Some Thoughts on Diversions, Discovery, and Delta Restoration

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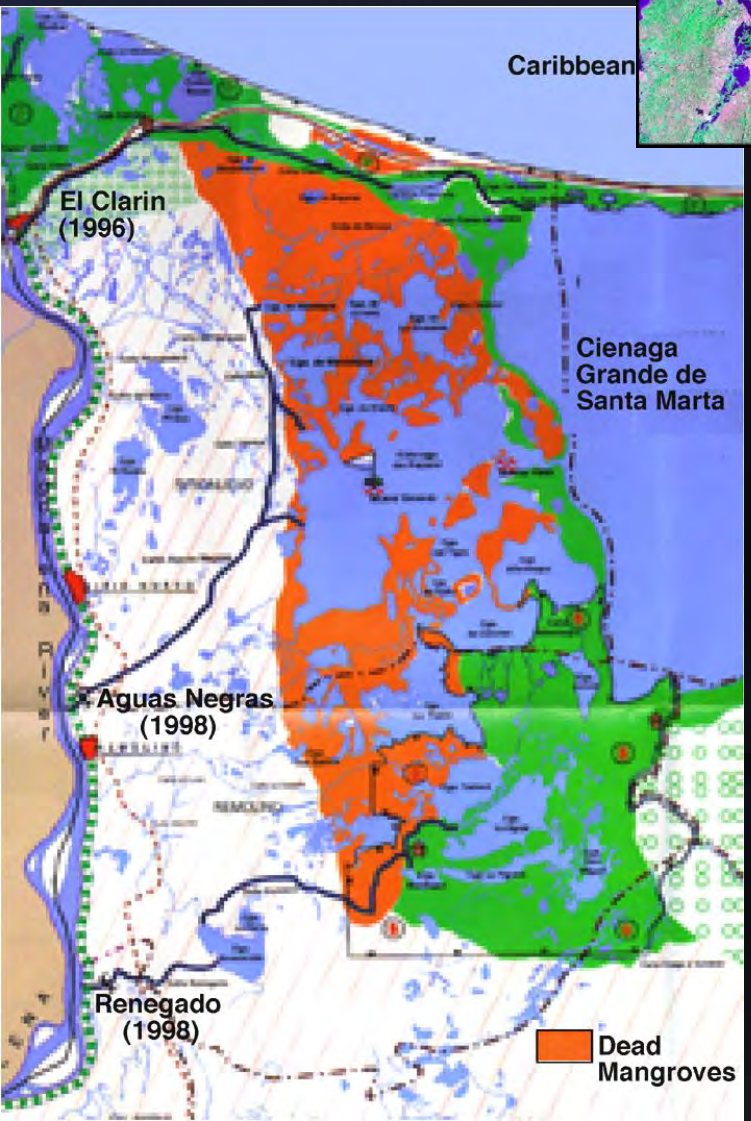
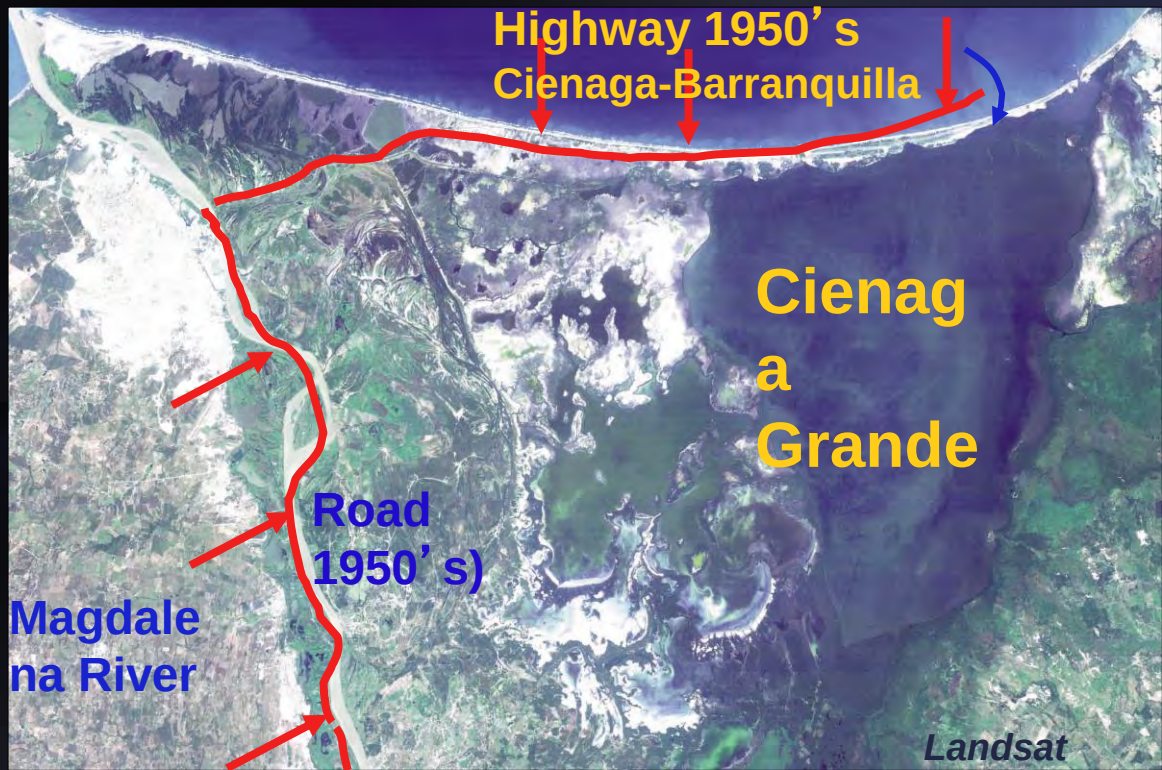
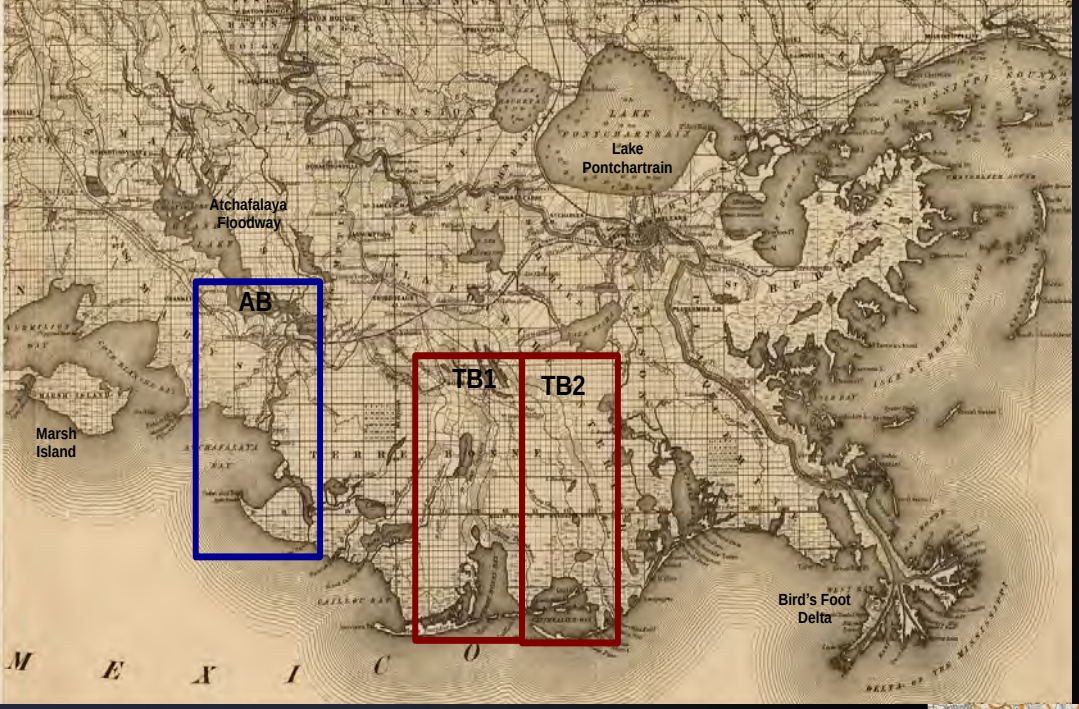
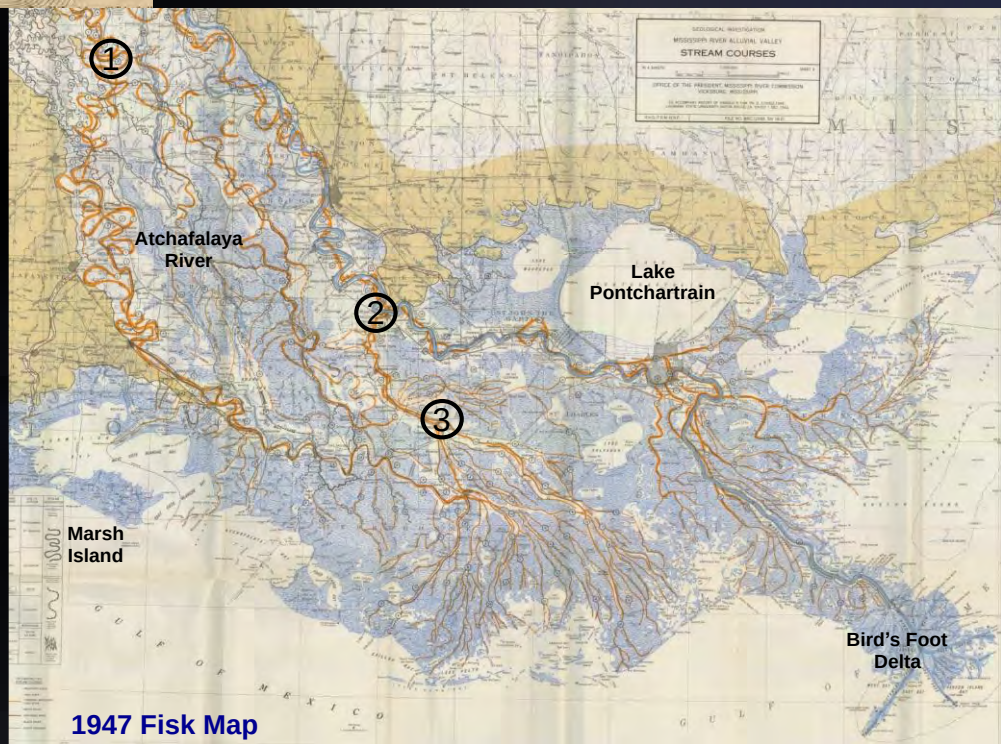
River Diversions to restore the Magdelena River Delta Complex - CGSM

