A PATH TOWARDS HOLISTIC COASTAL ZONE MANAGEMENT IN TEXAS LEVERAGING SIGNIFICANT INVESTMENTS IN DATA COLLECTION, PLANNING, AND IMPLEMENTATION

Coraggio Maglio, DCCM, cmaglio@dccm.com
David Green, Texas General Land Office, david.green@glo.texas.gov
Kevin Frenzel, Texas General Land Office, Kevin.Frenzel@glo.texas.gov
Tony Williams, Texas General Land Office, Tony.Williams@glo.texas.gov
Carla Kartman, Texas General Land Office, Carla.Kartman@glo.texas.gov
Kelly Brooks, Texas General Land Office, Kelly.Brooks@glo.texas.gov
Melissa McCutcheon, Texas General Land Office, melissa.mccutcheon@glo.texas.gov
Joshua Oyer, Texas General Land Office, Joshua.oyer@glo.texas.gov
Tyler Payne, Texas General Land Office, tyler.payne.glo@recovery.texas.gov
Kelly Burkes-Copes, U.S. Army Corps of Engineers Galveston District, kelly.a.burks-copes@usace.army.mil
Patrick Corbitt Kerr, U.S. Army Corps of Engineers Galveston District, patrick.c.kerr@usace.army.mil
Himangshu Das, U.S. Army Corps of Engineers Galveston District, himangshu.s.das@usace.army.mil
Jason Thies, U.S. Army Corps of Engineers Galveston District, jason.thies@usace.army.mil
Jessica Mallindine, Bureau of Ocean Energy Management jessica.mallindine@boem.gov
Jens Figlus, Texas A&M University, figlusj@tamu.edu
John Goff, University of Texas, goff@ig.utexas.edu

BACKGROUND and MOTIVATION

The Gulf of Mexico shorelines of Texas are in a largely regressive state due to an amalgamation of factors including but not limited to: sea level rise, subsidence, littoral drift, and riverine supply disruptions. In some areas the erosion rate is several meters annually, leading to significant loss of coastal barrier island area. The bulk of the coastal barrier systems in Texas is undeveloped. However, barrier island loss is no longer able to go unnoticed as there is ever-growing recognition of their intrinsic value to coastal habitat and economies and their role in coastal storm resilience.

Figure1. Coastal Texas Study Area and Regions (USACE 2021).

STRATEGIC EFFORTS

The U.S. Army Corps of Engineers recently completed an over $20 million USD feasibility study looking at Coastal Storm Risk Management mitigation and ecosystem restoration measures along the entirety of the Texas Coast (USACE 2021). The Texas General Land Office (GLO) is working on its third update to the Texas Coastal Resiliency Master Plan (TCRMP 2019), to be published in early 2023. The GLO is conducting one-mile grid geophysical surveys across offshore state waters and has partnered with the U.S. Bureau of Ocean and Energy Management (BOEM) to perform adjacent surveys in federal waters. This is an ongoing multiyear and several million-dollar investment to broadly inventory available offshore resources. The GLO is also performing a multi-million-dollar sand transport modeling project along the entirety of the coast to enhance coastal zone management through improved knowledge of nearshore coastal processes. All this foundational work is leading to substantial collaborations between local, state, and federal agencies, academia, and industry; specifically, related to coast wide data collection, hydrodynamic and sediment transport modeling efforts.

