# PREDICTING THE EVOLUTION OF COASTAL LOUISIANA'S BARRIER ISLANDS

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COASTAL ENGINEERING CONSULTANTS INC.

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Vadim Alymov

CPRA

Coastal Protection and Restoration Authority of Louisiana

committed to our coast

# Outline

- Introduction
- Physical Processes, Forcing Functions, and Geomorphic Forms
- Empirical Model Approach
- Process Based Model Approach
- Hybrid Model Model Approach
- Conclusions and Acknowledgments

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- **Introduction**
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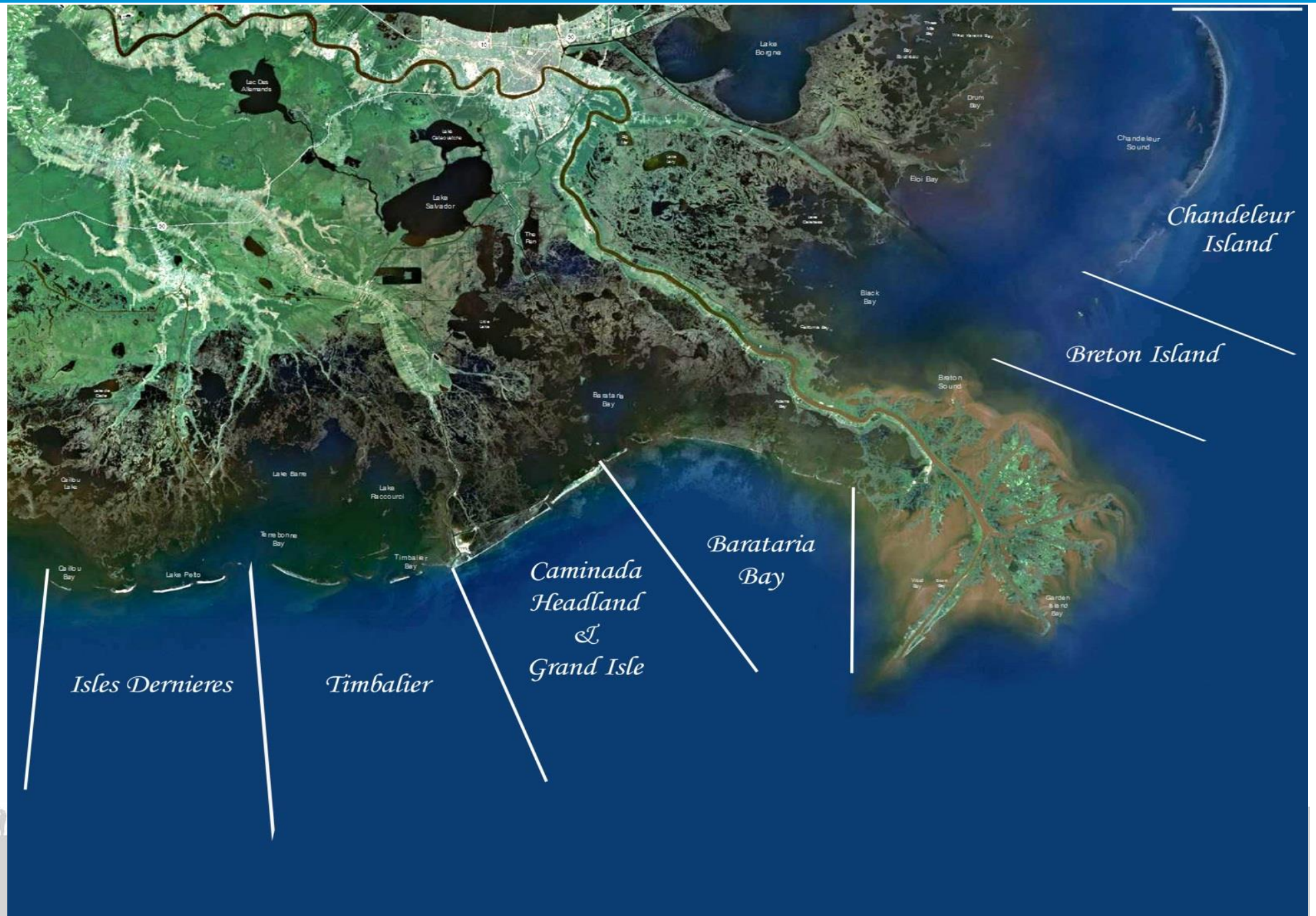
# Study Area


Lake Borgne
Lac Des Allemands
Lake Cataouatche
Lake Salvador
The Pen
Drum Bay
Chandeleur Sound
Eloi Bay
Chandeleur Island
Black Bay
Breton Island
Breton Sound
Barataria Bay
Lake Barre
Lake Raccourci
Terrebonne Bay
Timballier Bay
Caminada Headland & Grand Isle
Barataria Bay
Calibu Lake
Calibu Bay
Lake Pelto
Isles Dernieres
Timbalier
Garden Island Bay

# Barrier Island Evolution

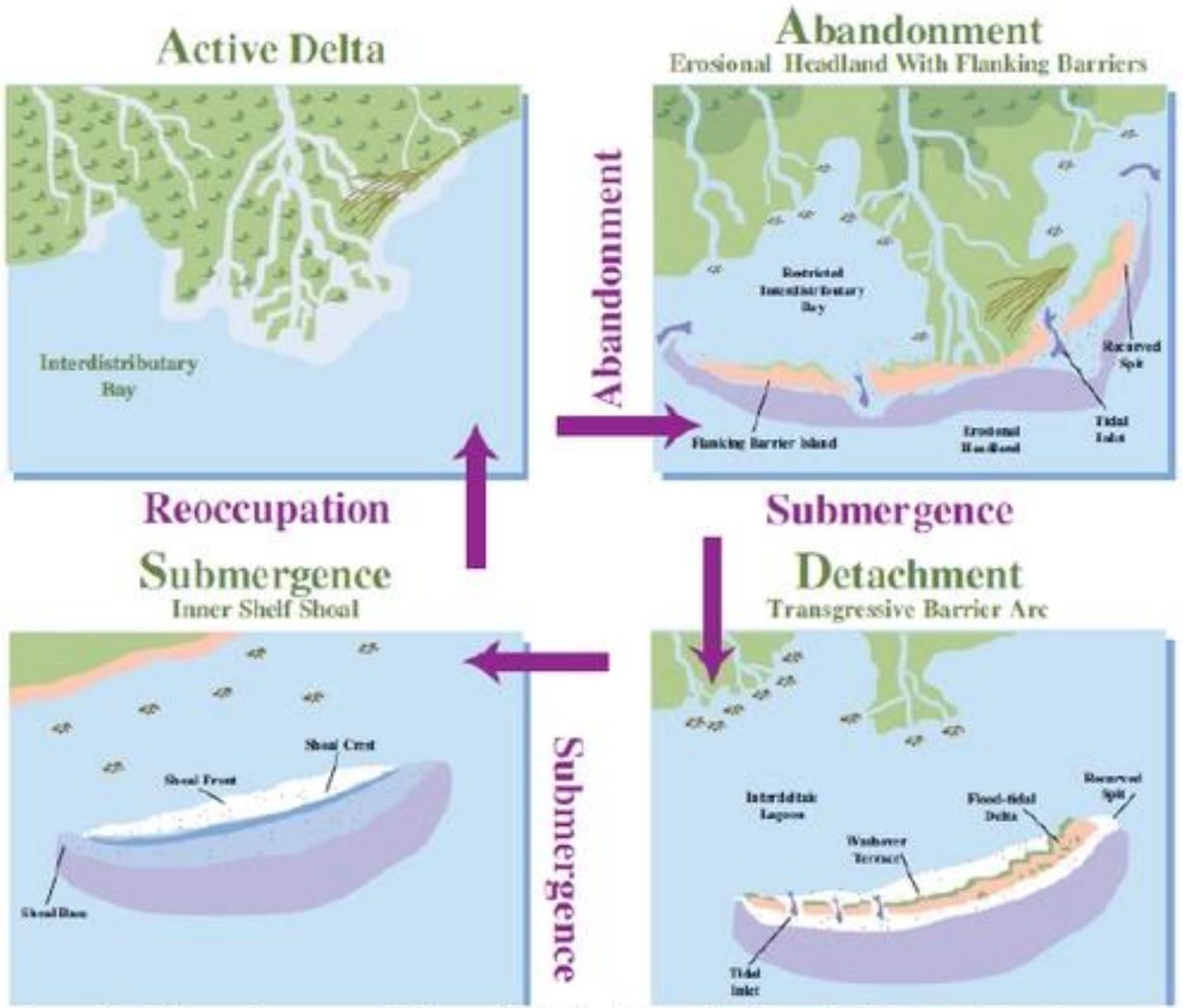
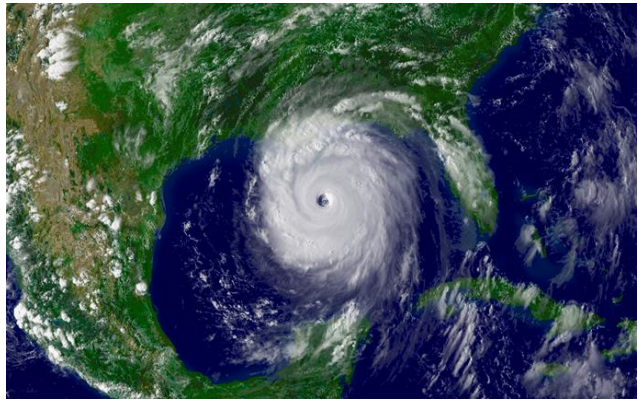
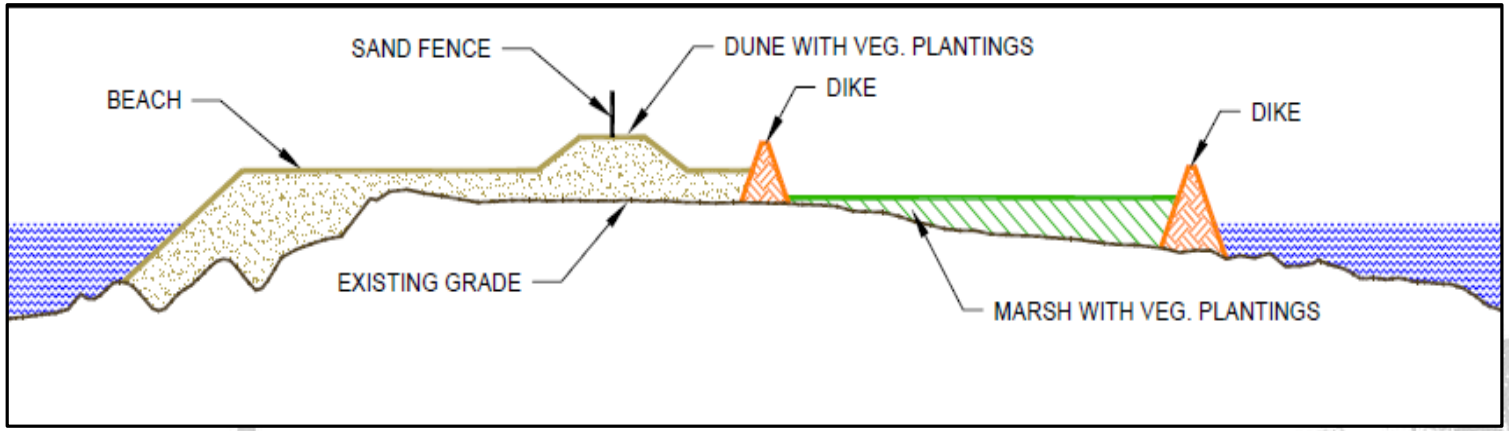


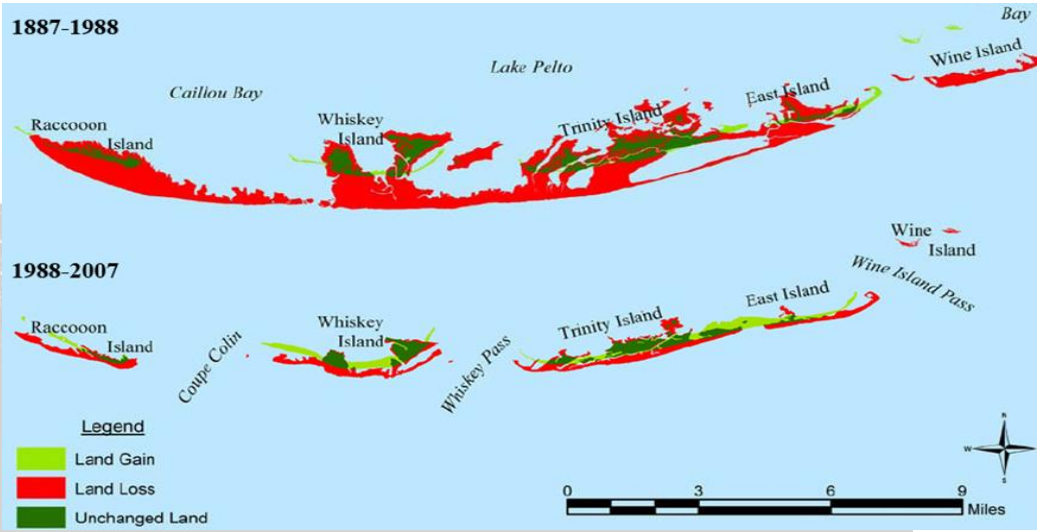

Figure 2. Three stage evolution of a deltaic barrier island. (Barrier Islands Educators Guide: model from Penland and Boyd, 1981.)

