THE IMPORTANCE OF SCIENCE IN COASTAL RESTORATION IN LOUISIANA

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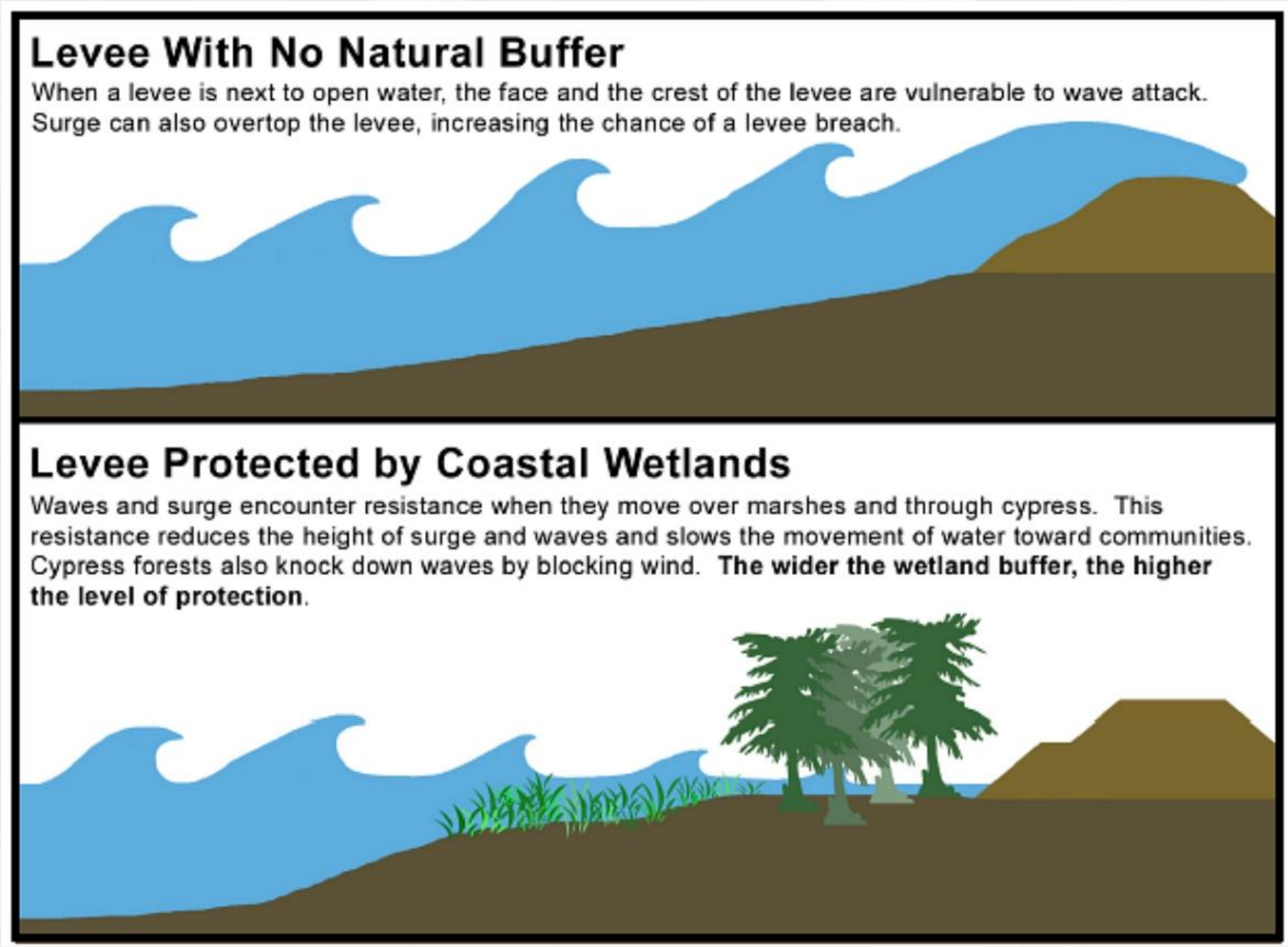
US Army Corps of Engineers
BUILDING STRONG®

LCA S&T Office

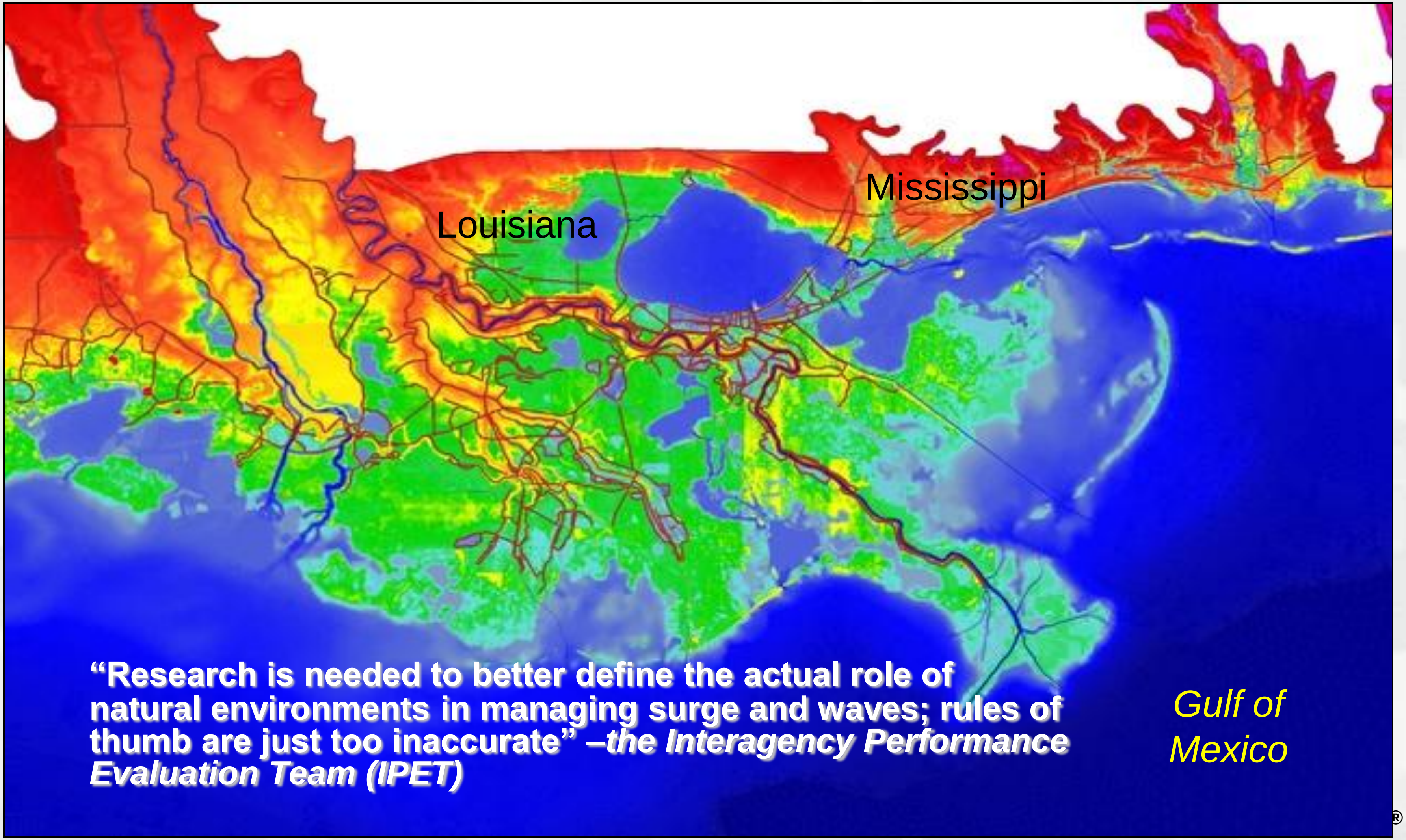
- Authorized under WRDA 2007
- Designed to address technical issues encountered by restoration projects and system-wide issues
- Completed approximately 40 reports to date, provided technical assistance to District and State dozens of times
- Currently not supported by State of Louisiana

WETLANDS , STORM SURGES, AND WAVES

“barrier islands and bayous…protected the low-lying coast from hurricanes and flooding.”

