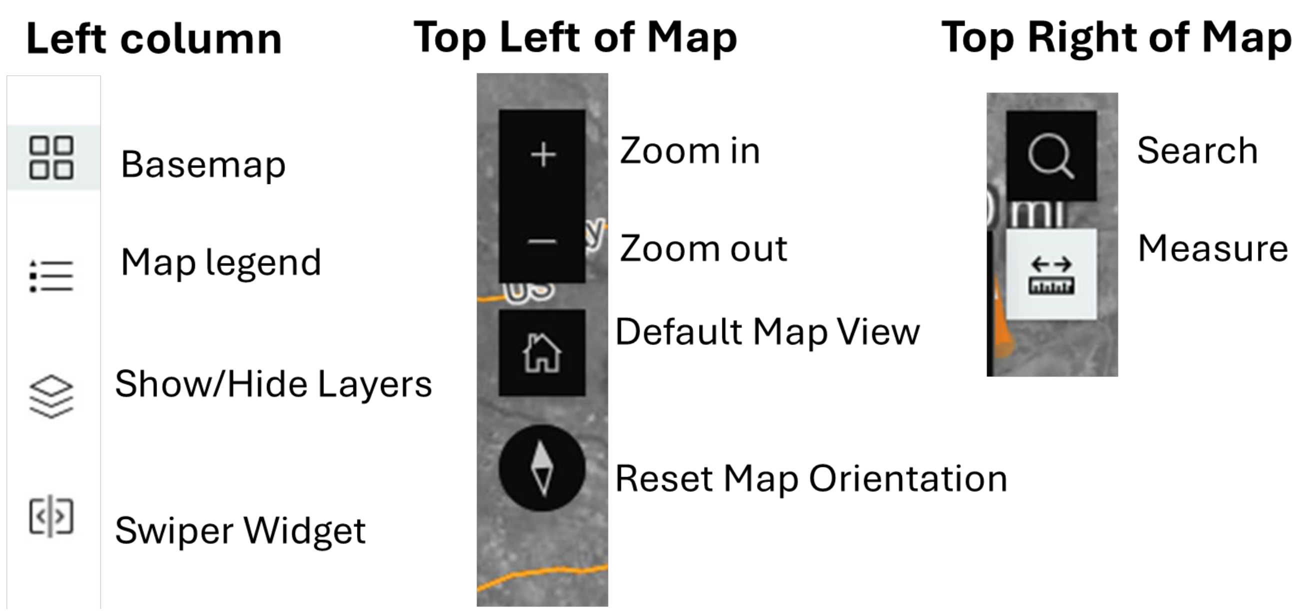
- Based on your analysis, choose one or more NNBFs that you believe should be prioritized for modeling and potential implementation.
- Write down your recommendations, noting why these NNBFs are suitable for the specific conditions in the Texas Coastal Bend.
- Which NNBFs could offer the most value in preserving wetland habitats and reducing SLR impacts? Why?
- How does your vote for an NNBF align with community resilience goals?
- Add your vote using the sticky note the list on the flip chart (you have 3 dots= 3 votes)

Quick Reference: Using the Web Map

Navigation

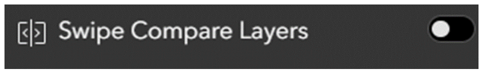
To:	Use the mouse in this way:
Move or pan the map	Click the left mouse button and drag the map in the direction in which you want to move it.
Center the map at a specific position.	Double-click the left mouse button on the point you want at the center of the map.
Zoom in or out on the map at the location of the cursor	Roll the mouse wheel forward or away from you to zoom in on the map at the location of the mouse cursor. Each click will zoom in approximately 75% of the current map scale.
Rotate the map	Click the right mouse button and drag left or right depending on the direction in which you want to rotate the map.

