IMPLEMENTATION OF COASTAL R&D INNOVATIONS IN HURRICANE SUPPLEMENTAL PROJECTS

USACE GALVESTON DISTRICT

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Hydraulic Engineer

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- USACE SWG Sabine-to-Galveston and Coastal TX team members (Cris Michalsky, Eddie Irigoyen, Brad Burrows, Jacob Breaux, Molly Ross, Jason Caldwell, Himangshu Das and many others)
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- S2G Local Sponsors (Drainage District 7, Velasco Drainage District, Orange Country Drainage District)

Biography

- BS – Ocean Engineering and Naval Architecture (India - 1997)
- MS and PhD – Coastal Engineering/Civil and Environmental Engineering (U. of Delaware – 2005)
- HPA-Halcrow-CH2MHill-Jacobs – Senior Coastal Engineer (New York City; 2005 – 2009)
- Ben C. Gerwick-COWI – Project Manager (Houston; 2009 – 2011)
- Professional Engineer, Civil (Water Resources), TX (2010)
- AECOM – Senior Project Manager/Principal Coastal Engineer (Houston; 2011 – 2012)
- Chevron – SME/Marine Facilities Engineer (Houston; 2012 – 2018)
- USACE SWG – Hydraulic Engineer/S2G HH-Coastal Lead (Galveston; 2018 – Present)

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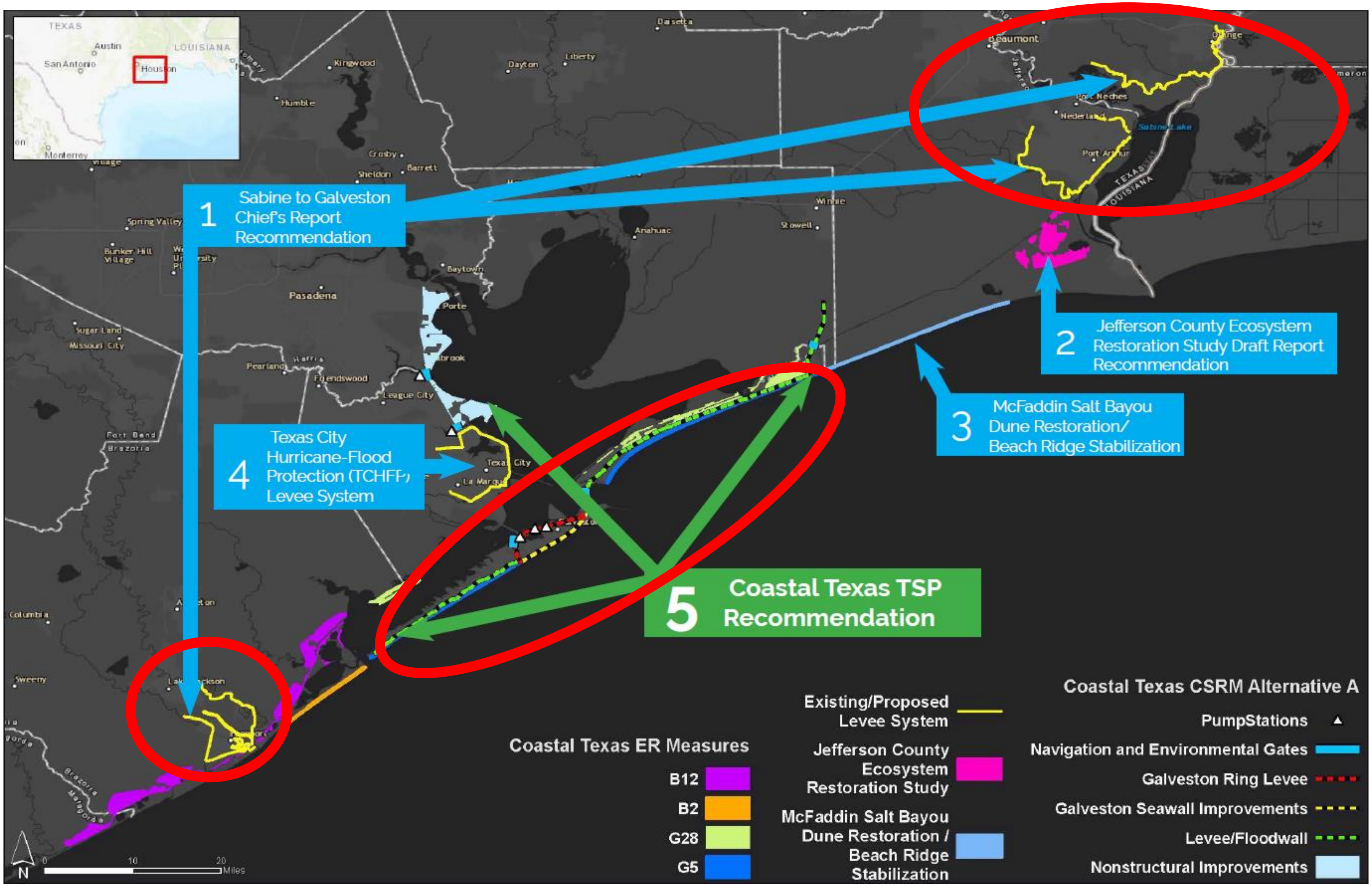
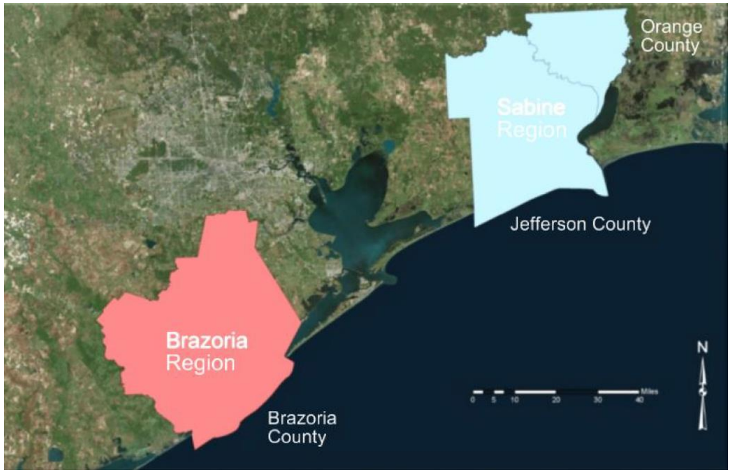
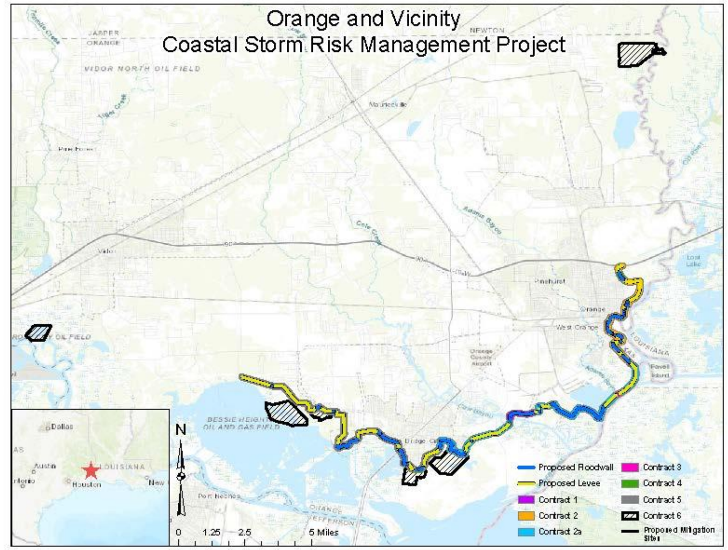
SWG Supplemental Projects