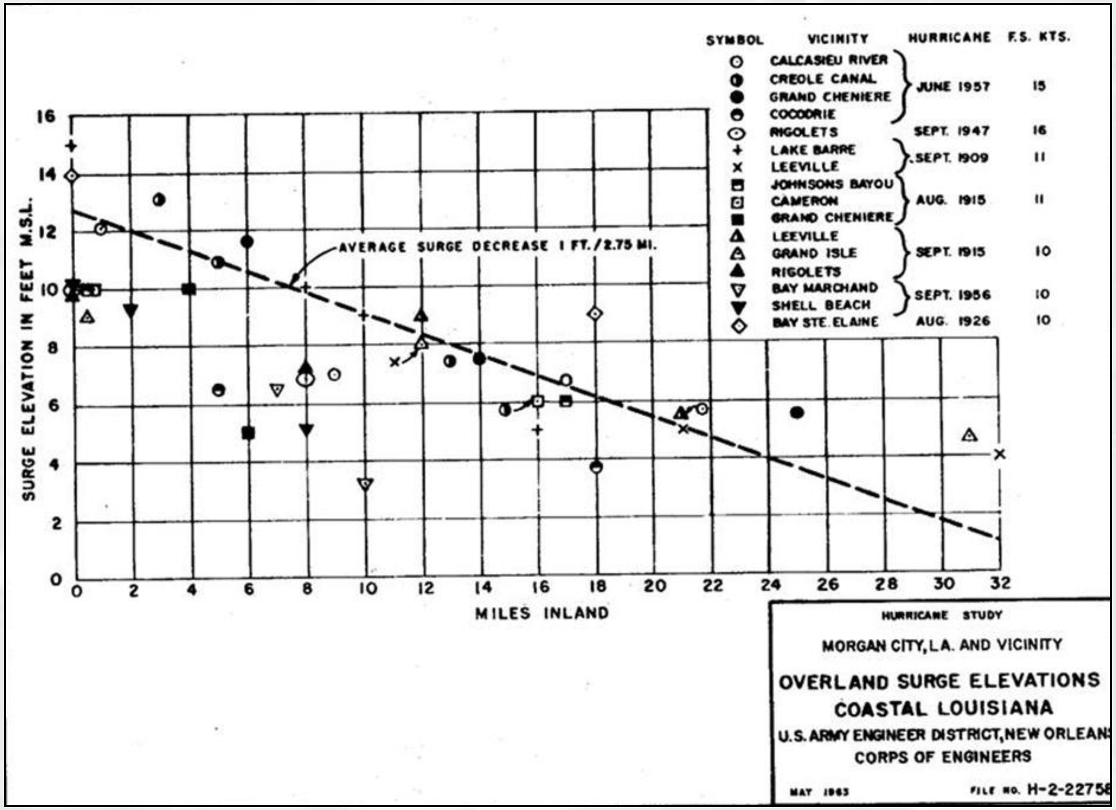

Levee With No Natural Buffer
When a levee is next to open water, the face and the crest of the levee are vulnerable to wave attack. Surge can also overtop the levee, increasing the chance of a levee breach.
Levee Protected by Coastal Wetlands
Waves and surge encounter resistance when they move over marshes and through cypress. This resistance reduces the height of surge and waves and slows the movement of water toward communities. Cypress forests also knock down waves by blocking wind. The wider the wetland buffer, the higher the level of protection.

Interaction of Hurricanes and Natural Coastal Features



Motivation

Commonly stated "rule of thumb": -1ft per 2.75 mi (USACE 1963)



When grouped by storm/area:
-1 ft per 11.4 mi to -1 ft per 1 mi

Approach

- High-resolution modeling system is capable of representing complicated coastal landscapes (both engineered and natural features) and simulating all the primary relevant physical processes, including winds, air-sea momentum transfer, atmospheric pressure, wind-driven waves, river flows, tides, and friction due to land cover.
- Model system is applied to quantify the surge and wave reduction potential of these features and understand how to integrate these features in a holistic storm damage reduction system.

Approach

Application of a high-resolution, integrated numerical modeling system

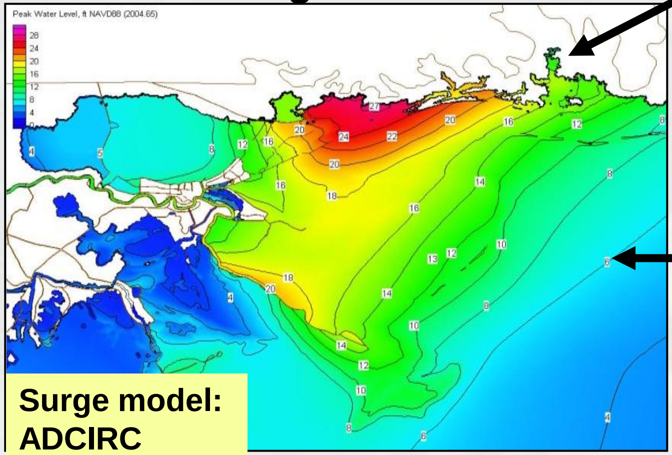
- IPET
- FEMA
- LaCPR
- MsCIP

Wind Field – Wind Stresses

MORPHOS
PBL

5 day storm simulation takes ~8 hours on 256 processors

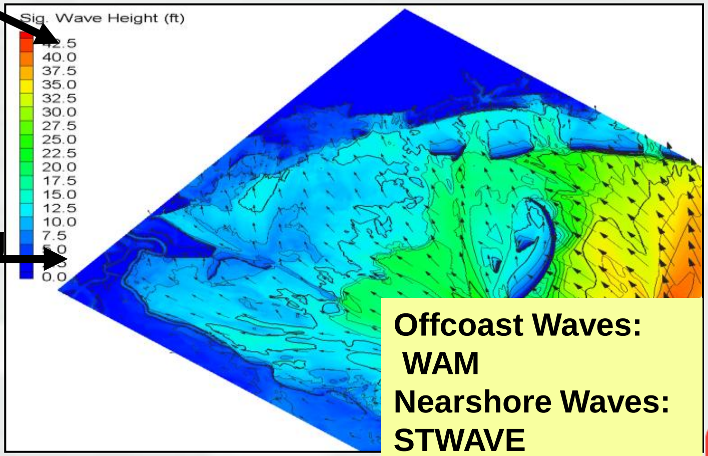
Surge Model



Surge model:
ADCIRC

Coupling

Wave Models



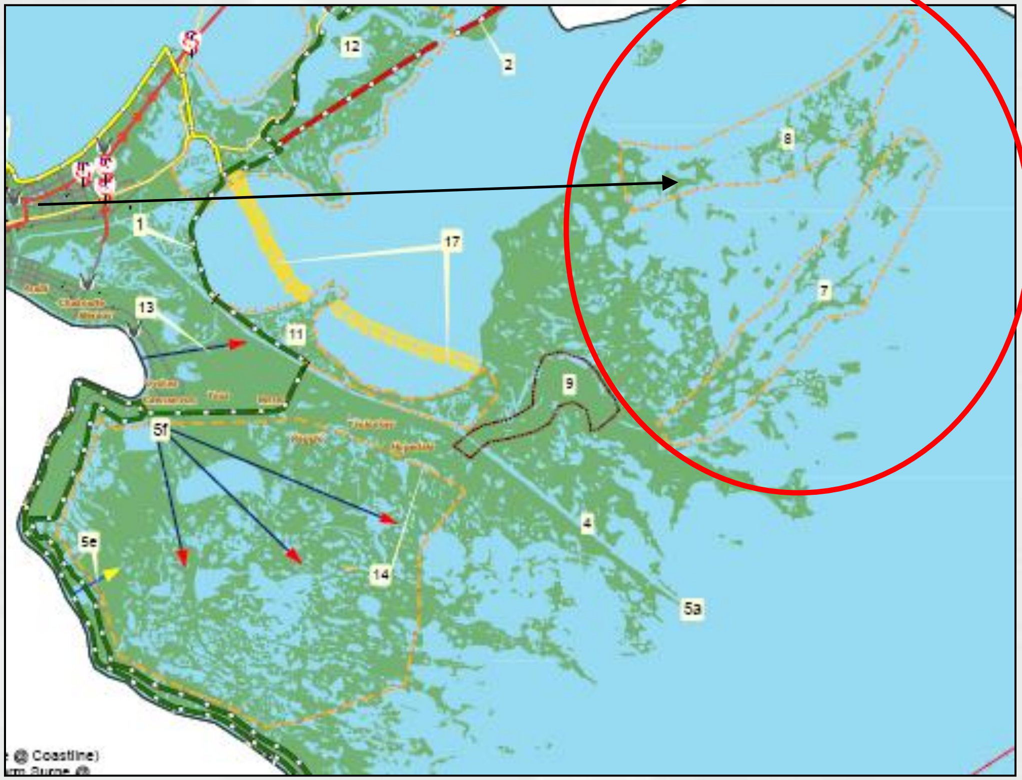
Offcoast Waves:
WAM
Nearshore Waves:
STWAVE