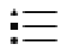
Map widgets- functionality

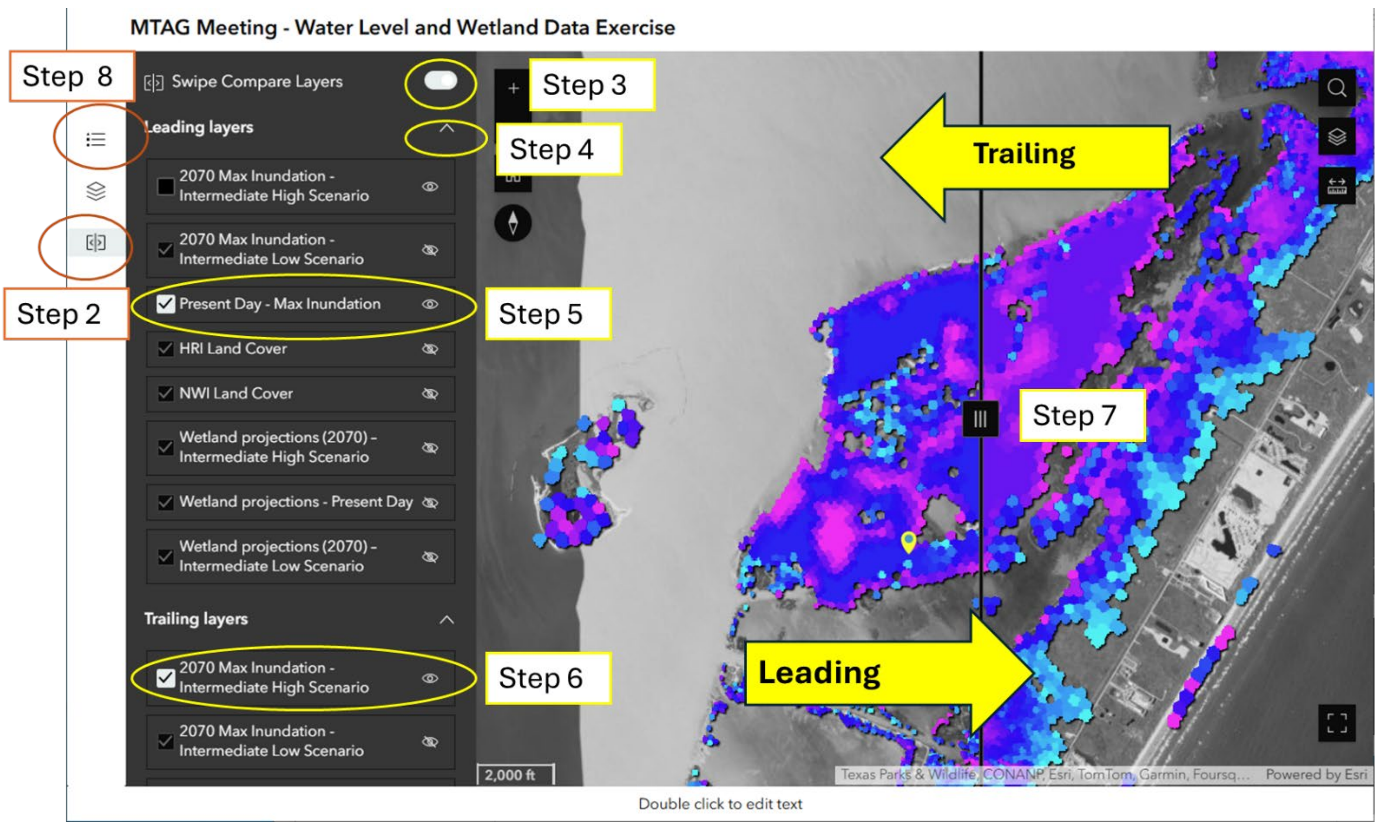


Using the Swiper Widget

To use the swiper widget (Figure 16), be sure that the appropriate layers are on Map Layers (left pane).

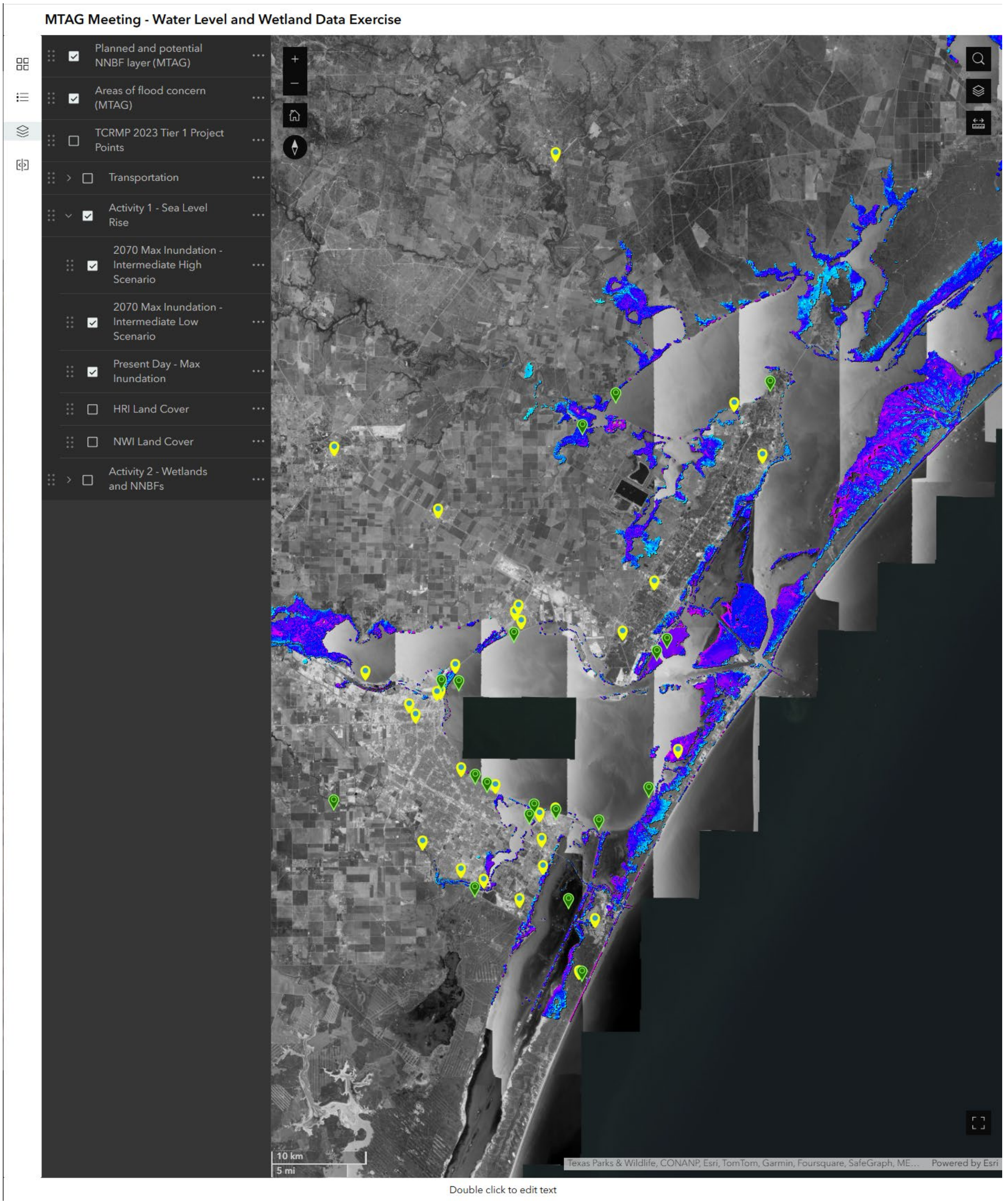
1. On the layers widget activate Activity group, zoom to area of interest
2. Click on the swiper logo on the right pane.
3. Turn on "Swipe Compare Layers
   - 