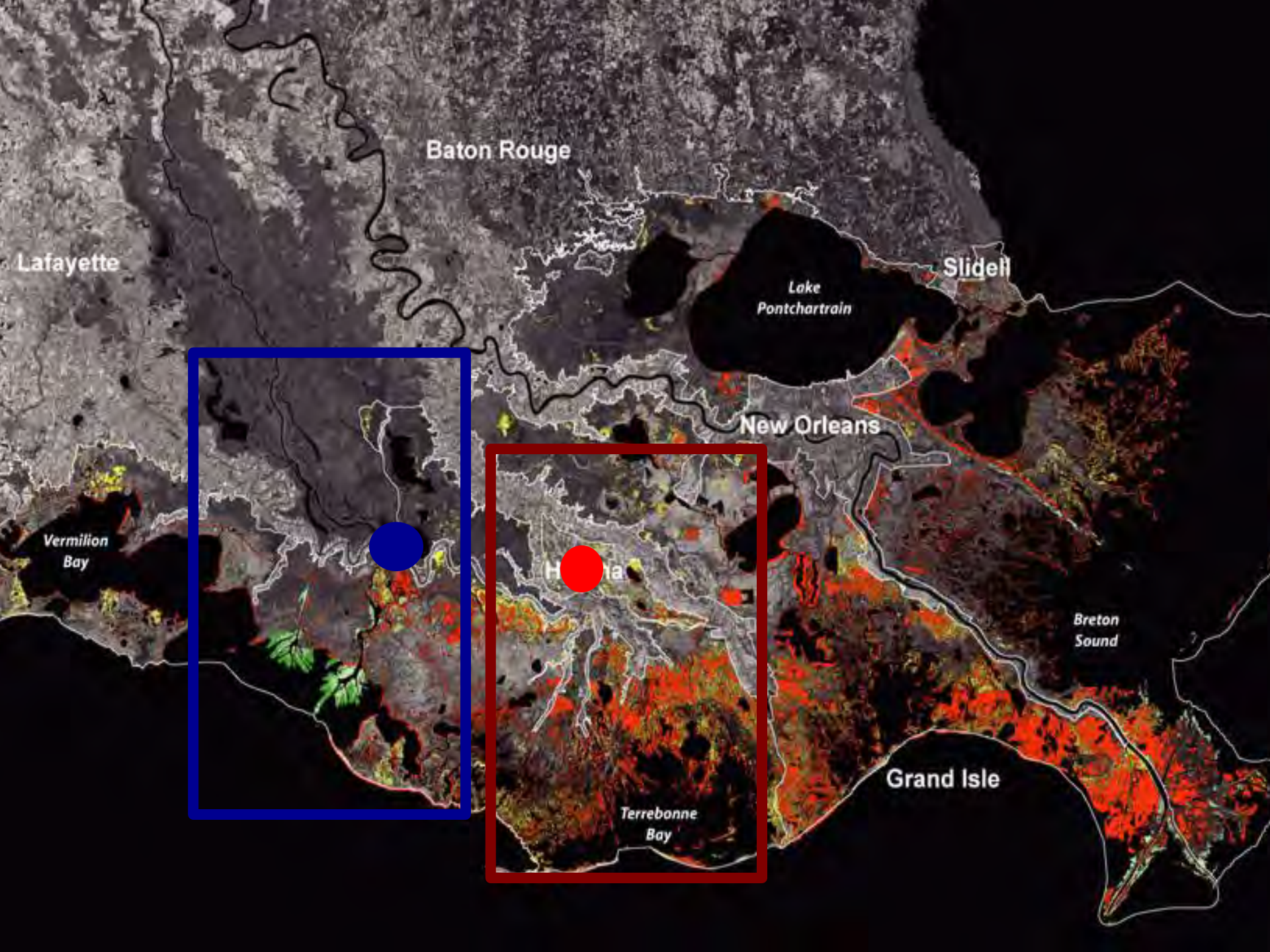






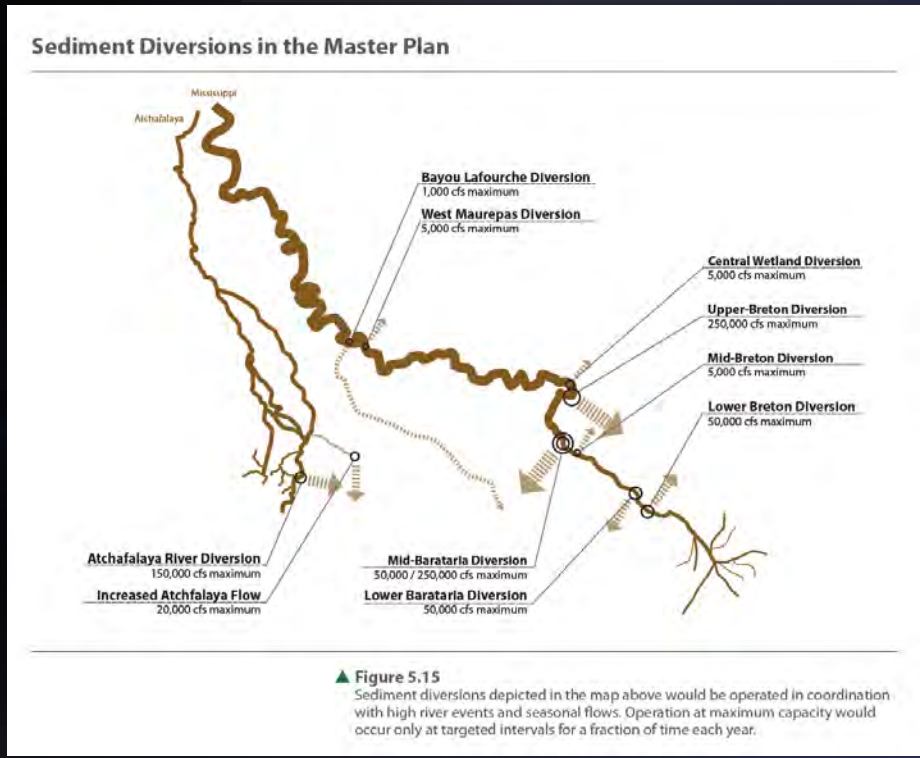


1947 Fisk Map

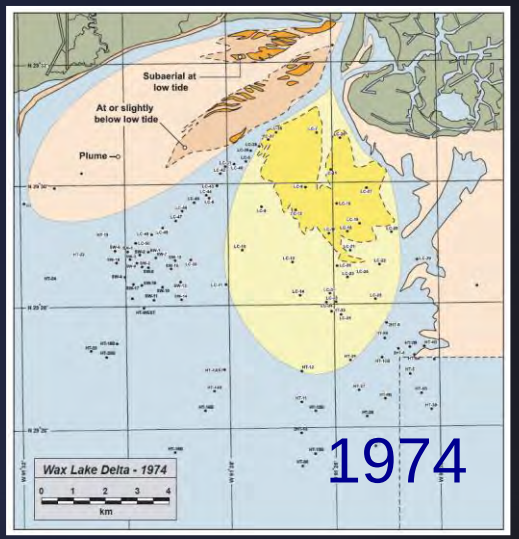

Baton Rouge
Lafayette
Slidell
Lake
Pontchartrain
New Orleans
Vermilion
Bay
Breton
Sound
Grand Isle
Terrebonne
Bay