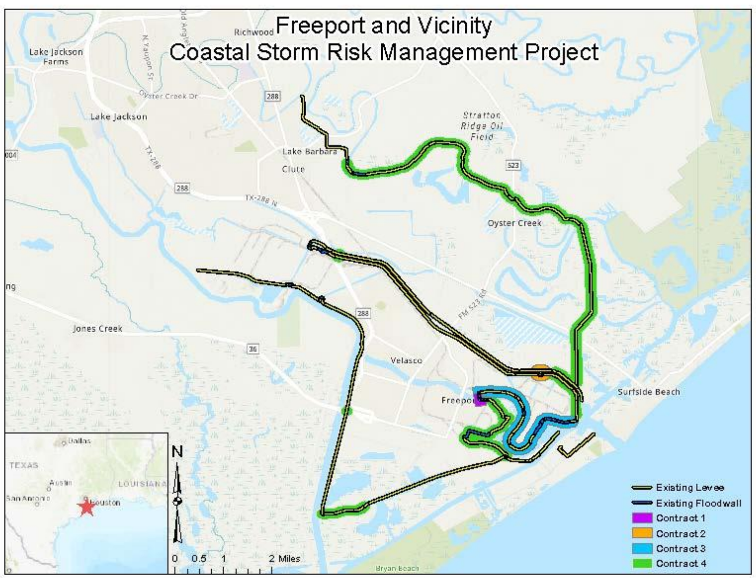


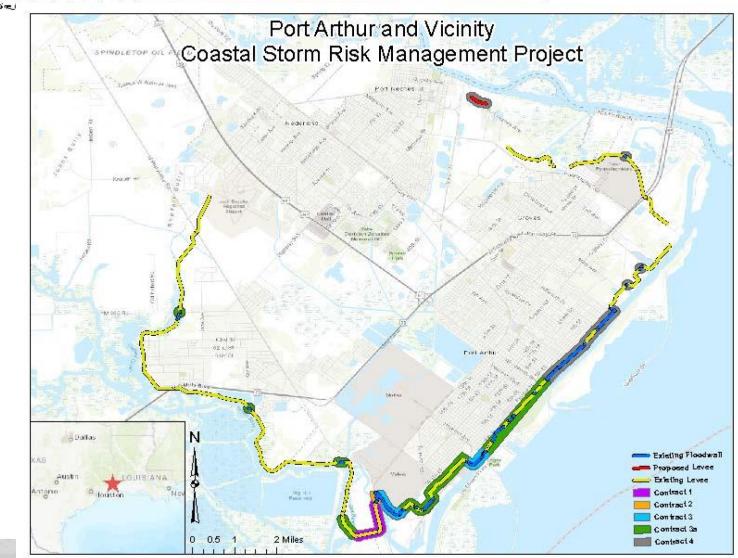
SWG Supplemental Projects

- *Sabine–to–Galveston* (S2G) : PED



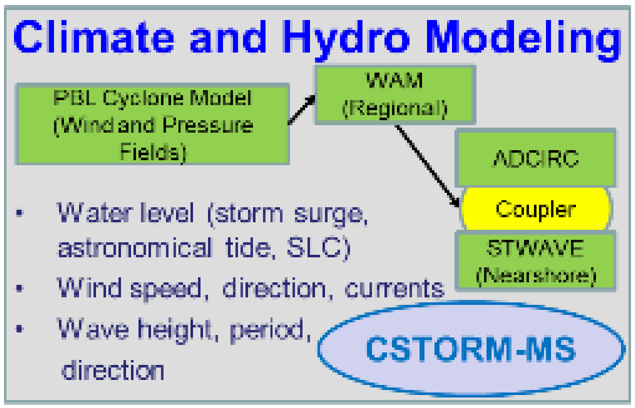


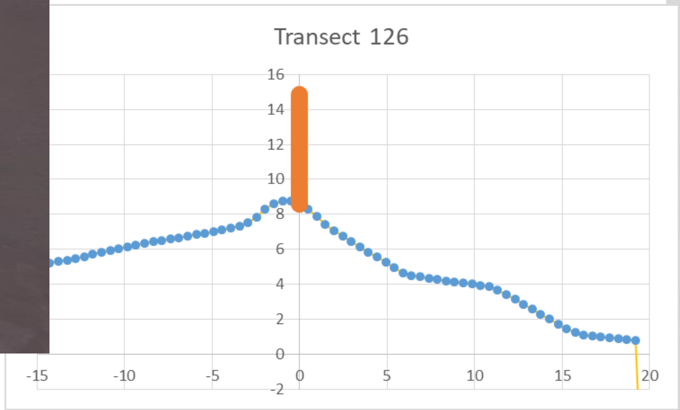




Coastal Storm Surge and Wave Hazards Modeling and Analysis

- ERDC CHL





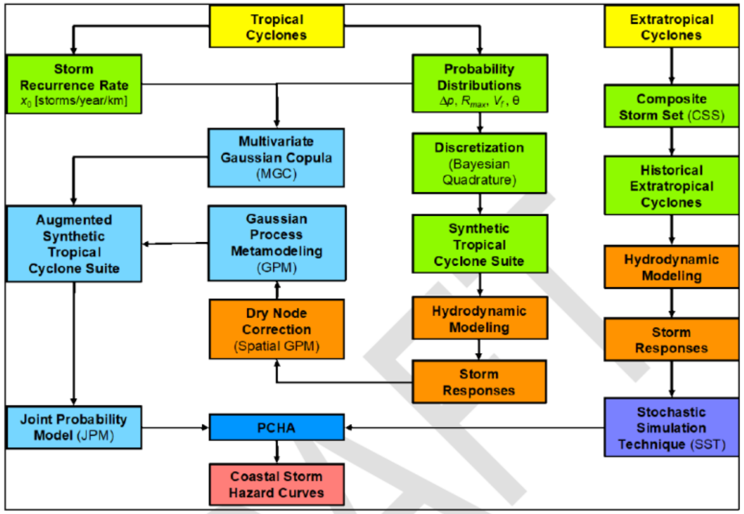
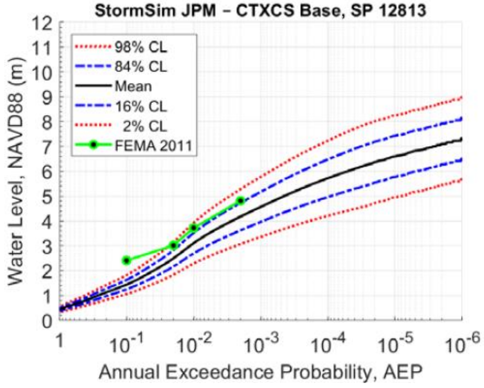
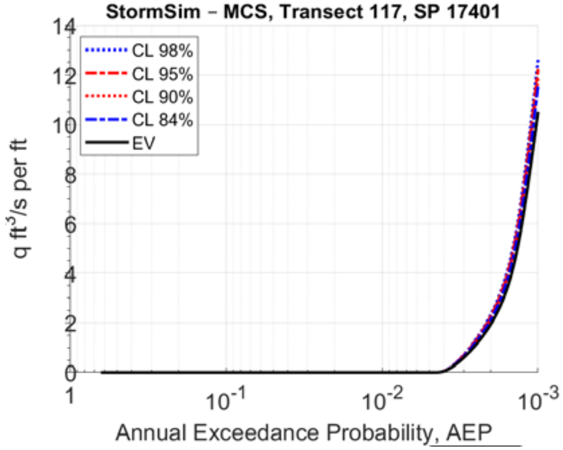


Figure 8: USACE's "new" Probabilistic Coastal Hazard Analysis (StormSim-PCHA) (Nadal-Caraballo et al. 2018)

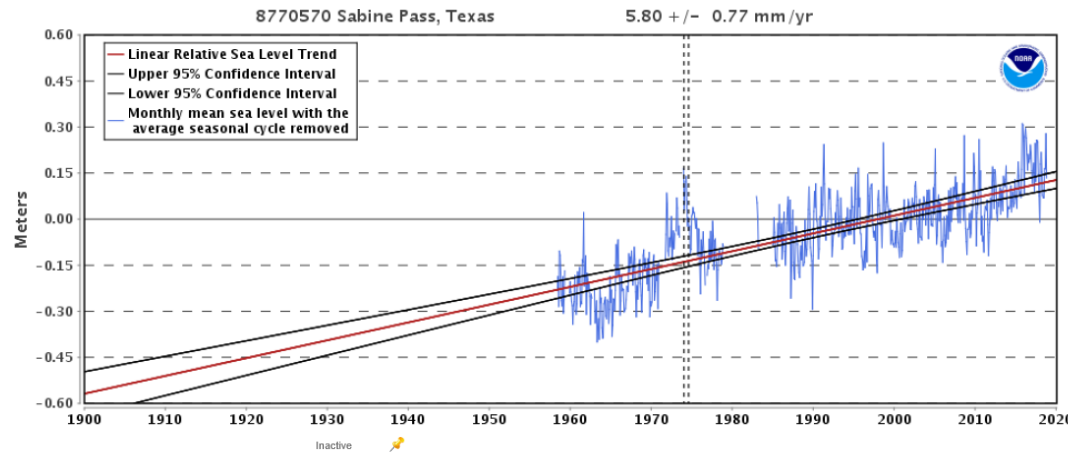




Relative Sea Level Change and Mean Sea Level

USACE Sea Level Change Curve Calculator (2017.55)

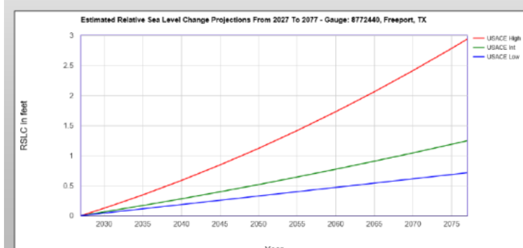
Project Name: Enter Project Name
Select Gauge: Select NOAA Gauge
Scenarios Source: USACE 2013
Output Units: Feet / Meters
Critical Elevation #1 (ft) : 0 NAVD88 - Description:
Critical Elevation #2 (ft) : 0 NAVD88 - Description:
SLC Rate:? NOAA 2006 Rates or enter rate (ft/yr) Display Data
FEMA BFE (ft): ? Information 0 (NAVD88) Search for BFE here
Project Start Year: 1992
Interval Year: 5
Project End Year: 2100
Output Datum: LMSL / (NAVD88)
User's Index (ft): ? 0 Description:
Datum Shift to MSL: 0(ft)
EWL Type: Highs / Lows
EWL Source: NOAA (GEV) / USACE (Percentile)
Plot EWL/BFE/Tides: None Select Curve: USACE High