System was validated against high water marks from Hurricanes Katrina and Rita

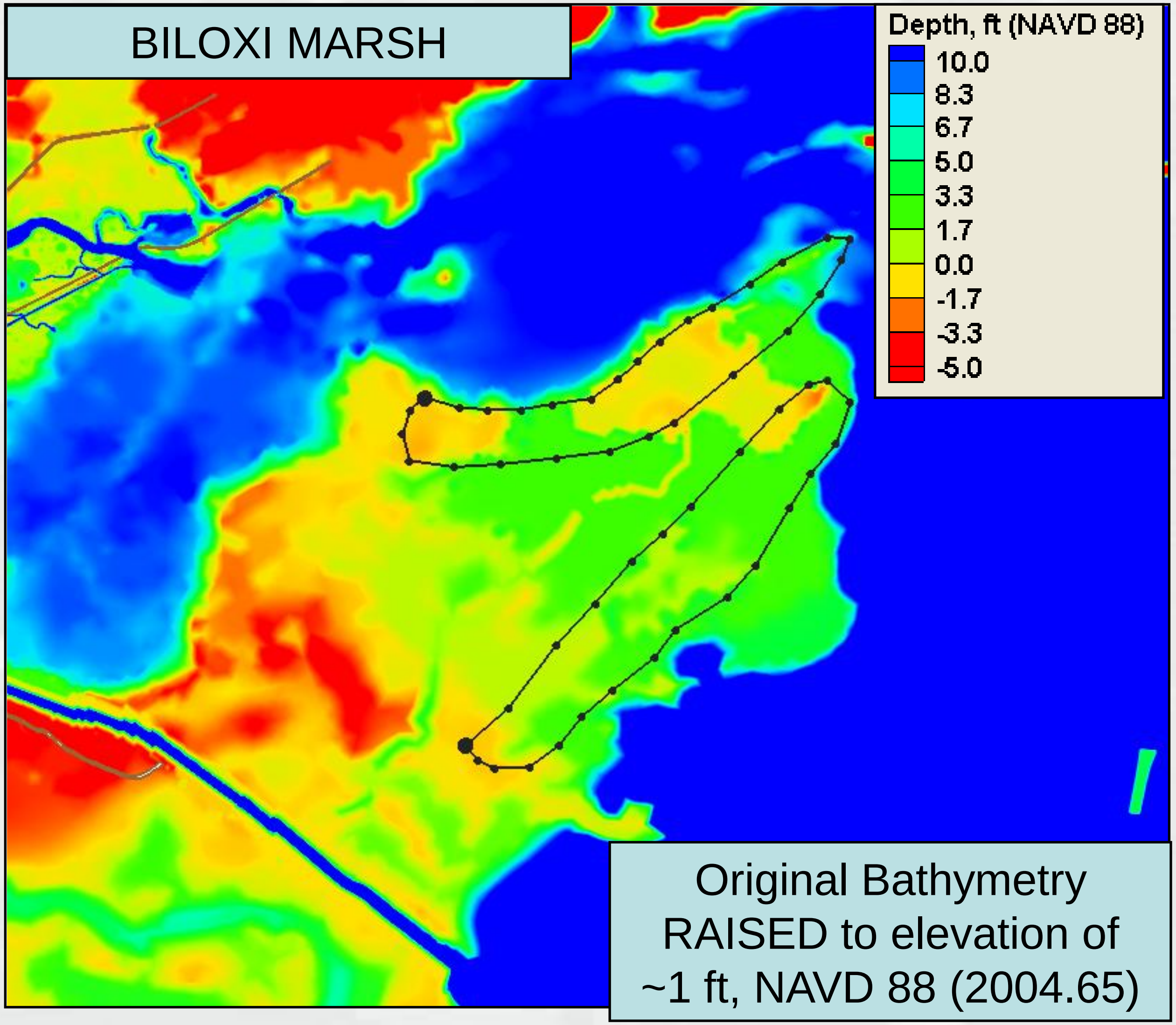
Sensitivity Analysis Bathy/topo & Manning-n