Louisiana's 2012 Coastal Master Plan

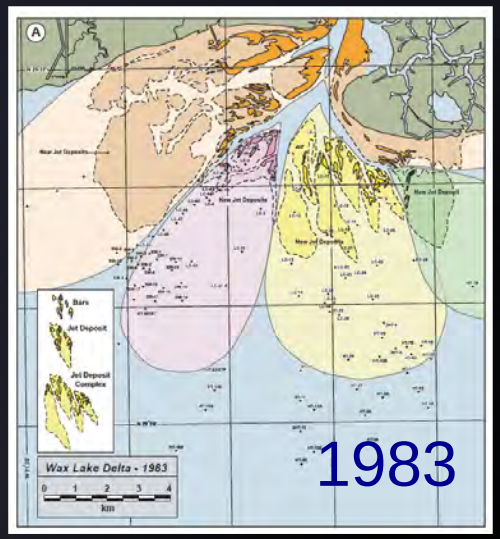
- Land building estimates:
  - Growth rate: 1-5 $km^2\ yr^{-1}$
  - Area: ~100 km^2 *(Kim et al. 2009; Allen et al. 2011; Shaw et al. 2013)*
- 10 diversions on Mississippi and Atchafalaya Rivers
  - Wax Lake Outlet: 900 to 8800 $m^3\ s^{-1}$
- Maximum discharge size categories:
  - 141.6 $m^3 s^{-1}$ (5,000 cfs)
  - 1416 $m^3 s^{-1}$ (50,000 cfs)
  - 7080 $m^3 s^{-1}$ (250,000 cfs)



