



# APPLICATIONS AND INSIGHTS FROM DELFT3D FLEXIBLE MESH (FM) MODELING IN COASTAL AND INLAND WATER SYSTEMS

**Akash Sahu, MS, Coastal Protection Engineering (CPE)**

Co-Authors:

Morjana Signorin, MS, Coastal Protection Engineering (CPE)

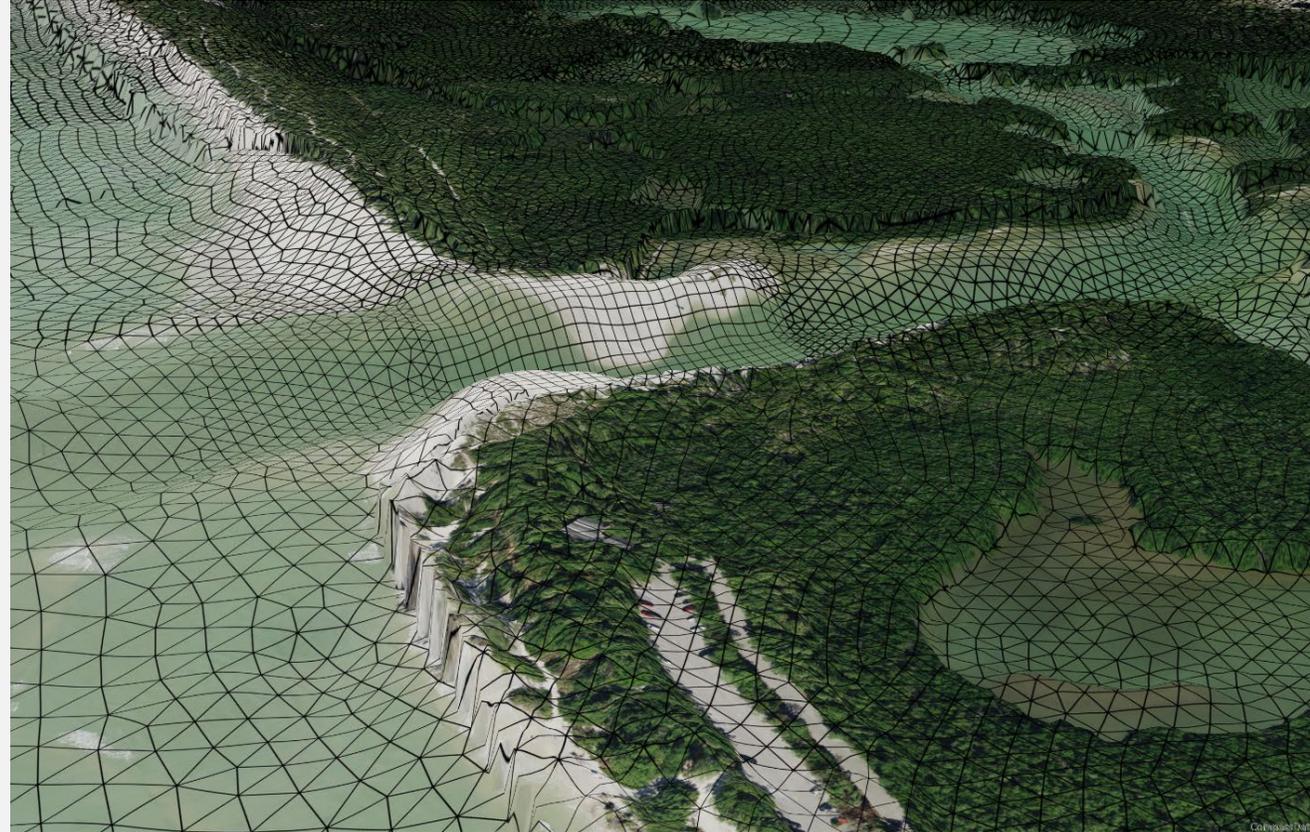
Lindino Benedet, PhD, Coastal Protection Engineering (CPE)



**FSBPA 39<sup>th</sup> Annual National Conference on Beach Preservation Technology**  
**February 2026, St. Augustine Beach, Florida**

# WHY DELFT3D FM?

- Successor of Delft3D structured and SOBEK from TU Delft/Deltares
- Unstructured 1D-2D-3D grids, widely used on the coast, lakes and rivers
- Allows for the simulation of the interaction of water, sediment, water quality, ecology, in time and space
- Includes coupling of coastal hydrodynamics & hydrological processes
- Allows for implementation of hydrological structures such as weirs, gates, pumps & flow obstacles like dams



**Wiggins Pass, Collier County, FL**

# CASE STUDIES

*Case Study 3*  
*Lake Mattamuskeet, NC* ★

*Case Study 5*  
*Lake Boudreaux & Lake* ★  
*Quitman, LA*

*Case Study 4*  
★ *Apalachicola Bay, FL*

*Case Study 2*  
*Caloosahatchee River, FL* ★

★ *Case Study 1*  
*Collier County, FL*



# **CASE STUDY 1**

## **COLLIER COUNTY, FL**



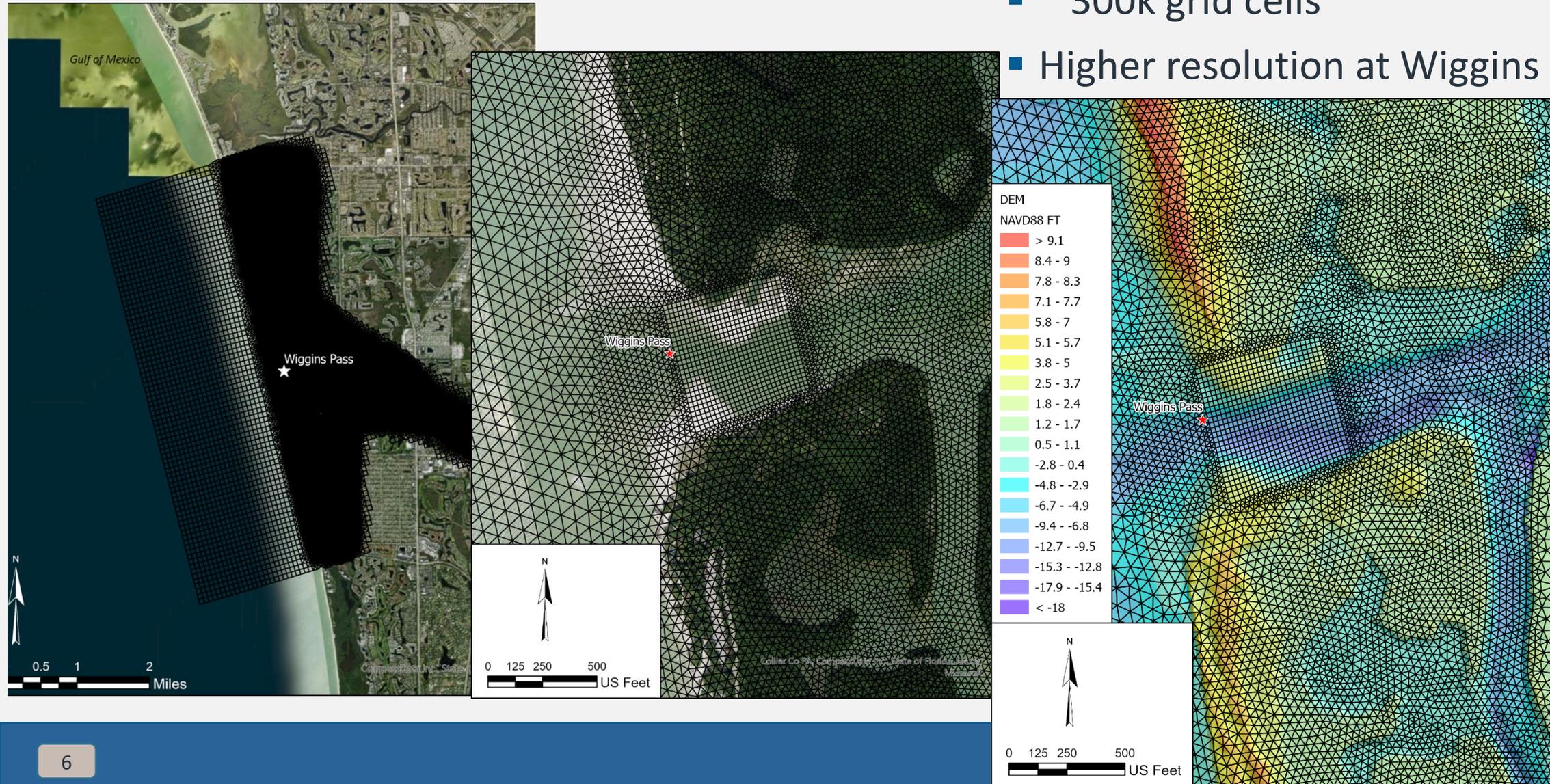
# BACKGROUND

- Collier County Coastal Storm and Risk Management (CSRМ) Draft Integrated Feasibility Study (IFS) and Environmental Impact Statement (EIS)
- Beaches, dunes, floodwalls, mangrove restoration, **storm surge gates at major inlets (Wiggins Pass, Doctors Pass)**
- Storm surge gates included sector gates, groins, T-Walls
- Questions about impact of the gates on water quality - freshwater discharges, flushing, back-bay salinities and flows
- Three historic storms simulated (H. Irma, H. Wilma and 1993 'Storm of the Century')