Marsh Restoration/Deterioration

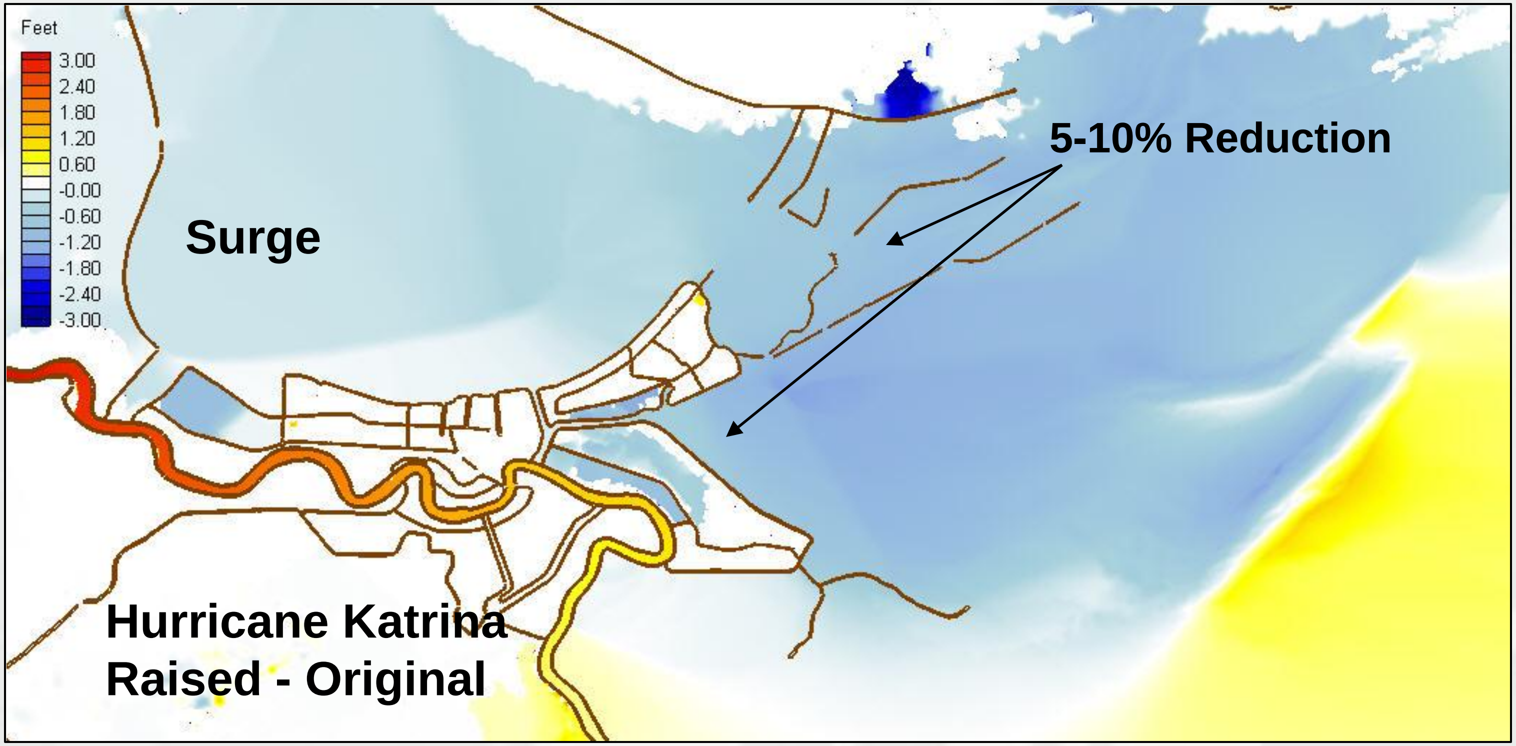
- Biloxi Marsh



Biloxi Marsh Restoration

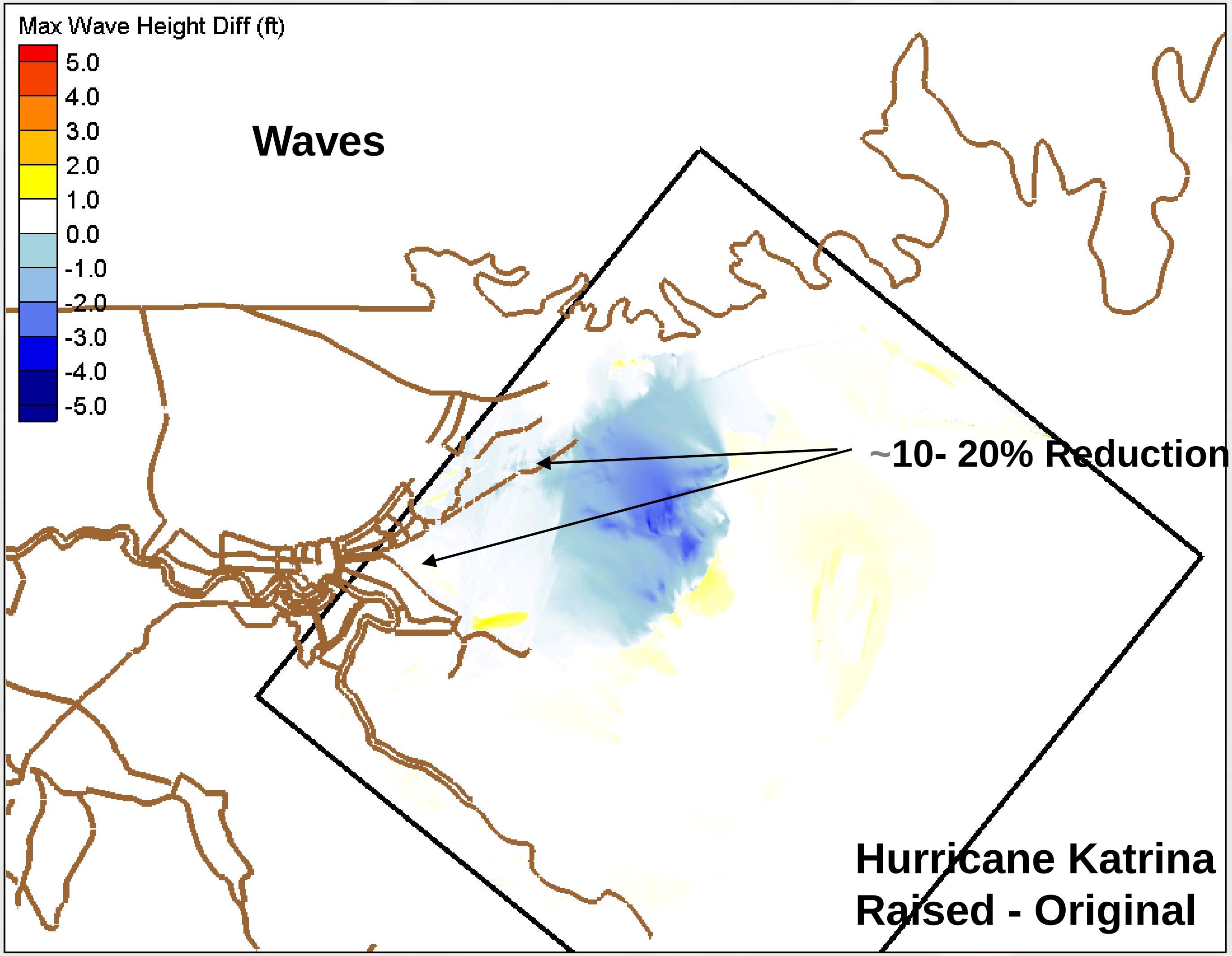


Biloxi Marsh Restoration



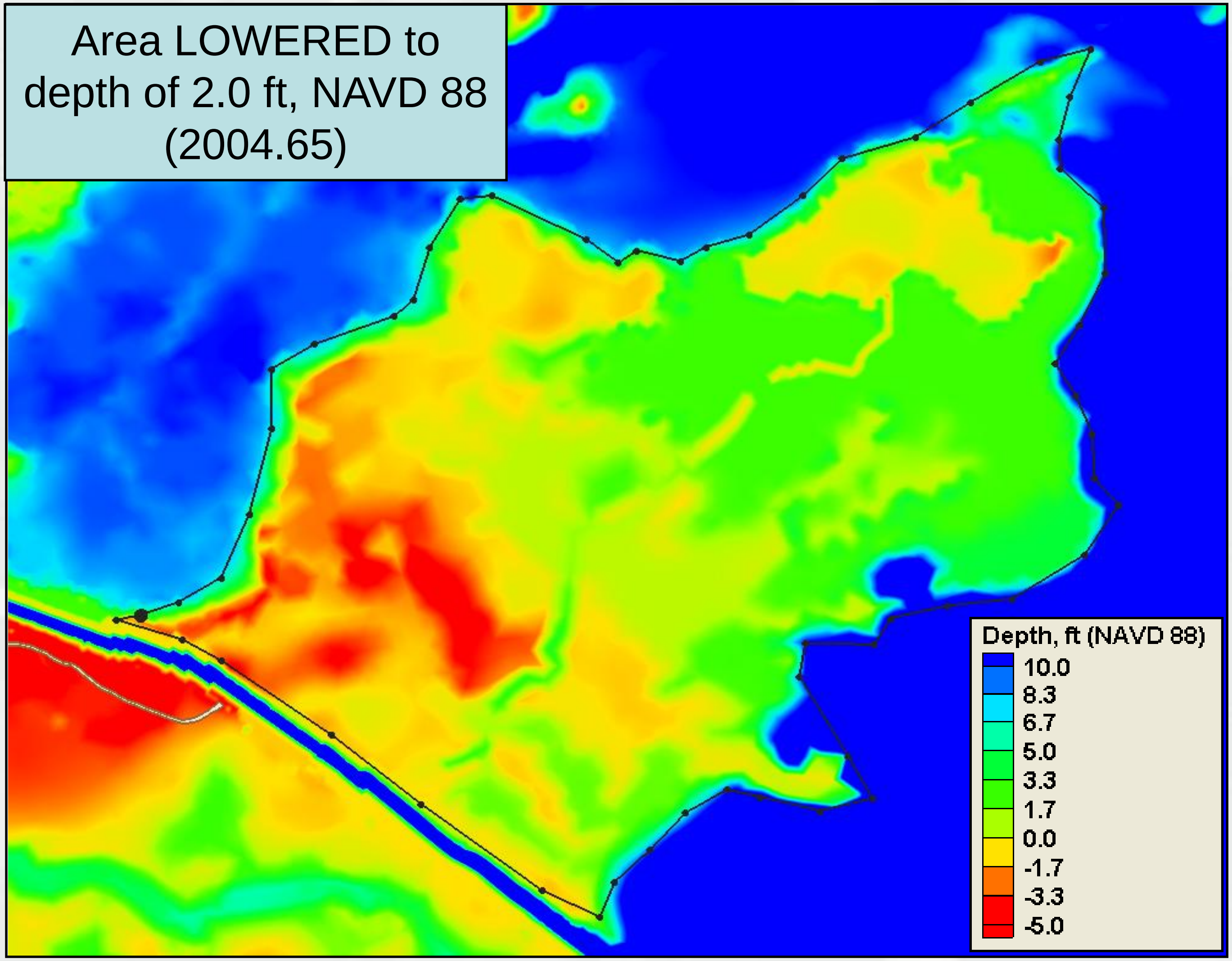
Similar % reduction for storm with half the surge potential of Katrina

Biloxi Marsh Restoration

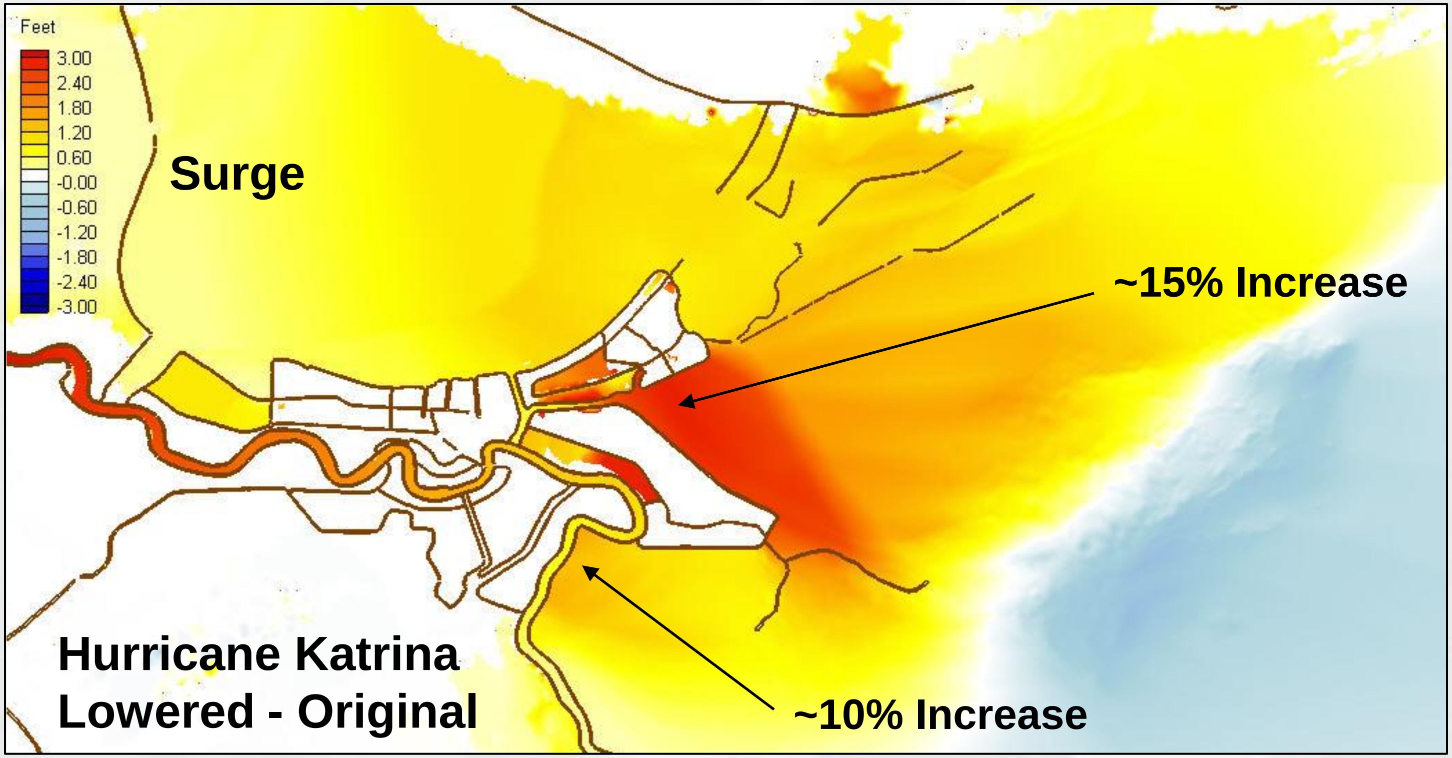


Biloxi Marsh Deterioration

Area LOWERED to depth of 2.0 ft, NAVD 88 (2004.65)