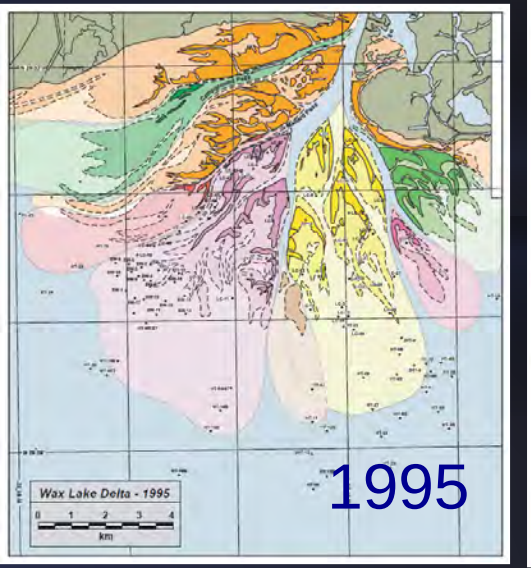
Coastal Deltaic Floodplain



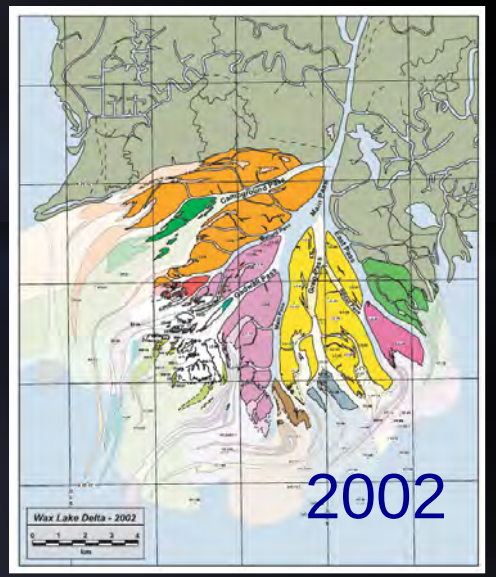
1974



1983



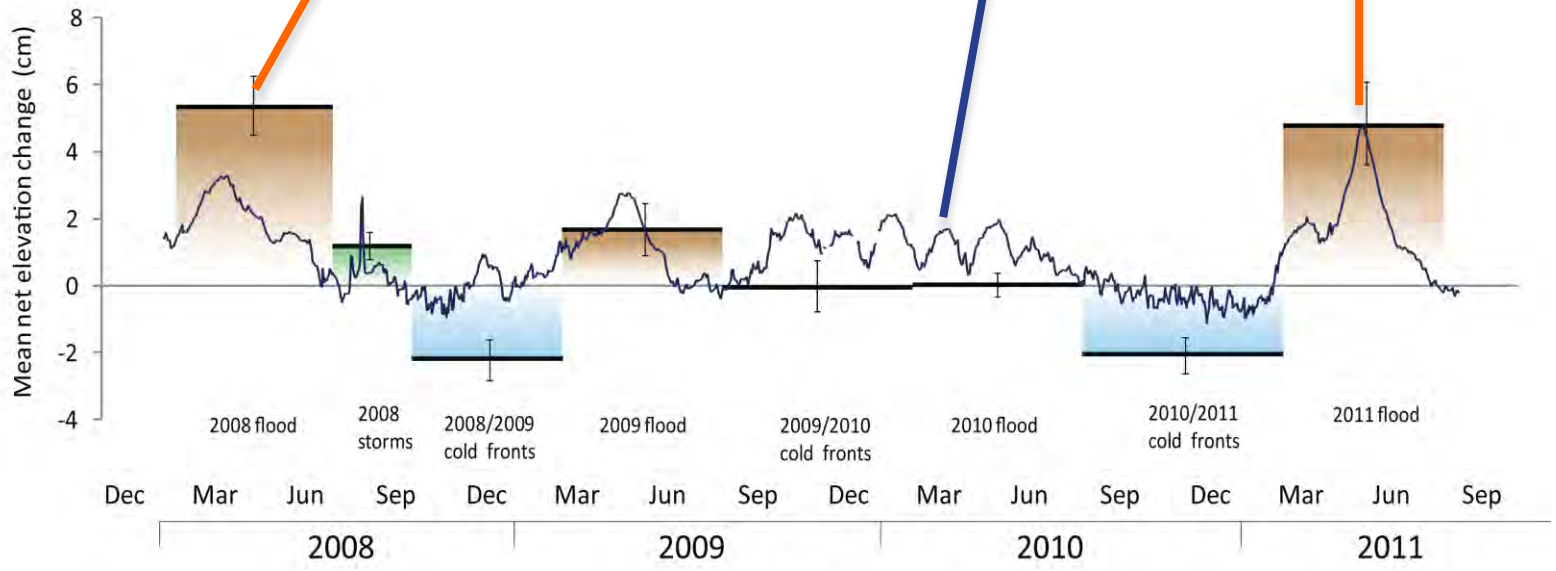
1995

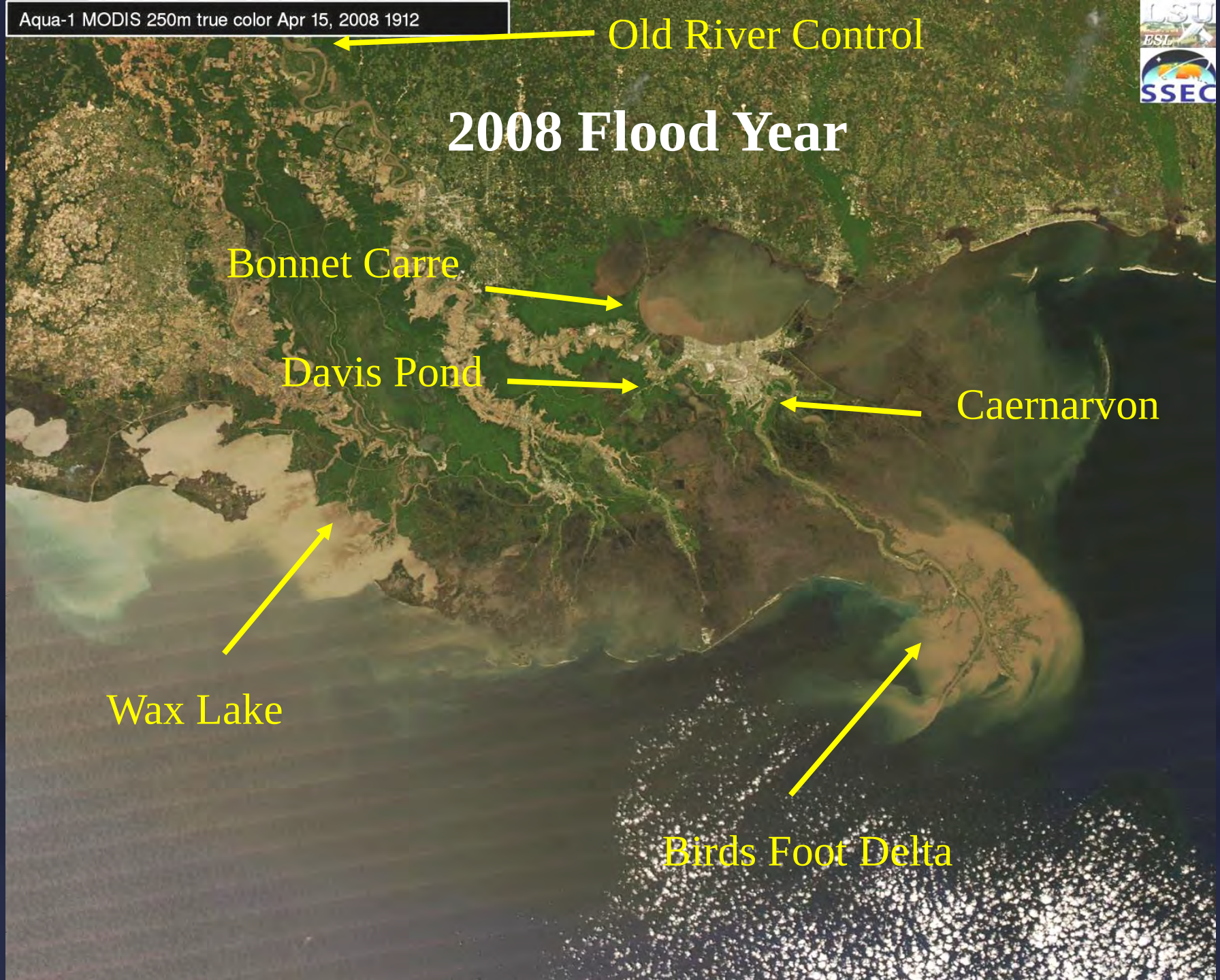


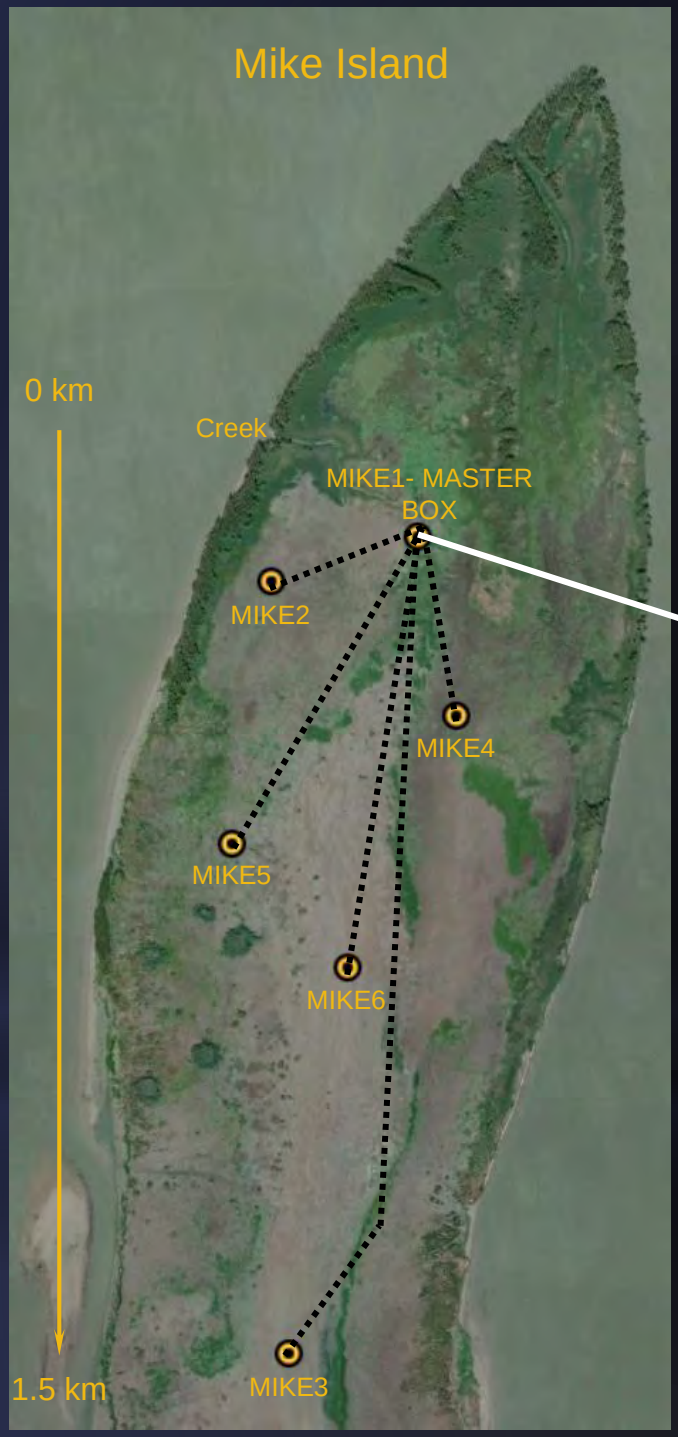
2002

Annual net elevation change

	2008	2009	2010	2011
Net elevation change (cm/yr)	6.6 (Feb to Sept)	0. 7	0.04	2.8
Total water discharge (km^3/yr)*	108	95	126	101
Total sediment discharge (10^6 metric tons/yr)*	20.1	16.9	24.6	~18-20 (estimate)




Aqua-1 MODIS 250m true color Apr 15, 2008 1912
Old River Control
2008 Flood Year
Bonnet Carre
Davis Pond
Caernarvon
Wax Lake
Birds Foot Delta

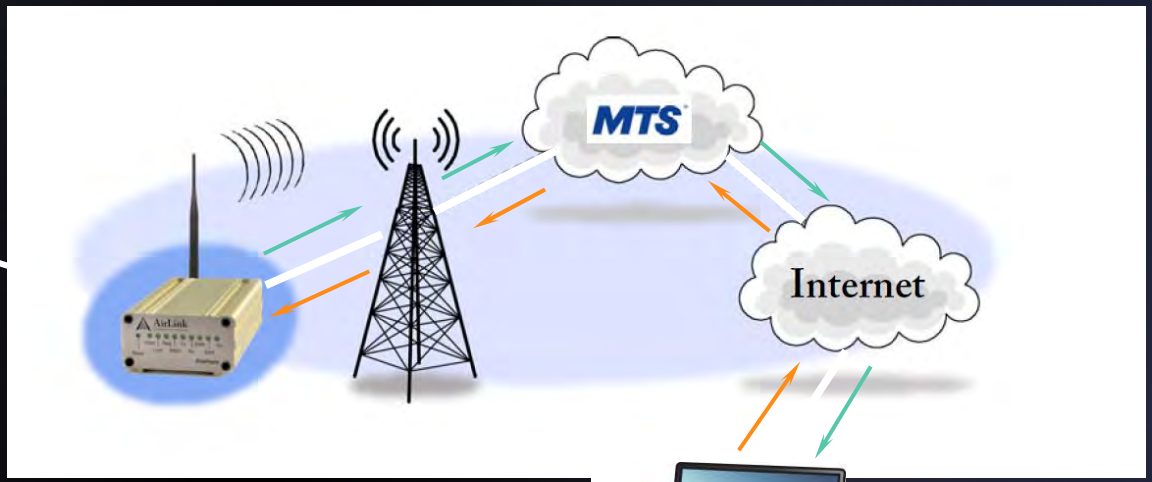


Frontiers in Earth System Dynamics (FESD): A Delta Dynamics Collaboratory.