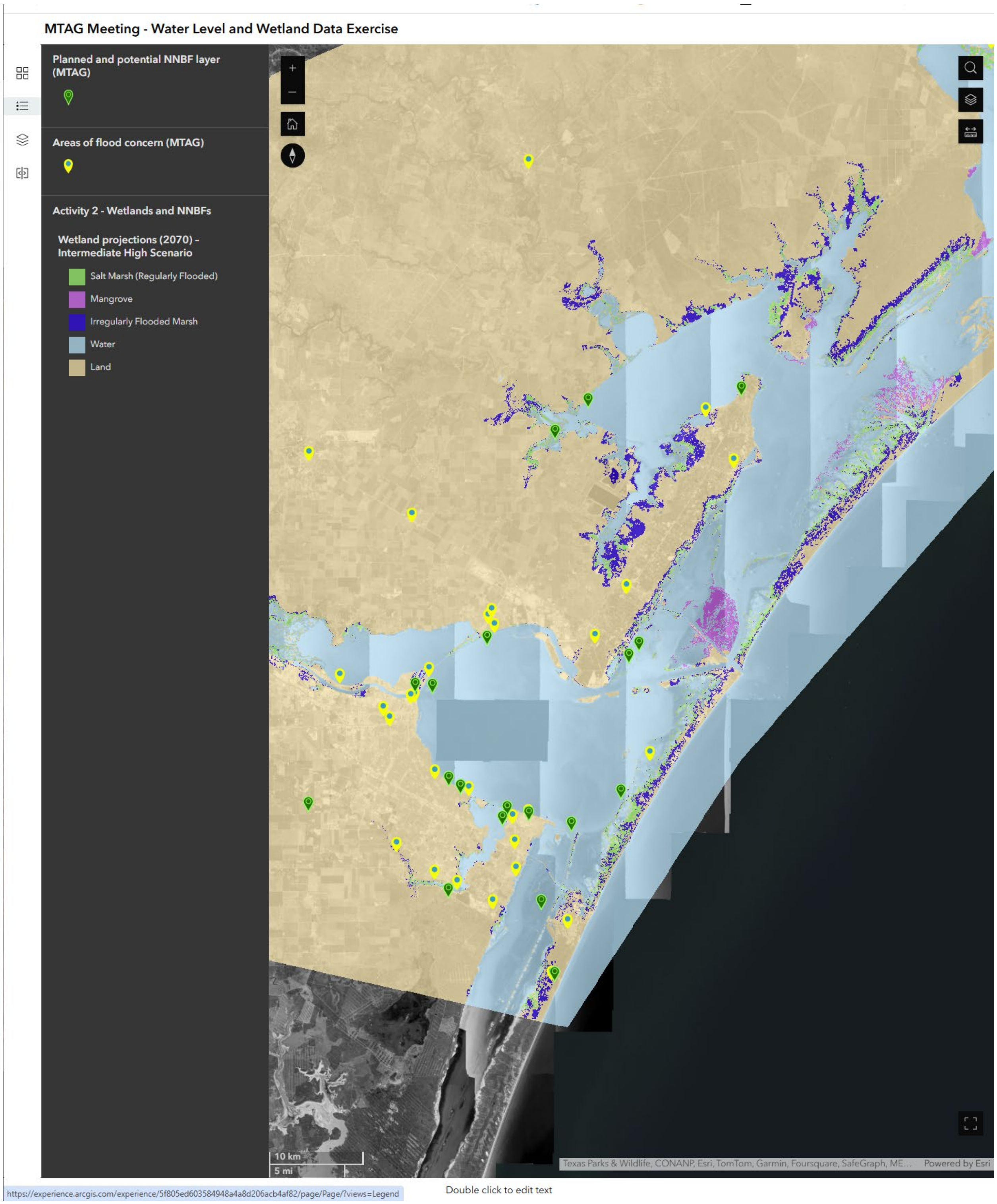
4. Expand "Leading Layers" and Training Layers" by clicking the arrow 
5. Select the present day scenario under "Leading Layer"
6. Select SLR Scenario on "Training Layer"
7. Swipe to see differences.
8. Turn on the legend to reference symbology 