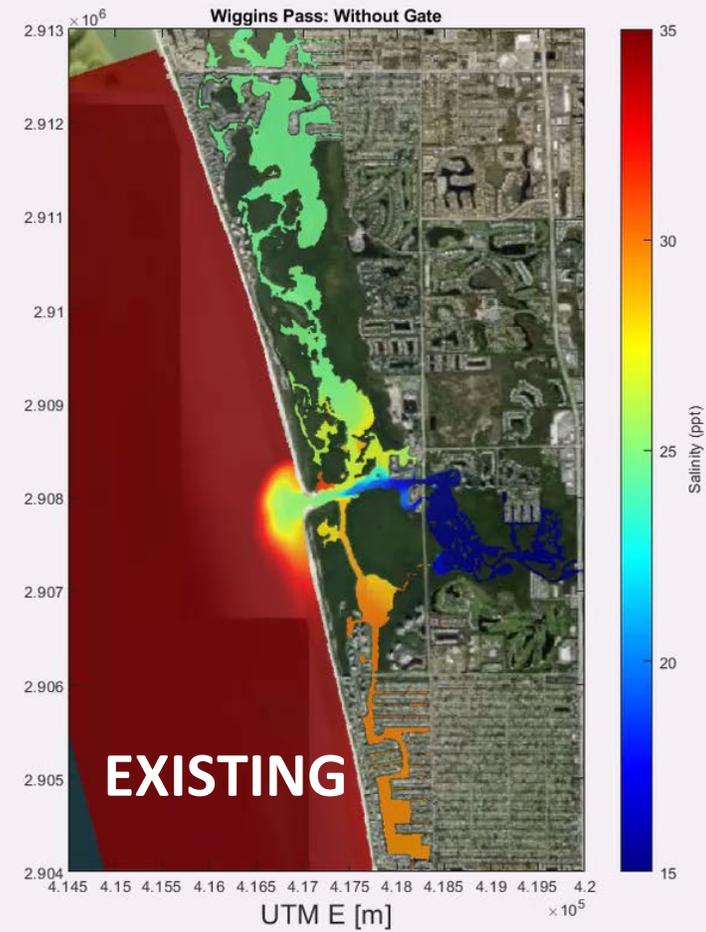
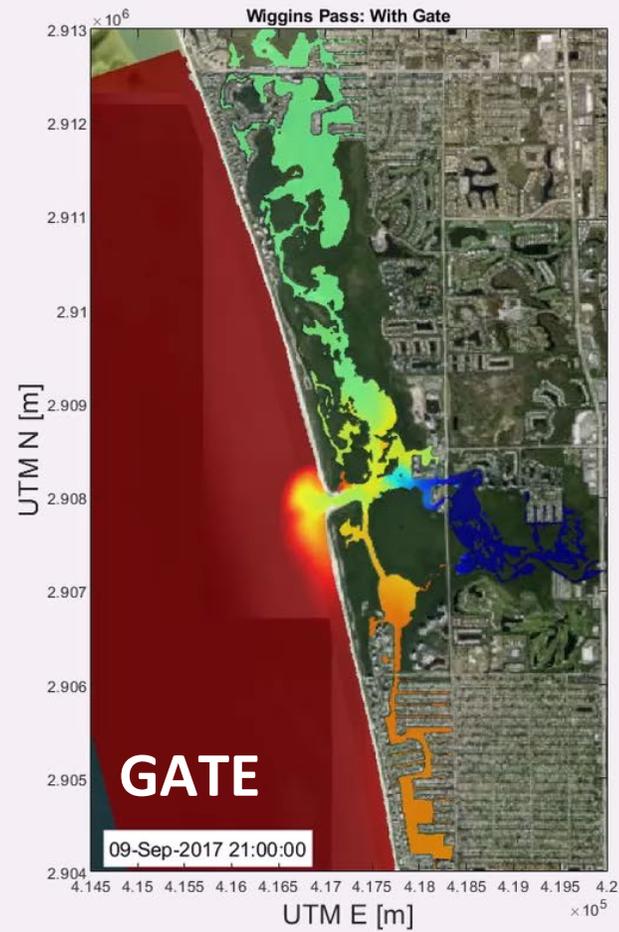


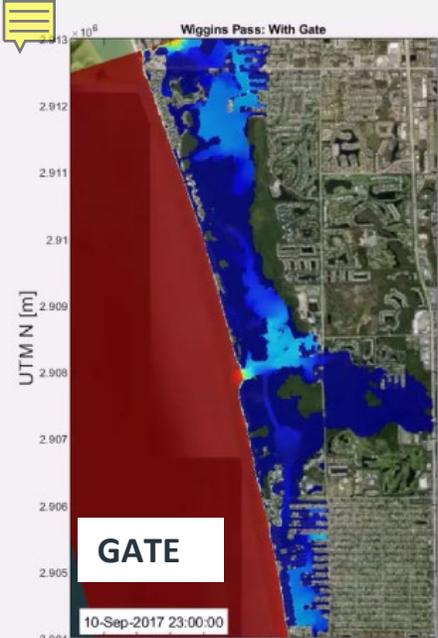
# MODEL SETUP – WIGGINS PASS

- ~ 300k grid cells
- Higher resolution at Wiggins Pass

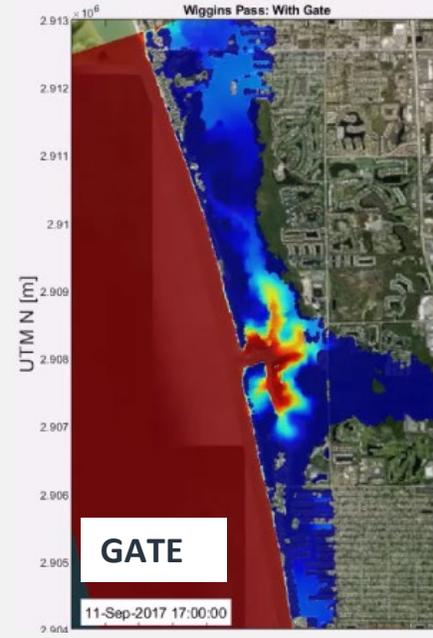
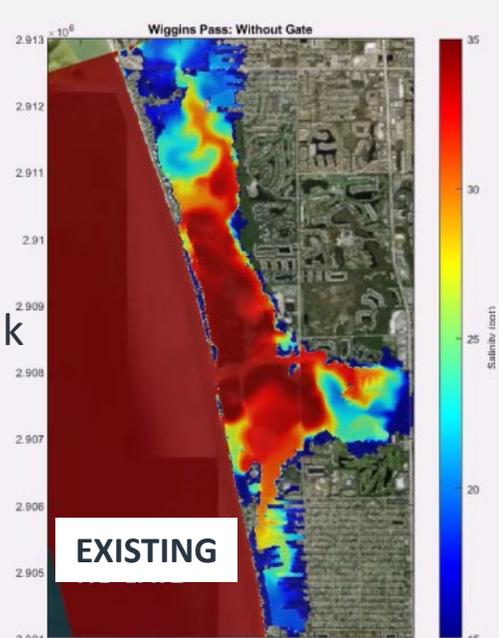


# HURRICANE IRMA – WIGGINS PASS SALINITY

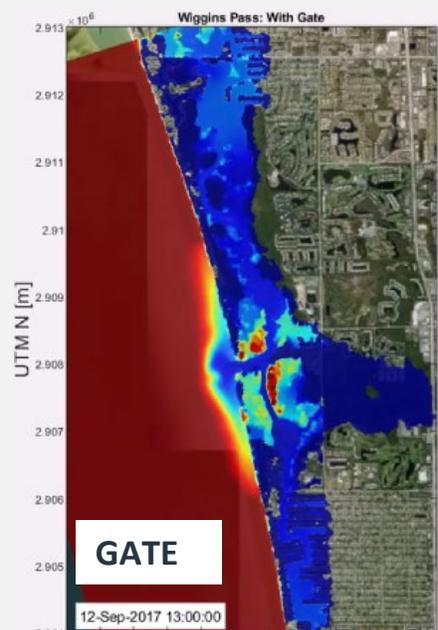
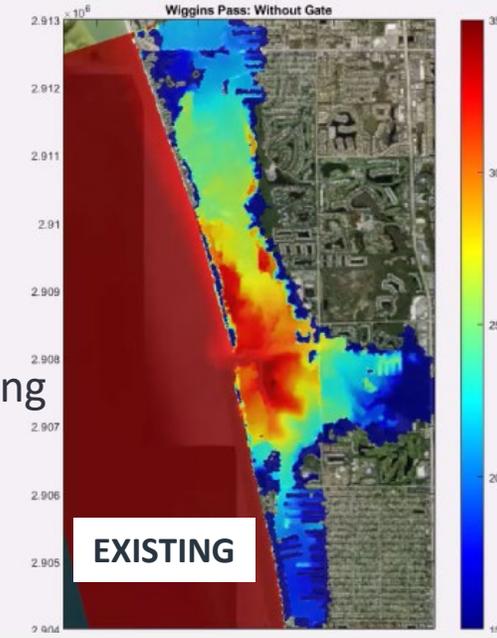