Telemetry System - WLD

Telemetry: tele = remote; metron = measure

Cellular Network CDMA



PinPoint X Modem @ MIKE1 "MASTER BOX"

LSU laptop with LoggerNet

CDMA *(Code Division Multiple Access) is a radio network technology used by many cellular providers across the globe*

Instrumentation set up

OBS-500
Turbidity

Pressure
transducer

Temperature/
Conductivity

SUNA-V2
Nitrate sensor

Argonaut-ADV
2D side-looking
probe

Funding Sources and Collaborations

NSF

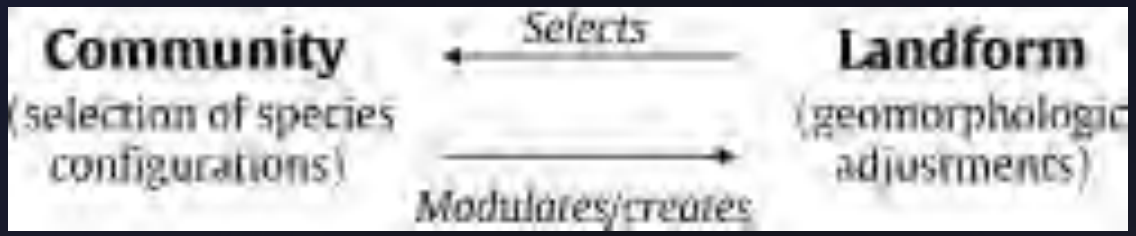
LSU - Robert R. Twilley, Edward Castaneda, Azure E. Bevington, Kelly Henry, Ben Branoff, Alex Christiansen, Anika Aarons, Guerry O. Holm Jr., Charles E. Sasser

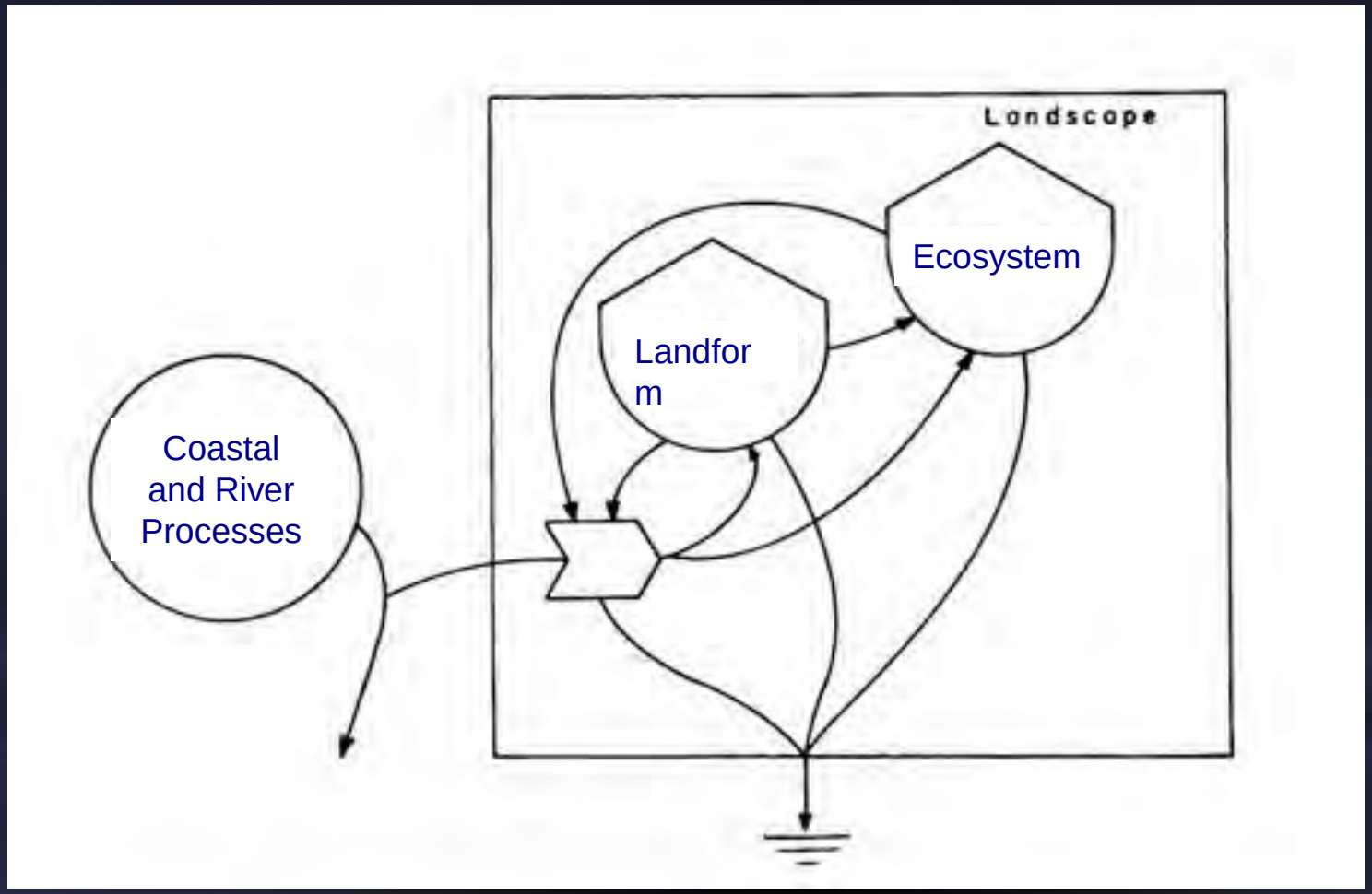
Senior Personnel
FESD Type II: A Delta Dynamics Collaboratory

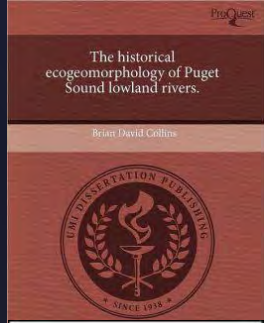
Last Name	First Name	Institution
Duke-Sylvester	Scott	University of Louisiana at Lafayette
Edmonds	Douglas A.	Boston College
Foufoula-Georgiou	Efi	University of Minnesota – Twin Cities
Kim	Wonsuck	University of Texas at Austin
Meselhe	Ehab	University of Louisiana at Lafayette
Mohrig	David	University of Texas at Austin
Paola	Christopher	University of Minnesota – Twin Cities
Parker	Gary	University of Illinois at Urbana-Champaign
Passalacqua	Paola	University of Texas at Austin
Power	Mary	University of California - Berkeley
Slingerland	Rudy	Pennsylvania State University
Syvitski	James	University of Colorado at Boulder
Twilley	Robert	University of Louisiana at Lafayette
Venturelli	Paul	University of Minnesota – Twin Cities

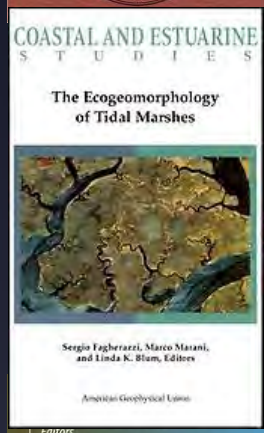
Wax Lake Delta Research Overview

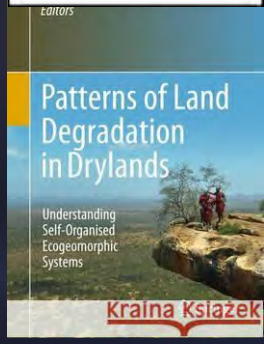
* STC: National Center for Earth-surface Dynamics. NSF Award Number: #EAR-0120914. Subcontract amount: $439,560. Period: 8/1/07 - 7/31/13 ; Beginning in 2007, research was redirected to focus entirely on channel and island sedimentation in distributary networks with applications to the Mississippi Delta. Publications include: [Kim et al. 2009; Twilley et al. 2009; Galloway et al. 2009; Twilley & Rivera-Monroy 2009; Paola et al. 2011; Lorenzo-Trueba et al. 2012]
*
* Frontiers in Earth System Dynamics (FESD): A Delta Dynamics Collaboratory. NSF Award Number: #OCE-1135427 . 9/15/11 to 8/31/16. Subcontract amount (YR 1-3): $739,255. The observational goal will be to create a network of self-activating sensors to monitor delta behavior, at Wax Lake Delta, during major events (storms, river floods) that will complement an intensive survey program to measure ecosystem properties; while the virtual modeling center will contribute to an evolving library of modules for computation and visualization of geomorphic and sedimentary systems, including access to many of the existing delta models. [Kelly & Twilley 2013]



