ANALYSIS OF BARRIER ISLAND MORPHOLOGICAL FEATURES ALONG THE GULF AND ATLANTIC COASTS

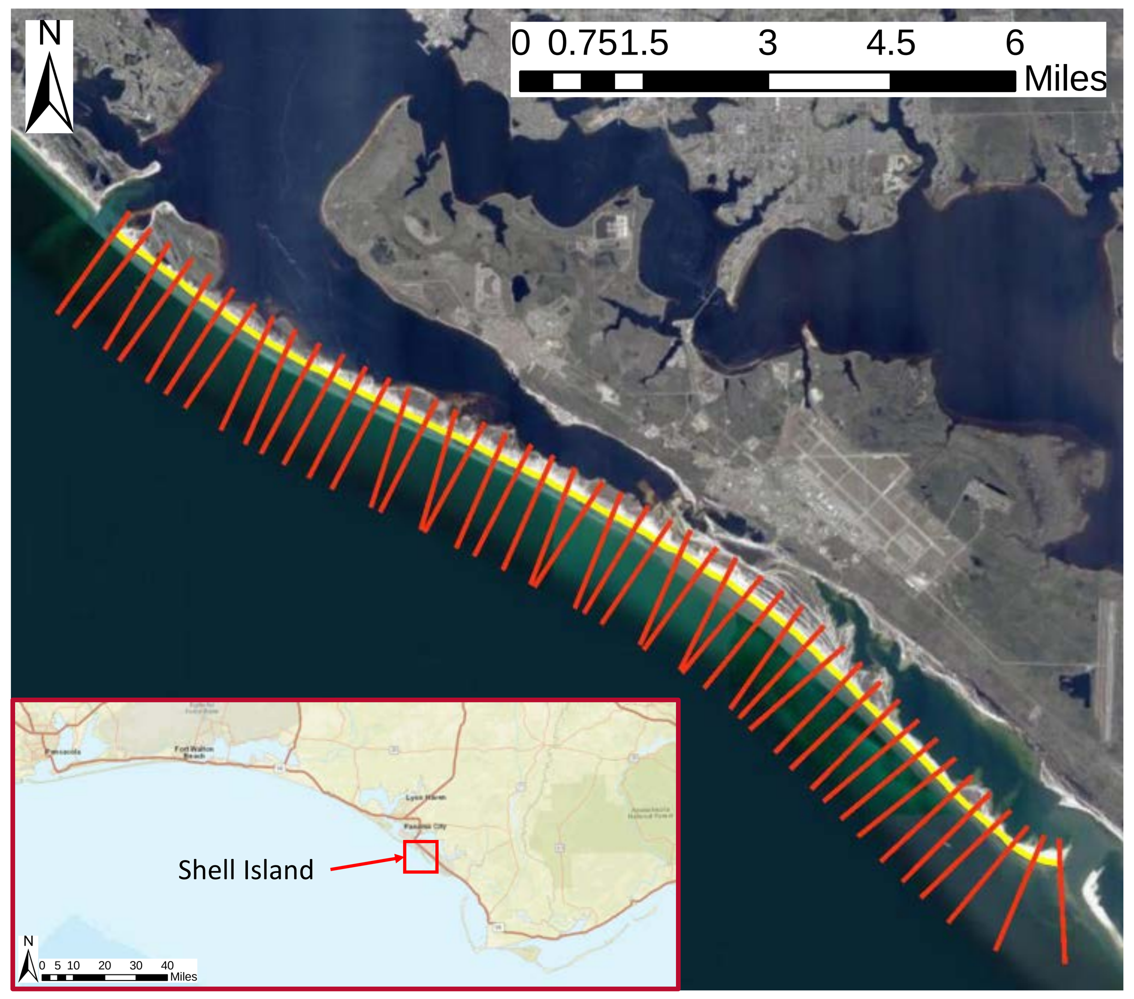
Coastal Ocean Analysis and Simulation Team
UNIVERSITY OF GEORGIA

Sheppard D. Medlin[1], Matthew V. Bilskie[1], and Viyaktha Hithaishi Hewageegana[1]
[1]School of Environmental, Civil, Agricultural and Mechanical Engineering
University of Georgia, Athens, GA
ASBPA 'Geaux Resilient' Conference: Sept 28-Oct 1 2021, New Orleans, LA Contact: Sheppard.medlin@uga.edu