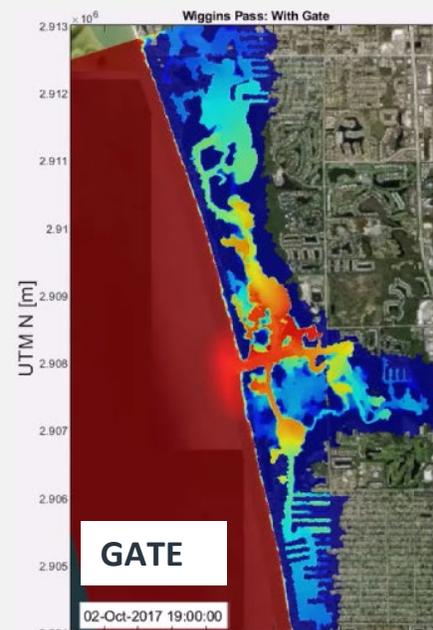
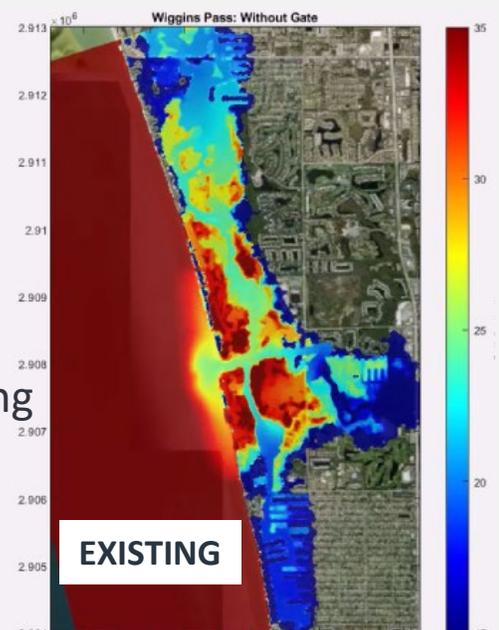
1. H. Irma, Peak



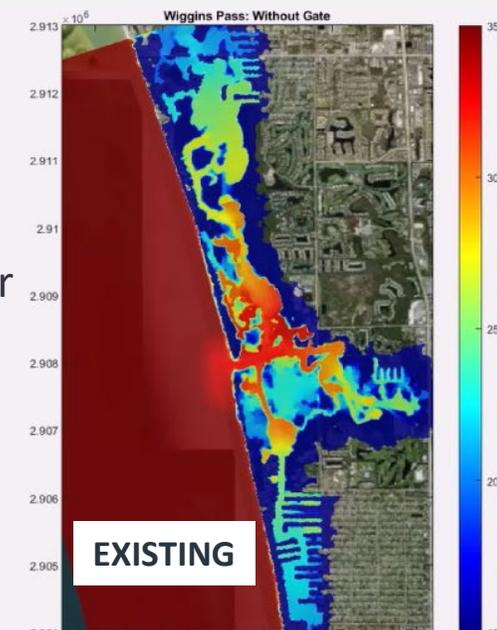
2. H. Irma, Gate Reopening



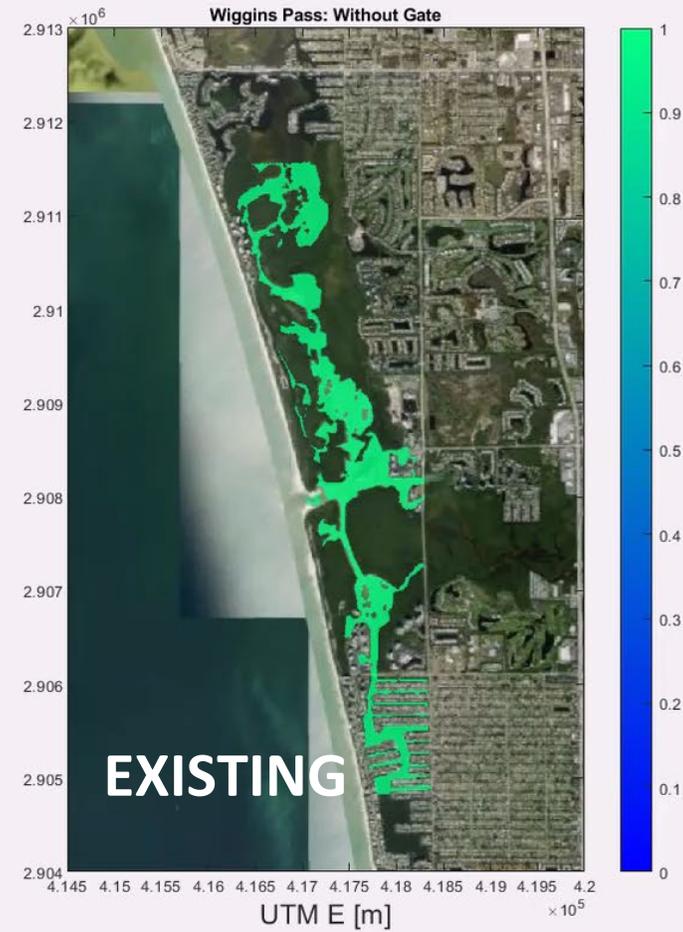
3. H. Irma, 1<sup>st</sup> Outgoing Tide After Gate Reopening

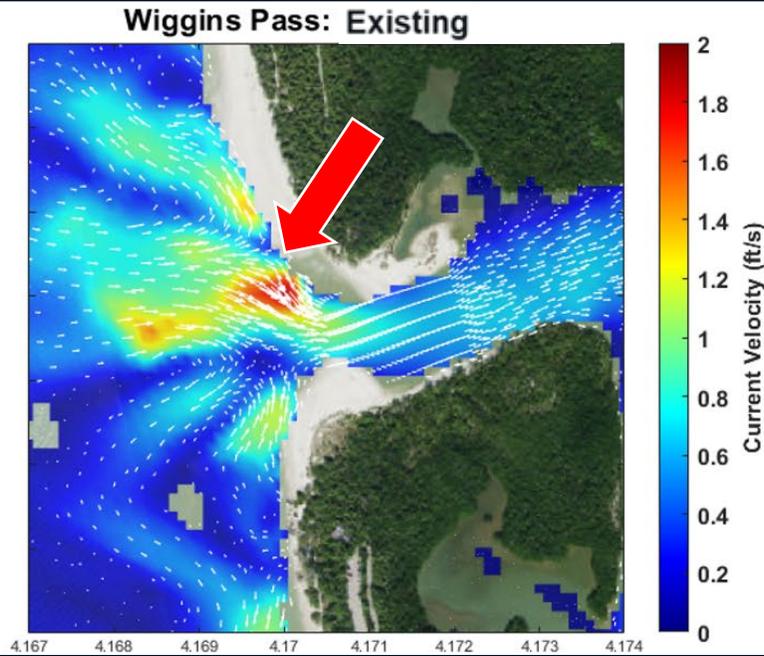
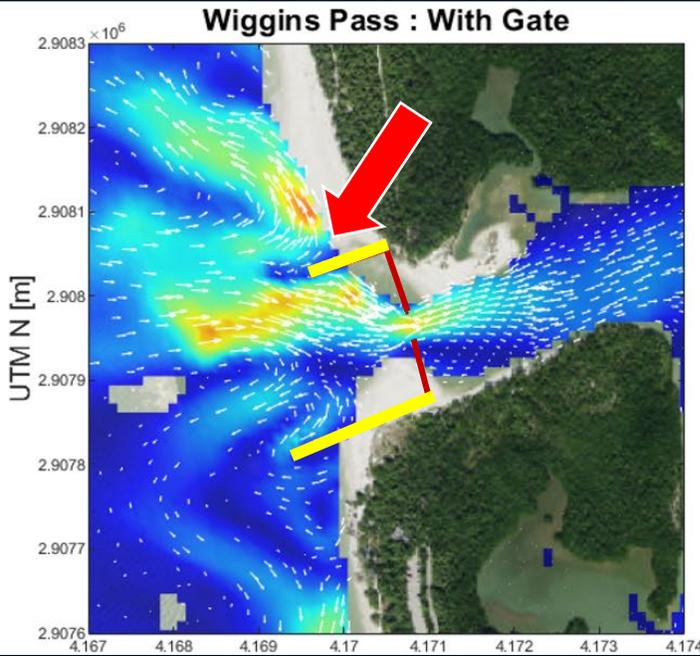
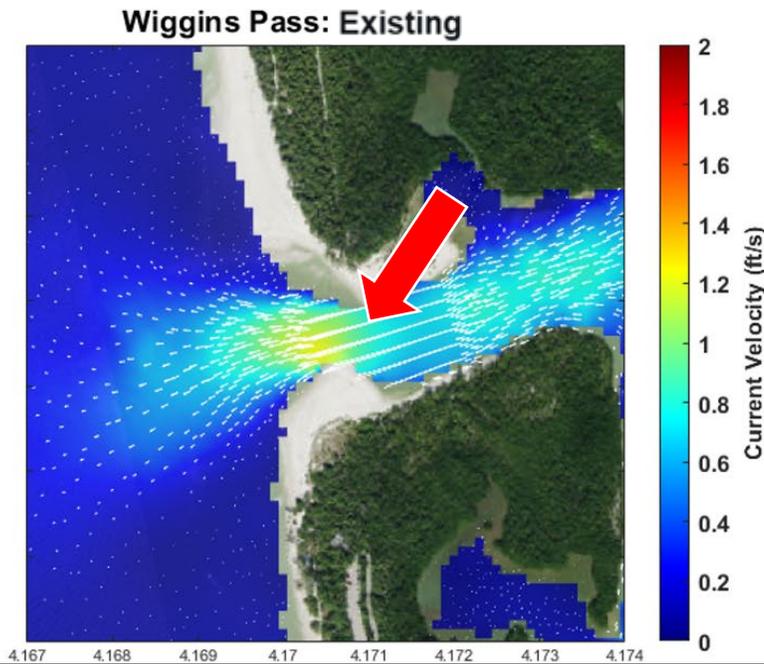
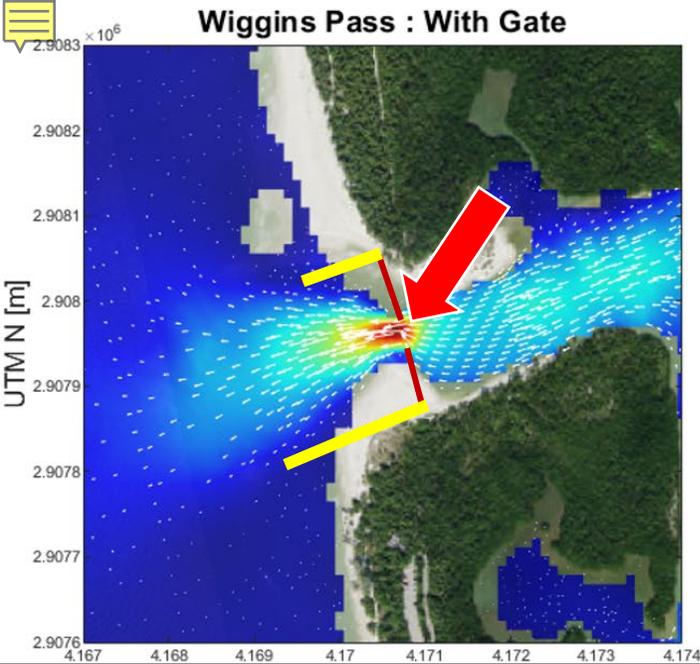