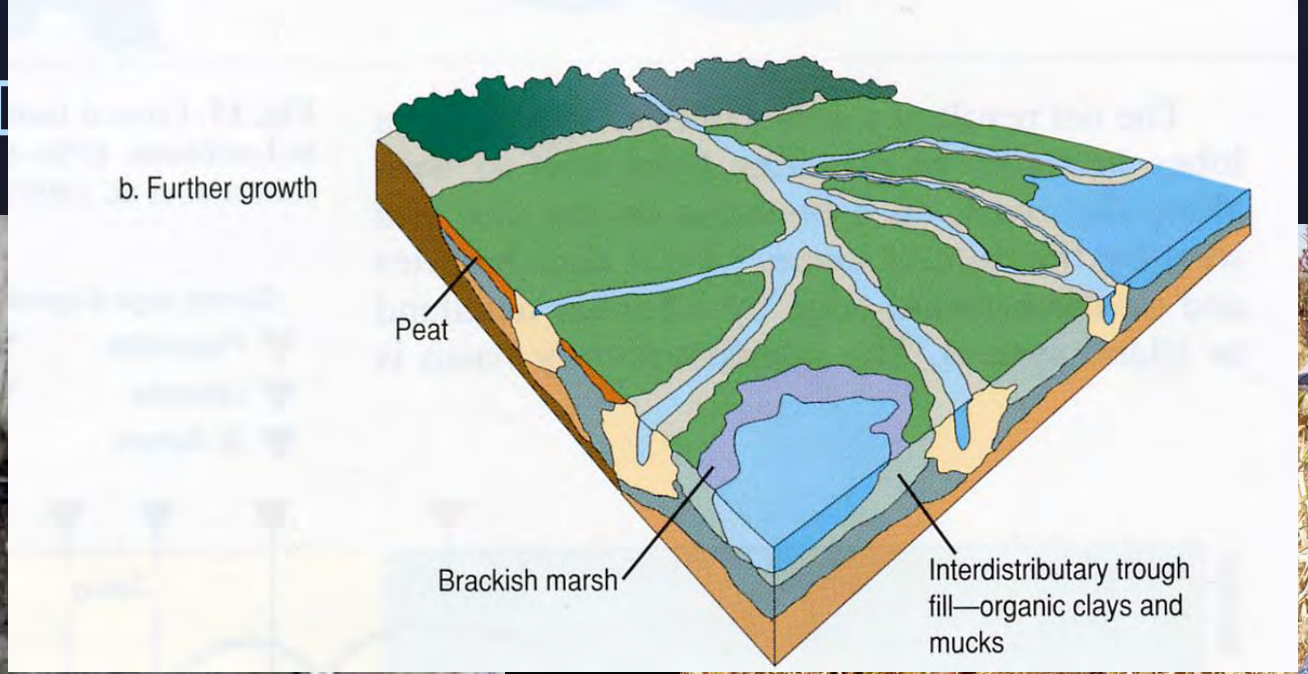


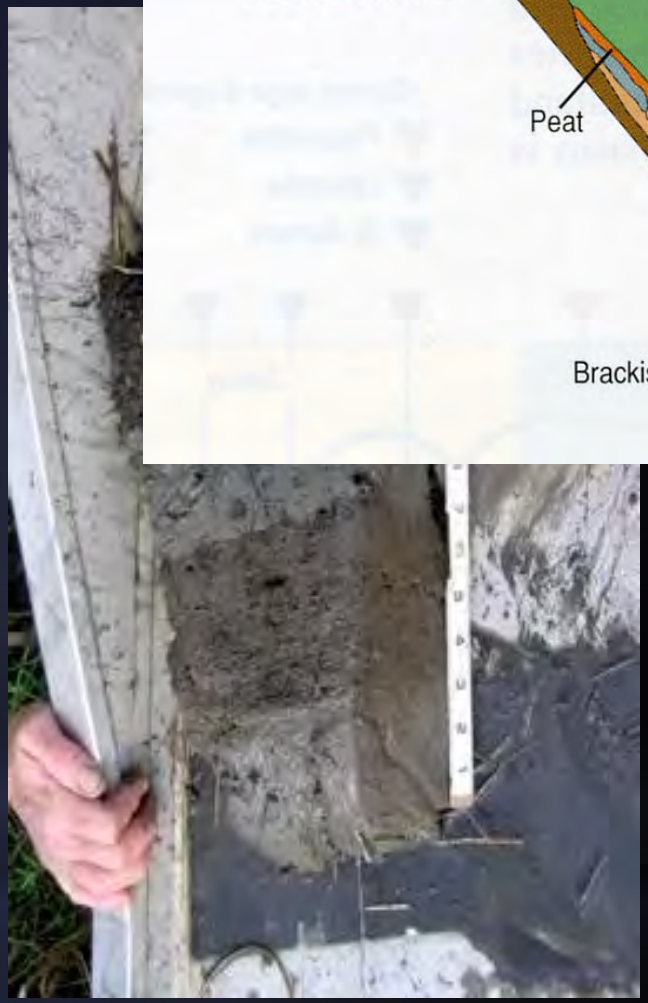






Ecogeomorphology





Growth = River

Maintenance = Plants

Calibrating Coastal Processes associated with Engineering Design relative to SCALE of Coastal Landscape Issues (constraint is normally $$$$) (Boesch et al. 1994)