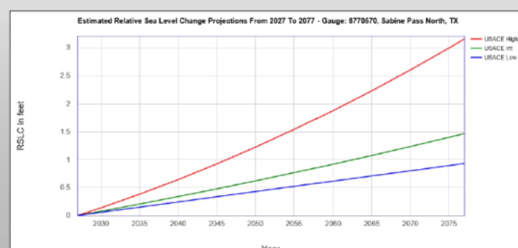


Results: RSLC After 50-Year Service Age (Start of Service Life : 2027)

Estimated RSLC from ***2027 to 2077*** *(50-year service age)*

Project Area	Tidal Gage	Relative Sea Level Change Values (USACE)					
		Low (ft)		Intermediate (ft)		High (ft)	
		Historic Rate	*Sabine to Galveston FIFR EIS (2017)*	NRC Curve I	*Sabine to Galveston FIFR EIS (2017)*	NRC Curve III	*Sabine to Galveston FIFR EIS (2017)*
Port Arthur, TX Orange, TX	Sabine Pass North	0.93	*1.58*	1.46	*2.22*	3.15	*4.26*
Freeport, TX	Freeport	0.71	*1.21*	1.25	*1.86*	2.94	*3.89*
Base (Start) Year for RSLC Cal		2027	*1992*	2027	*1992*	2027	*1992*





Tidal Elevation

National Geodetic Survey

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ELEVATION INFORMATION

PID: AV1014
VM: 1572
STATION ID: 8770570
EPOCH: 1983-2001
DATE: Tuesday, January 22, 2019 1:07:39 PM EST

MHHW = 1.60 feet (0.488 meters)
MHW = 1.50 feet (0.457 meters)
MSL = 0.96 feet (0.293 meters)
MTL = 0.95 feet (0.291 meters)
MLW = 0.41 feet (0.124 meters)
NAVD88 = 0.37 feet (0.114 meters)
MLLW = 0.00 feet (0.000 meters)

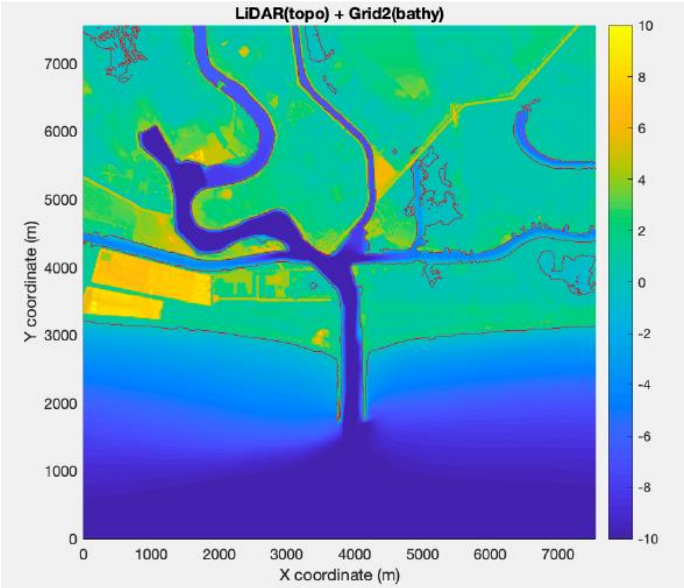
The NAVD 88 and the NGVD 29 elevations related to MLLW were computed from Bench Mark, , at the station.

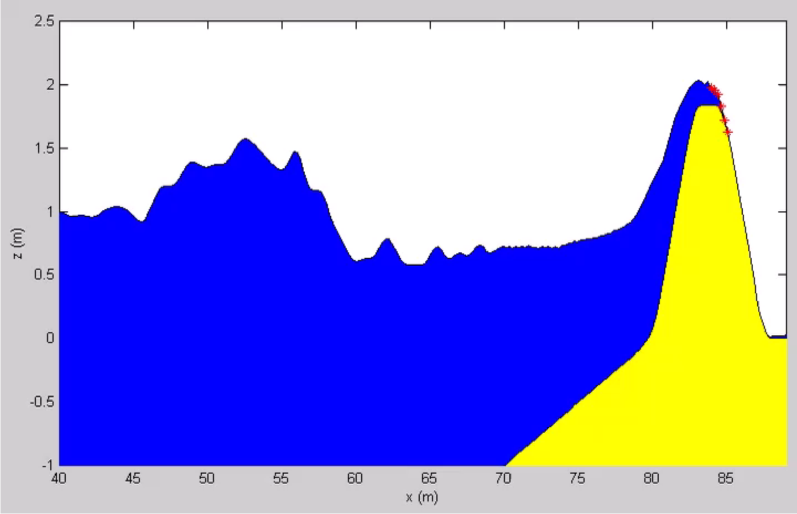
Displayed tidal datums are Mean Higher High Water(MHHW), Mean High Water (MHW), Mean Tide Level(MTL), Mean Sea Level (MSL), Mean Low Water(MLW), and Mean Lower Low Water(MLLW) referenced on 1983-2001 Epoch.

Elevations of datums referred to Mean Lower Low Water (MLLW).