# Geomorphic and Ecologic Form and Function (GEFF)

- Three Physical Features: Beach, Dune, and Marsh
- Geomorphic Form and Function
- Ecologic Form and Function





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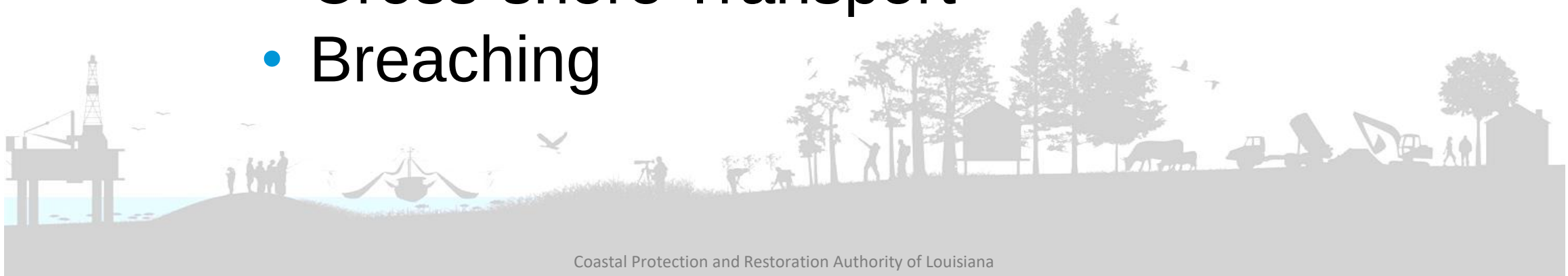
# Physical Processes, Forcing Functions, and Geomorphic Forms

- Longshore Transport
- Silt Loss
- Bayside Erosion
- Sea Level Change
- Subsidence
- Cross-shore Transport
- Breaching



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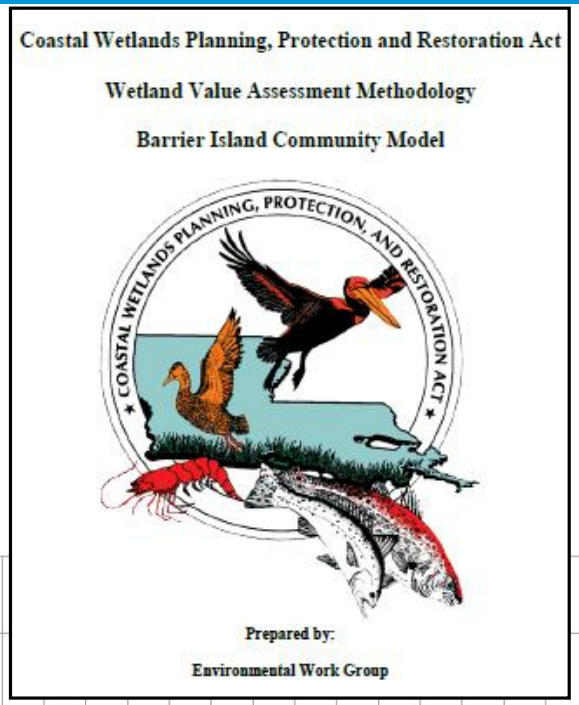
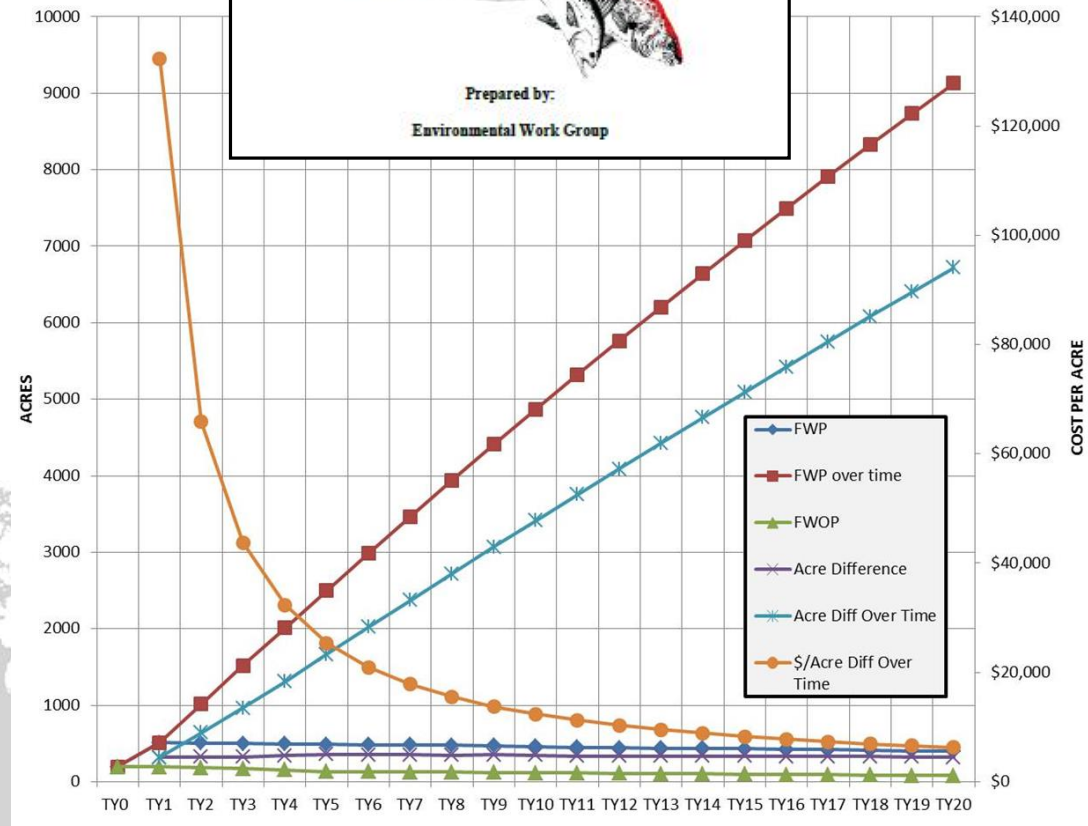
# Barrier Island Value Assessment

- Variable 1 – Dune Habitat (% Area > +5.0’ NAVD88)
- Variable 2 – Supratidal Habitat (+2.0’ < % Area < +5.0’ NAVD88)
- Variable 3 – Intertidal Habitat (+0.0’ < % Area < + 2.0’ NAVD88)
- Variable 4 – Vegetative Cover
- Variable 5 – Woody Species
- Variable 6 – Interspersion
- Variable 7 – Beach Zone Habitat

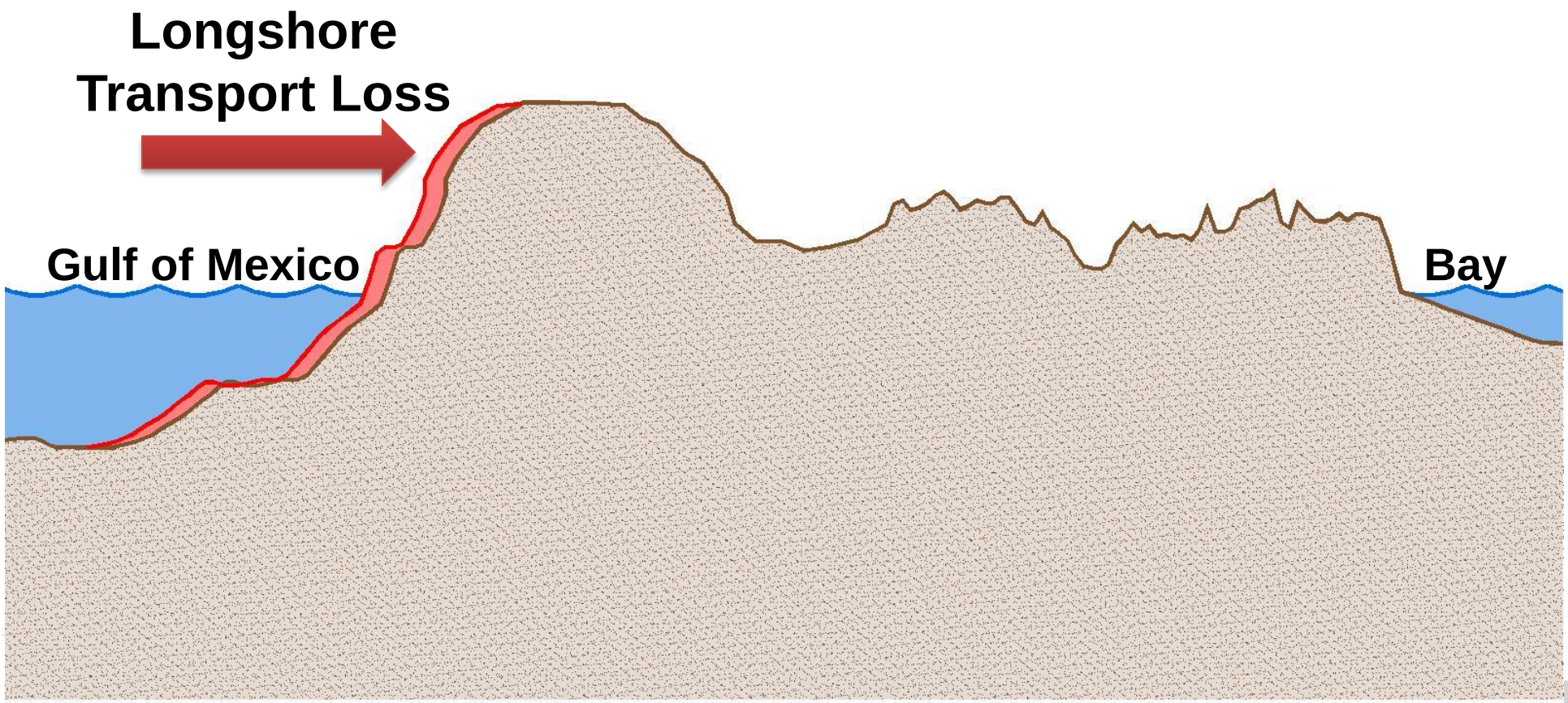
- Habitat Suitability Index Equation

HSI = 0.14(V1) + 0.14(V2) + 0.17(V3) + 0.20(V4) + 0.10 (V5) + 0.15(V6) + 0.10(V7)