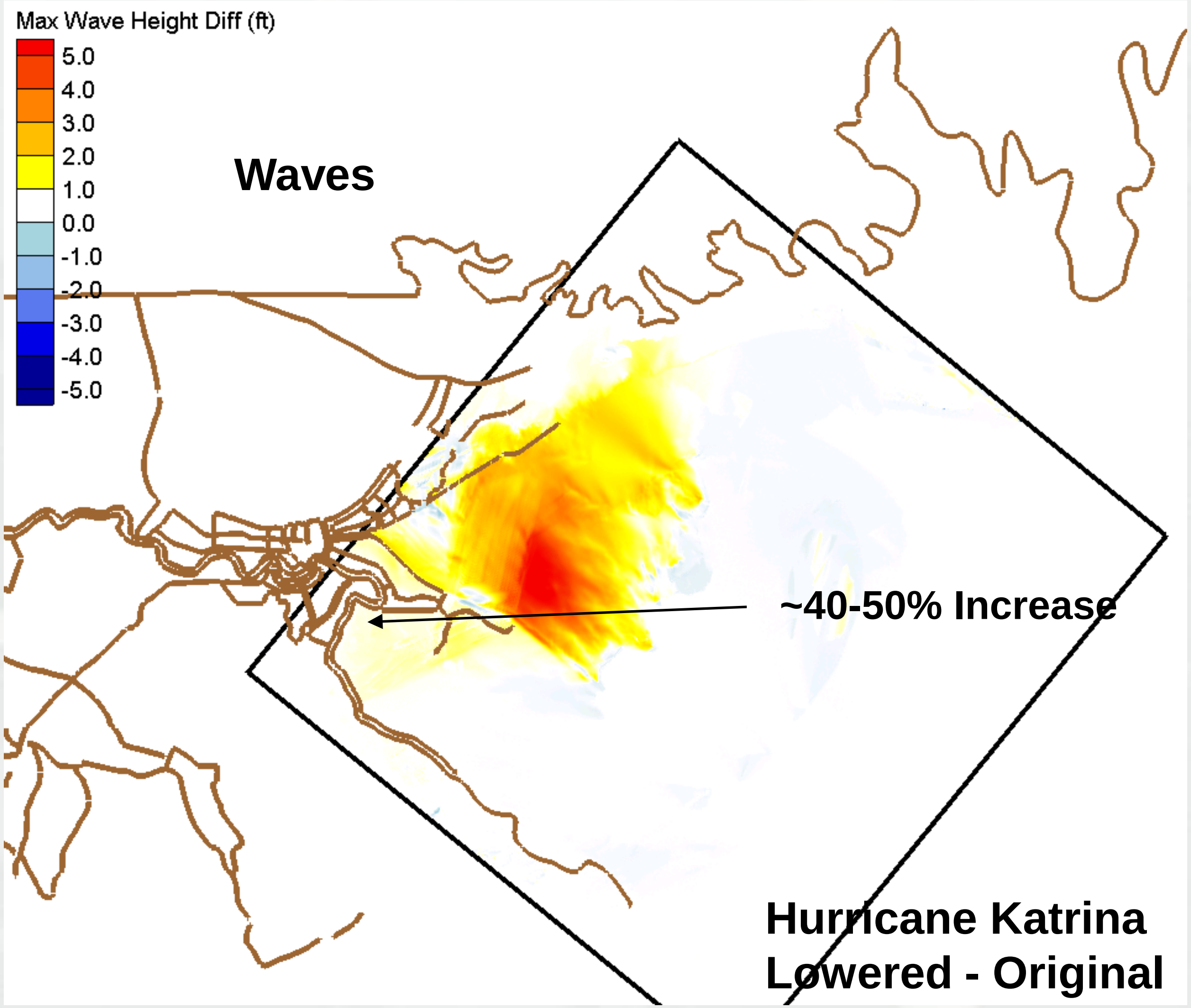


Biloxi Marsh Deterioration

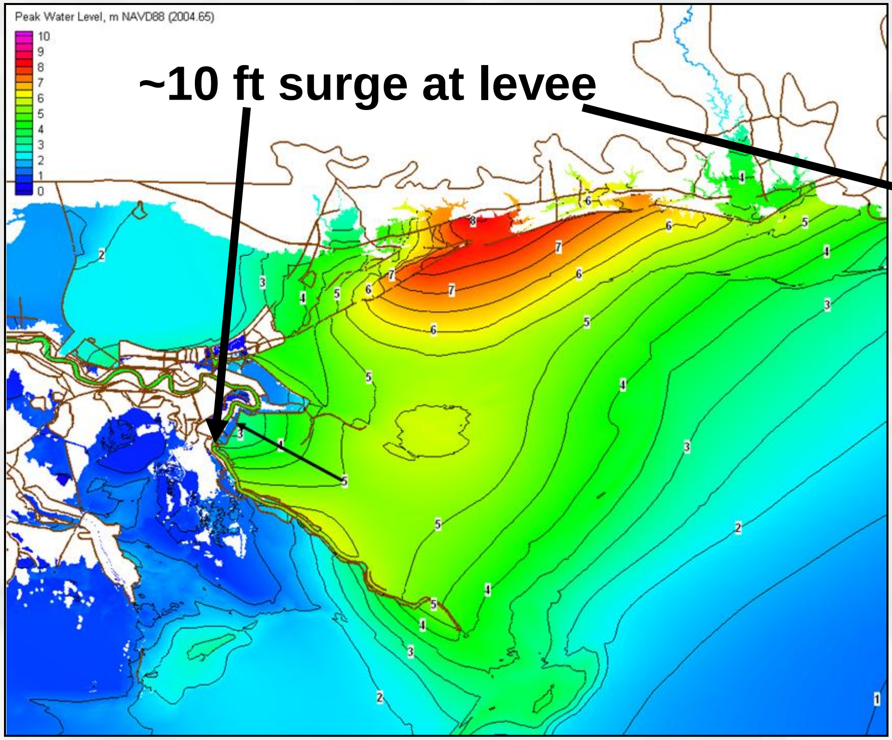


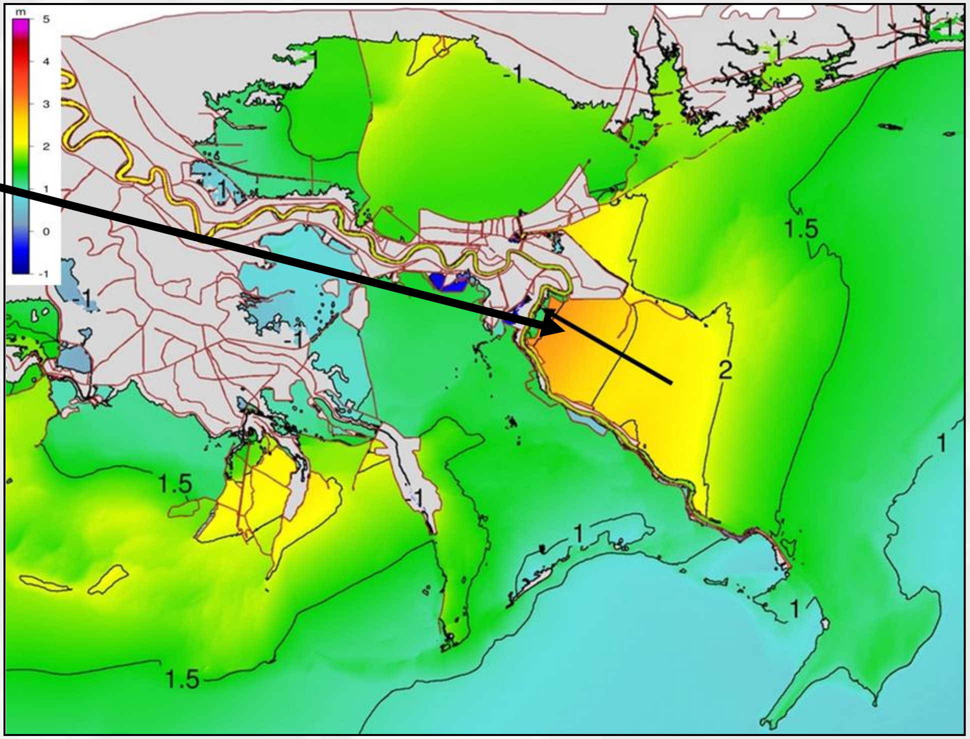
Similar % increase for storm with half the surge potential of Katrina

Biloxi Marsh Deterioration



Results – Peak Surge





Katrina: Surge attenuates

-1 ft per 4.3 mi of marsh

Rita: Surge INCREASES

+1 ft per 8.7 mi of marsh

Summary

- Analyses of model results indicate that surge attenuation rates estimated by the modeling system are consistent with observations.
- Wetlands do have the potential to reduce surges but is dependant on:
  - Strength and duration of storm forcing:
    - Track
    - Intensity
    - Forward speed
  - Coastal landscape:
    - Surrounding topography/bathymetry
    - Vegetation type
- Results also suggest wetlands reduce wave heights and the magnitude of reduction is sensitive to water depths and the propagation distance across the wetland.
- Numerical models that simulate the relevant physical processes can provide valuable information on how to best integrate wetlands for coastal storm damage reduction.

SEDIMENT LOAD OF THE MISSISSIPPI RIVER

“Today millions of tons of sediment simply vanish off the continental shelf deep in the Gulf of Mexico….the levees limited any chance of recovery….”