TEXAS A&M UNIVERSITY CORPUS CHRISTI | HARTE RESEARCH INSTITUTE FOR GULF OF MEXICO STUDIES
LSU Center for Coastal Resiliency
THE WATER INSTITUTE OF THE GULF
NOAA

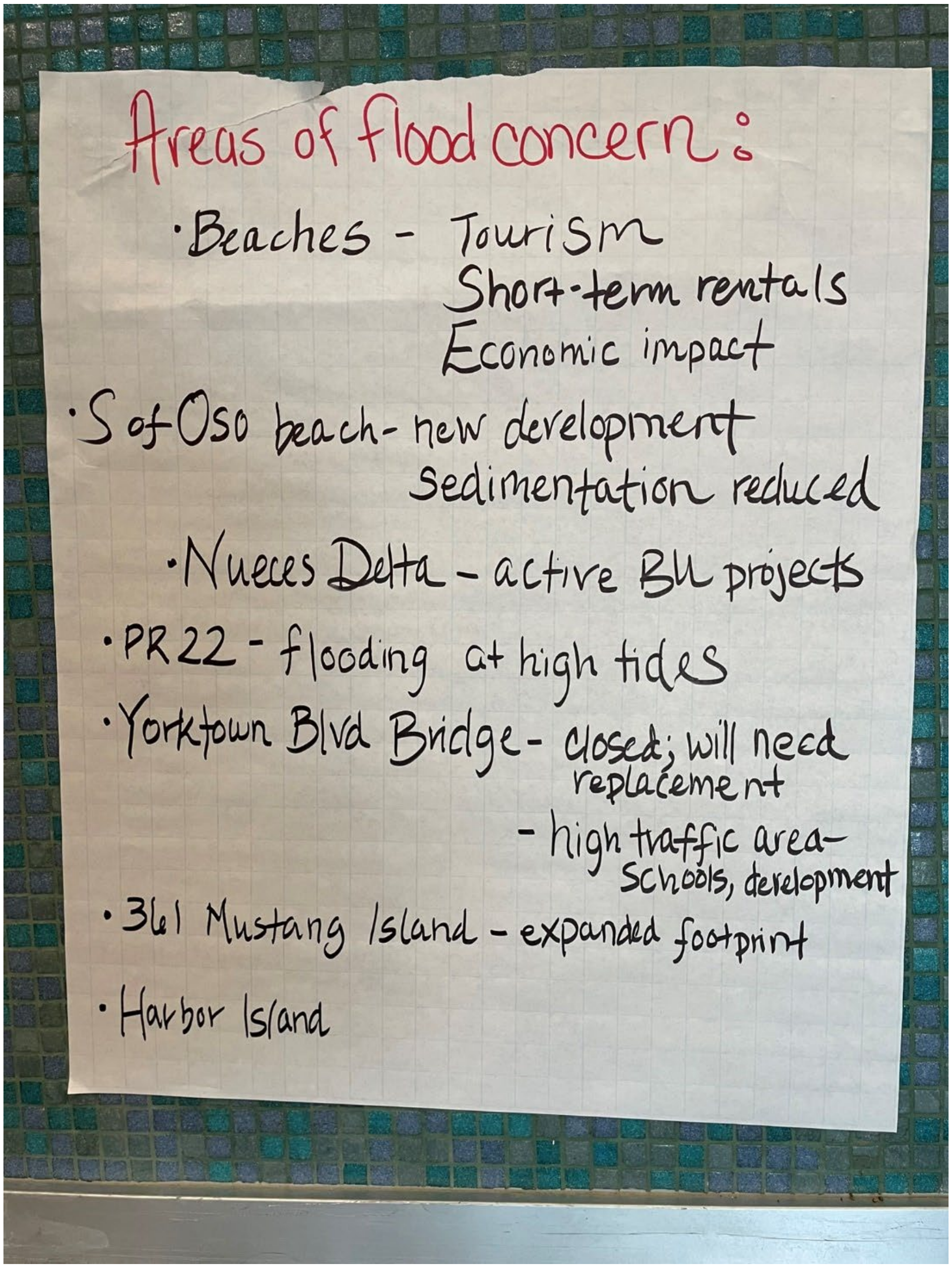
Appendix G: Screenshot of Online Tool for Activities