Phase-resolving Boussinesq Models (Coastal Wave Hazards)

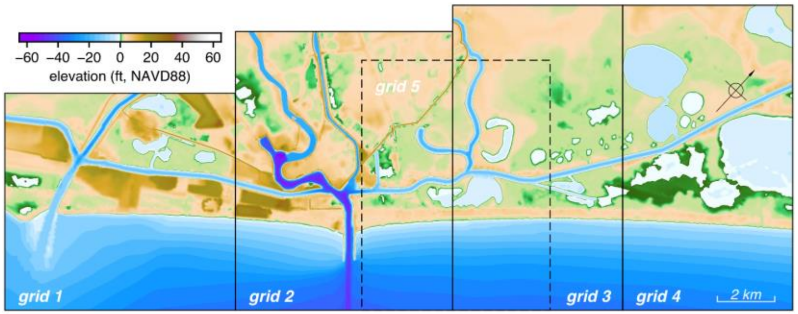
- University of Southern California; ERDC CHL; University of Delaware

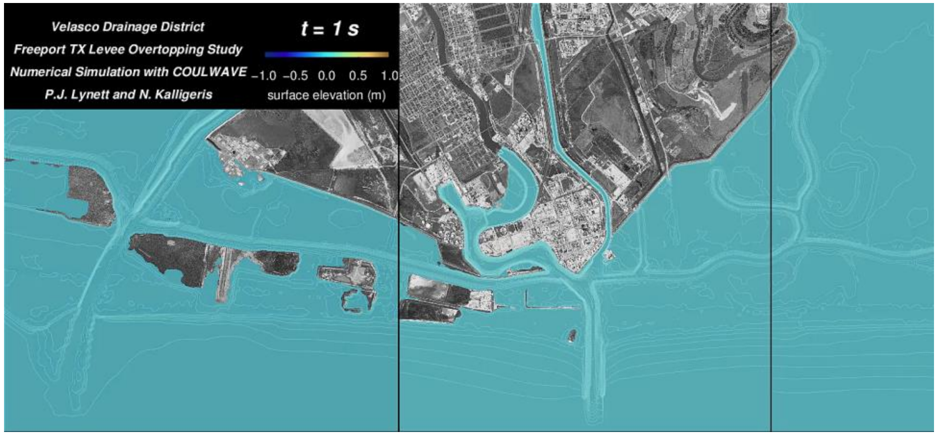




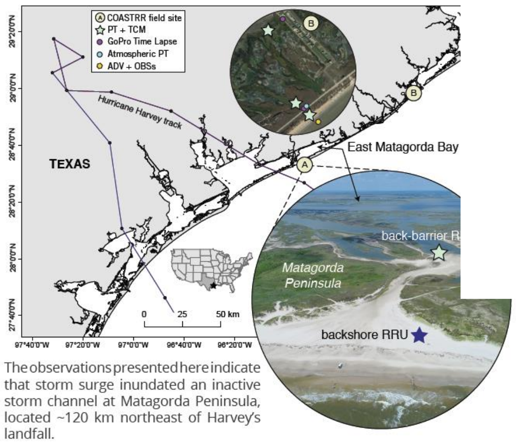
Phase-resolving Boussinesq Models (Infragravity Waves)

- Texas A&M University, Galveston; University of Delaware; University of Southern California; ERDC CHL

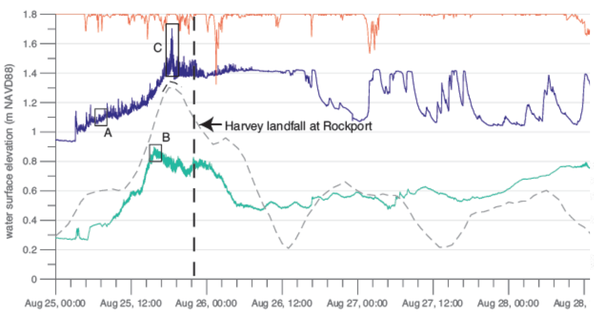


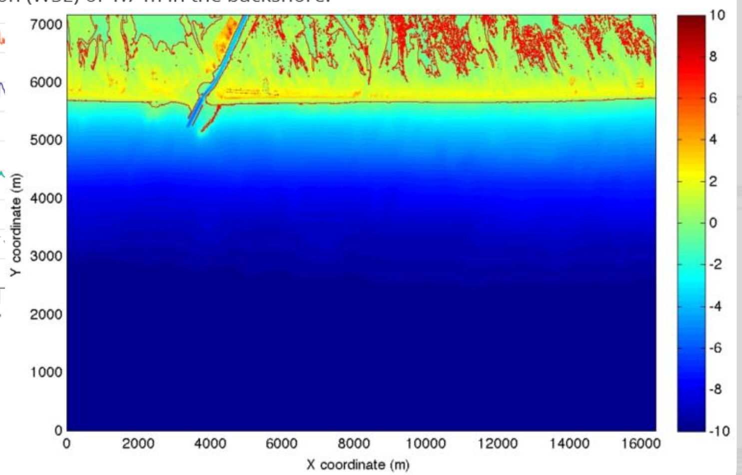


Infragravity waves (0.003 – 0.05 Hz) dominated the water motion onshore of the berm crest over 24-hours proximate to storm landfall resulting in a peak water surface elevation (WSE) of 1.7 m in the backshore.



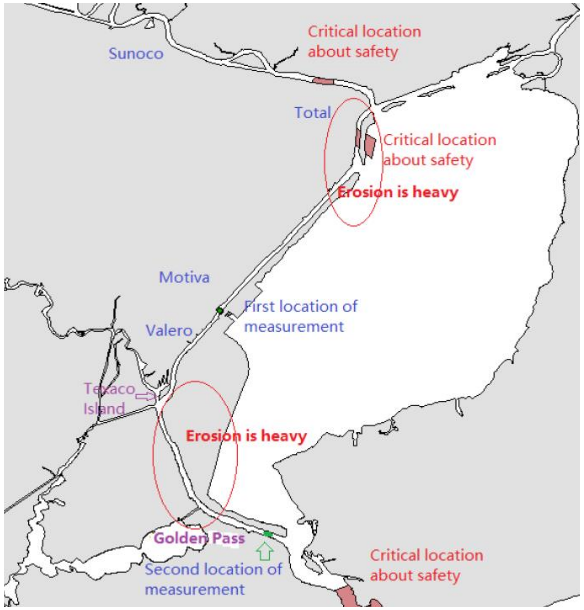
The observations presented here indicate that storm surge inundated an inactive storm channel at Matagorda Peninsula, located ~120 km northeast of Harvey's landfall.