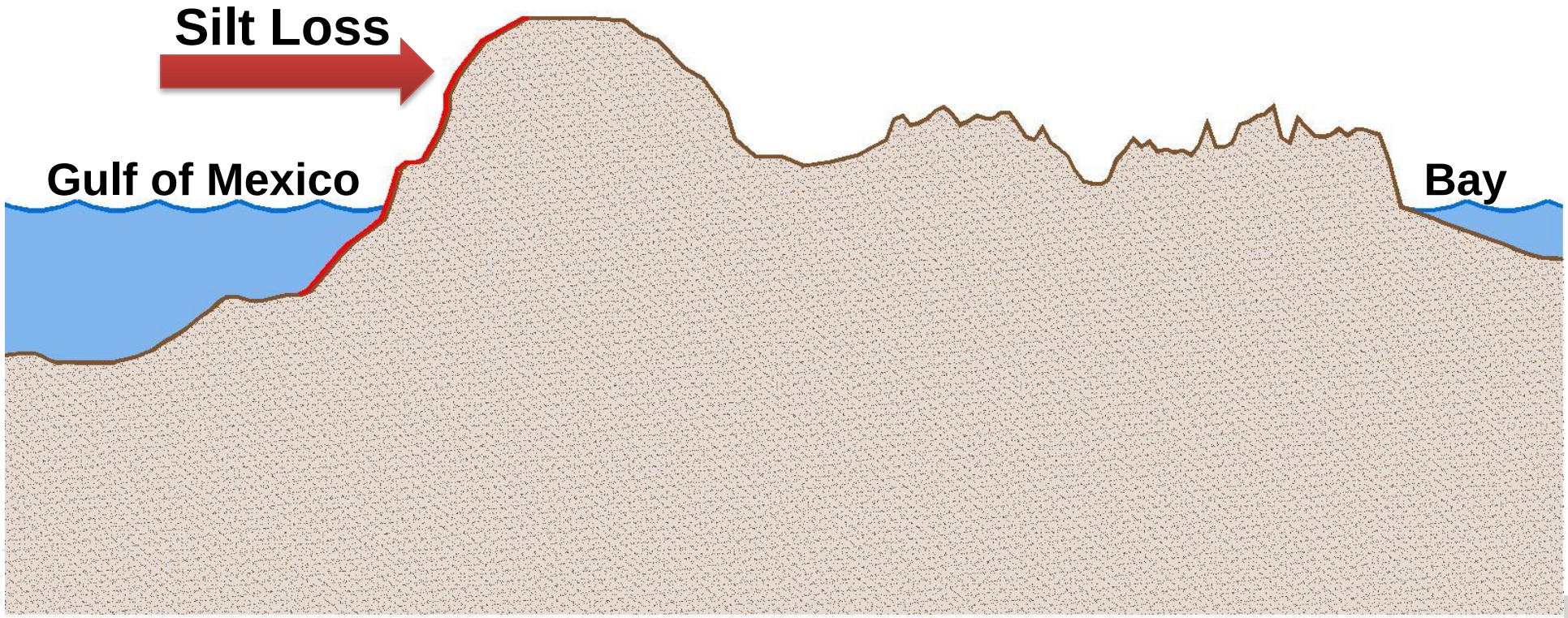


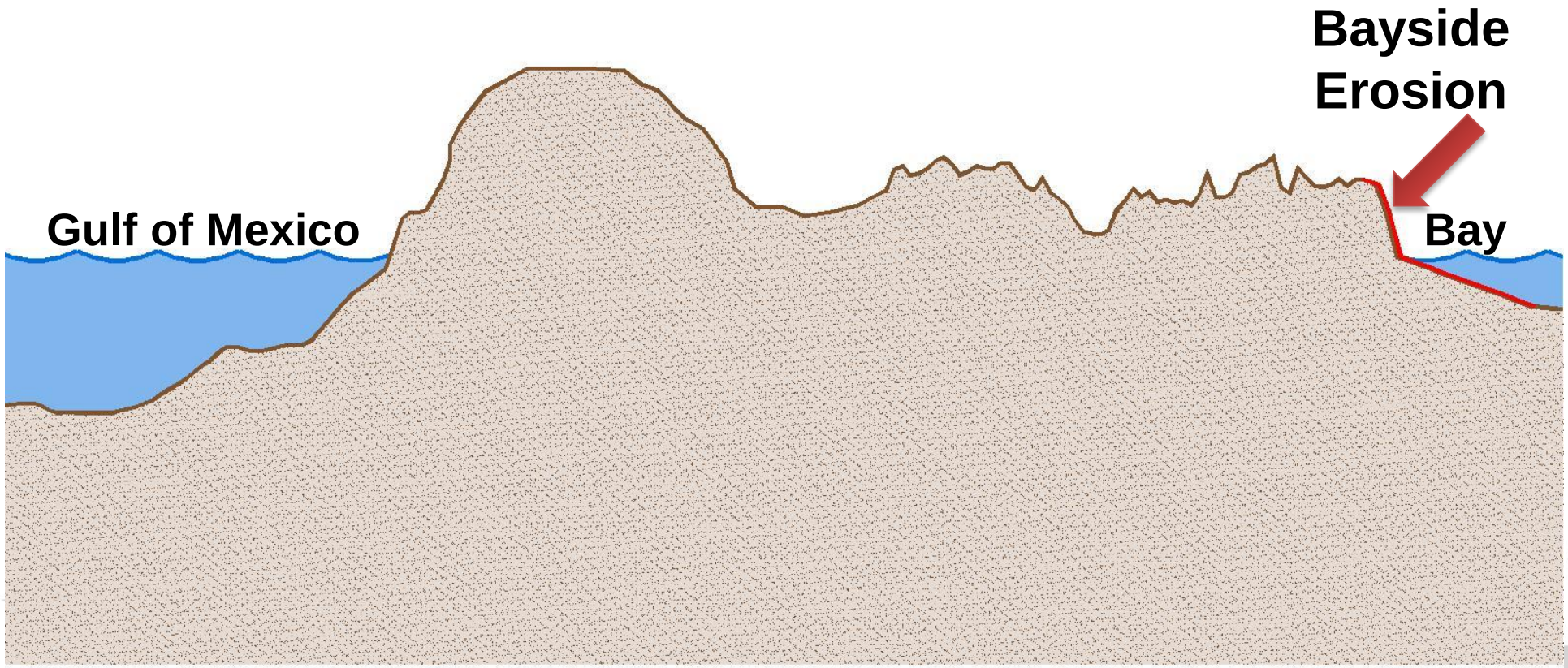
# Longshore Sediment Transport



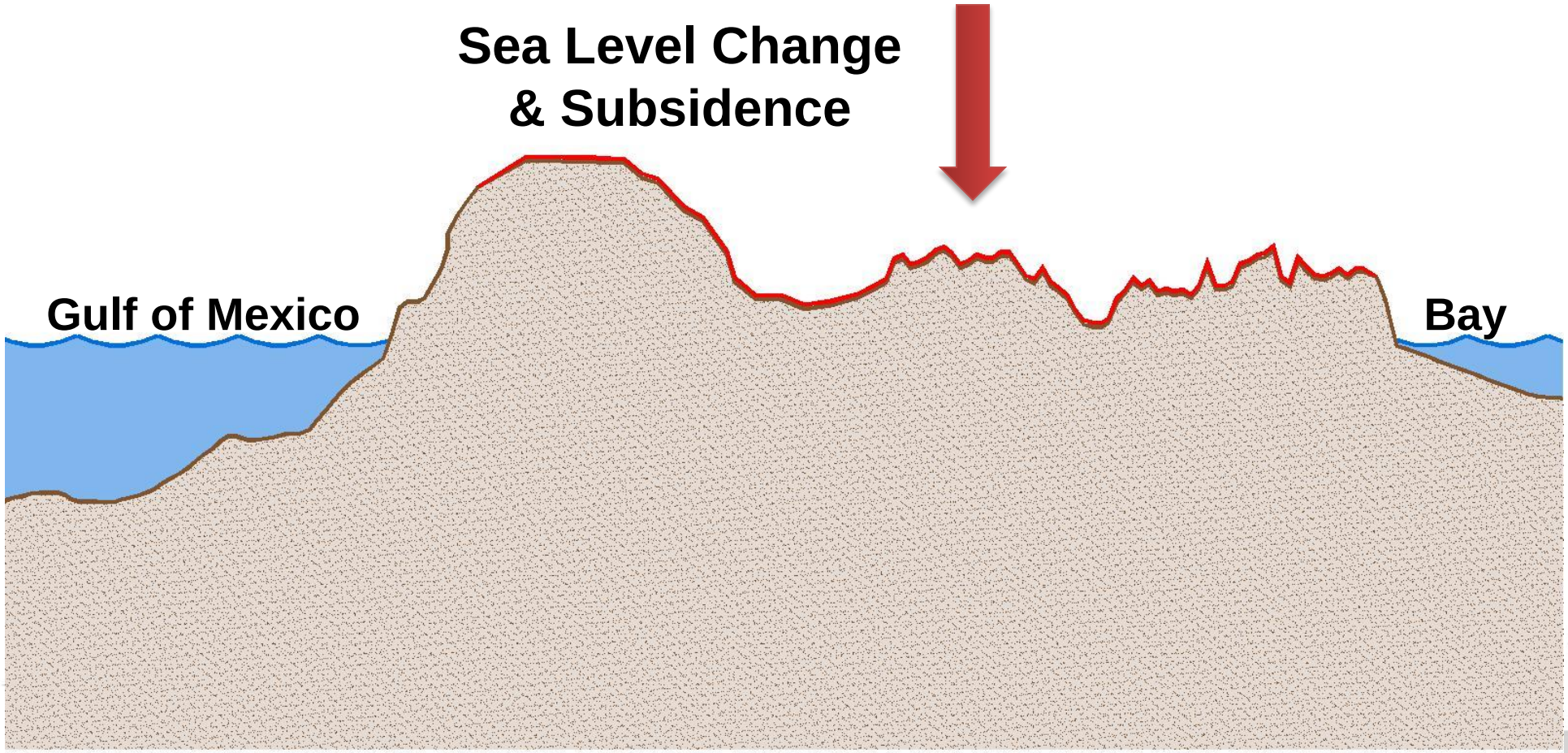
# Silt Loss



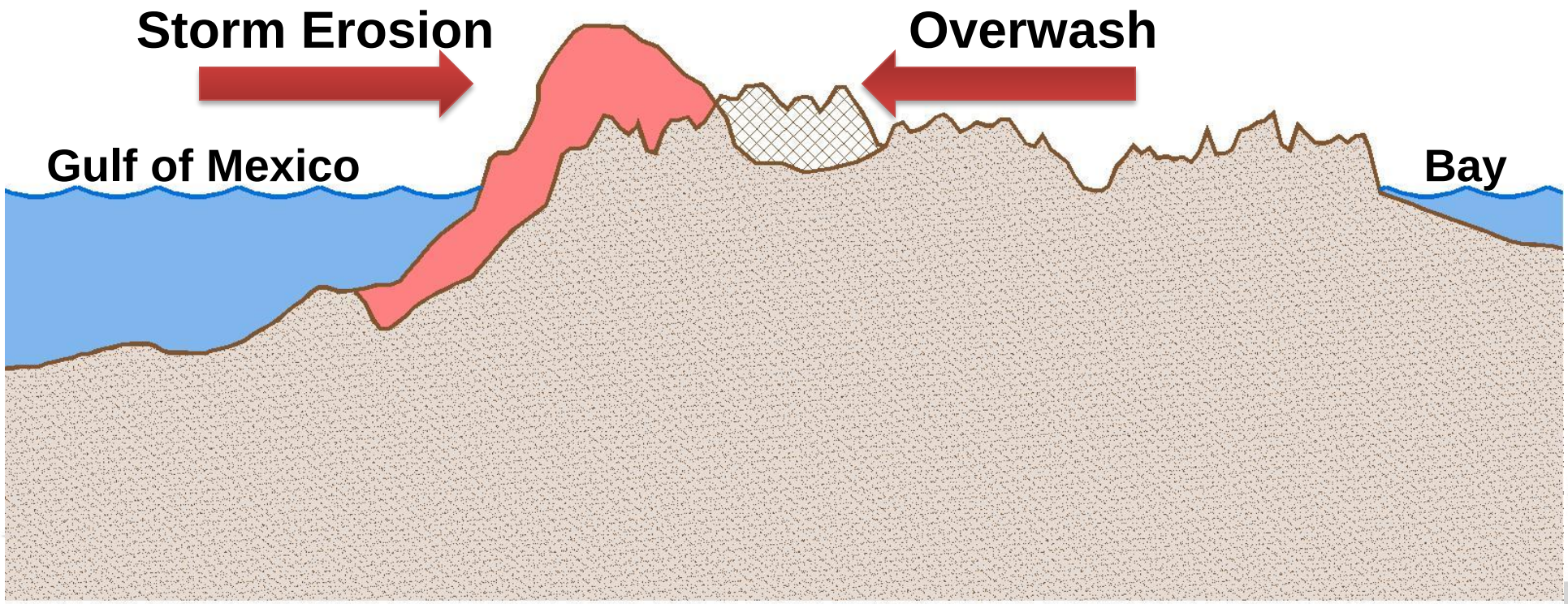
# Bayside Erosion



# Sea Level Rise and Subsidence



# Cross-Shore Sediment Transport



# Breaching


RACCOON ISLAND: DECEMBER 2010
MAJOR BREACH
Image USDA Farm Service Agency
Google earth

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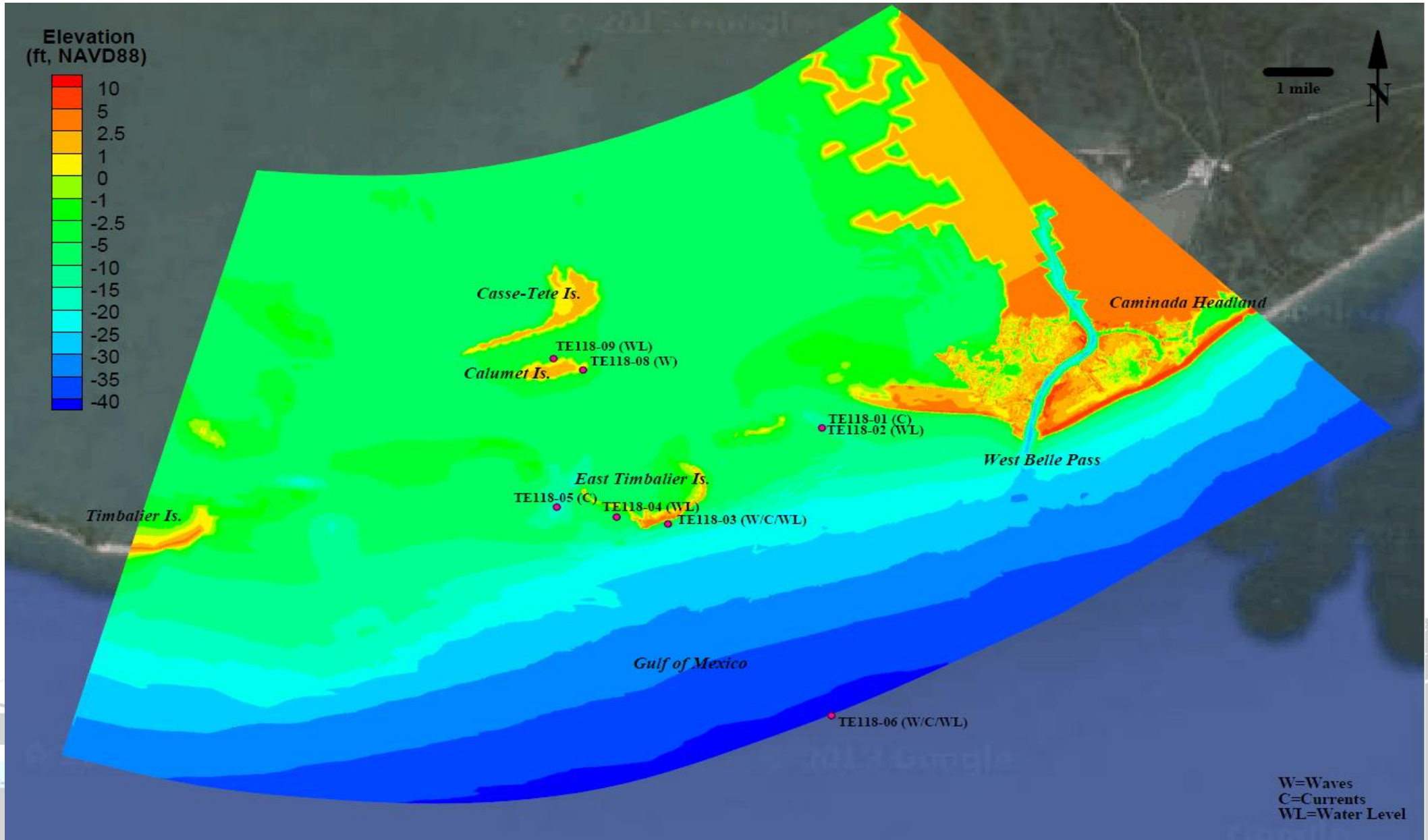
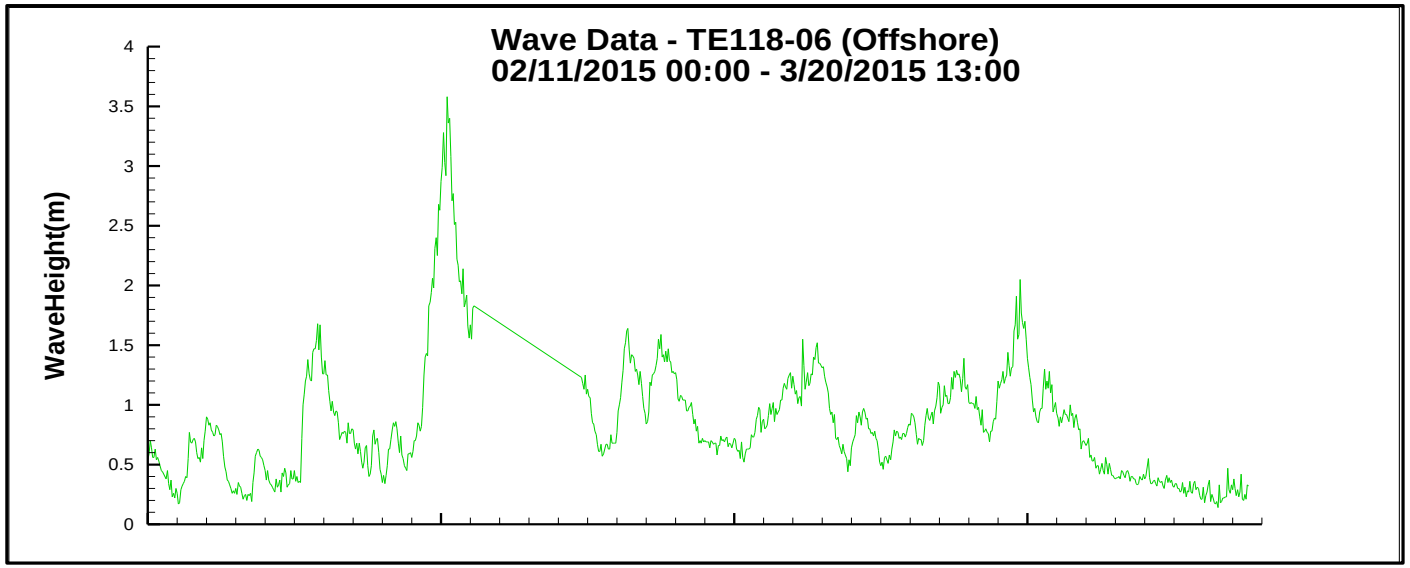
# Process Based Model Approach