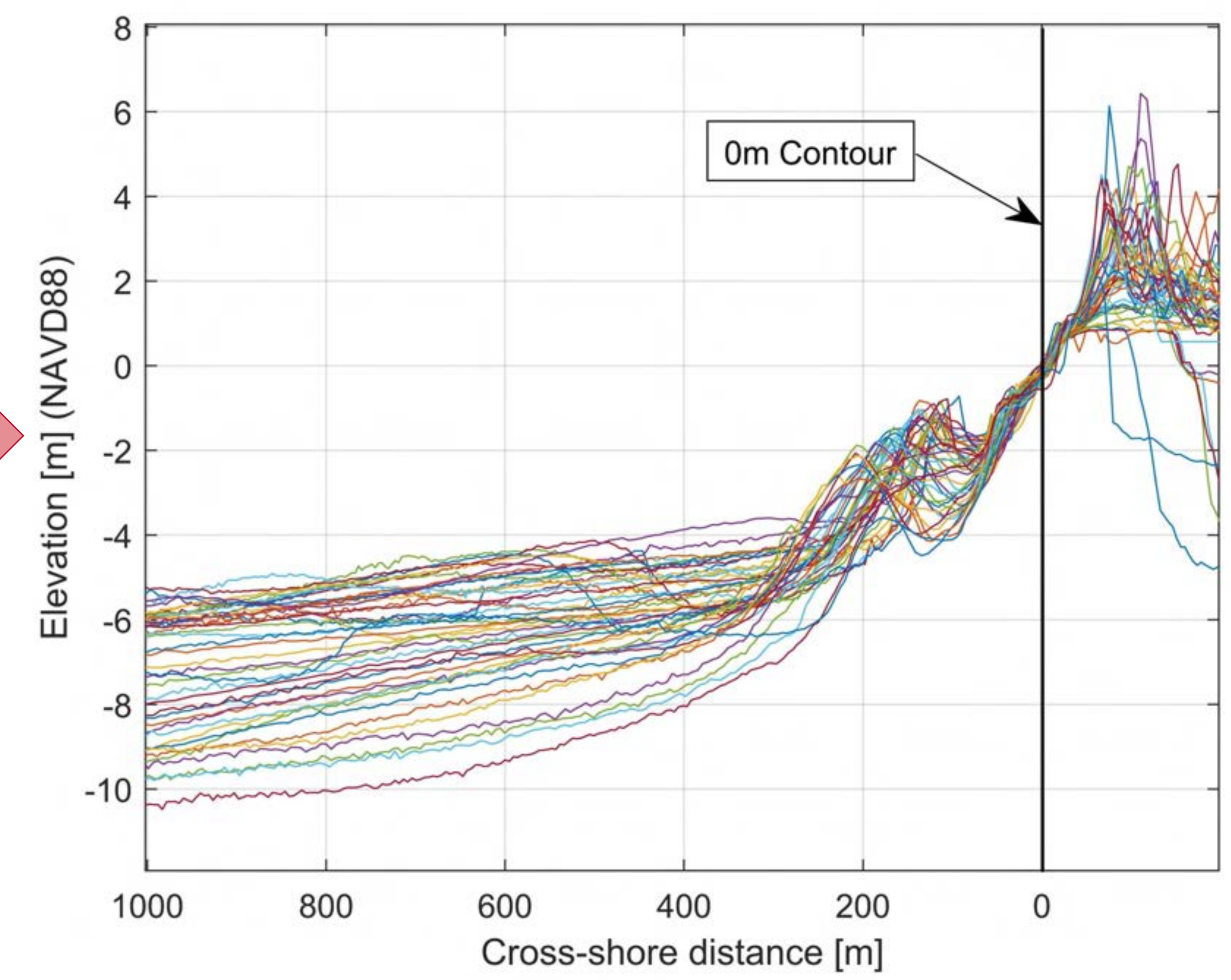
US Army Corps of Engineers
USGS science for a changing world

Introduction

- Tropical cyclones have caused $1.034 trillion in damages in the U.S. since 1980 (CPI adjusted to 2021 USD).
- The majority of hurricane damages are caused by flooding.
- Barrier islands can be effective at reducing mainland flooding by attenuating incoming storm surges.
- This ability is likely dependent on the island's scale and configuration.
- Past numerical modeling studies investigating the ability of barrier islands to reduce storm surges have typically focused on a few real-world locations rather than broad, idealized studies.
- This is problematic since barrier islands naturally have a wide range of variability.
- Data must be collected on their natural variability to model a wide range of potential barrier islands accurately.