HOLISTIC RESOURCE MANAGEMENT NEED

Projects with significant merit and sediment needs are being identified for funding, which could result in a first-come-first-serve extraction of the easily available and less costly sediment resources. Without proper management, the complexity and cost of future projects will naturally escalate, leading to a reduction in investments due to lower returns. The following questions need to be addressed: how can lower returns be avoided to incentivize investment and maximize coastal restoration efforts in Texas? And what can be done to galvanize support for beneficial use (BU) placement of beach-quality dredge material to minimize its removal from the littoral system? What can be done now to inform and leverage the existing and future knowledge so that management decisions lead to better outcomes for the environment and
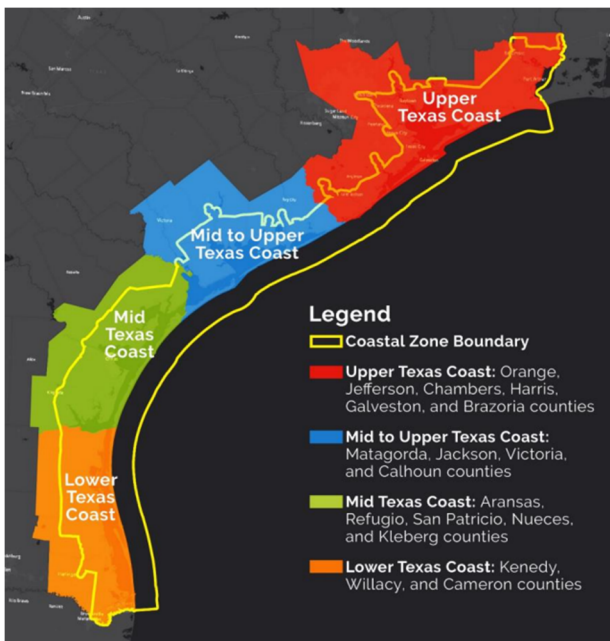
Texas constituents? A well thought out and executed plan maximizing returns and coastal resilience will enable other regions to more easily replicate the success.

PATH FORWARD
The answers to these questions require collaboration from an array of institutions and disciplines. Similar to the coastline itself, the state of the science informing our regional regulations and designs needs to be continually re-evaluated, advanced and incorporated into the selection and implementation process. The foundational physical processes and principles such as the shoreline profiles, depth of closure and sediment transport should, statistically, be leveraged to guide expansion of nourishment and restoration efforts with BU of dredged material. This should allow for increased frequency, gradations, and quantities of BU material to be employed without changing the character of the active system. This approach requires continued improvement and organization of foundational data collections to enhance the resolution, scale and precision of modelling efforts that continue to advance our collective knowledge of the coastal system. Such efforts have already helped identify and isolate seasonal variations and long-term trends in coastal processes. These activities provide improved understanding of the systems resilience to perturbations, amongst many other fundamental questions, which leads to informed decision making and an improved outcome of coastal zone management in Texas.

BASELINE PLANNING
The GLO is also in the process of collecting baseline sediment data along the entire coast of the State of Texas. This sampling will include collection of sediments across six locations along the beach profile spanning from the toe of the dune to the second nearshore sand bar at a total of 75 transects that fall within seven major beach areas in the upper coast and six major beach areas in the lower coast. Only beach segments without nourishment history were selected to try to ensure that beach profile sediments are representative of the "native" sediment. This dataset will greatly supplement the existing TXSED database allowing for statistical analyses to be performed demonstrating the larger range of graduations that may be acceptable to be placed in the littoral zone.

The location, quantity, and characteristics of offshore sediments will have a significant impact on future optimized coastal planning. The GLO, in coordination with BOEM, is working on their second of 3 regions to collect order of magnitude geophysical data in both State and Federal waters. Once potential high likelihood sediment resources are identified additional lines are collected to delineate the feature and borings are conducted to characterize the resource. This process has already allowed for the discovery of new previously unknown substantial sediment resources. Once this initial survey of likely sediment resources is complete the focus will change to the full development and permitting of these resources to support the ongoing and proposed large scale coastal resiliency efforts.

SEDIMENT MANAGEMENT PLANS
The GLO is working on the Texas Sediment Management Plan–a statewide Plan that will provide comprehensive sediment management guidance on identifying, developing, inventorying, permitting, allocating, monitoring, and developing or modifying policy surrounding sediment resources–with estimated completion by 2024. The USACE has a forthcoming Gulf of Mexico Regional Sediment Management Plan. The USACE Galveston District has developed Sediment Management Plans for Galveston Island, and South Padre Island. They also have projects in the works to develop plans for Nueces and Brazoria Counties.