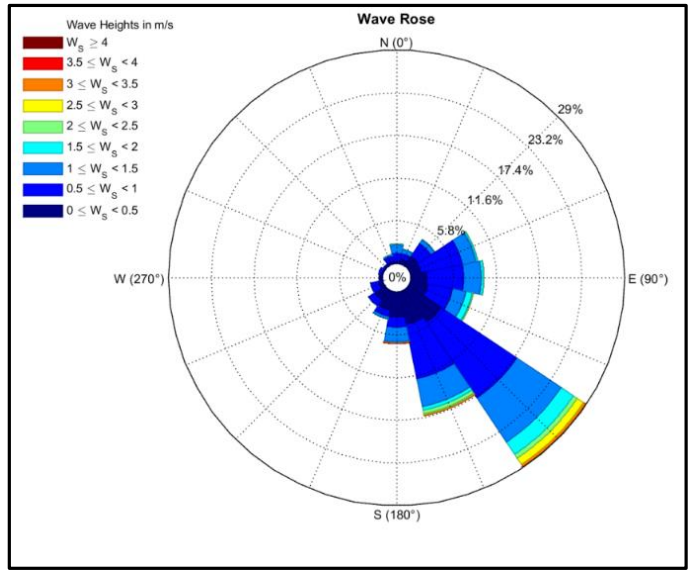
- Spatial Scale ~ Single Basin (Timbalier Bay)
- Temporal Scale ~ 20 Years
- Combined Hydrodynamic and Morphologic Numerical Model Program – DELFT 3D
- Input Data: Bathy/Topo, Waves, Currents, Water Levels ~ 20-Year Synthetic Time Series
- Calibration and Validation
- Output: DEM's on 5-Year Intervals