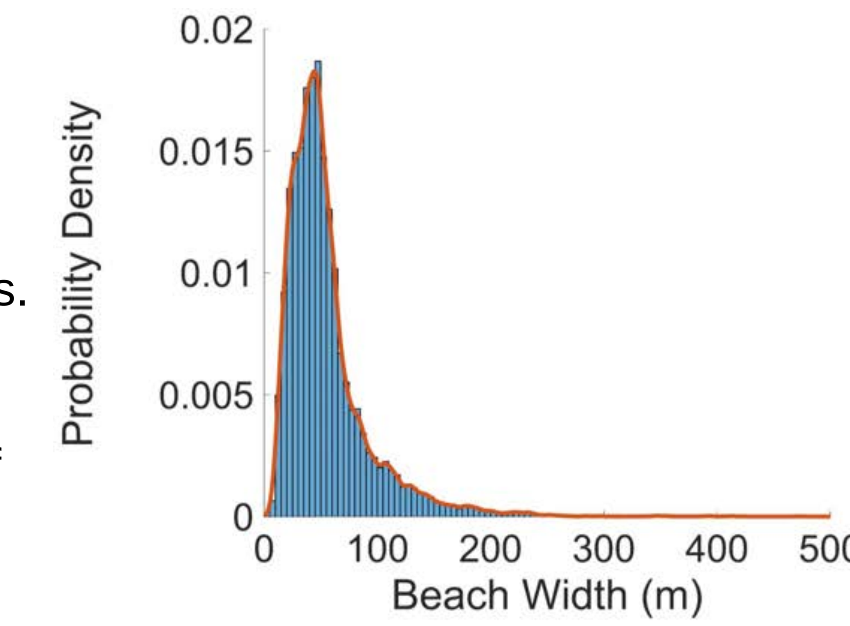
Aerial view of transects (red lines) taken from lidar – derived DEM data at Shell Island, directly seaward of Tyndall AFB.



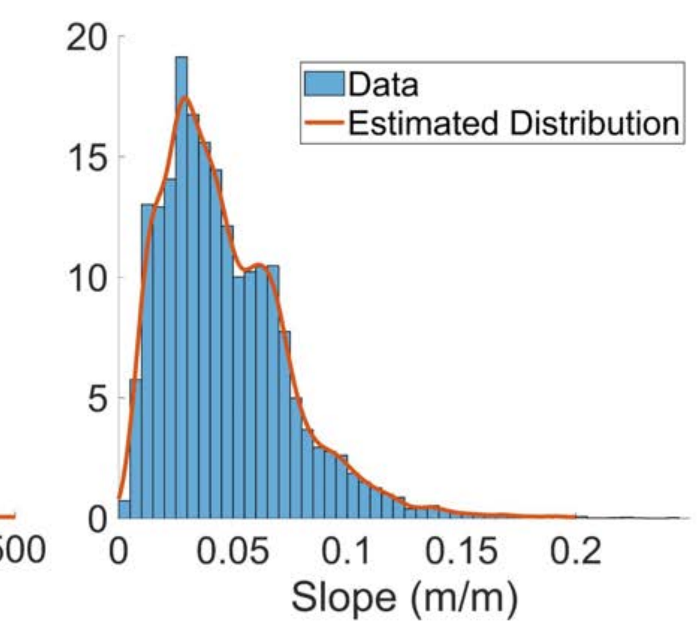
Cross shore profile of the Shell Island transects, directly seaward of Tyndall AFB.