Constructing a Sediment Budget for the Mississippi-Atchafalaya River in Louisiana in Support of Coastal Restoration

Mead Allison (University of Texas)

Charlie Demas (USGS Baton Rouge)

Barb Kleiss (LCA Science & Technology Office)

Charlie Little (USACE-ERDC)

Ehab Meselhe (University of Louisiana-Lafayette)

Nancy Powell (USACE-New Orleans)

Thad Pratt (USACE-ERDC)

Brian Vosburg (LA-OCPR)

Office of Coastal Protection and Restoration

University of Louisiana Lafayette

US Army Corps of Engineers® Engineer Research and Development Center

Louisiana Coastal Area (LCA)

The University of Texas at Austin Jackson School of Geosciences

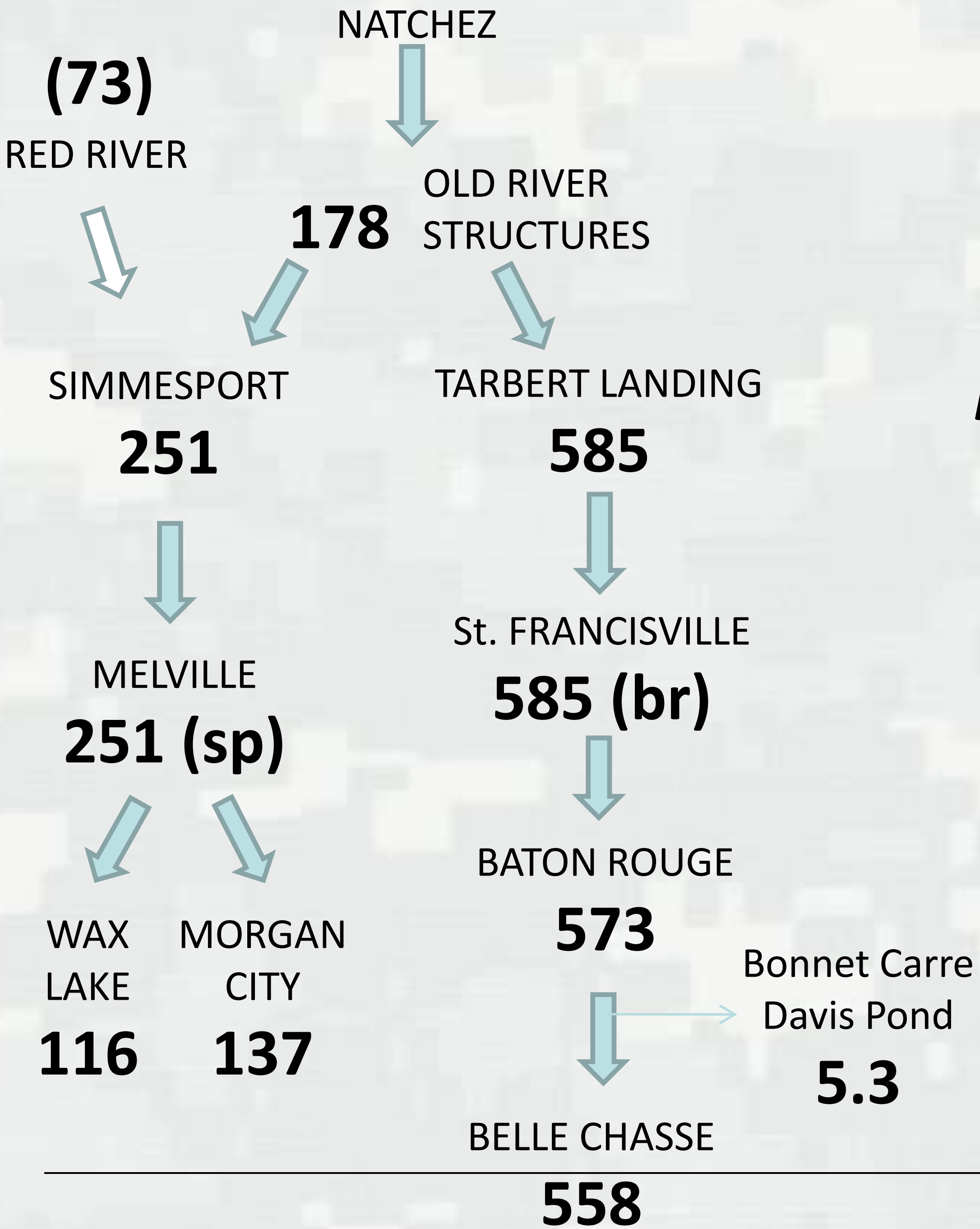
USGS science for a changing world

US Army Corps of Engineers Team New Orleans


Tarbert Landing
St. Francisville
Baton Rouge
Belle Chasse
Louisiana
Lafayette
Marsh Island
Metairie
Gulfport
Cat Island
Horn Island
Jan 15, 2009
4:22pm
© 2008 Europa Technologies
Image NASA
© 2008 Tele Atlas
Image © 2009 DigitalGlobe
©2008 Google
29°59'46.41" N 90°23'09.53" W
Eye alt 204.04 mi

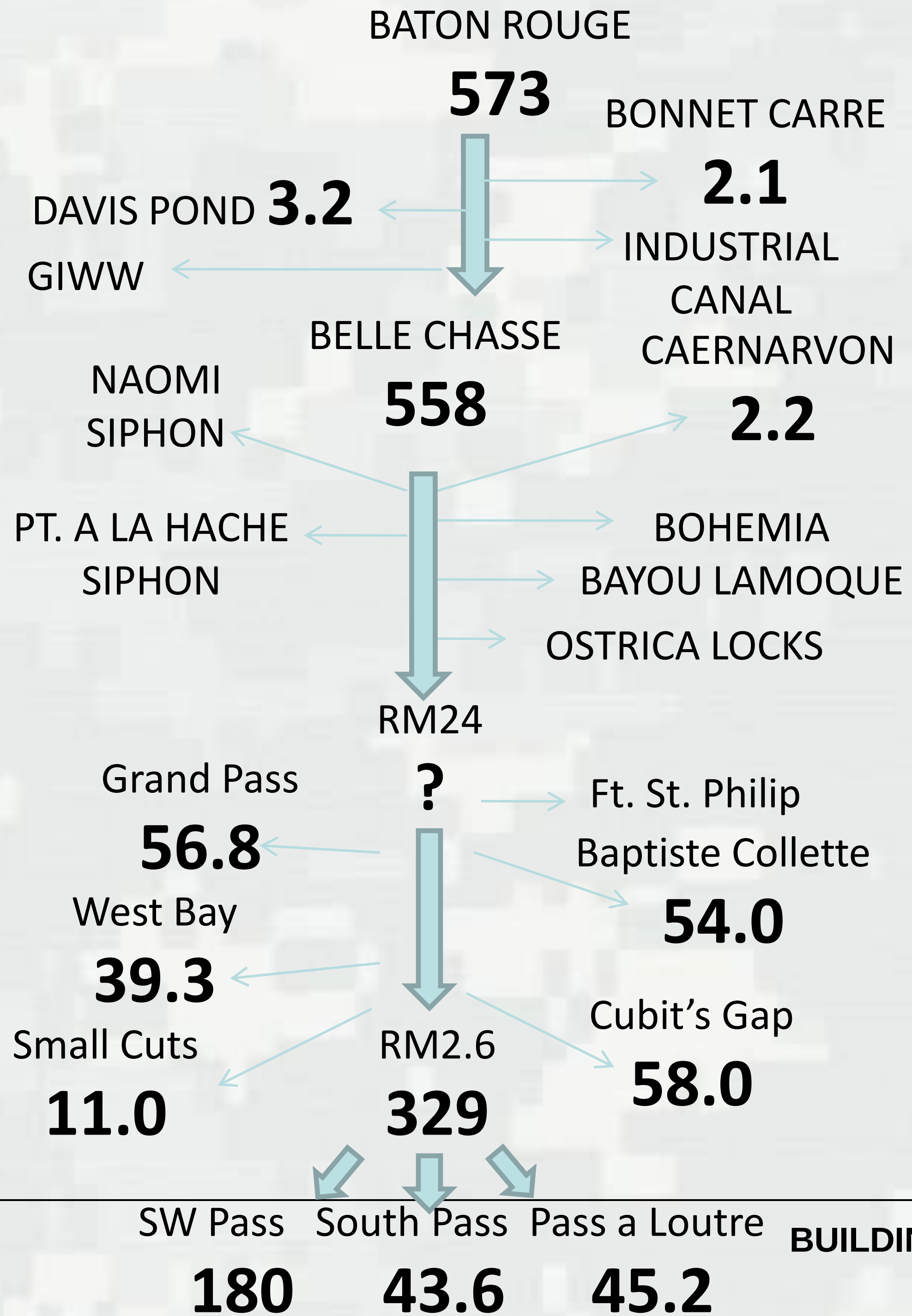
WATER FY 08-10
in 10^{11} cubic ft.