4. H. Irma, 20 Days after Storm Peak



# HURRICANE IRMA – WIGGINS PASS TRACER





# WIGGINS PASS - CHANGES IN FLOW

- USACE proposed the addition of add two jetties, T-walls and sector gates
- Structures significantly influence ebb and flood flow velocities and will in-turn affect ebb and flood shoals



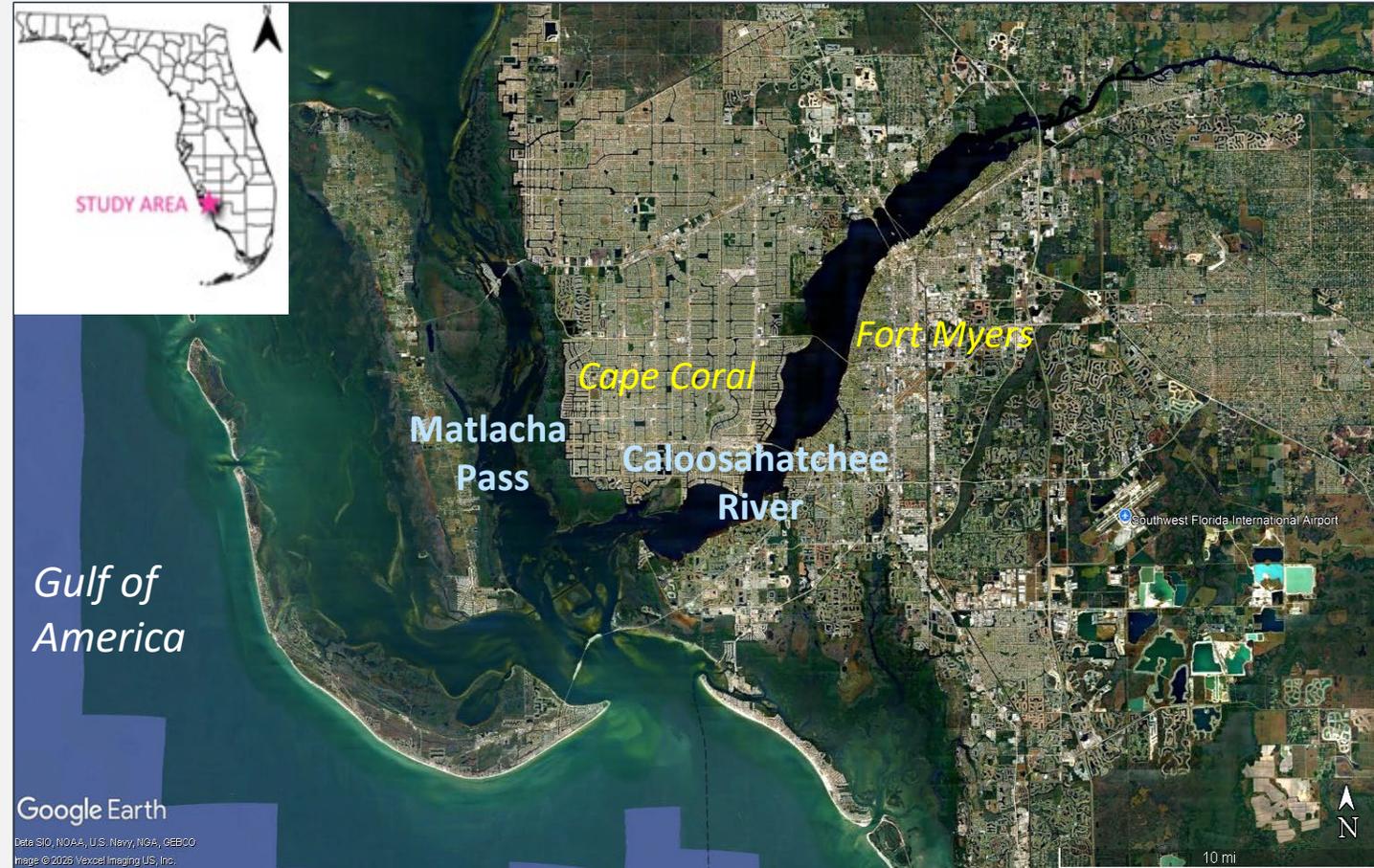
# **CASE STUDY 2**

# **CALOOSAHATCHEE RIVER, FL**

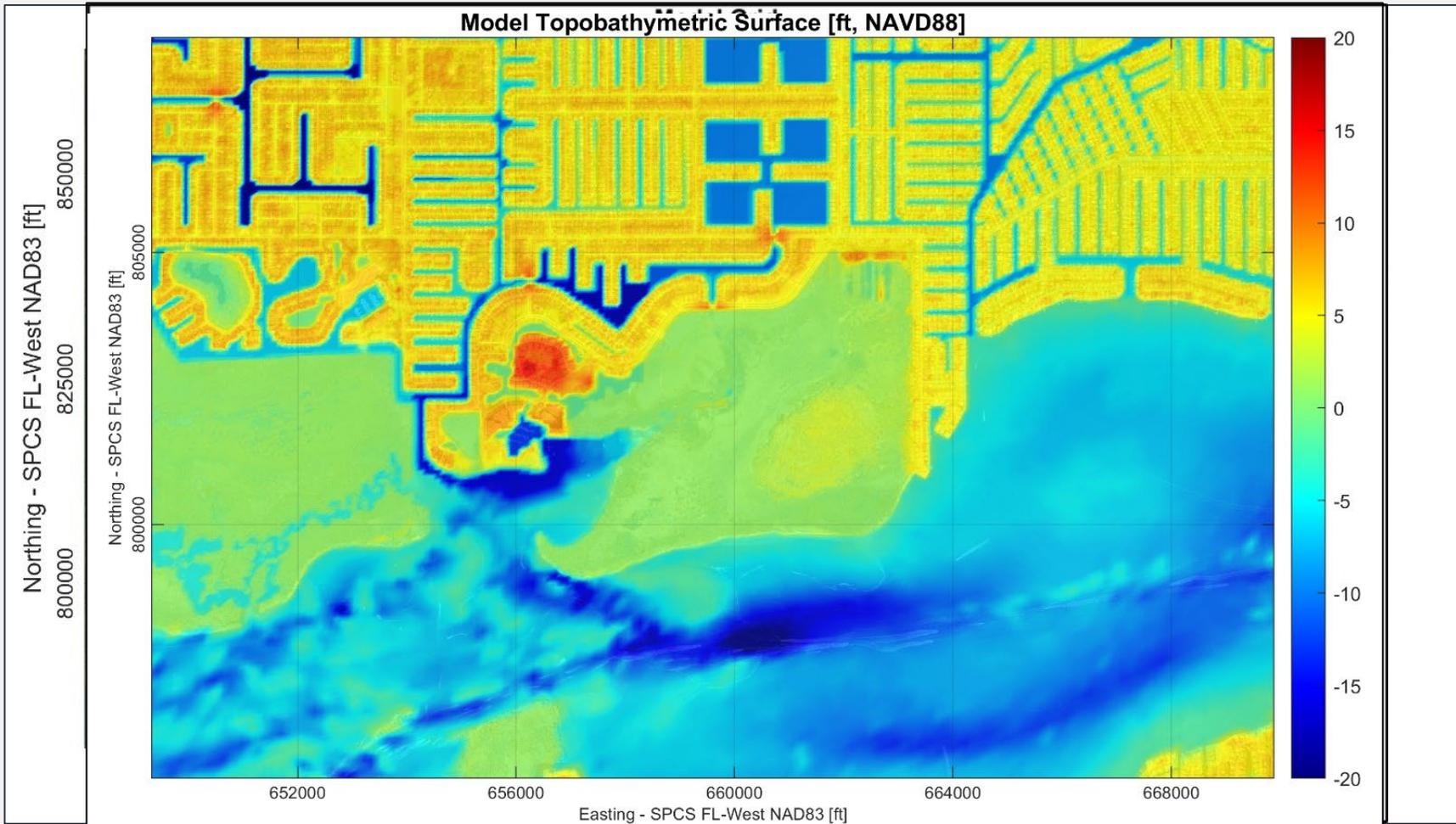


# BACKGROUND

- Study conducted to assess flooding along the Caloosahatchee River in Lee County, FL
- Delft3D FM was utilized to simulate the hydrodynamics of Caloosahatchee River for Hurricanes Ian (Cat 4) and Milton (Cat 3)



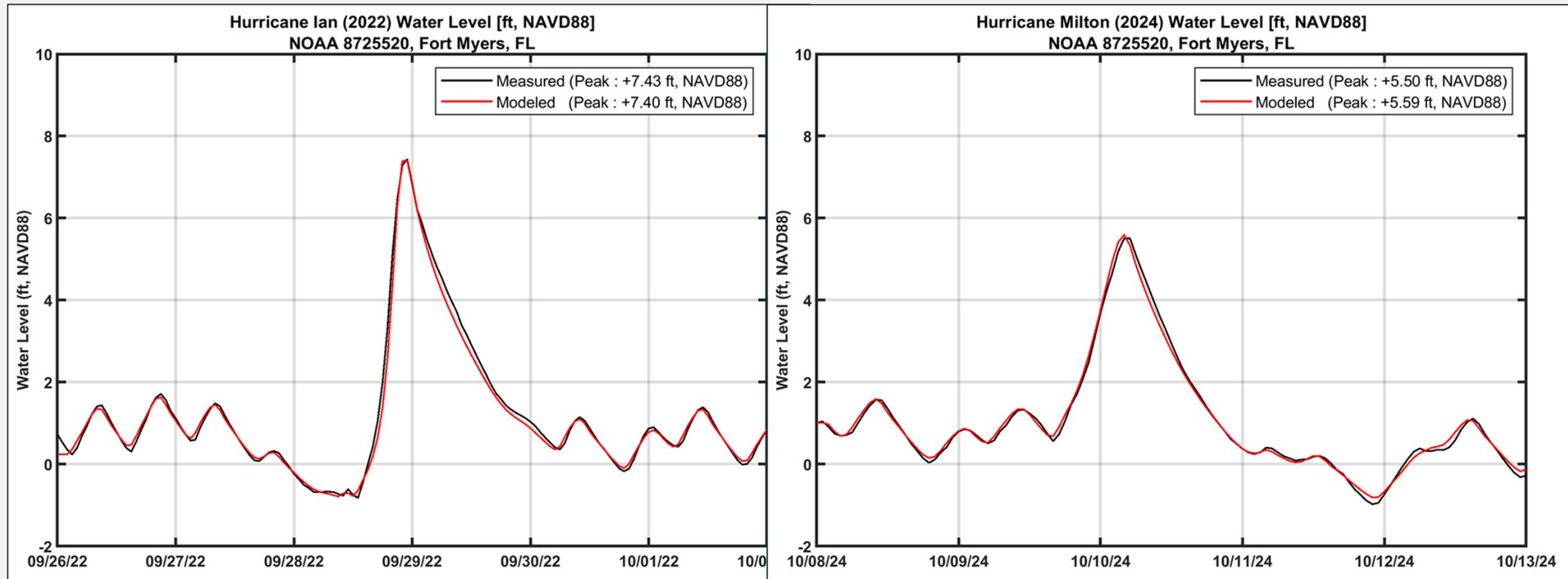
# MODEL SETUP



- ~ 500k grid cells
- Higher resolution provided where flooding assessment was required