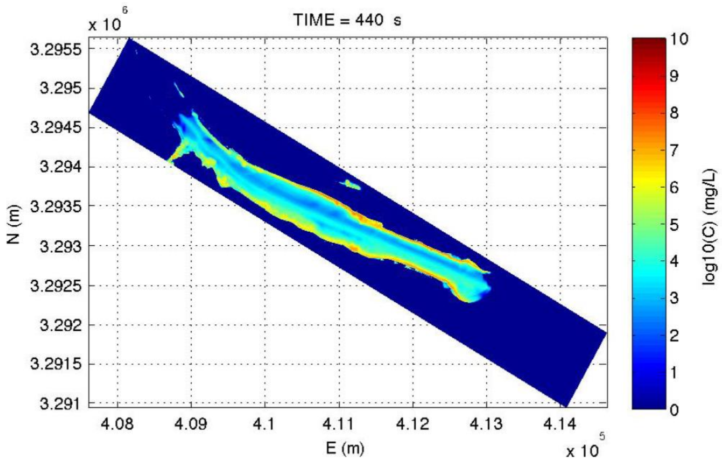


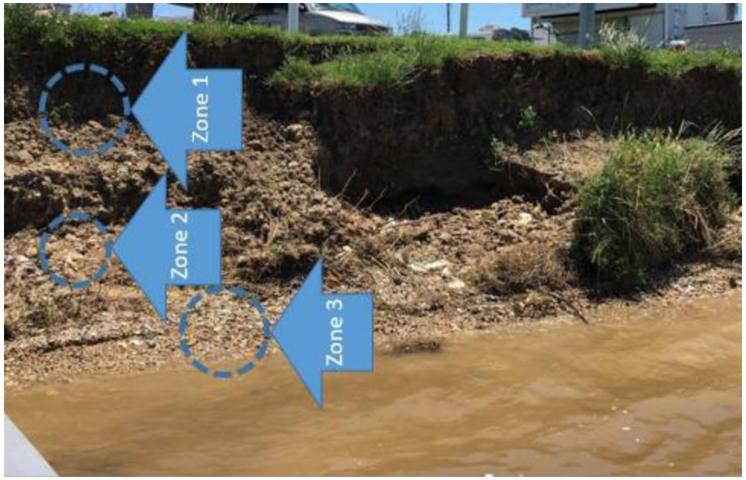


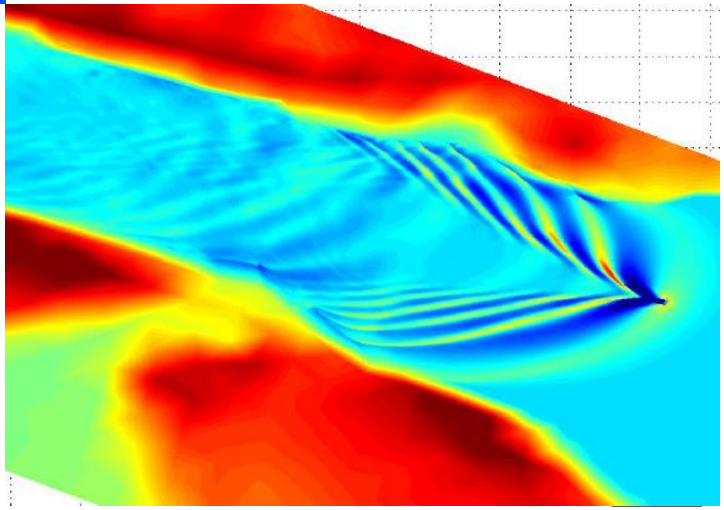
Phase-resolving Boussinesq Models (Ship-induced Waves and Sediment Transport)