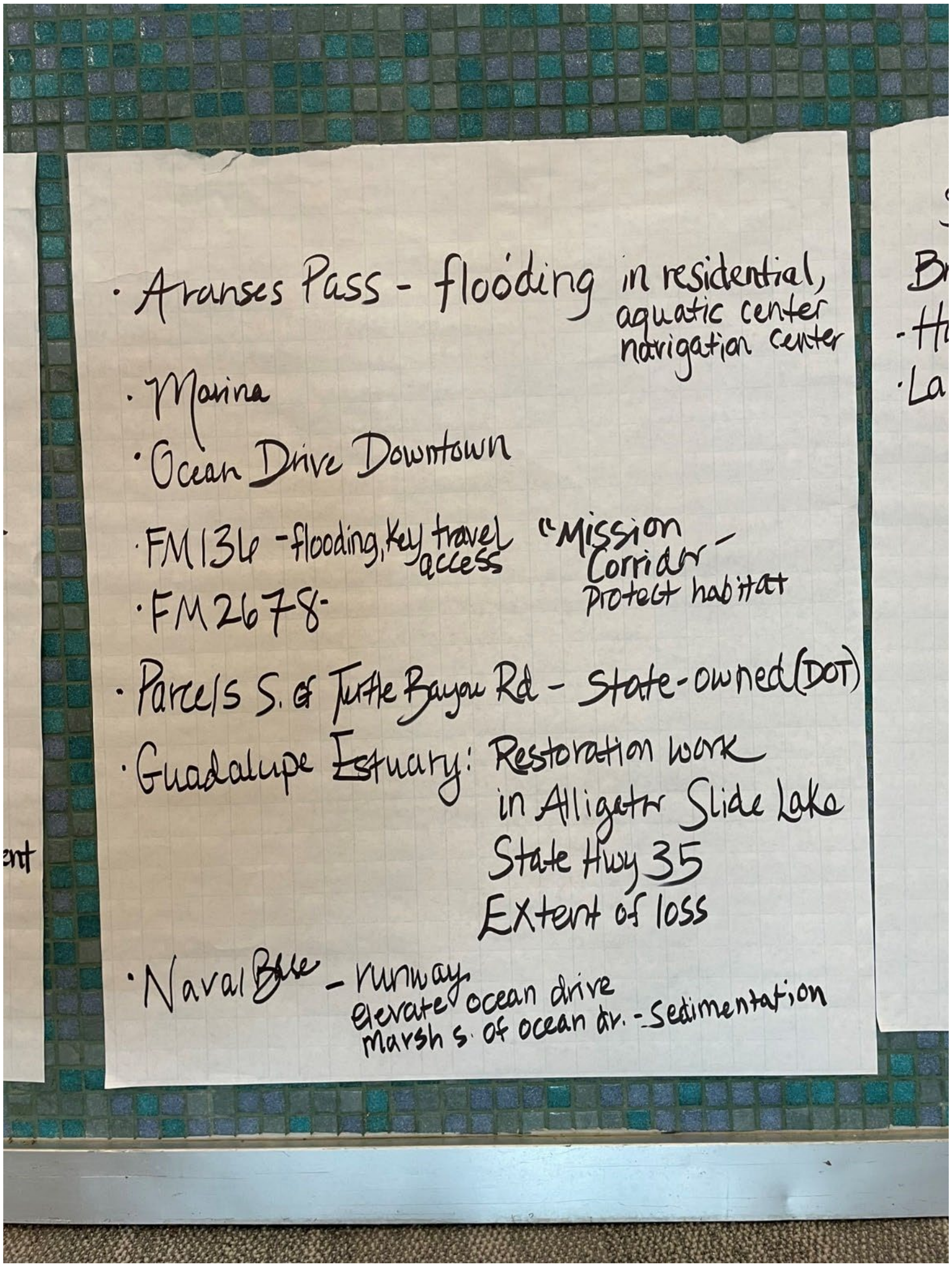


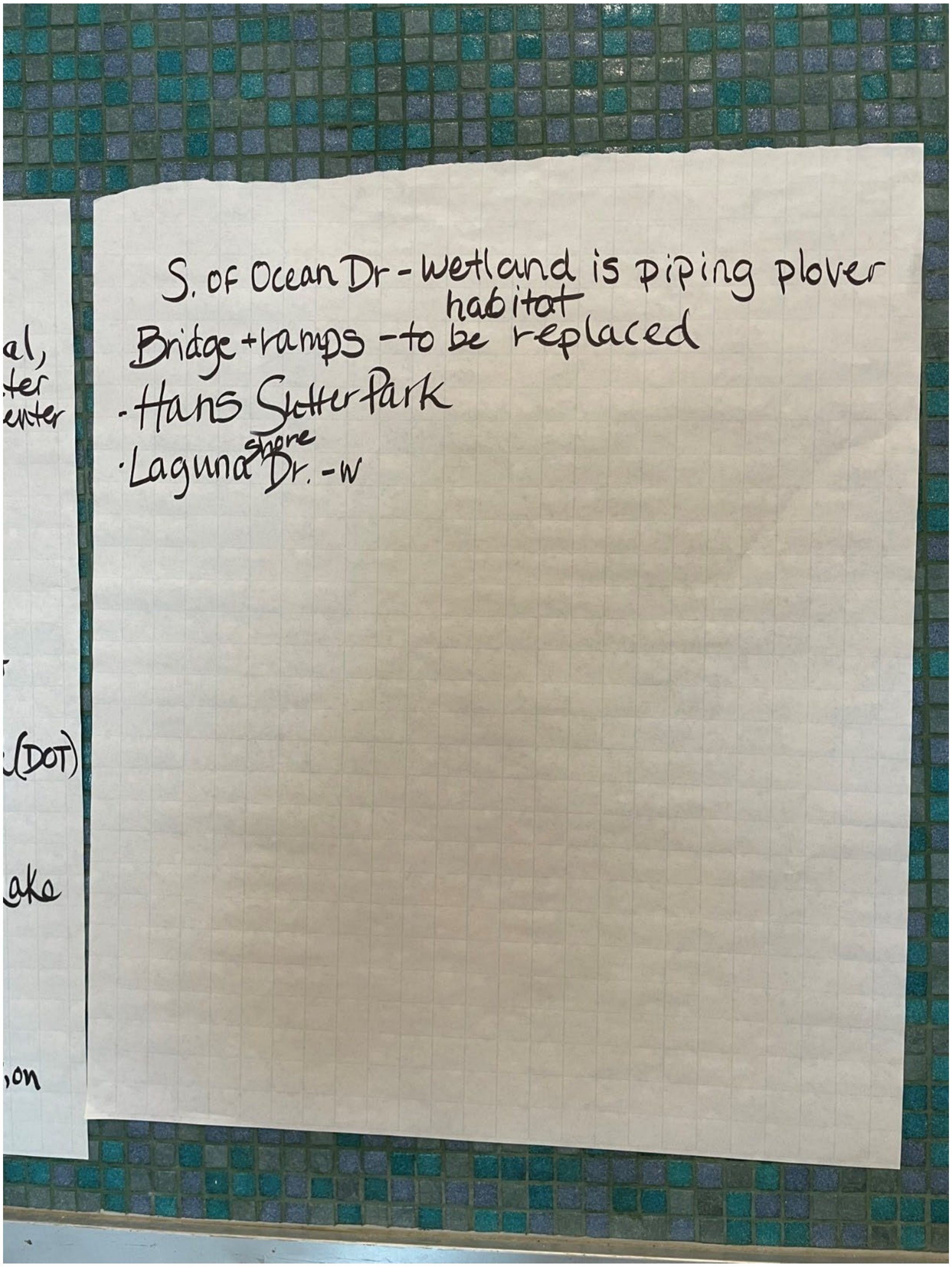

MTAG Meeting - Water Level and Wetland Data Exercise
Planned and potential NNBF layer (MTAG)
Areas of flood concern (MTAG)
Activity 2 - Wetlands and NNBFs
Wetland projections (2070) - Intermediate High Scenario
Salt Marsh (Regularly Flooded)
Mangrove
Irregularly Flooded Marsh
Water
Land
10 km
5 mi
Texas Parks & Wildlife, CONANP, Esri, TomTom, Garmin, Foursquare, SafeGraph, ME...
Powered by Esri
https://experience.arcgis.com/experience/5f805ed603584948a4a8d206acb4af82/page/Page/?views=Legend
Double click to edit text

Appendix H: Flipchart Notes During Discussion:

