

Development and Application of Methods for Assessing Nature-based and Engineered Adaptation Solutions to Climate Change in the Coastal Zone

In order to minimize the economic and social loss associated with climate change, local, regional, and national governments and other decision-makers are developing plans to respond and adapt. The suite of actions under consideration includes both engineered solutions (e.g. seawalls) and natural solutions (e.g. marsh restoration). Making informed decisions requires a systematic comparison of the costs and benefits of natural and engineered solutions. By strategically choosing alternatives that are cost-effective, these plans can ensure the protection of people and property while also protecting or restoring dwindling critical habitat and the full suite of benefits those habitats provide to people.

To support decision-makers in their efforts to manage coastal resources in a changing world, our interdisciplinary team proposes to: (1) Work with decision-makers to design and assess the effectiveness of oyster and marsh restoration strategies for harvest and other objectives in the face of climate change; (2) Work with decision-makers to construct relevant scenarios of natural and engineered approaches to climate change adaptation; (3) Modify existing interdisciplinary modeling approaches for quantitatively assessing the economic and social costs and benefits of natural and engineered solutions; (4) Apply the methodology in several settings in Galveston Bay, TX, to assess the effects of coastal adaptation and climate scenarios on other ecosystem services provided by nearshore environments; (5) Use assessments to inform decision-making and enhance the capacity of key sectors (e.g., coastal real estate and insurance companies, local and regional governments) to respond to and plan for a changing climate, and (6) Adapt and refine a suite of decision-support tools that can be used in other locations.

Outcomes and outputs from the proposed research include: (1) Maps of vulnerability of coastal areas and communities to coastal hazards and climate impacts are provided under different scenarios of climate adaptation strategies, (2) Maps of ecosystem services and their values are used to inform climate adaptation and coastal hazard mitigation decisions in the Galveston Bay region, (3) A guidance document outlining principles for climate adaptation strategies, (4) A transferable tool for use in other locations, and (5) Peer reviewed research papers documenting the approaches and results.

The mapping and modeling work we propose will highlight vulnerable human communities and infrastructure and enhance our understanding of how benefits we draw from nature are likely to change under different management and climate scenarios. We will work closely with practitioners to develop and assess relevant habitat restoration and climate adaptation scenarios and ensure the development of maximally useful tools for incorporating climate information into management strategies. We will use a process-based ecosystem service-modeling tool (marine InVEST) to ask how changes in marsh and oyster habitats affect ecosystem functions and the value of services they provide. Our models produce outputs that include both service currencies (e.g., oyster biomass harvested, hectares of shoreline for which erosion or inundation are avoided) and value metrics (e.g., numbers of humans, houses, or roads protected from storms or sea level rise; numbers of recreational fishers). Our tools will be applied in demonstration sites but also developed to be transferable to other locations. We will build upon ongoing modeling with marine InVEST in Galveston Bay, TX to map and value the myriad services provided by

oyster reefs and marshes, including erosion and inundation control, food from commercial harvest of blue crab, and opportunities for recreation. Our work is fundamentally about developing methods and transferable tools for incorporating climate information in restoration, fisheries, and development-related decision-making processes within Texas and throughout the world.