Methods

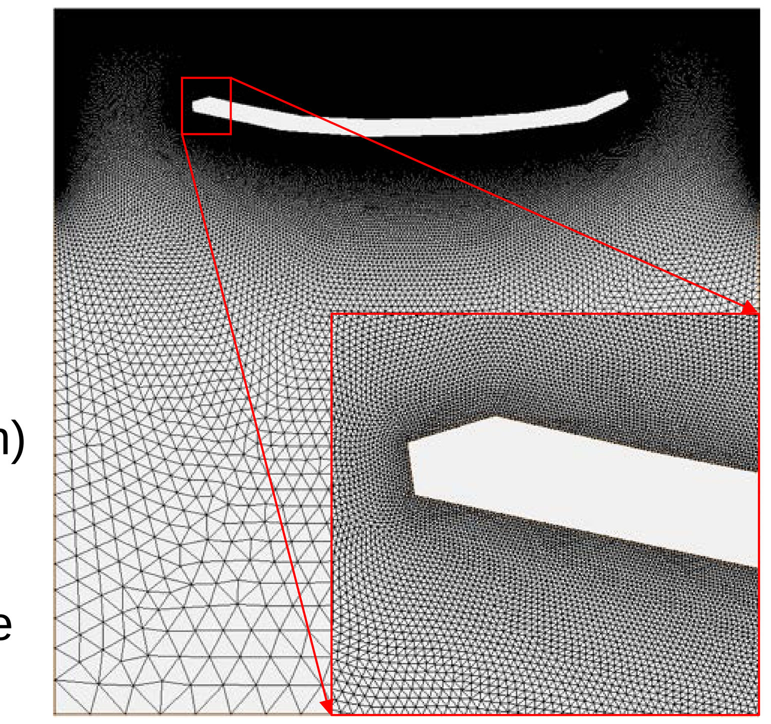
- Out of the 15 variables in the dataset, variations to island length, distance to shore, inlet width, and inlet depth were shortlisted for initial simulations.
- Data distributions for all variables were found to aid in choosing appropriate scales of islands being represented in modeling.
- This was accomplished by fitting Kernel distributions to each variable in MATLAB.
- Prototype meshes were designed to accommodate the largest barrier islands found in the dataset.
- These meshes contain:
  - 92,588 nodes (left mesh)
  - 182,219 elements (left mesh)
  - 100m min element size
  - 5km max element size
  - 100km x 100km domain size



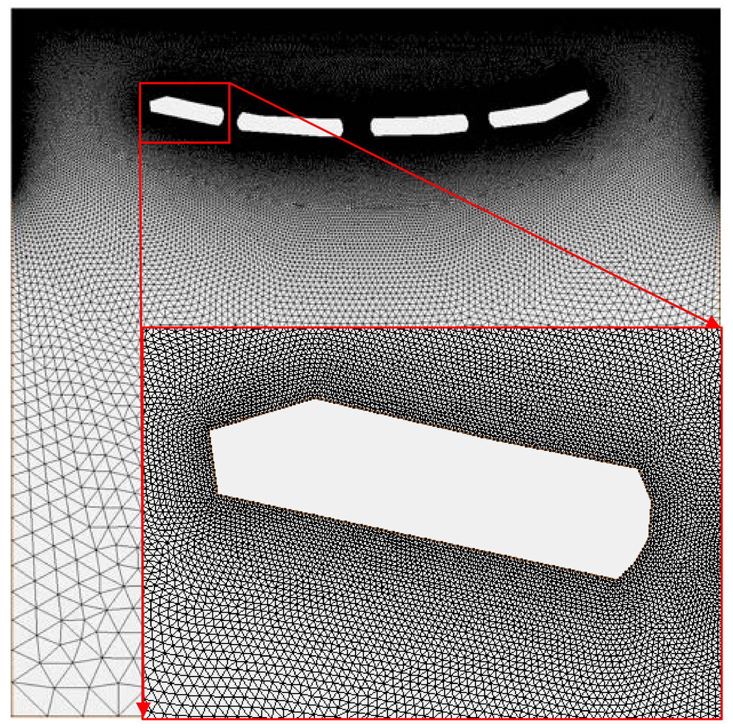
Probability density function (PDF) of beach widths overlaid with a fitted Kernel distribution.



Probability density function (PDF) of beach slopes overlaid with a fitted Kernel distribution.