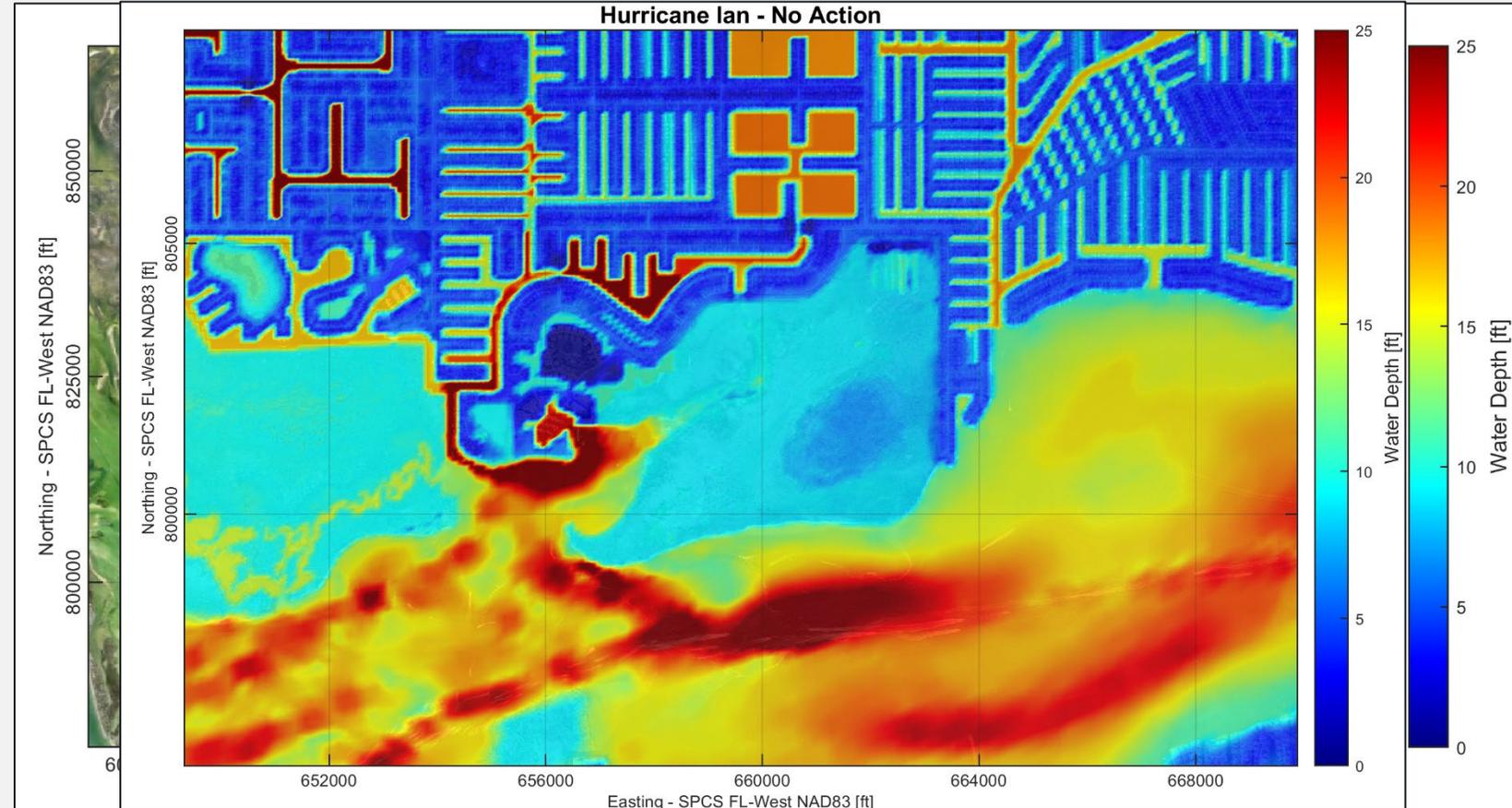
# MODEL CALIBRATION

- Measured vs Modeled Water Levels at NOAA Fort Myers Station location



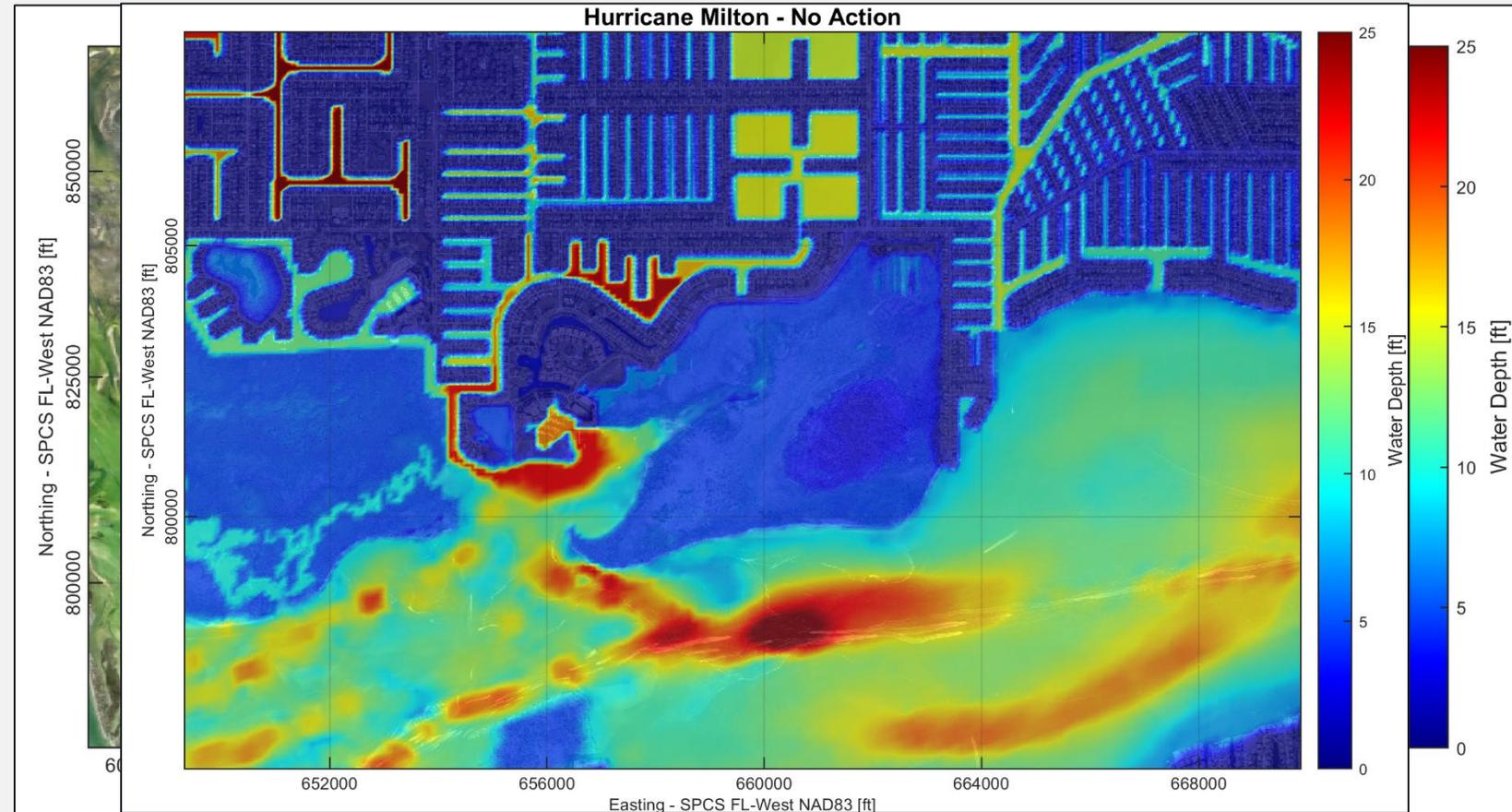
# MODEL RESULTS – FLOODING

- Hurricane Ian caused more inland inundation on the west side of Caloosahatchee River and east of Matlacha Pass
- Hurricane Ian also led to higher flood levels



# MODEL RESULTS – FLOODING

- Relative to Hurricane Ian, Hurricane Milton led to less inland inundation and lower flood levels





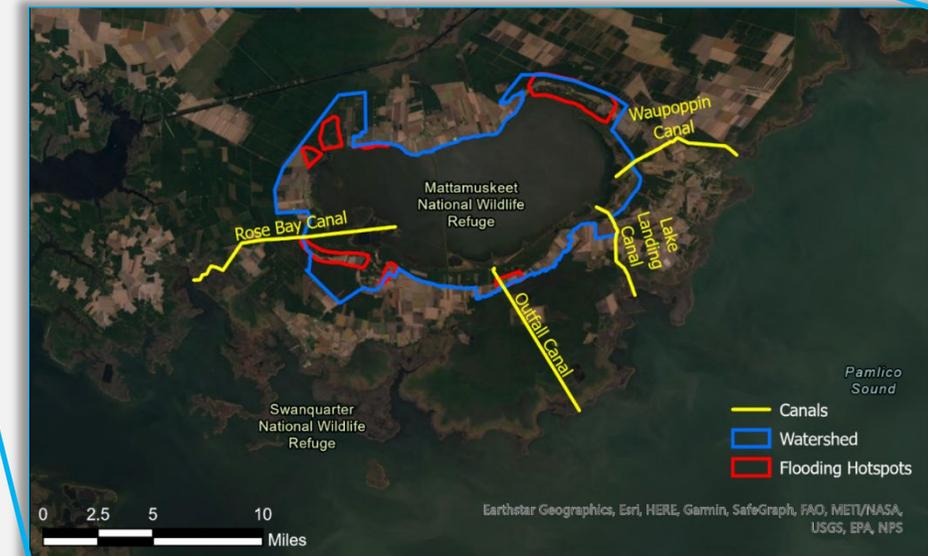