HYDRODYNAMIC MODELING
The ongoing sand transport modeling being performed for the GLO is utilizing the TELEMAC modeling systems and has leveraged the best sediment budget and high-fidelity hydrosurveying data to better define sand transport pathways to improve sediment management planning. A complimentary effort is also being funded by the GLO and being performed by the USACE, which is the development of a DELFT-3D hydrodynamic model utilizing the best available grid data. This grid data has been developed for a Texas focused ADCIRC model to better predict surge response from tropical cyclone events. The statewide DELFT model will allow for the engineers to quickly develop boundary conditions for "nested" models, which will lower the computational time to run highly resolved detailed models for specific project areas, increasing accuracy, lowering cost, and more importantly shortening analysis schedules.

REGULTORY GUIDANCE
Texas currently has two primary fundamental regulatory considerations that impact coastal zone management and they are driven by water and sediment quality. Sediment compatibility is a very influential issue as a more restrictive directive will reduce the amount of sediment eligible to be placed into the system, increase costs, and eventually lead to a more rapid exhaustion of these valuable resources. It is understood that sediment changes through the dredging and placement process, however many regulatory agencies take the conservative approach that sediment samples at the borrow source is what they will use for their regulatory purposes as change due to the dredging process is difficult to determine. Luckily there has been significant research into sediment changes due to the dredging process over the past decade, see Smith et al. 2019 and Maglio et al. 2019. Both of these papers show a greater than 60% reduction of fines, i.e., sediment passing the 230 sieve, for each time the material is hydraulically slurried. The Maglio 2019 paper also provides an empirical formula that allows for the estimation of sediment change by sieve size based on the design of the dredging process, incorporating the placement process. The dredging process influence in changes to grain size can also have a sizable influence on sediment color which is another important factor when developing a beach compatibility analysis. Sediment color is greatly influenced by minerology, silt content, and staining among other things. Estimations on the physical processes impacting color change can be found in Berkowitz et al. 2020 and Maglio et

al 2020. The science and statistics to inform a more accurate sediment compatibility analysis and overarching regulation exists and should be incorporated into a holistic coastal zone management methodology.

Offshore sediment resource utilization must compete with other offshore commercial and industrial purposes, such as: oil and gas pipelines, renewable energy projects, and commercial fisheries. To optimize Coastal Zone Management, the GLO's Coastal Management Program will utilize its enforceable policies and extend their use into the Outer Continental Shelf through the intended adoption of a Geographic Location Description to help safeguard important offshore sediment reserves.

INVESTMENT
The GLO advances ongoing, long-term, and state-led coastal planning through the Texas Coastal Resiliency Master Plan (TCRMP). The 2019 TCRMP has 123 Tier 1 projects identified and the 2023 update to the TCRMP will maintain a similar number of projects after a more recent stakeholder engagement process through meetings with the Technical Advisory Committee. The TCRMP serves to assist the GLO, networked agencies, and other partners in identifying stakeholder priorities and collaborative opportunities. Sea level rise and landscape change modeling is being advanced through this effort to inform the Technical Advisory Committee, local communities, and the ultimate priorities presented in the TCRMP. These projects as they are pushed forward to the implementation phase will be funded by a variety of local, state and federal sources at a total estimated cost of $4.9 billion USD.

The Coastal Texas Protection and Restoration Feasibility Study made recommendations for $31 billion USD to be invested along the coast. It includes approximately 63 miles of beach and dune, 15 miles of oyster reef, 105 miles of breakwaters, 838 acres of island, 35,000 acres of marsh, and 112,860 acres of hydraulic restorations. This is one of the largest recommendations for federal investment in U.S. history and is currently in the hands of congress with strong bipartisan support.

The presentation and paper will provide an up-to-date overview of investments, approaches, and projects to be incorporated into holistic coastal zone management for Texas.

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