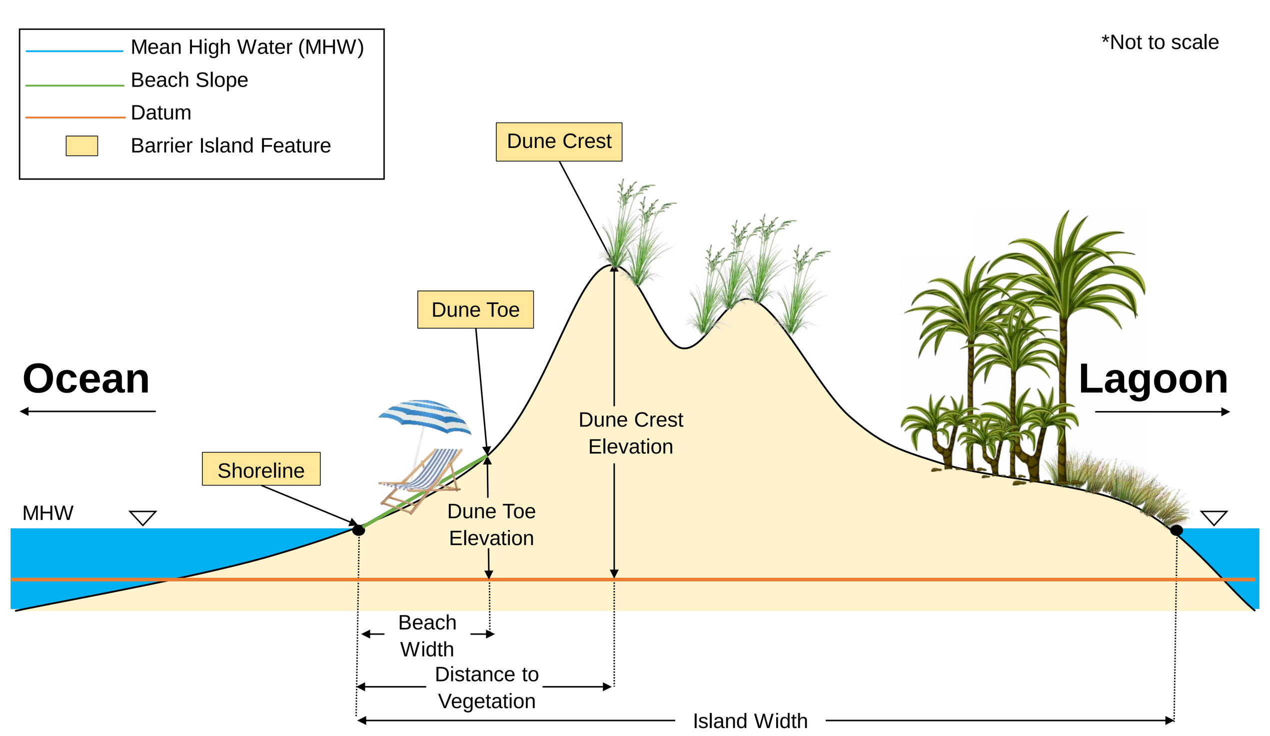
Work-in-progress mesh that may be used in idealized modeling containing a single barrier island.



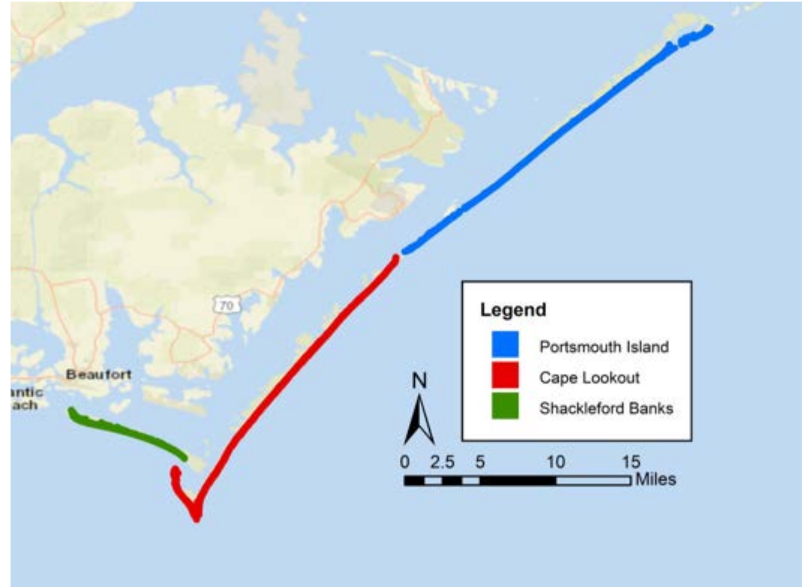
Work-in-progress mesh that may be used in idealized modeling containing four barrier islands.