# **CASE STUDY 3**

# **LAKE MATTAMUSKEET, NC**



# BACKGROUND

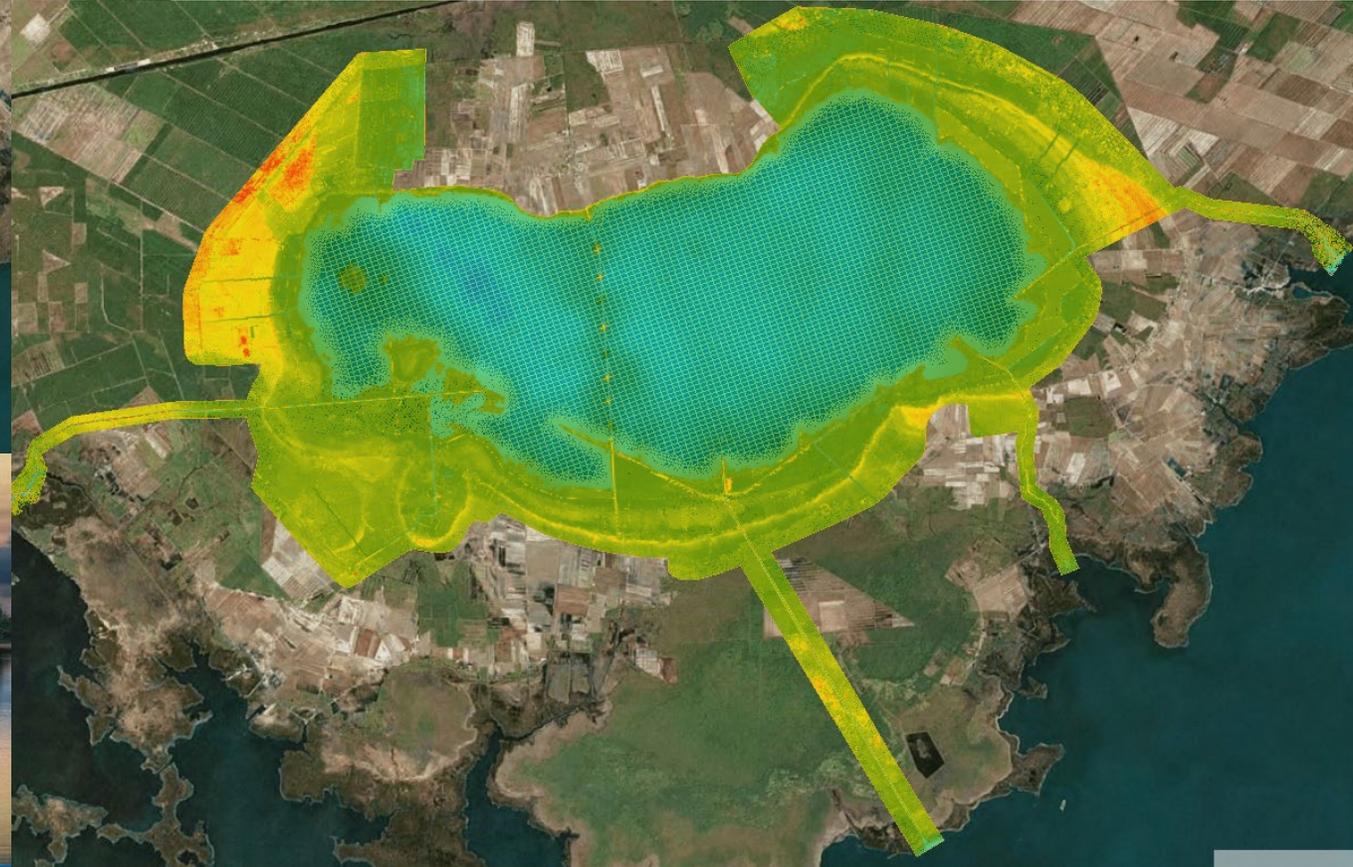
- Coastal lake in Hyde County, NC, that drains into the Pamlico Sound (Outer Banks) by four outlet canals. Canals have gravity gates (salinity control structures)
- Due to SLR, ability to drain has decreased. Lake water levels often lower than the Sound water levels
- Severe flooding due to extreme rainfall events associated with tropical storms, long periods to drawdown
- Delft3D FM utilized to understand flooding processes and evaluate adaptation strategies