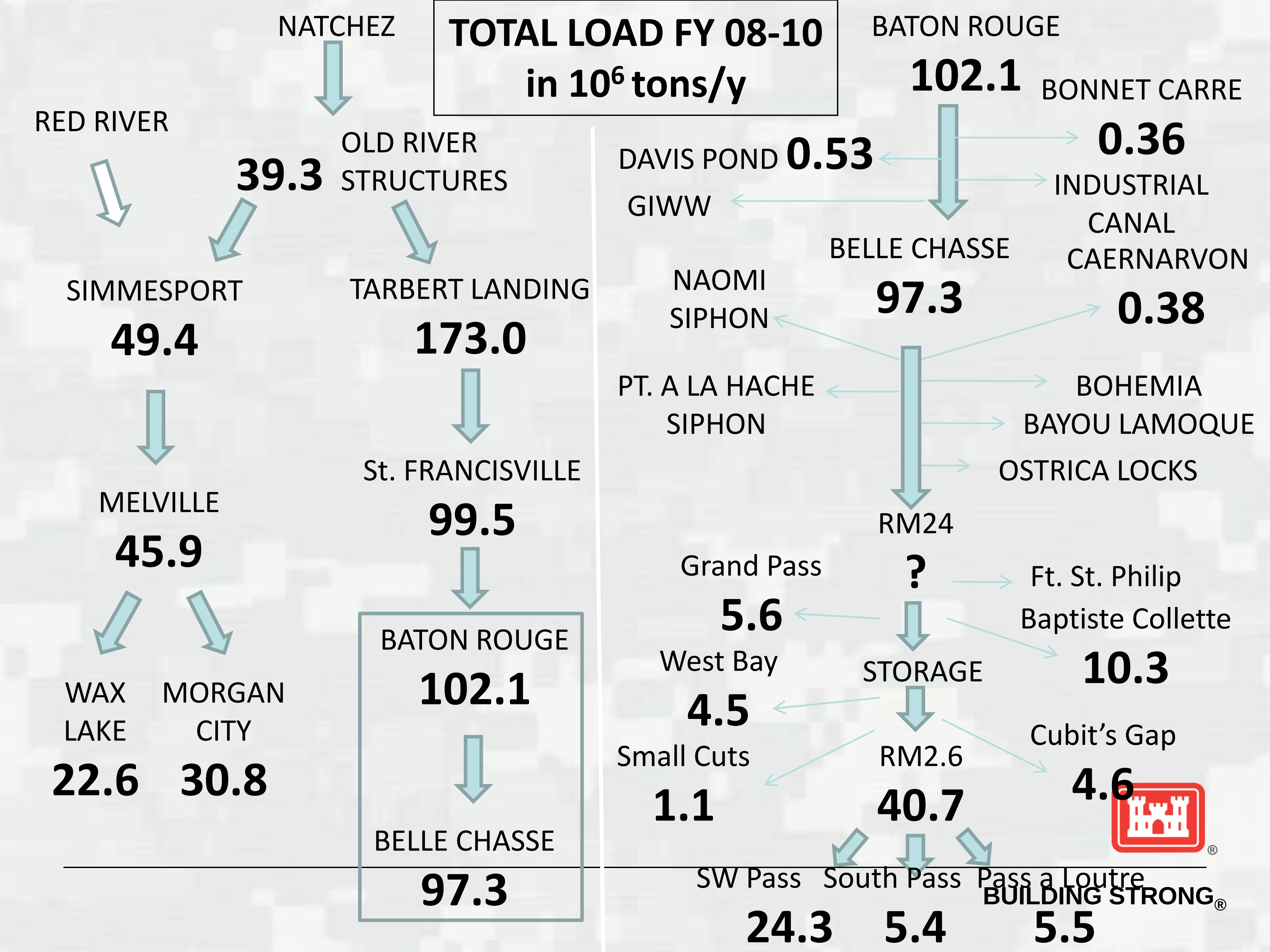
MISSISSIPPI & ATCHAFALAYA MAINSTEM STATIONS



WATER FY 08-10
in 10^{11} cubic ft.

LOWER MISSISSIPPI EXITS




TOTAL LOAD FY 08-10
in 10^6 tons/y
NATCHEZ
RED RIVER
OLD RIVER
STRUCTURES
39.3
SIMMESPORT
49.4
MELVILLE
45.9
WAX
LAKE
22.6
MORGAN
CITY
30.8
TARBERT LANDING
173.0
St. FRANCISVILLE
99.5
BATON ROUGE
102.1
BELLE CHASSE
97.3
BATON ROUGE
102.1
BONNET CARRE
0.36
DAVIS POND 0.53
INDUSTRIAL
CANAL
GIWW
BELLE CHASSE
97.3
CAERNARVON
0.38
NAOMI
SIPHON
PT. A LA HACHE
SIPHON
BOHEMIA
BAYOU LAMOQUE
OSTRICA LOCKS
RM24
?
Grand Pass
5.6
Ft. St. Philip
Baptiste Collette
10.3
West Bay
4.5
STORAGE
Small Cuts
1.1
RM2.6
40.7
Cubit's Gap
4.6
SW Pass
24.3
South Pass
5.4
Pass a Loutre
5.5
BUILDING STRONG®

TOTAL LOAD FY 08-10
in 10^6 tons/y

LOSS (storage) GAIN (erosion)

MISSISSIPPI MAINSTEM STATIONS

NATCHEZ

OLD RIVER STRUCTURES

39.3

TARBERT LANDING

173.0

Sand *Mud*

50.8 *15.6*

St. FRANCISVILLE

99.5

Sand *Mud*

9.9 *7.3*

BATON ROUGE

102.1

Bonnet Carre
Davis Pond

0.89

Sand *Mud*

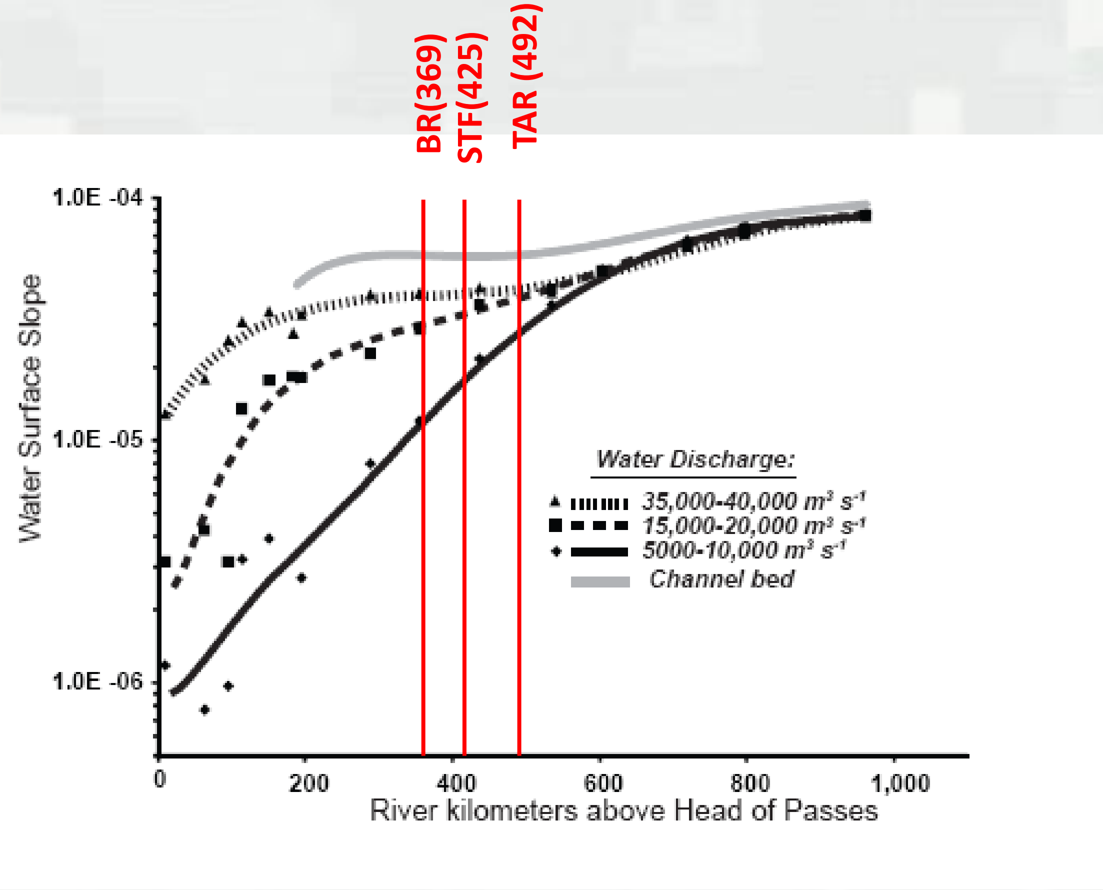
10.8 *5.5*

BELLE CHASSE

97.3

Net basin storage of 74.8 (51.7 sand)