- ERDC CHL; University of Delaware; Lamar University; University of Houston



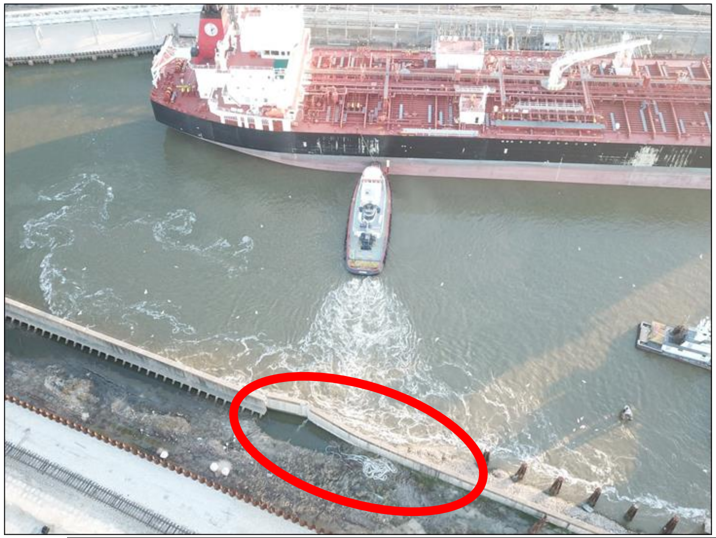


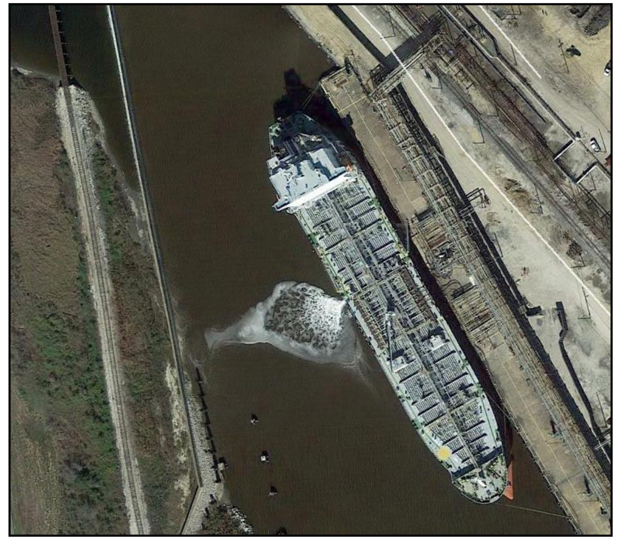


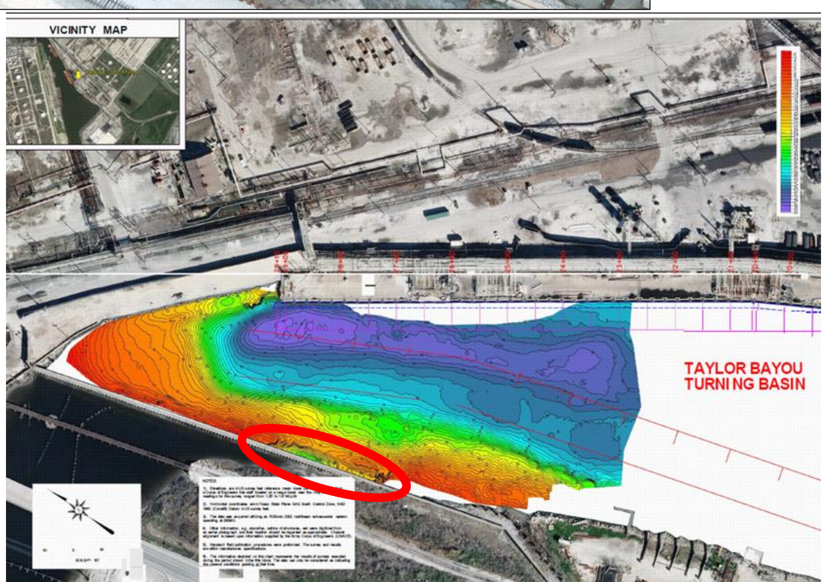


Ship-induced Scour and Empirical Assessment

- SWG







THRUSTER-INDUCED SCOUR		
Input Name and Description	Unit	Input Value
P_thruster (Installed power of thruster)	W	
D_thruster (Thruster diameter)	m	
L (Distance between outflow and quay wall)	m	
D85	m	
h_w (thruster tip clearance to seabed)	m	

PROPELLER-INDUCED SCOUR		
Input Name and Description	Units	Input Value
P_prop (Installed power)	W	1454115
D_prop (Propeller diameter)	m	2.18
C3 (Ducted or free propeller: 1.17 for ducted prop or 1.43 for free prop)	-	free
Single or **twin** prop?	-	twin
D85	m	0.005
h_w (propeller tip clearance to seabed)	m	5.04
f_p (% of engine power used: 0.1 if maneuvering, 1.0 if fully operational)	-	1

RESULTS	Thruster		Prop	
	German	Dutch	German	Dutch
Scour Depth (m)	#DIV/0!	#DIV/0!	2.32	2.32