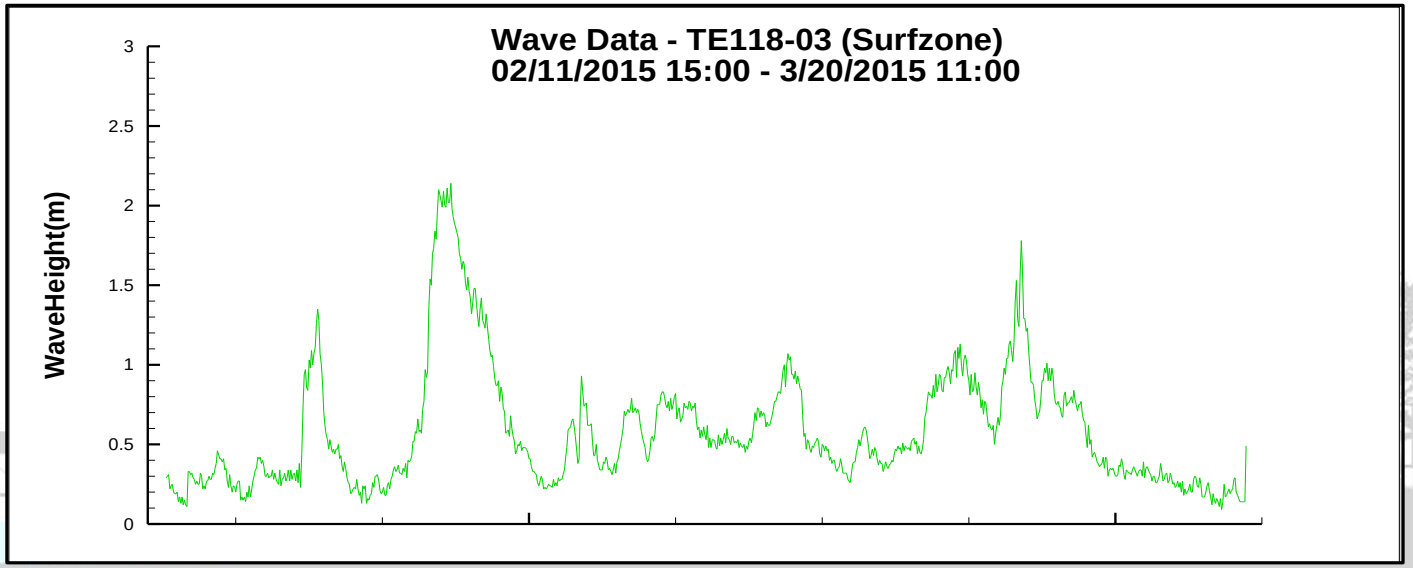
# Model Topography & Bathymetry

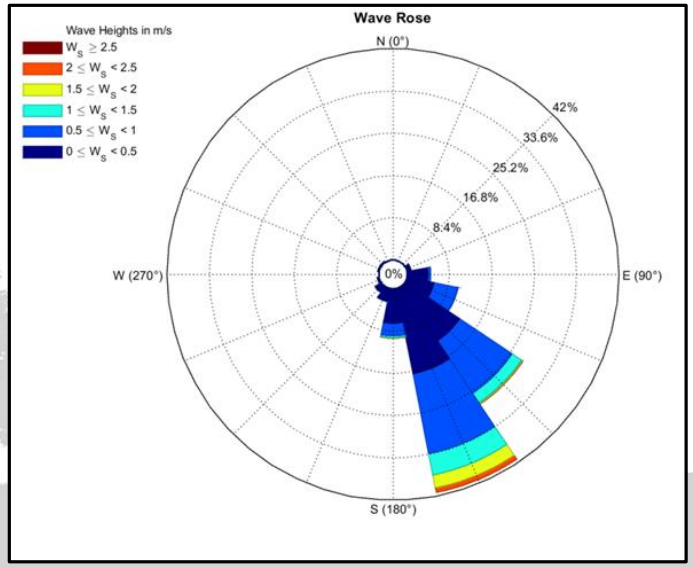


# Input Wave Data

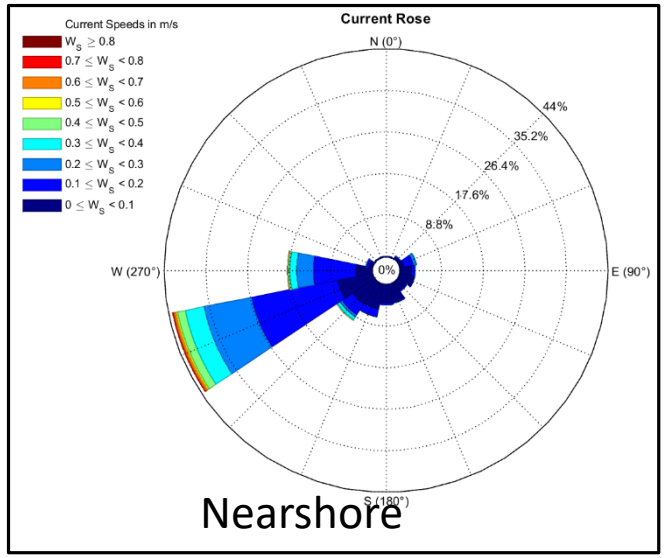


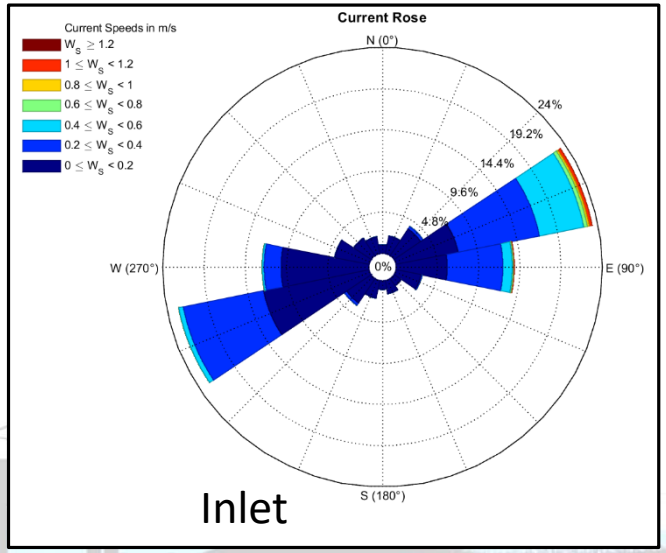



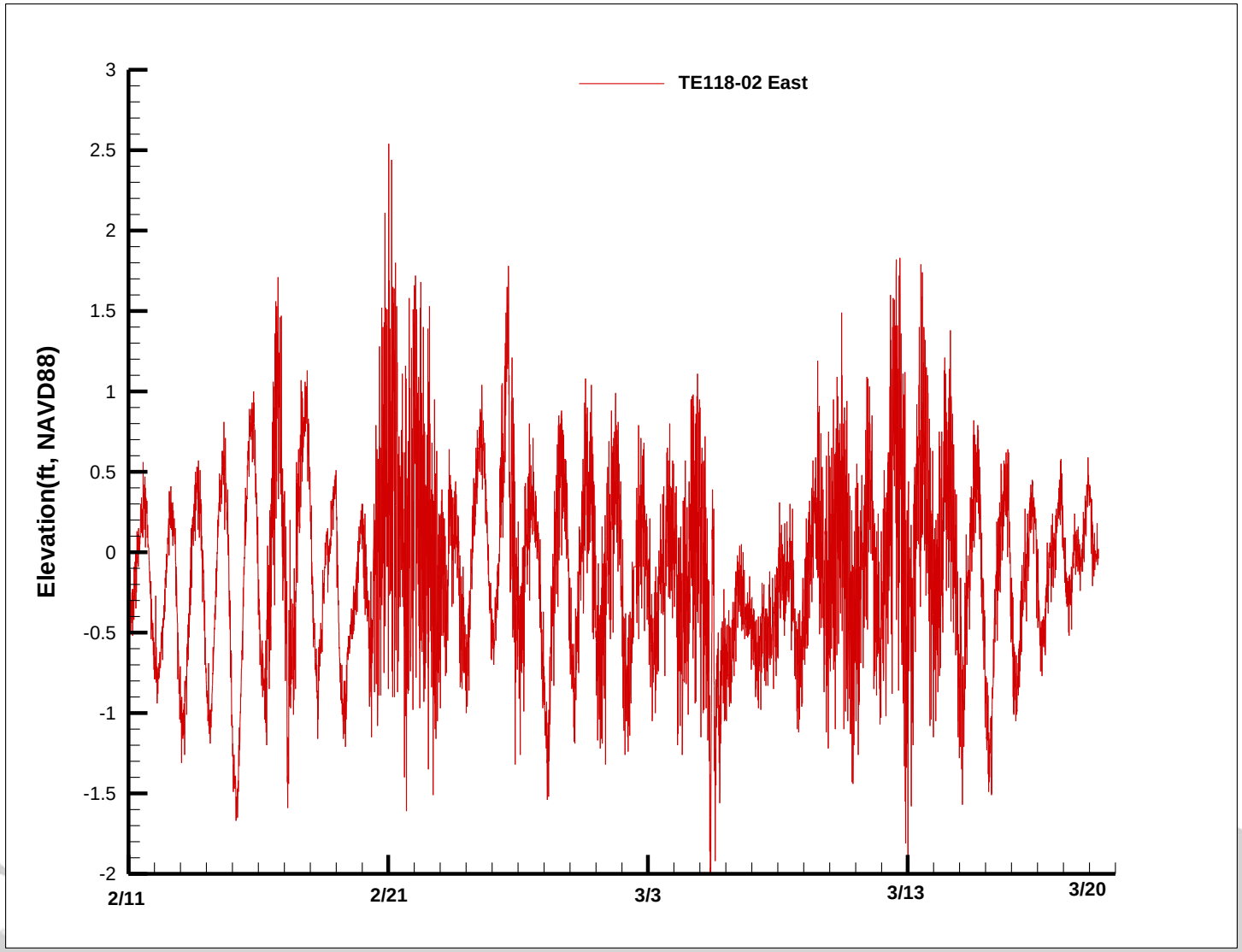
# Input Water Level and ADCP Data



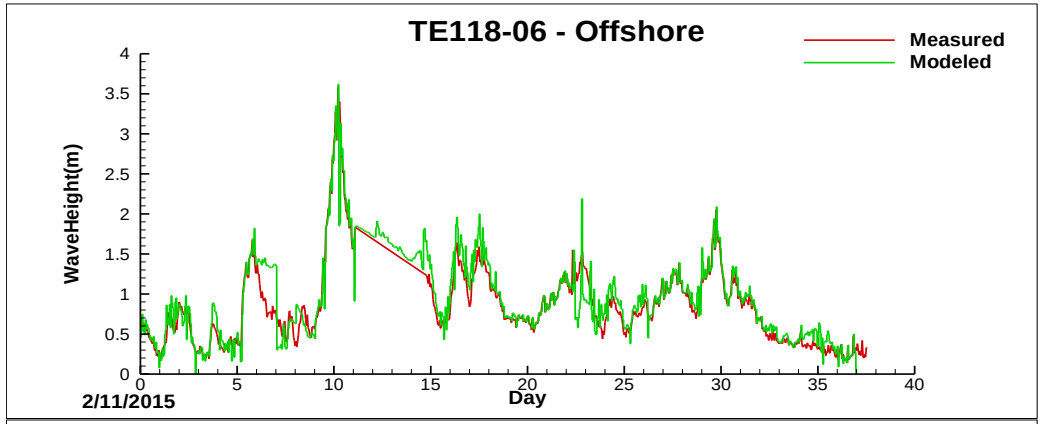

Nearshore

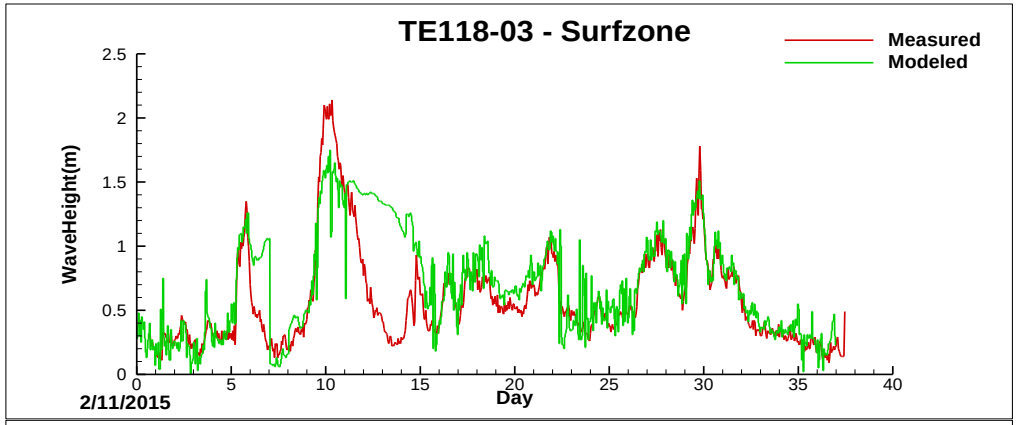


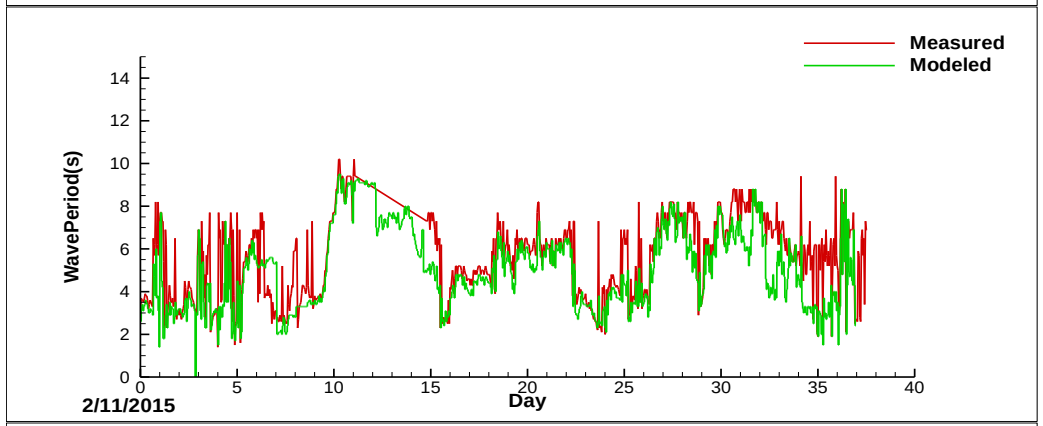