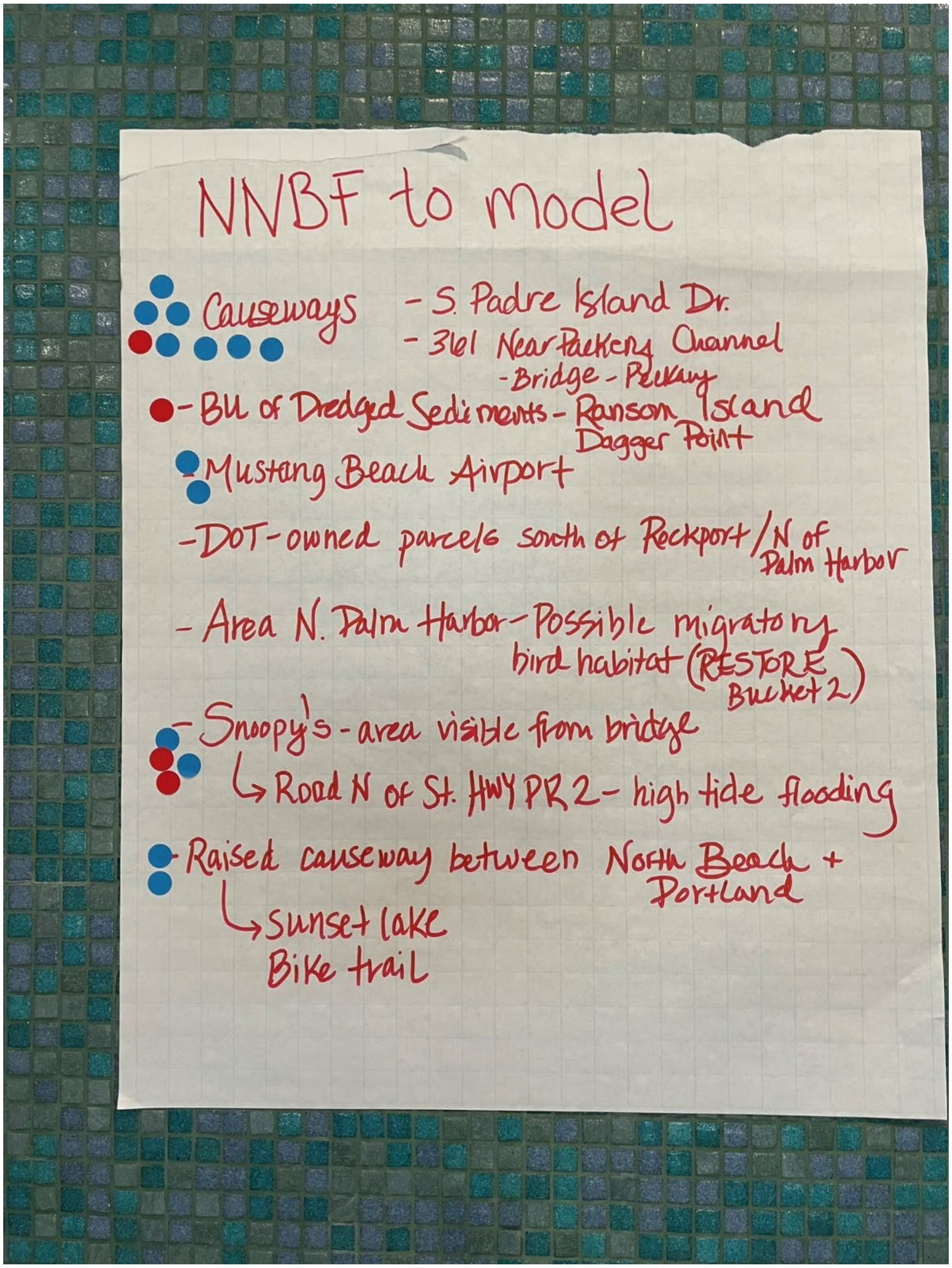
Areas of Flood Concern

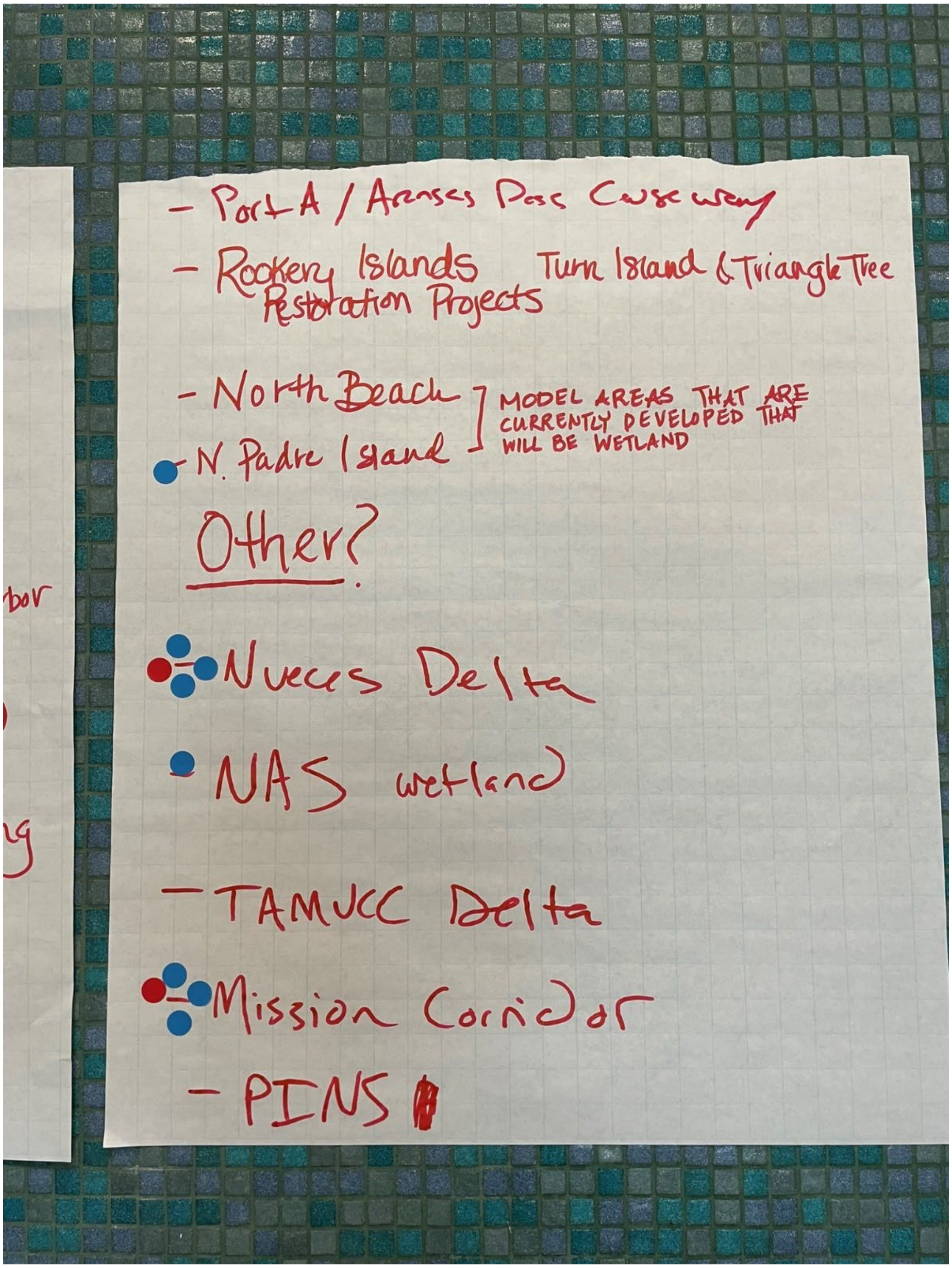



· Aranses Pass - flooding in residential, aquatic center navigation center
· Marina
· Ocean Drive Downtown
· FM136 - flooding, key travel access
"Mission Corridor - Protect habitat
· FM2678 -
· Parcels S. of Turtle Bayou Rd - State-owned (DOT)
· Guadalupe Estuary: Restoration work in Alligator Slide Lake
State Hwy 35
Extent of loss
· Naval Base - runway,
elevate ocean drive
marsh s. of ocean dr. - Sedimentation


S. of Ocean Dr - wetland is piping plover habitat
Bridge + ramps -- to be replaced
· Hans Sutter Park
· Laguna Shore Dr. - W

NNBF to Model




- Port A / Aransas Pass Causeway
- Rookery Islands Restoration Projects
Turn Island & Triangle Tree
- North Beach
- N. Padre Island
MODEL AREAS THAT ARE CURRENTLY DEVELOPED THAT WILL BE WETLAND
Other?
- Nueces Delta
- NAS wetland
- TAMUCC Delta
- Mission Corridor
- PINS

Appendix I: Acronym List

Organizations and Agencies

CBCOG – Coastal Bend Council of Governments

CC Regional EDC – Corpus Christi Regional Economic Development Corporation

HRI – Harte Research Institute for Gulf of Mexico Studies

LSU – Louisiana State University

MSU – Mississippi State University

NERR – National Estuarine Research Reserve

NOAA – National Oceanic and Atmospheric Administration

PLACE-SLR – Program for Local Adaptation to Climate Effects: Sea-Level Rise

TAMUCC – Texas A&M University – Corpus Christi

TGLO – Texas General Land Office

TWDB – Texas Water Development Board

CBBEP - Coastal Bend Bays and Estuaries

CC MPO - Corpus Christi Metropolitan Planning Organization

Other Acronyms

ADCIRC – ADvanced CIRCulation (hydrodynamic model)

DEM – Digital Elevation Model

ESLR – Effects of Sea Level Rise Program

MEM – Marsh Equilibrium Model

MTAG – Management Transition Advisory Group

NNBF – Natural and Nature Based Features

NWI – National Wetlands Inventory

SLAMM – Sea Level Affecting Marshes Model

SLR – Sea level rise

SPID – South Padre Island Drive

TCRMP – Texas Coastal Resiliency Master Plan