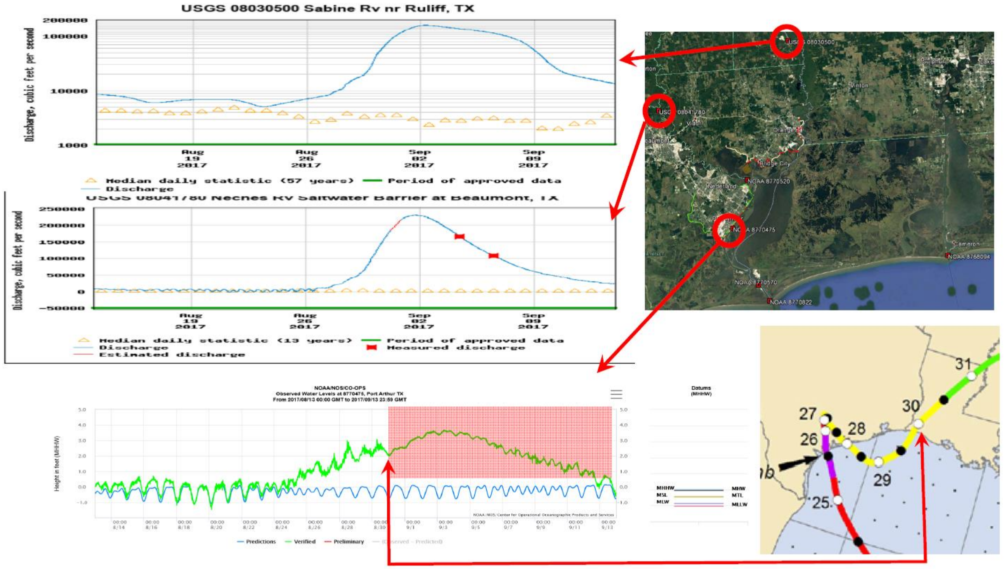
CLEAR THRUSTER INPUTS

CLEAR PROPELLER INPUTS

Samson

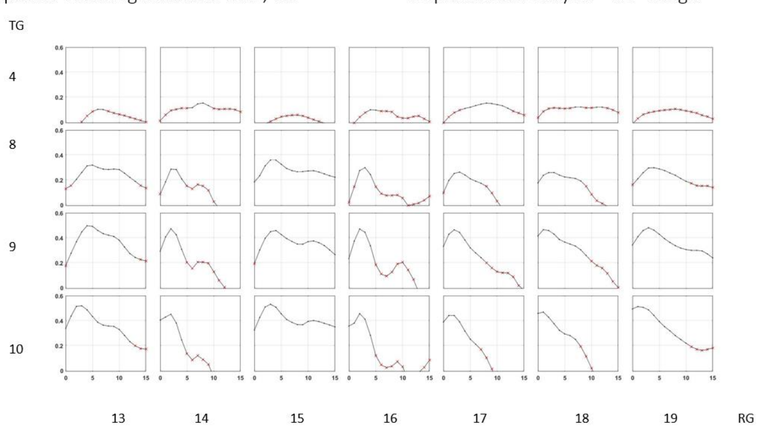
Compound Flooding

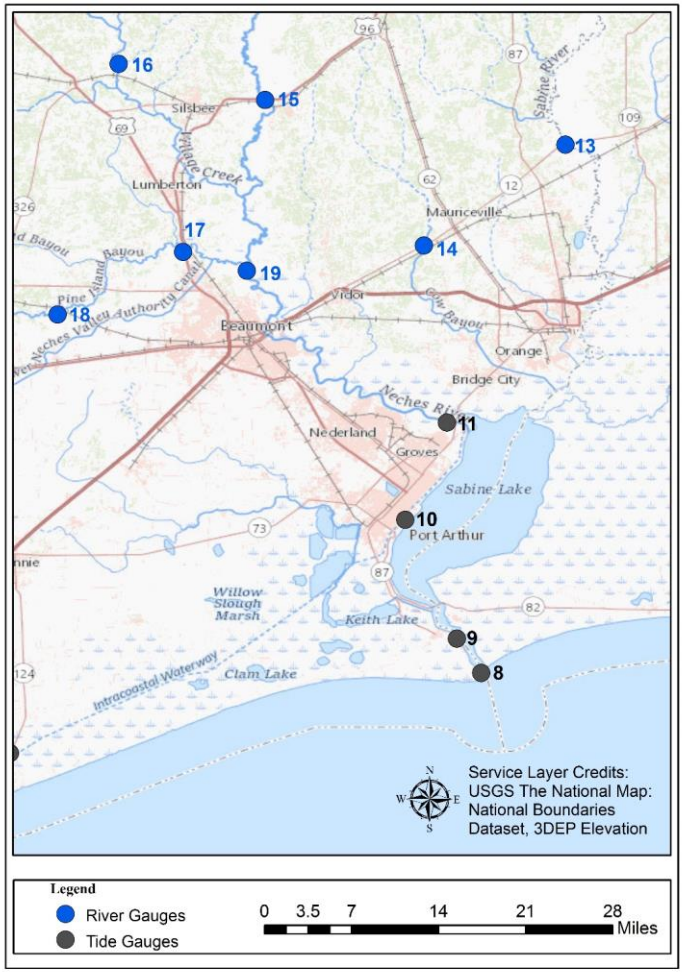
- University of Central Florida (Data and Statistical Analysis); University of Texas, Austin (Two-way ADCIRC and HEC-RAS coupling); SWG-MVN-SAJ Workshop



Compound Flooding in Sabine Lake, TX

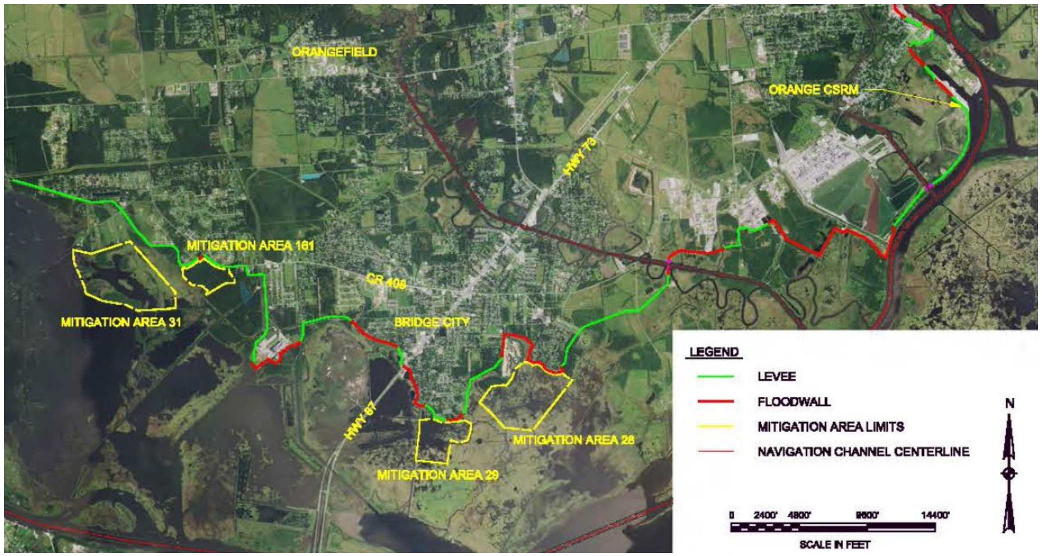
Dependence Analysis – 95th Surge

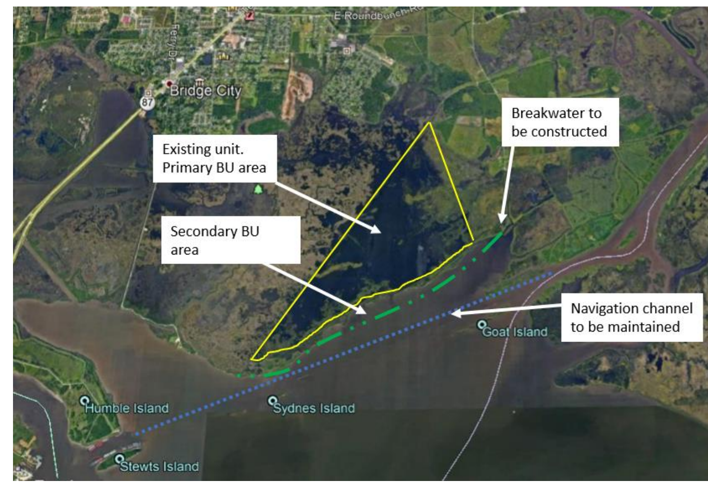




Engineering-with-Nature (EwN) / Natural and Nature-Based Features (NNBF)

- ERDC, DRC (Various Universities), Texas A&M, Galveston





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Challenges and Opportunities

- Significant (implementable) advancements have been made, but equally significant challenges remain with regard to uncertainty and accuracy, as well as fundamental understanding of physical processes, in implementing presently available tools and methodologies

- Coastal storm hazard models – both for surge and waves - must be comprehensively validated against observational data from historical storms, updated incorporating latest topographic/bathymetric data, and continually validated for new events/data.

- Integrate phase-resolving wave models (e.g. Boussinesq) to supplement/complement spectral phase-averaged wave models (e.g. STWAVE, SWAN) into coastal storm hazards modeling and analysis

- Develop process-based and calibrated/validated models to supplement empirical tools (with large uncertainties, and limited parameter range validity) presently being used (e.g. ship-induced waves; run-up and overtopping)

- Develop quantitative understanding of the importance of Compound Flooding (specifically, interaction of coastal surge and inland rainfall-induced runoff) and reliable, accurate and validated (translatable) tools and best practice/guidance that can be applied on projects

- Quantify performance metrics, including geomorphic evolution of NNBF with EwN principles and develop best practice/design guidance