Inlet

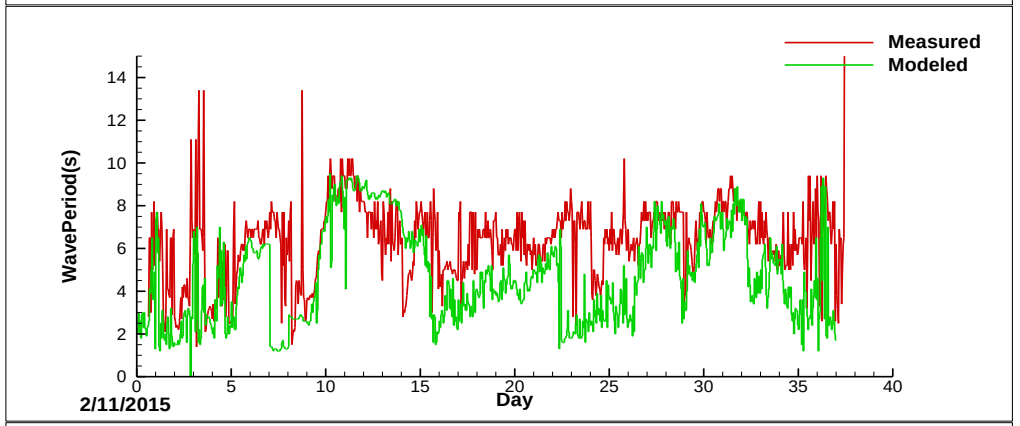


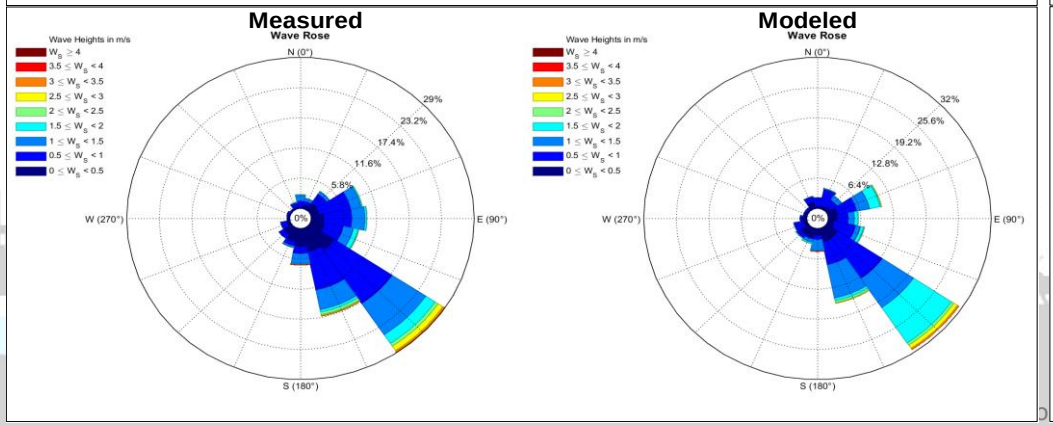
# Calibration & Validation

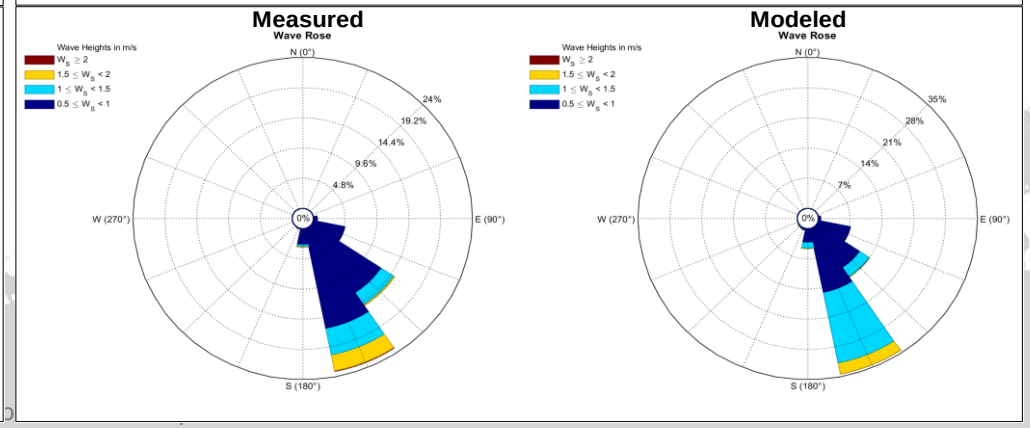


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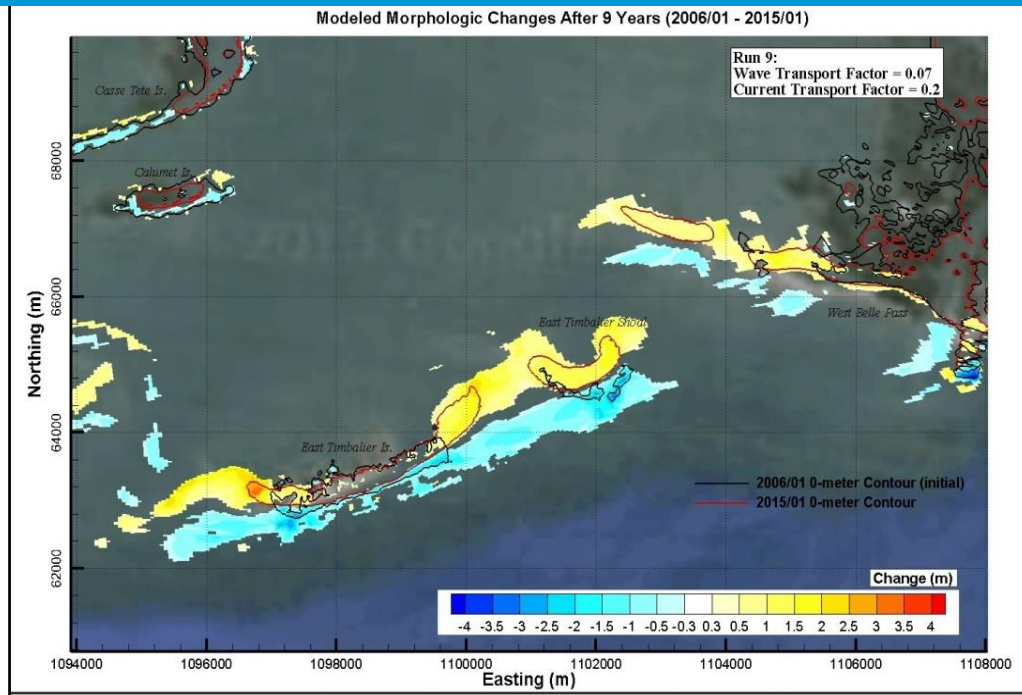
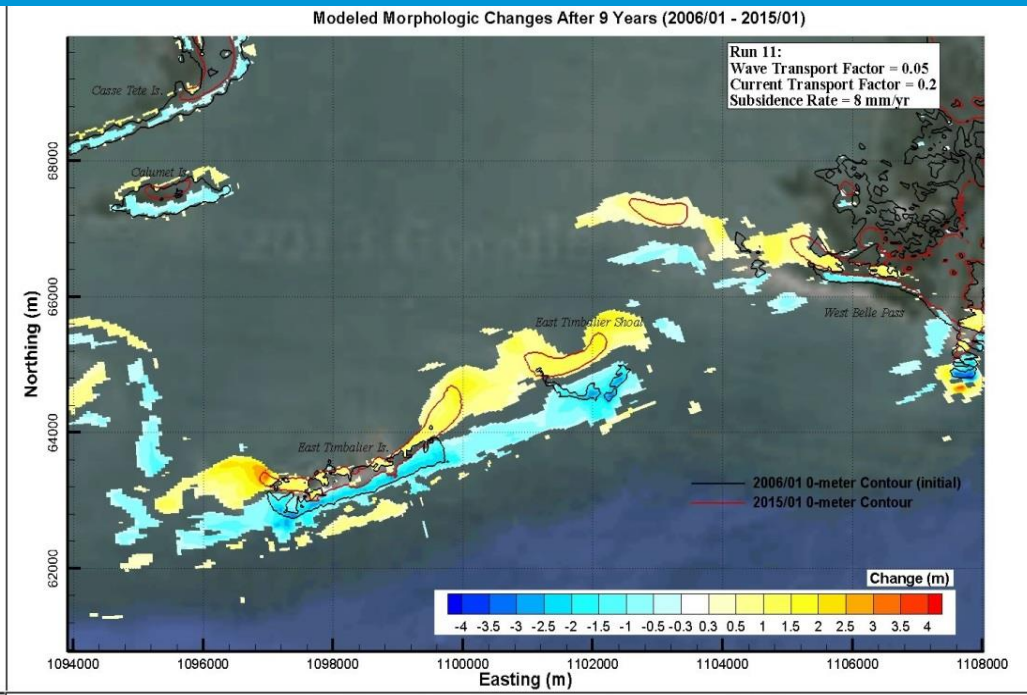
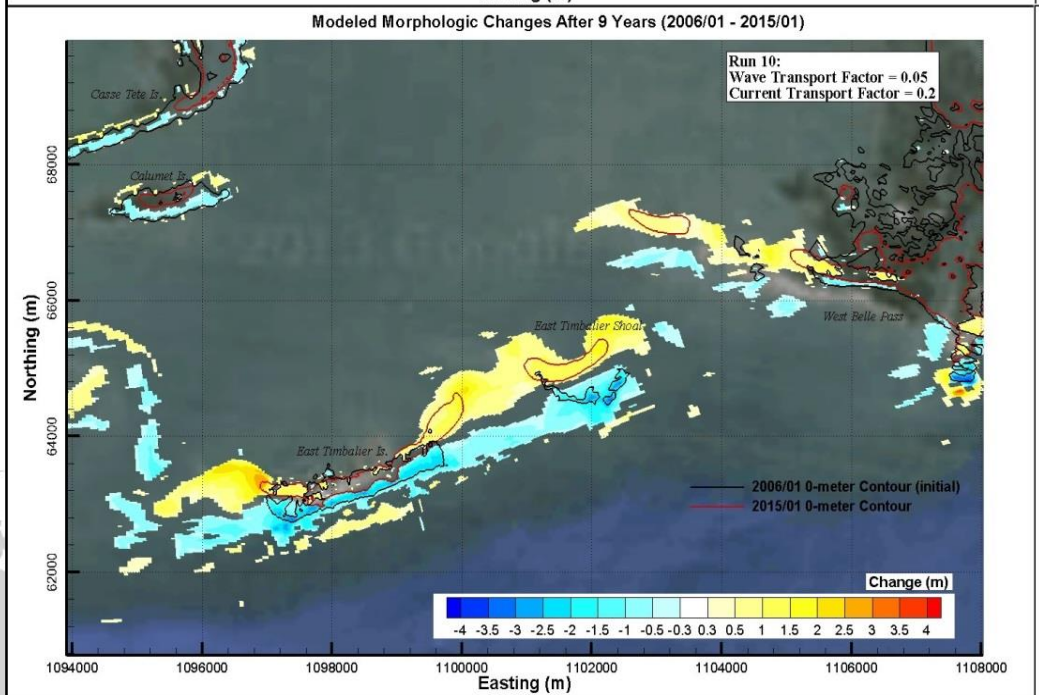
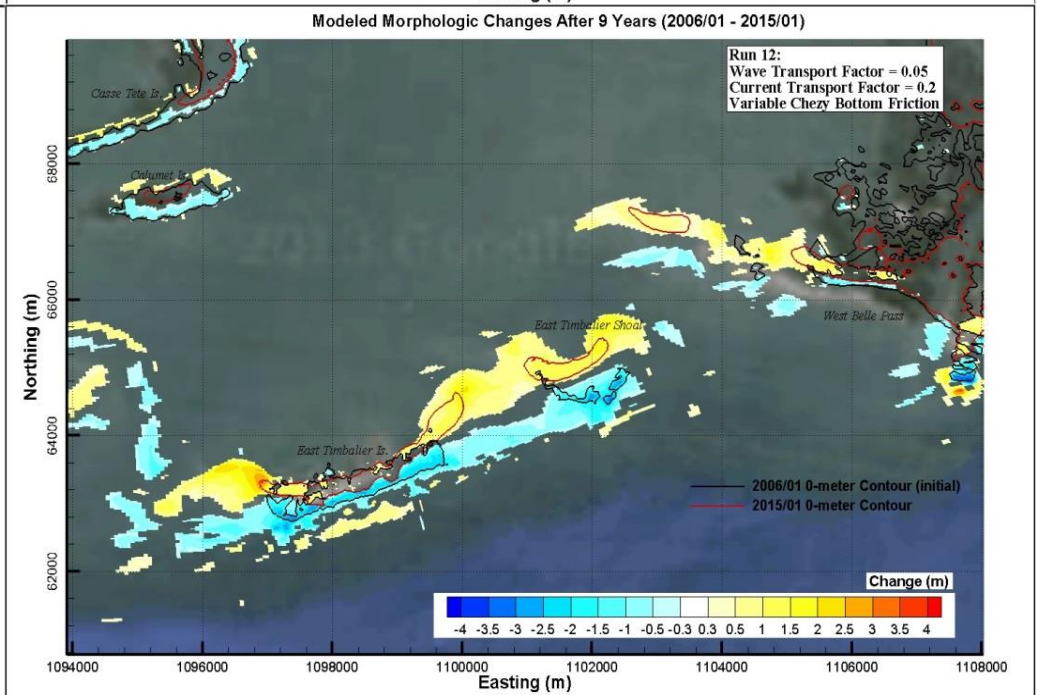
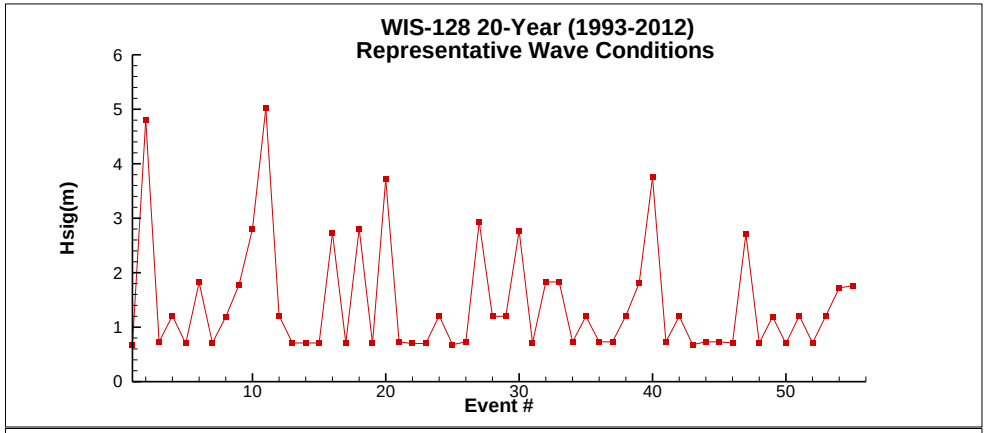