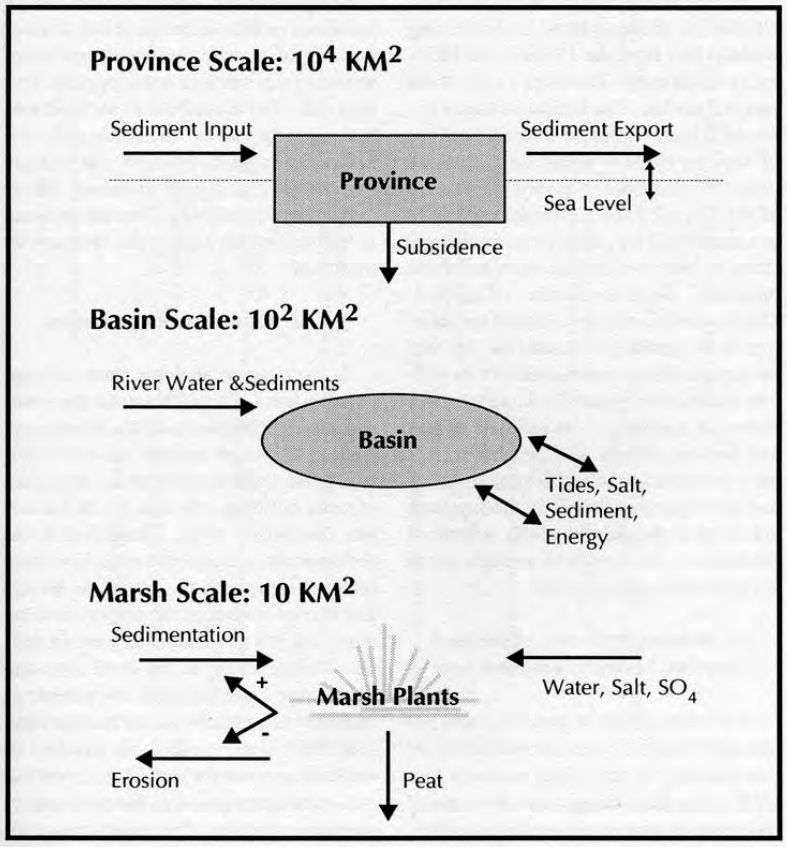
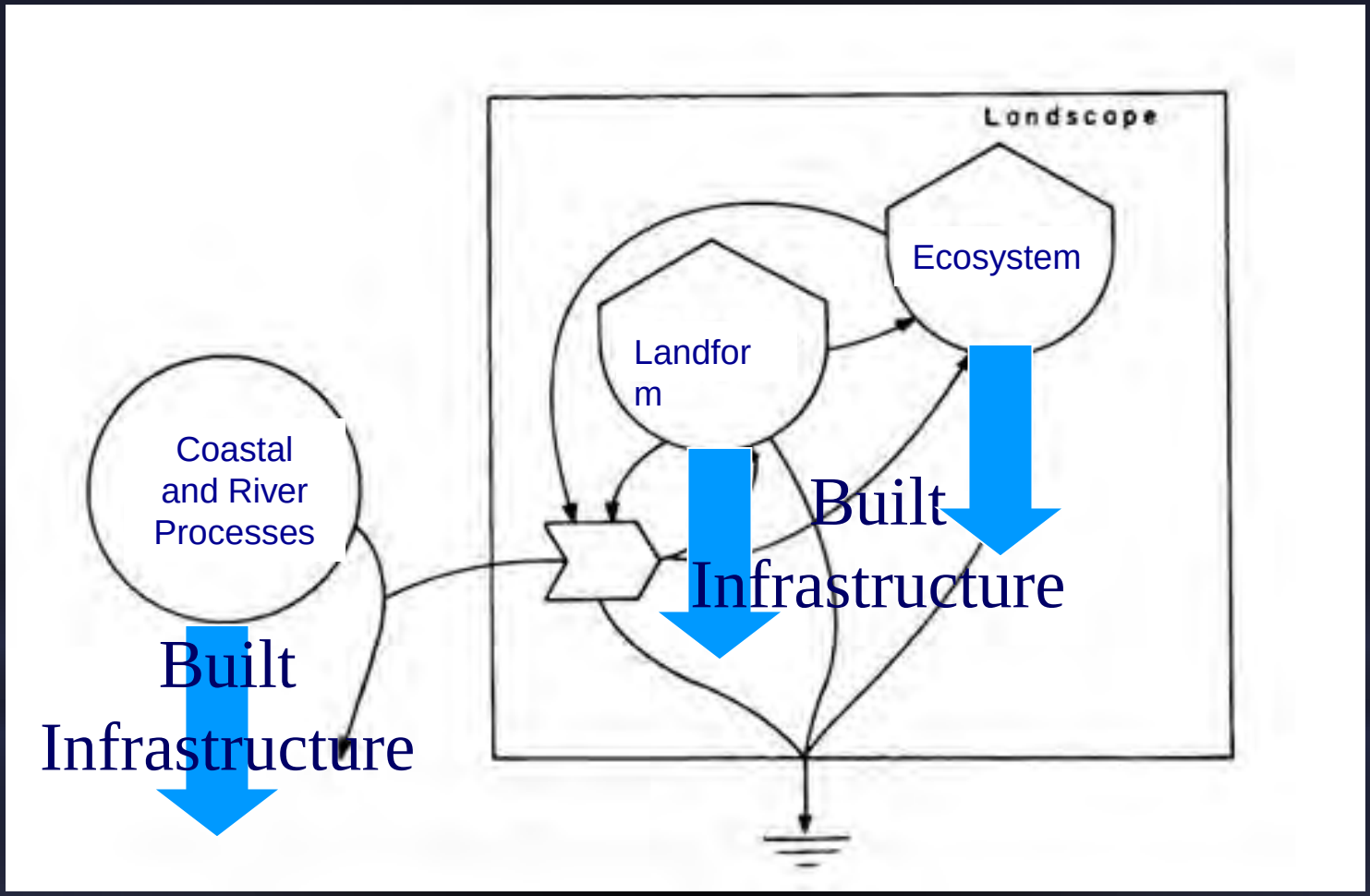
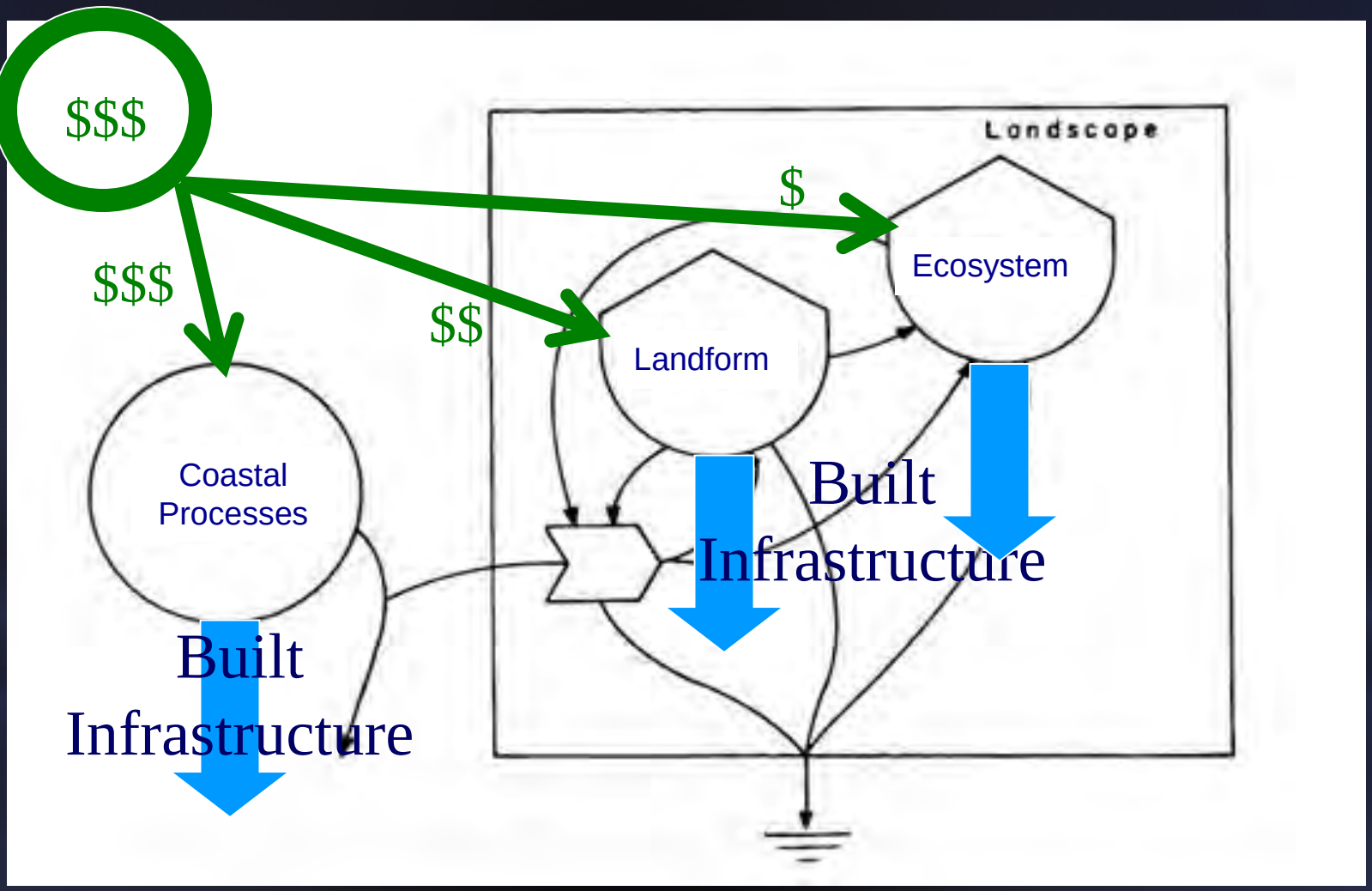


Figure 7. *Conceptual framework of dominant processes operable over three spatial scales in Louisiana's coastal wetlands.*

Table 4. *Water and sediment control strategies and the spatial scales on which they primarily operate (shaded).*

Strategies	Spatial Scale		
	Marsh	Hydrologic Basin	Province
1. Vegetation planting	■		
2. Shore fences/barriers	■		
3. Weirs/berms	■		
4. Terracing	■		
5. Marsh impoundments	■	■	
6. Hydrologic restoration	■	■	
7. Dredged material disposal	■	■	
8. Shoreline modification	■	■	
9. Herbivore control	■	■	
10. Sediment transport by pipelines	■	■	
11. Siphons		■	
12. Crevasse formation		■	
13. Major water/sediment diversion		■	■
14. New channels		■	■
15. Critical land bridges		■	■
16. Reoccupation of existing channels		■	■
17. Major river modifications		■	■
18. Barrier island restoration		■	■


Landscape
Ecosystem
Landfor
m
Coastal
and River
Processes
Built
Infrastructure
Built
Infrastructure


$$$
$$$
$$
$
Landscape
Ecosystem
Landform
Coastal
Processes
Built
Infrastructure
Built
Infrastructure


Gate
SAND!