Data Collection and Compilation

- A database of barrier island morphological features was compiled from multiple sources. i, ii, iii
- Data from 22 barrier islands along the Gulf of Mexico and Atlantic Coasts was included.
- Sites were chosen for inclusion based on:
  - Data availability
  - Geographic location
  - Morphology
  - Level of development
- 15 different morphologic variables were included in the database.
- This data will be used to determine the appropriate sizing of artificial barrier islands in future idealized modeling.
- This data will be made freely available to the public at a later date.

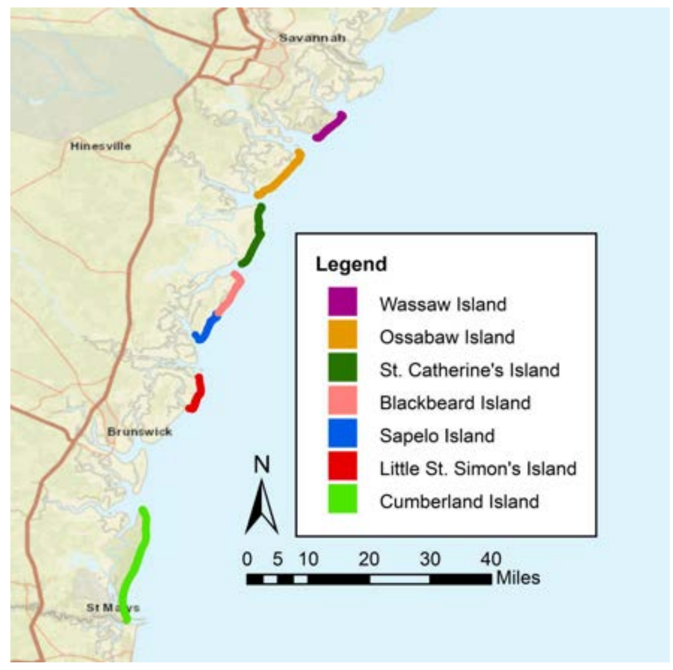


Typical barrier island cross section; some variables included in the dataset are labeled.



Map of North Carolina barrier islands included in the database.

Map of Gulf Coast barrier islands included in the database.



Map of Georgia barrier islands included in the database.

Future Work

- Run initial modeling experiments using the ADCIRC hydrodynamic model while varying island length, inlet width, inlet depth, and the distance from the barrier island to the mainland.
- Model will be forced along the boundary using a storm surge signal with different properties.
- Investigate the interaction between these variables and how the inundation characteristics are affected.
- Future experiments will be designed to improve preliminary efforts.
- Results may enhance coastal resiliency measures by providing government agencies, stakeholders, and authorities guidance on barrier island restoration and creation.

Acknowledgements / References

- *This material is based upon work supported by the USACE under award #: W912HZ2020031 and the USGS under award #: G21AC10281-00. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the USACE or USGS.*

i. Doran, K.S., Long, J.W., Birchler, J.J., Brenner, O.T., Hardy, M.W., Morgan, K.L.M, Stockdon, H.F., and Torres, M.L., 2017, Lidar-derived beach morphology (dune crest, dune toe, and shoreline) for U.S. sandy coastlines (ver. 4.0, October 2020): U.S. Geological Survey data release, https://doi.org/10.5066/F7GF0S0Z.

ii. Mulhern, Julia S. et al. "Is Barrier Island Morphology a Function of Tidal and Wave Regime?" *Marine Geology, vol. 387, 2017, pp. 74-84, doi:https://doi.org/10.1016/j.margeo.2017.02.016.*

iii. Murshid, Shamim and Giulio Mariotti. "Geometry of Natural and Engineered Tidal Inlets." *Coastal Engineering, vol. 164, 2021, p. 103828, doi:https://doi.org/10.1016/j.coastaleng.2020.103828.*