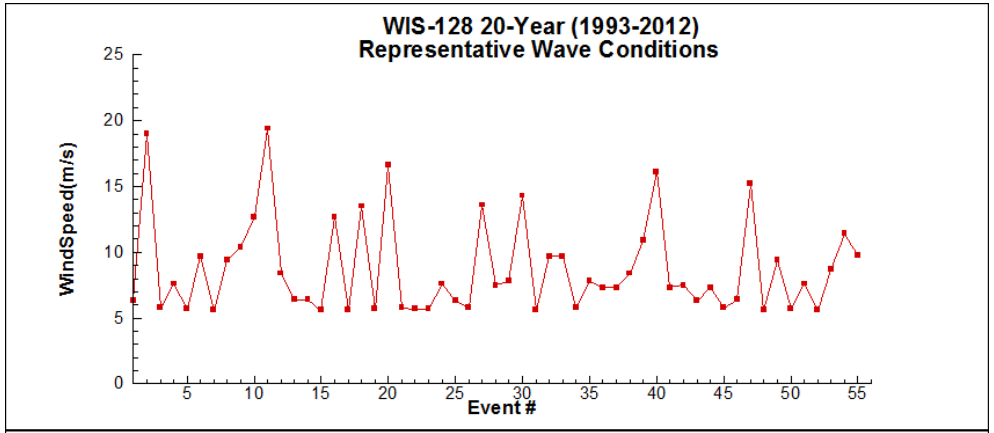



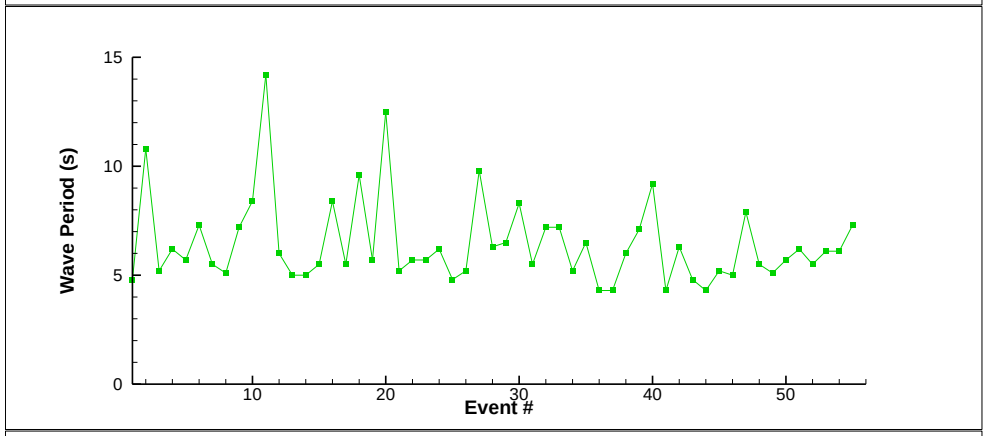



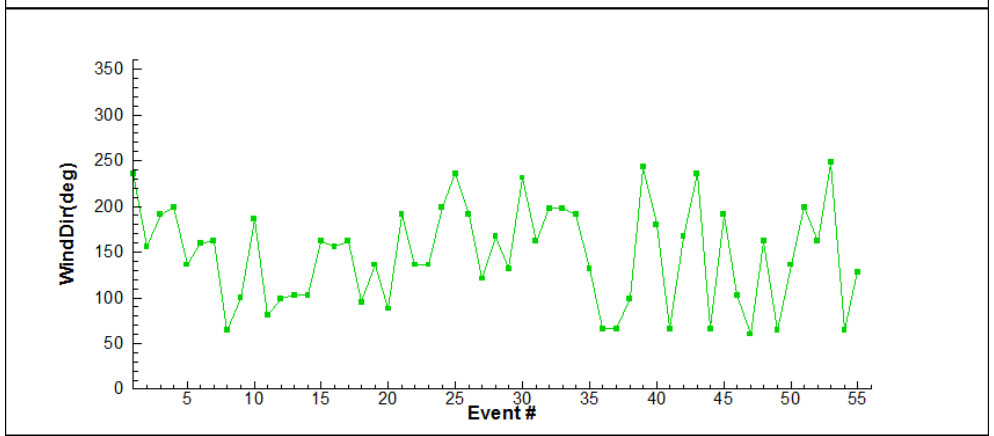



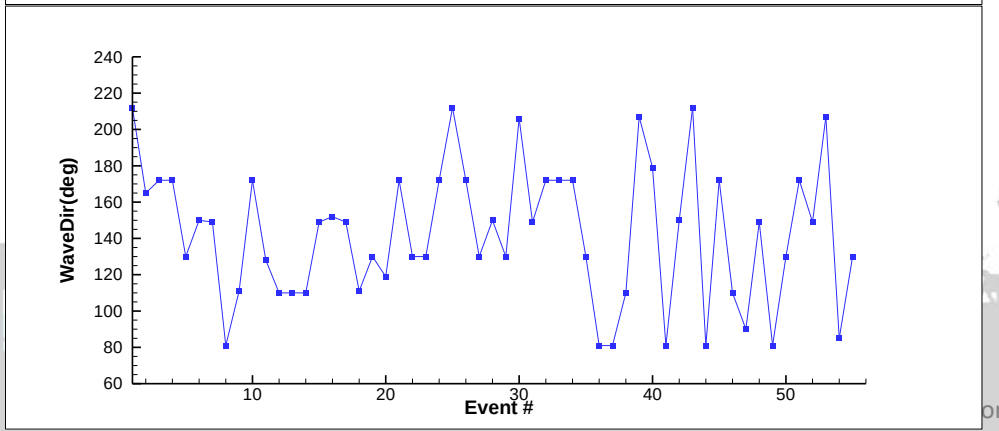
# 20-Year Synthetic Time Series

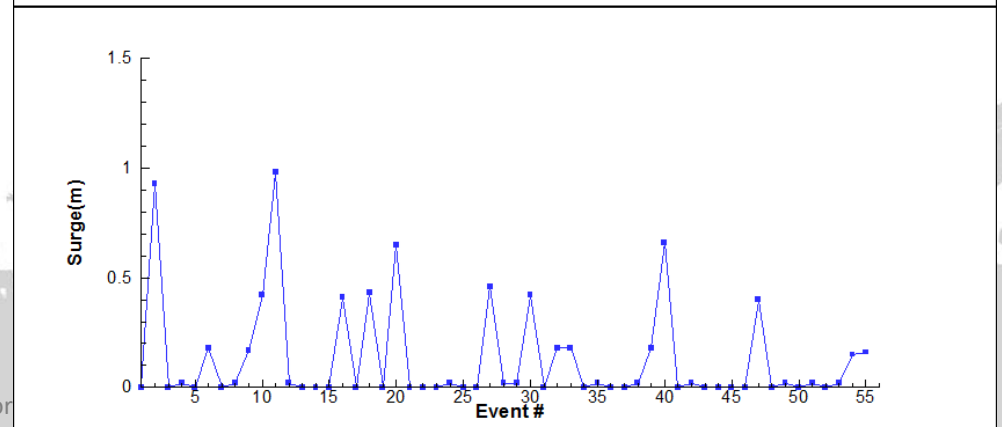


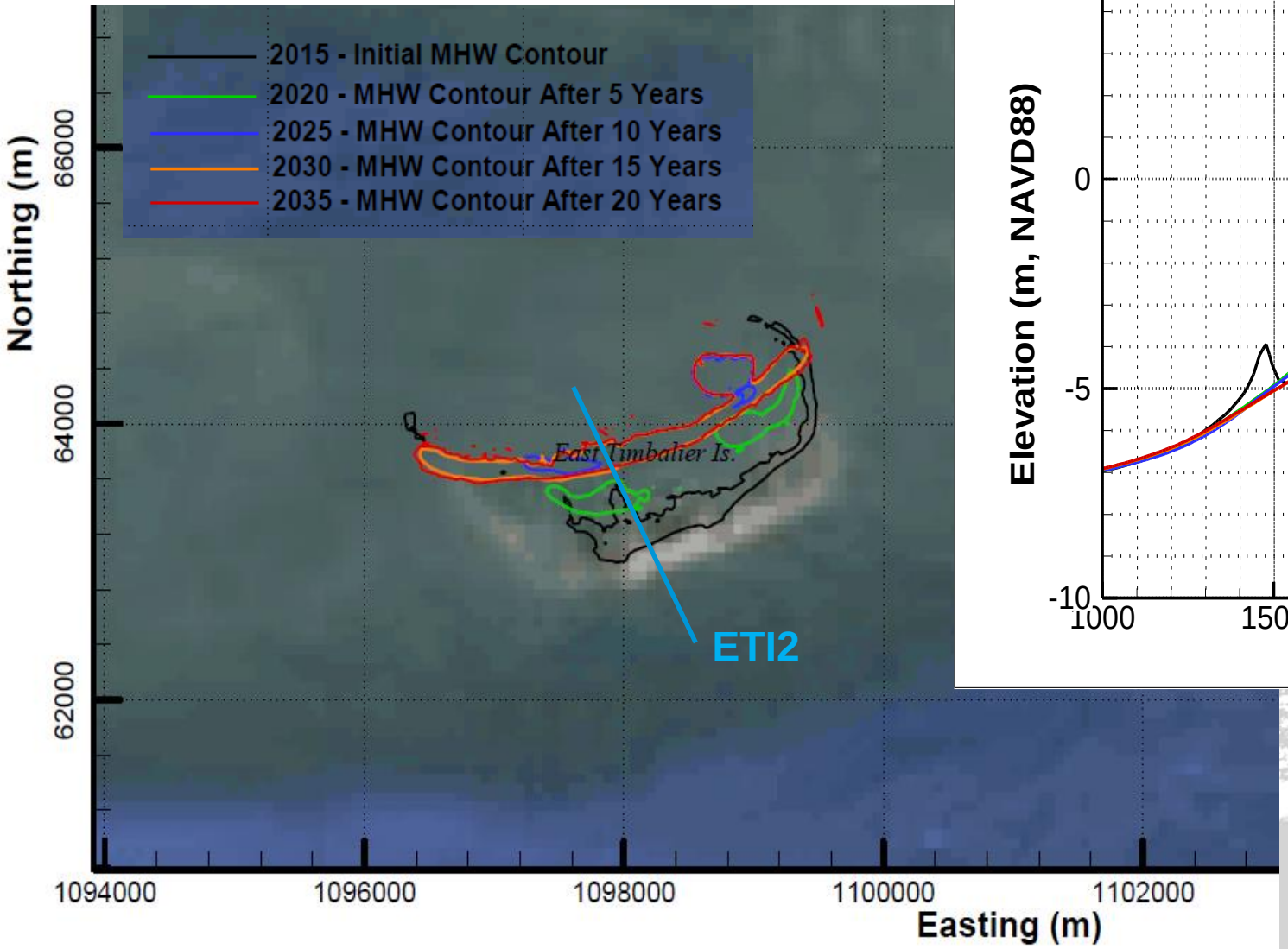



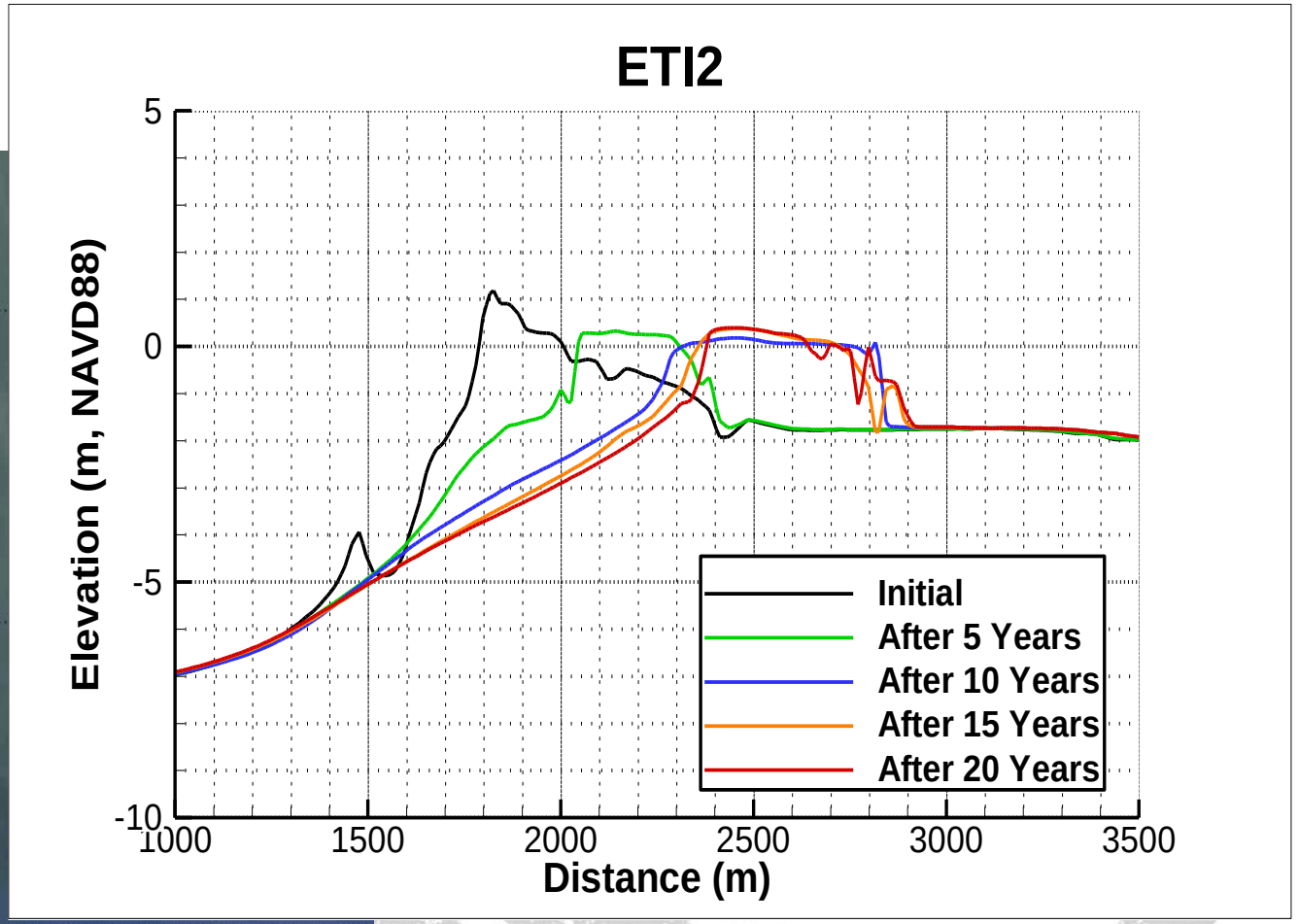



# Model Predictions



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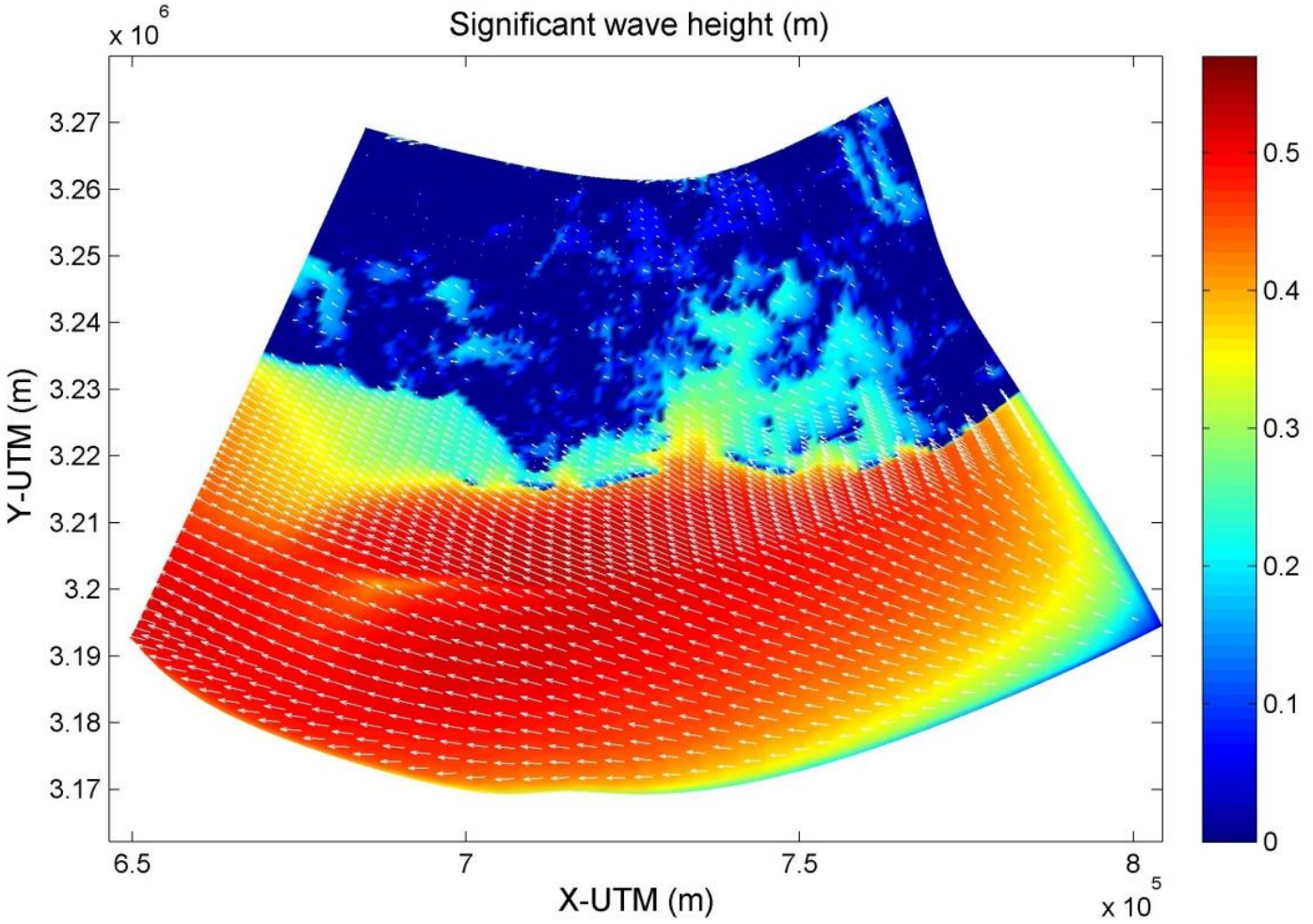
# Hybrid Model Approach

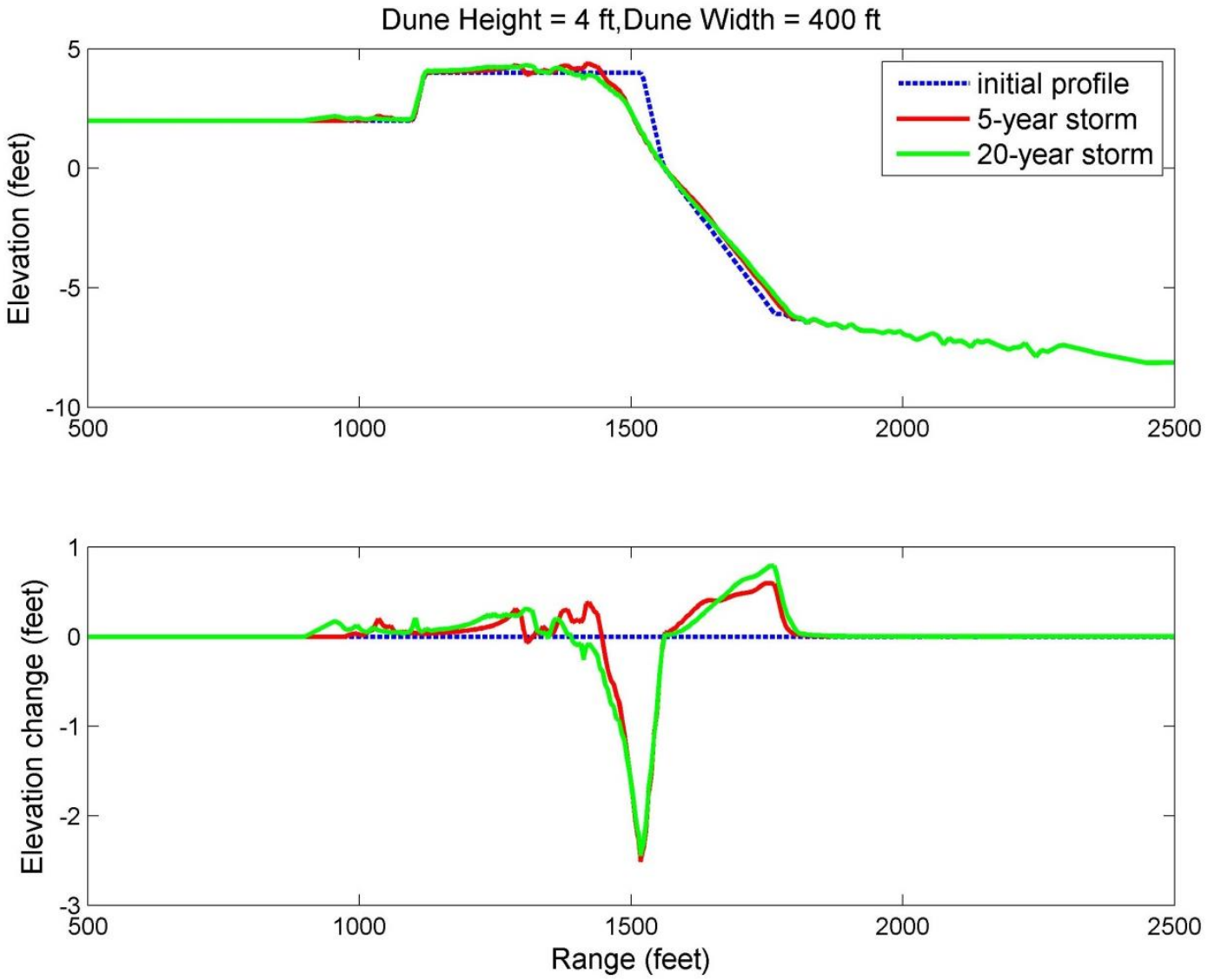
- *2017 Coastal Master Plan*
- Temporal & Spatial Scales ~ 50 Years & 99 Miles (6 Basins)
- Combined Empirical and Numerical Modeling
- Input Data: Bathy/Topo, Wave Data; Storm and Sediment Data; and Design Criteria for Bayside Erosion, Silt Content, Sea Level Rise, Subsidence, and Breaching
- Future w/ Project Scenarios: Input Restoration Templates
- Calibration for LT (Sediment Budgets) & CT (SBEACH)
- Output: DEM's on 1-Year Intervals

# Longshore Transport




- WIS Phase 3 Wave Transformation Process (Offshore)
- SWAN Model (Nearshore)
- CERC Transport Formulation