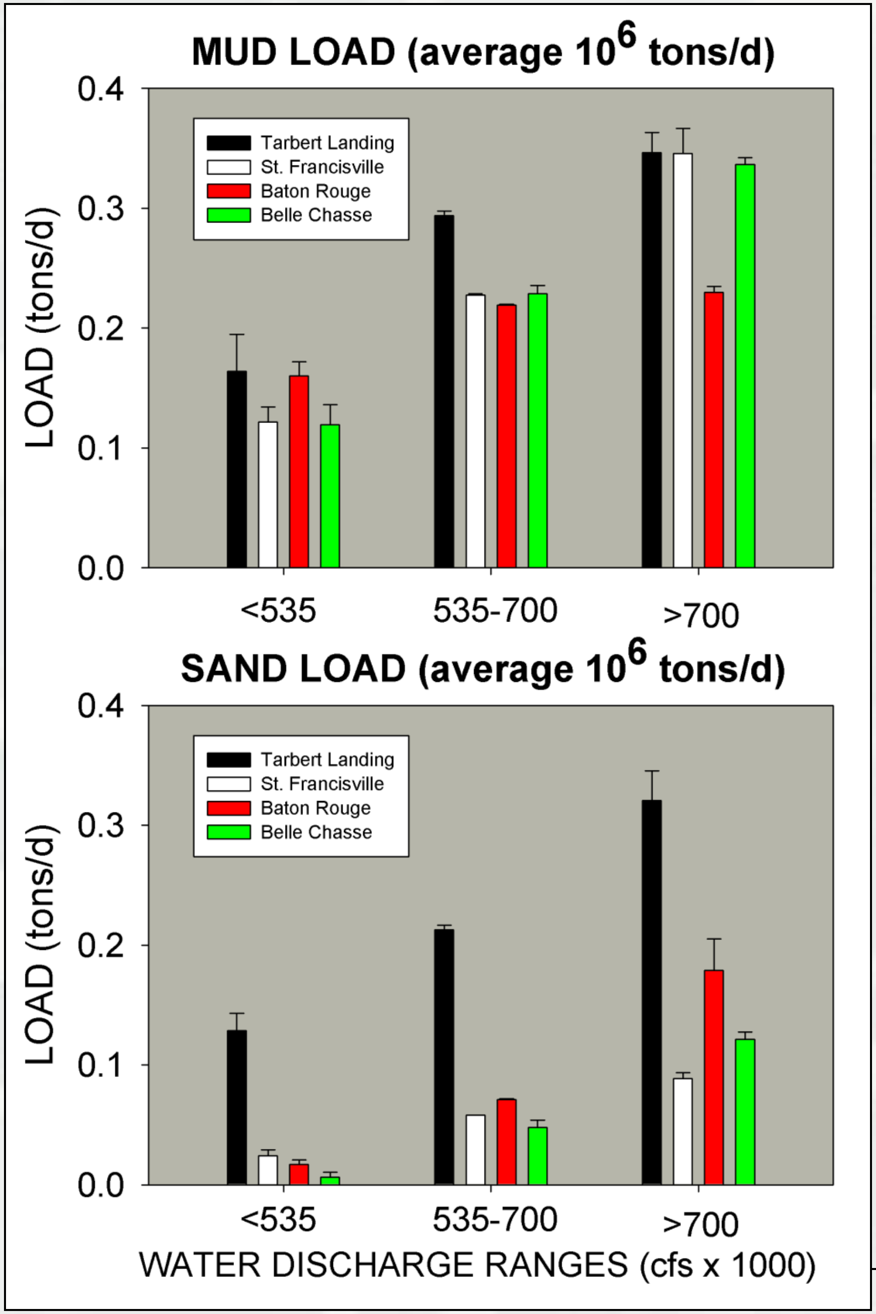
The Tidal Reach: Importance of the "backwater effect"



Surface Slopes Impact:

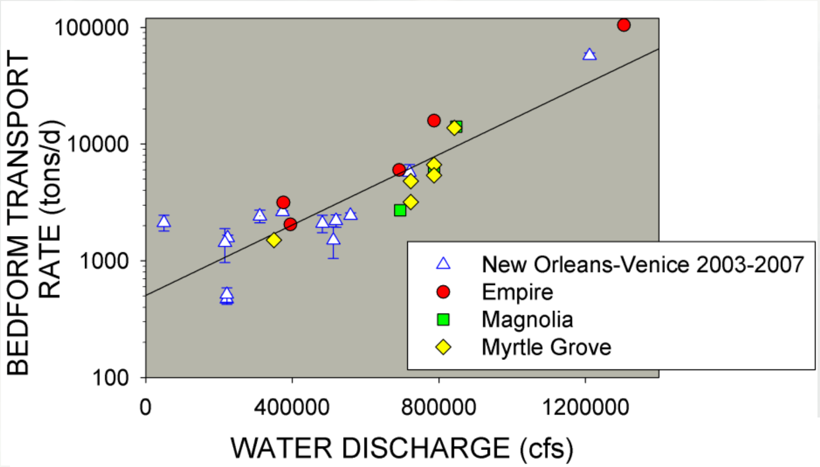
-river flow velocity
-sediment transport stress
-flux of bed materials through reach

From Nittrouer, Mohrig and Allison, submitted. *Sediment transport in the lowermost Mississippi River: effect of non-uniform flow*.

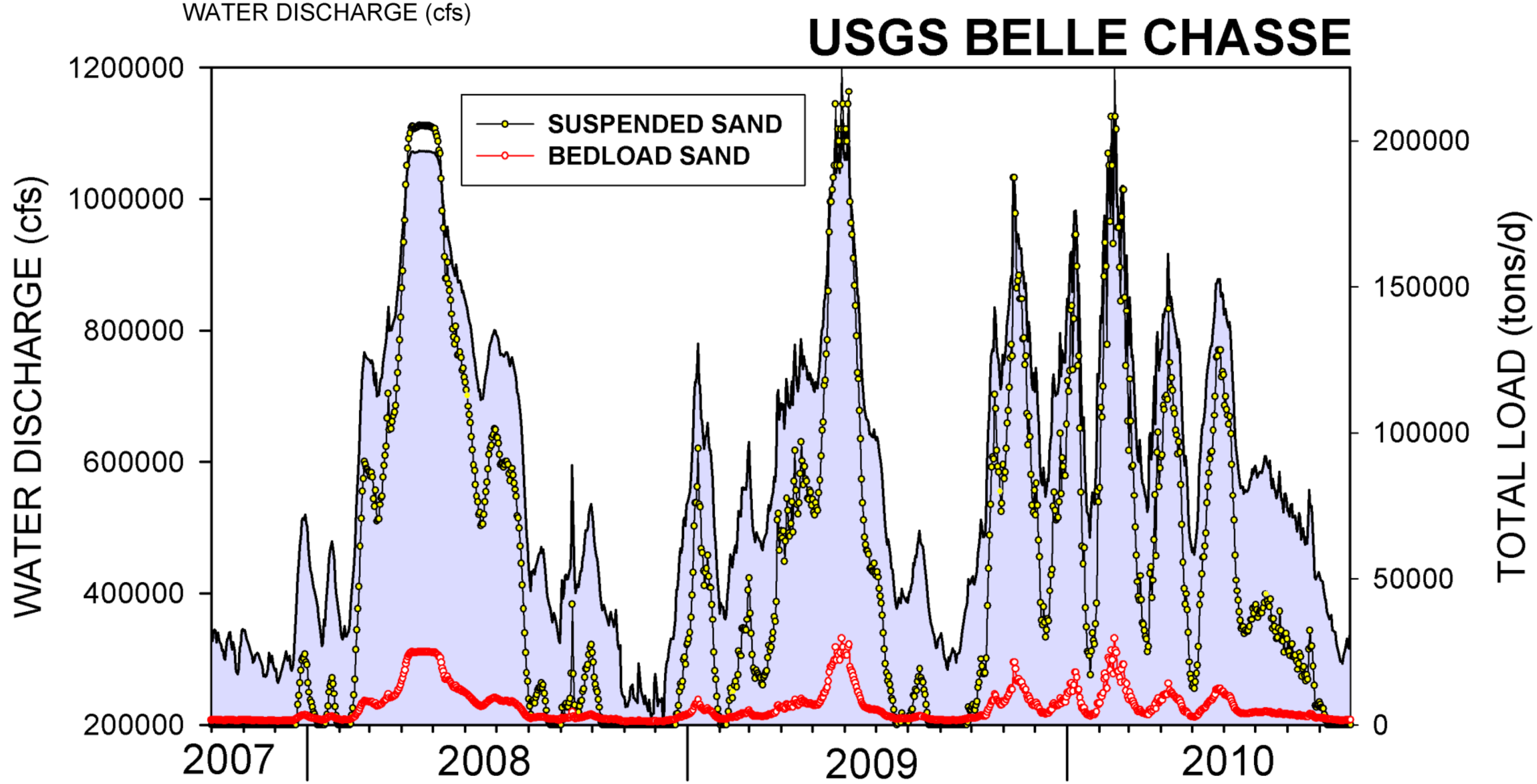


Comparison of Suspended Load With Discharge: Mississippi Stations

LOW (less than 535,000 cfs)
TRANSITIONAL (535,000-700,000 cfs)
HIGH (greater than 700,000 cfs



19.6 mt/y Suspended Sand
2.3 mt/y Bedload Sand



Preliminary Conclusions:

1. Both Pathways Have Net Storage of Sediment Interannually
   -Mississippi (channel storage, batture?)
   -Atchafalaya (channel and overbank storage)

2. Significant Portion of Mississippi Discharge at Baton Rouge Exits Channel above HOP
   -42% water
   -60% sediment (some sand stored in channel)

Preliminary Conclusions:

3. Bedload Transport ~12% of the Sand flux

4. Hysteresis and Seasonal Bed Storage Concentrate Suspended Flux into Early Freshet Phase

5. Re-design of Suspended-Bedload Monitoring System Needed to Support Operation of Future Sediment Diversions

Conclusions

- Understanding the how the “system works” is critical to restoration project success and will still need to be accomplished
- In the future, science issues will have to be incorporated into individual projects
- System-wide or multi-project issues will be difficult to address


Lane Lefort