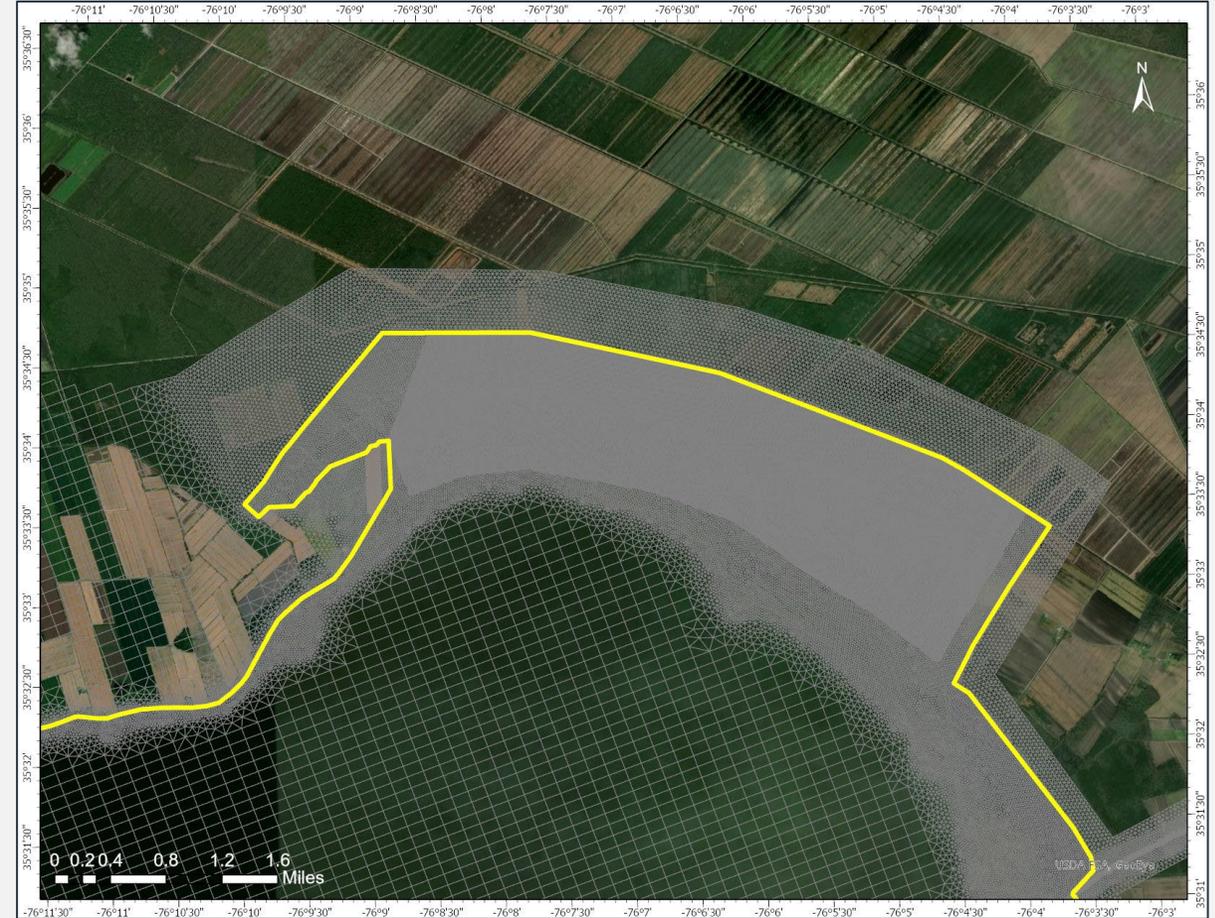
# MODEL SETUP



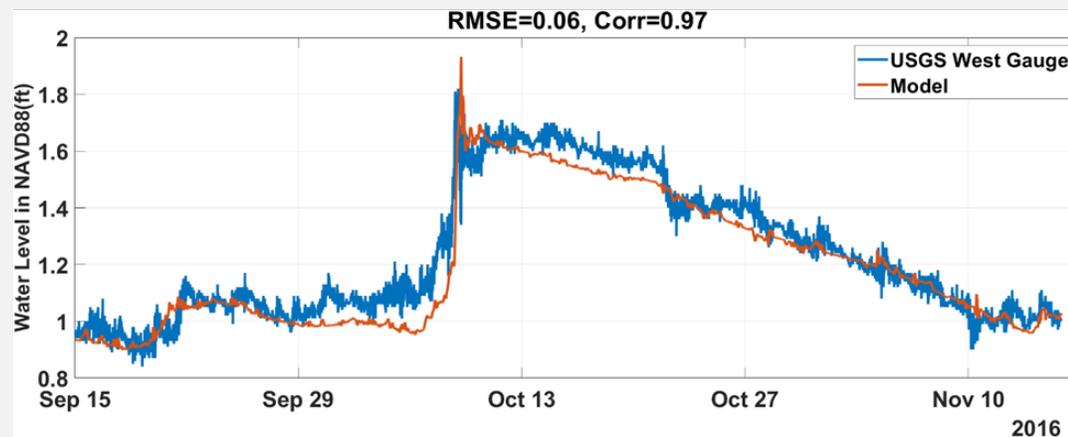
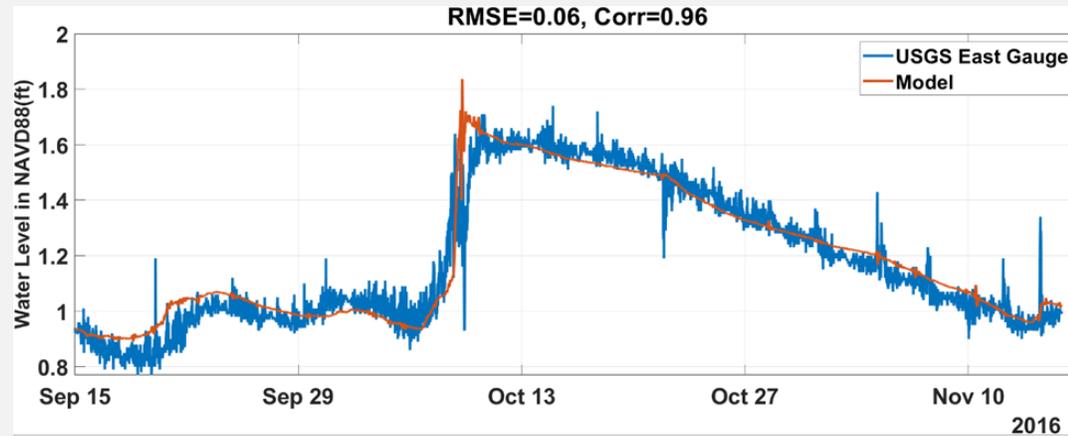
- > 1M grid cells
- Higher resolution at flooding hotspots, bridges and canals