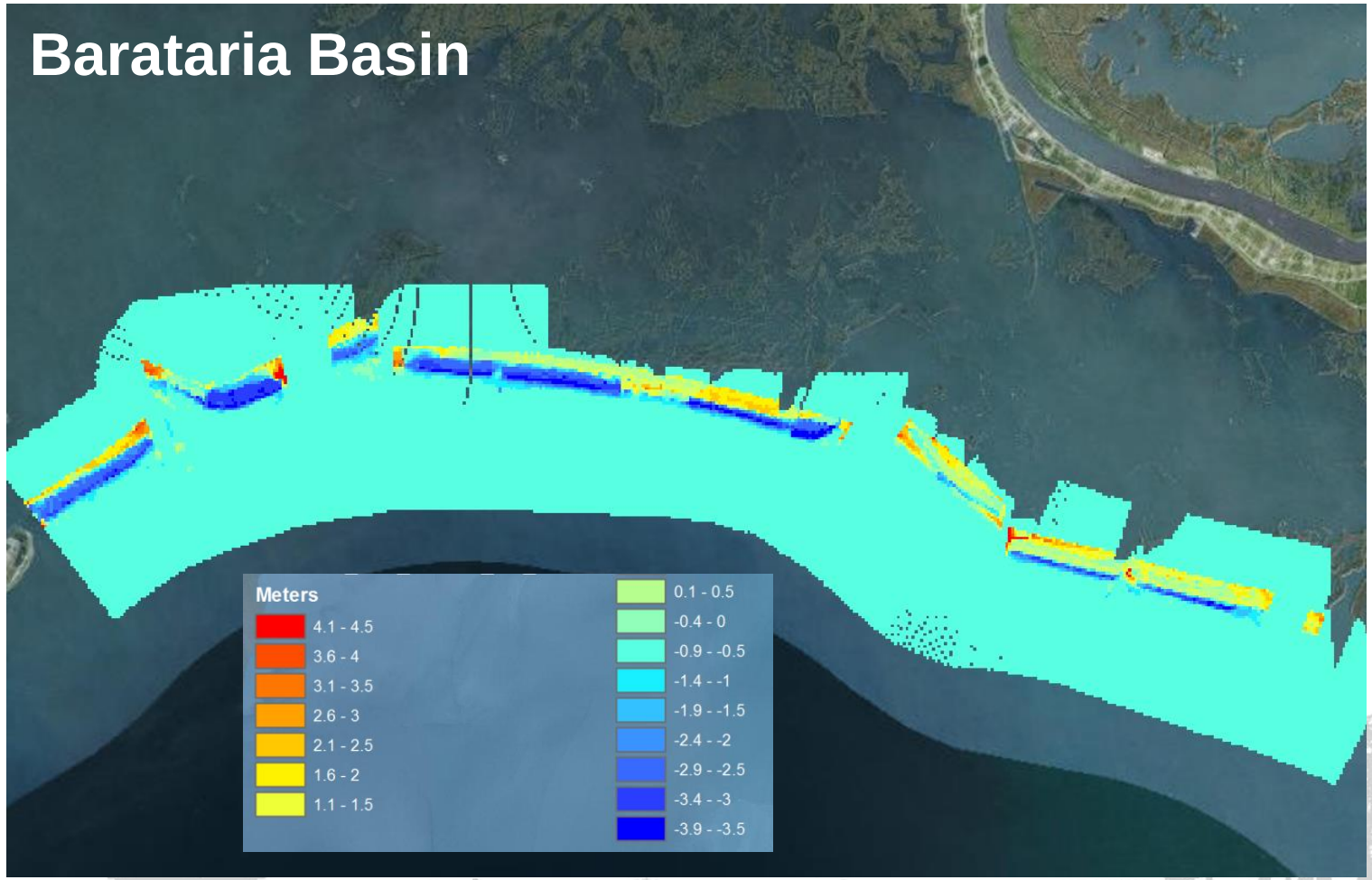
# Cross-Shore Transport




- SBEACH Model
- ~ 1000 Storm Model Runs
- Look-Up Tables

# *BIMODE* Model Schematization

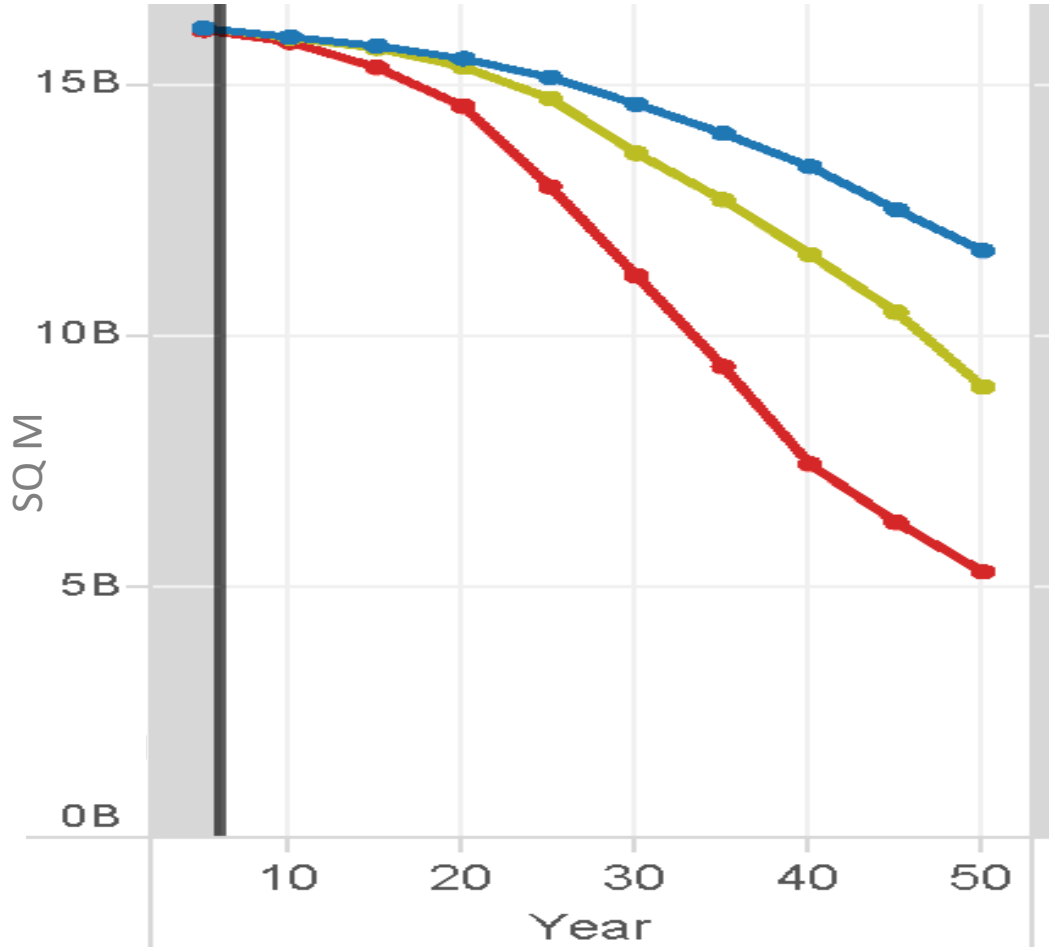
# Barrier Island Evolution Modeling



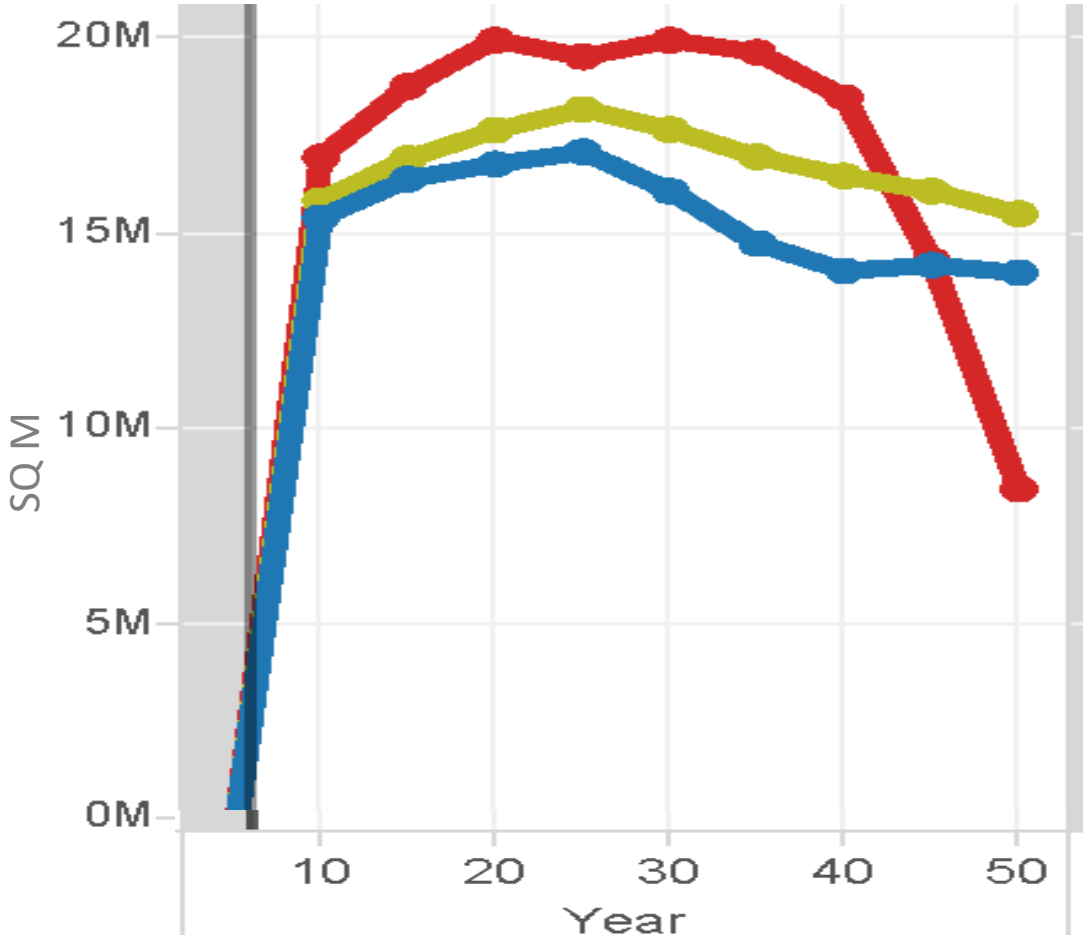

- 21 Islands
- 99 Miles of Barrier Shorelines
- 50-Year Simulation
  - Island Rollover
  - Island Migration
  - Breaching

# Hybrid Model Output (*Barataria Basin*)

## Future Without Action




## Project Effects



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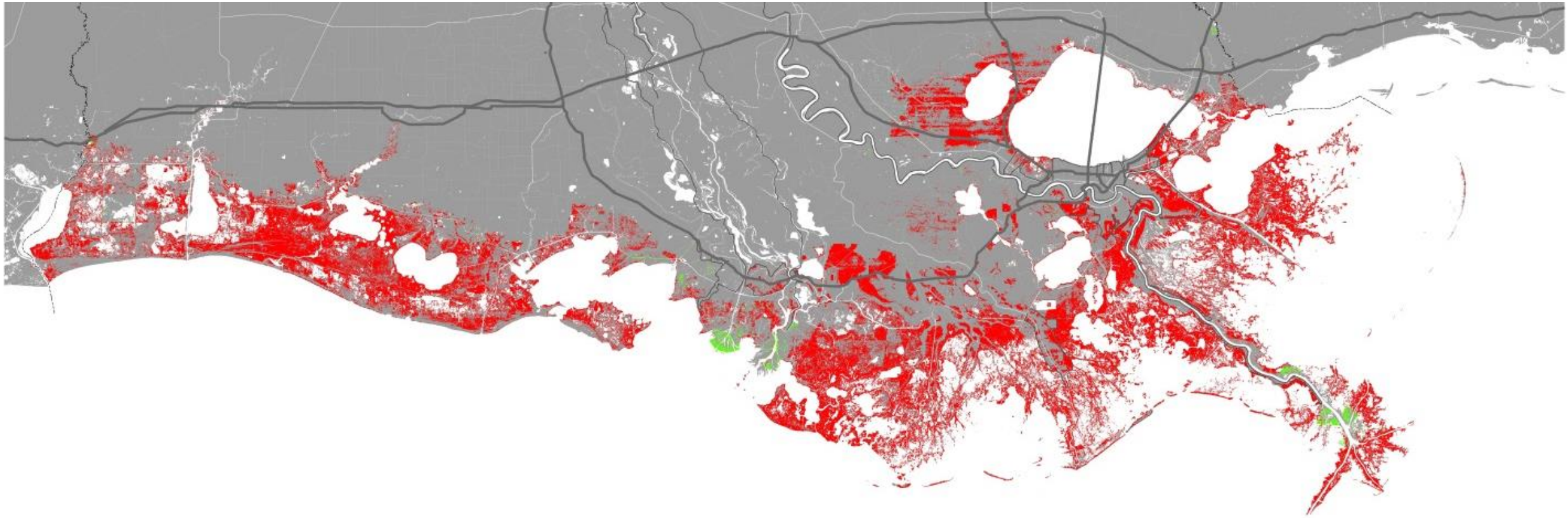
# Conclusions




50-Year Land Change Predictions Future Without Action

CPRA
Coastal Protection and Restoration Authority of Louisiana

# Conclusions

- LA Coastal Master Plan
- BI Evolution Modeling
  - Empirical
  - Numerical
  - Hybrid
- **Professional Judgement!**
- BI Restoration Successes

Caillou Lake Headland Restoration
aka Whiskey Island (2018)
Photo Courtesy of GLDD

# Acknowledgments


- Coastal Protection & Restoration Authority
- The Water Institute
- BIMODE Team { 2017 Coastal Master Plan }
  - Ioannis Georgiou – University of New Orleans
  - Mark Kulp – University of New Orleans
  - Mark Leadon – CPRA
  - Gordon Thomson – Baird (formerly with CB&I)
  - Dirk Jan Walstra – Deltares
- Special Acknowledgement ~ Mark Gravens
- Cast and Crew of CEC