Kirwan et al. 2010

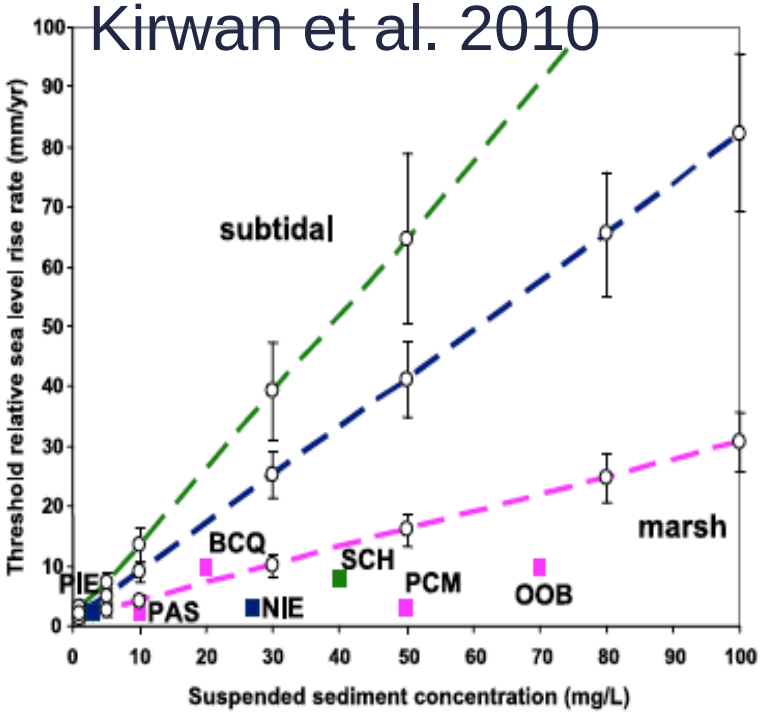
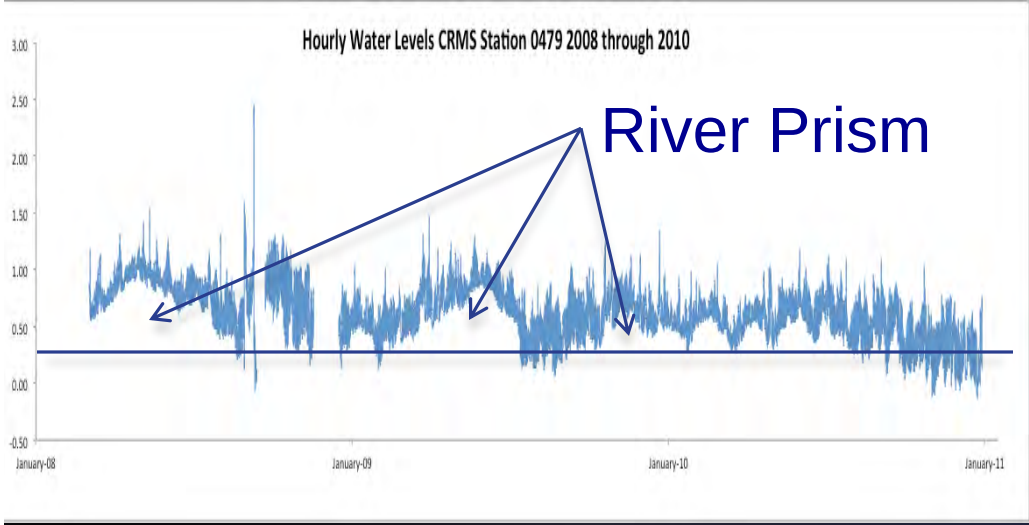
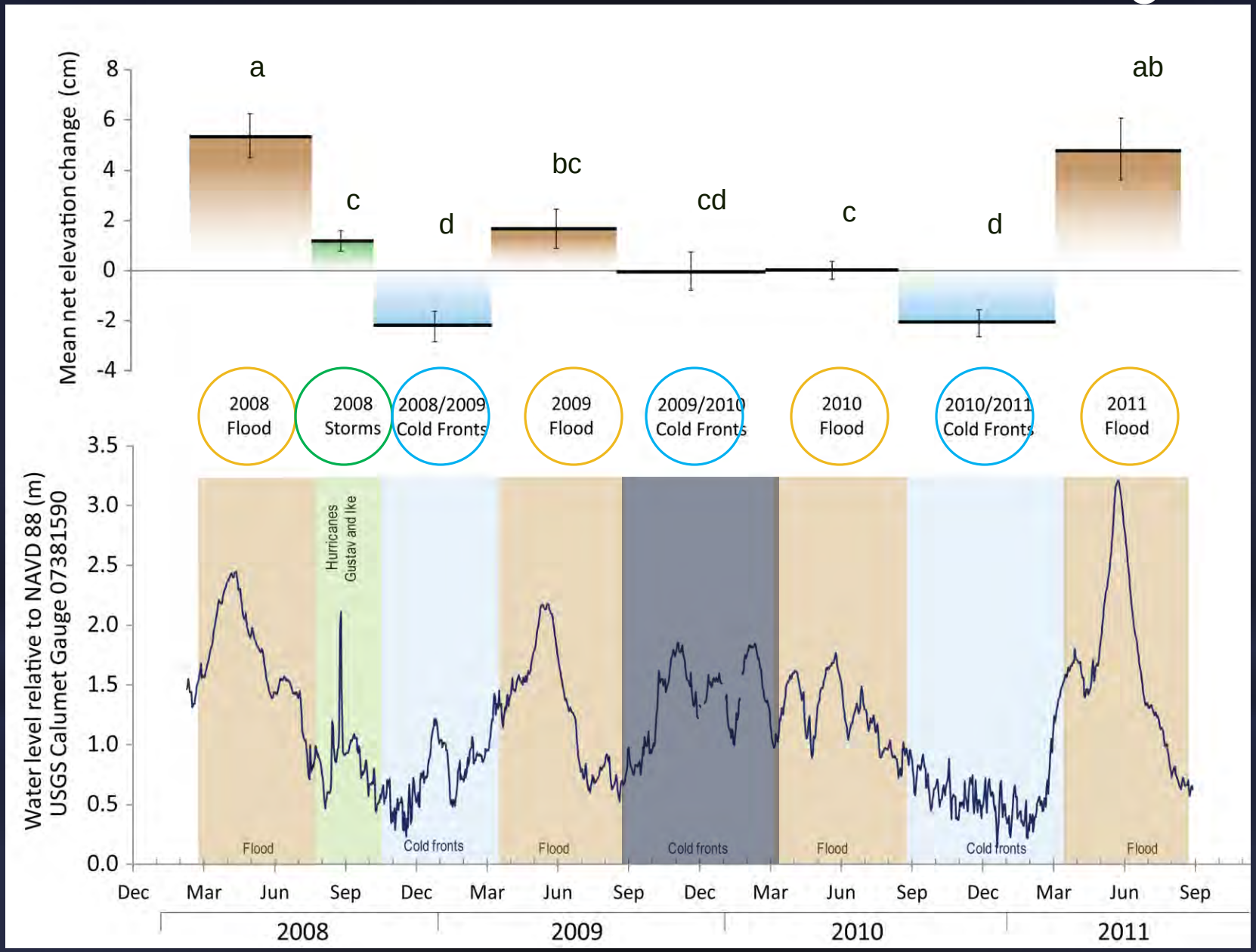


Figure 3. Predicted threshold rates of sea-level rise, above which marshes are replaced by subtidal environments as the stable ecosystem. Each line represents the mean threshold rate (±1 SE) predicted by 5 models as a function of suspended sediment concentration and spring tidal range. Pink line denotes thresholds for marshes modeled under a 1m tidal range, blue line denotes 3 m tidal range, and green line denotes 5 m tidal range. For reference, we have included examples (denoted with square markers) of marshes worldwide in estuaries with different rates of historical sea-level rise, sediment concentration, and tidal range. (Abbreviations: PIE = Plum Island Estuary, Massachusetts; PAS = Pamlico Sound, North Carolina; BCQ = Bayou Chitique, Louisiana; NIE = North Inlet Estuary, South Carolina; SCH = Scheldte Estuary, Netherlands; PCM = Phillips Creek Marsh, Virginia; OOB = Old Oyster Bayou, Louisiana).



Seasonal event net elevation change



Wax Lake Delta Research Overview

- NCED (2007-2012)
  - Elevation/vegetation transects: Azure's dissertation
  - Elaine Evers vegetation mapping
- Sea Grant (2010-2012)
  - Flux studies (MIMS and Mulvaney)
  - N mass balance (Greenhouse)
  - Modeling of nitrate attenuation across marsh: Ben's thesis
- Shell funding (2008-2012)
  - Nutrient fluxes across chronosequence: Kelly's dissertation
  - Monthly water quality surveys
- FESD-Delta Observatory (2012-2017)
  - Instrumentation for long-term monitoring of water quality and flow
  - Integration of data with Delft-3D (hydrodynamics, biogeochemical models)
  - Continue field studies across marsh and sediment/water column nutrient fluxes