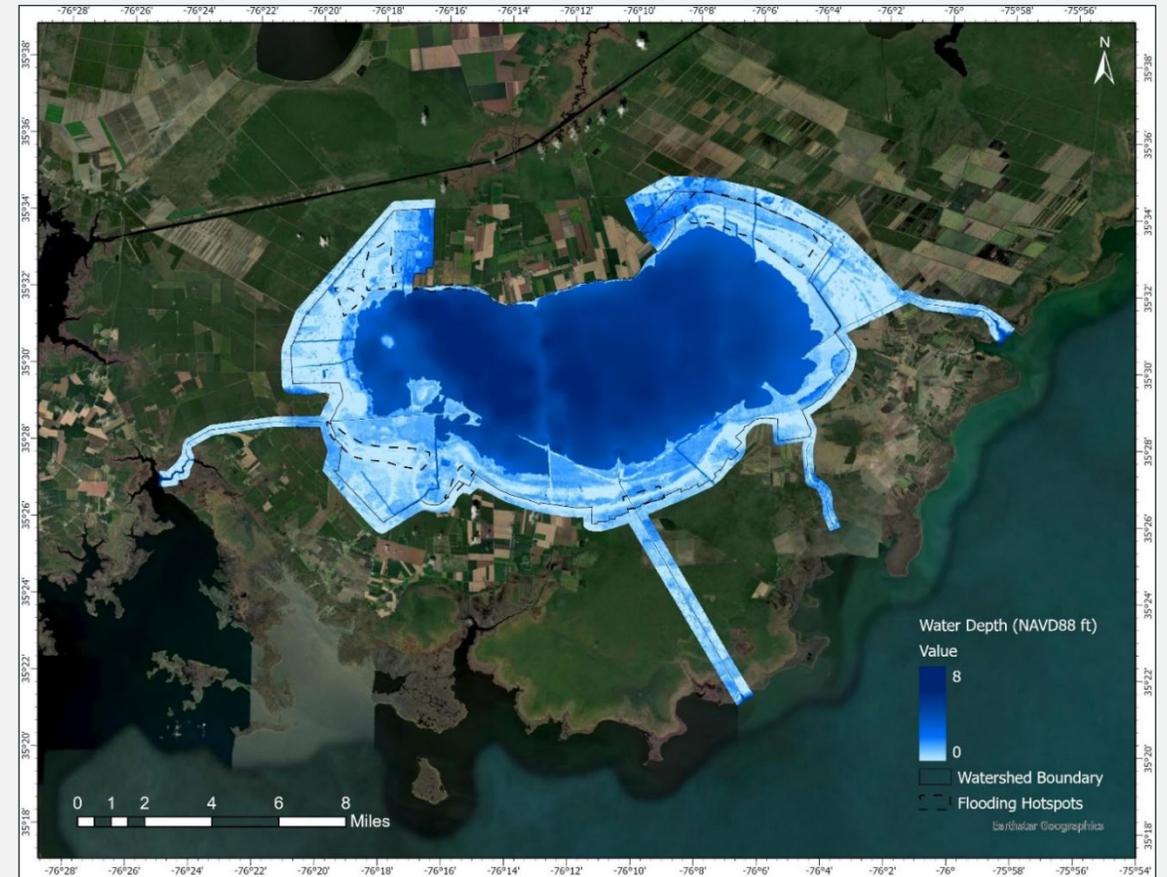
# MODEL SETUP – GRID REFINEMENT



# MODEL CALIBRATION



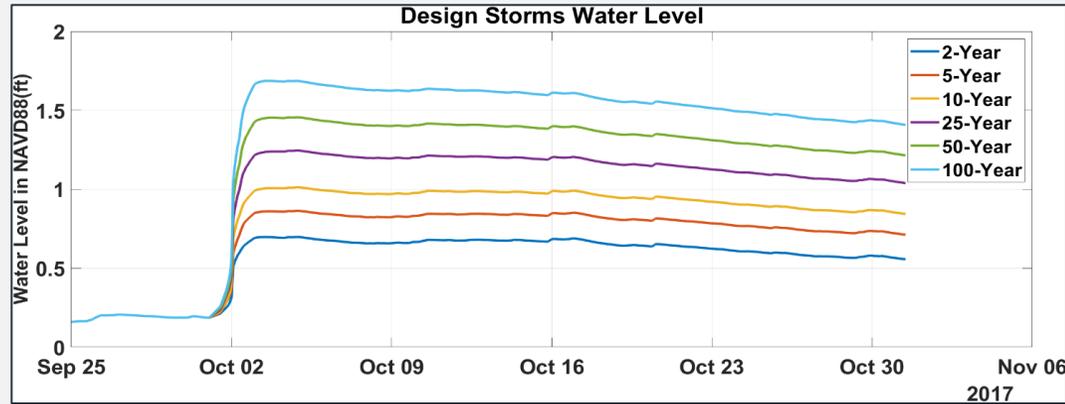
Model Performance, Hurricane Matthew



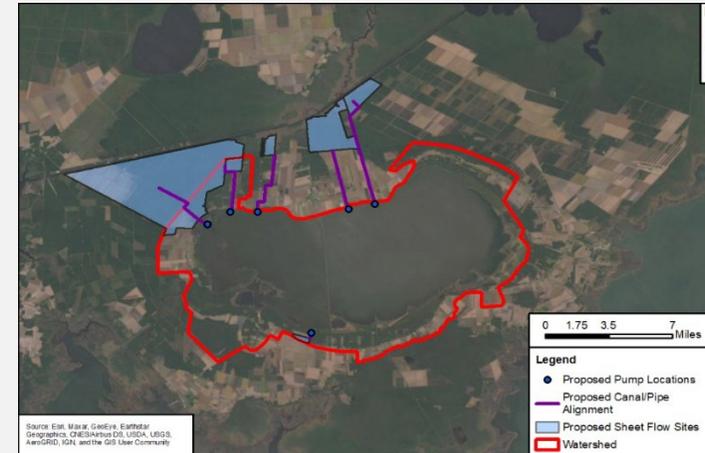
Flooding, H. Matthew Peak

# MODEL PRODUCTION RUNS

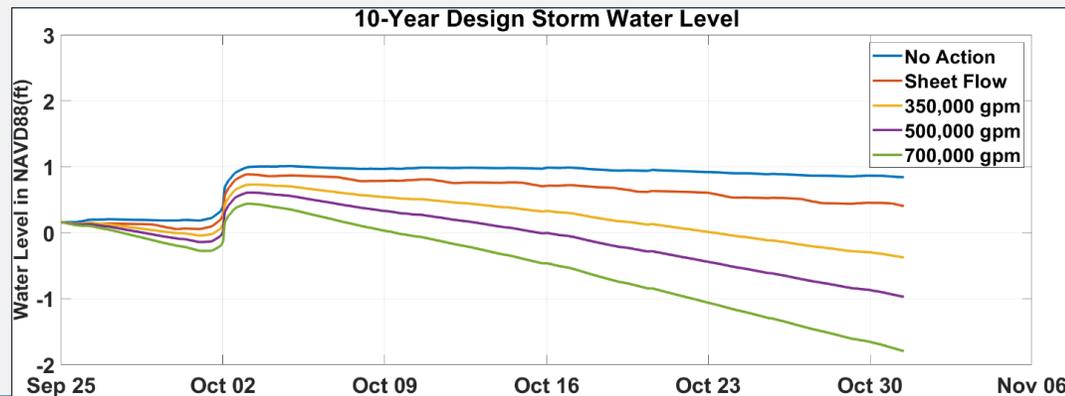
## (1) Developed design storms



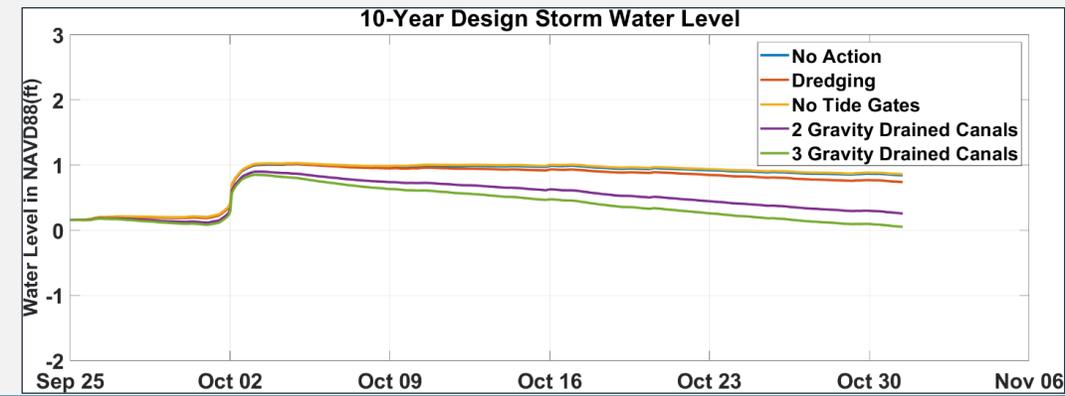
## (2) Evaluated alternatives - dredging, pumping, sheet flow sites, gravity drained canals



### 10 Yr design storm, sheet flow sites and pumps



### 10 Yr design storm, dredging and gravity canals



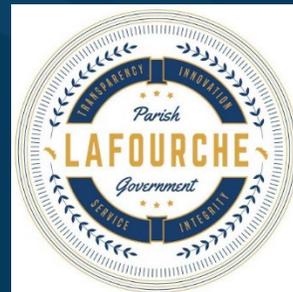


# MAIN TAKEAWAYS

- **Excellent for coastal applications:** Integrated hydrodynamic and hydrologic processes support comprehensive coastal resiliency studies.
- **Flexible unstructured mesh:** Capable of accurately representing meandering rivers, branching estuaries, tidal creeks, and coastal inlets.
- **Efficient multi-scale resolution:** Allows local refinement near banks, structures, and shoals without unnecessary offshore or upstream refinement.
- **Hydraulic structures:** Includes weirs, culverts, bridges, vertical lift gates, flap gates, gravity gates, pipes, pumps and other control structures within the flexible mesh framework.
- **User-friendly, interactive GUI:** Facilitates efficient model setup, visualization, and analysis.
- **Fully coupled system modeling:** Seamless integration of hydrodynamics with waves, sediment transport, morphology, and water quality.

# THANK YOU!

## Special thanks to:



## Contact Information:

Akash Sahu

Coastal Modeler

Coastal Protection Engineering

[asahu@coastalprotectioneng.com](mailto:asahu@coastalprotectioneng.com)