Accelerating Elevation Gain Indicates Land Loss Associated with Tidal Erosion at CRMS sites

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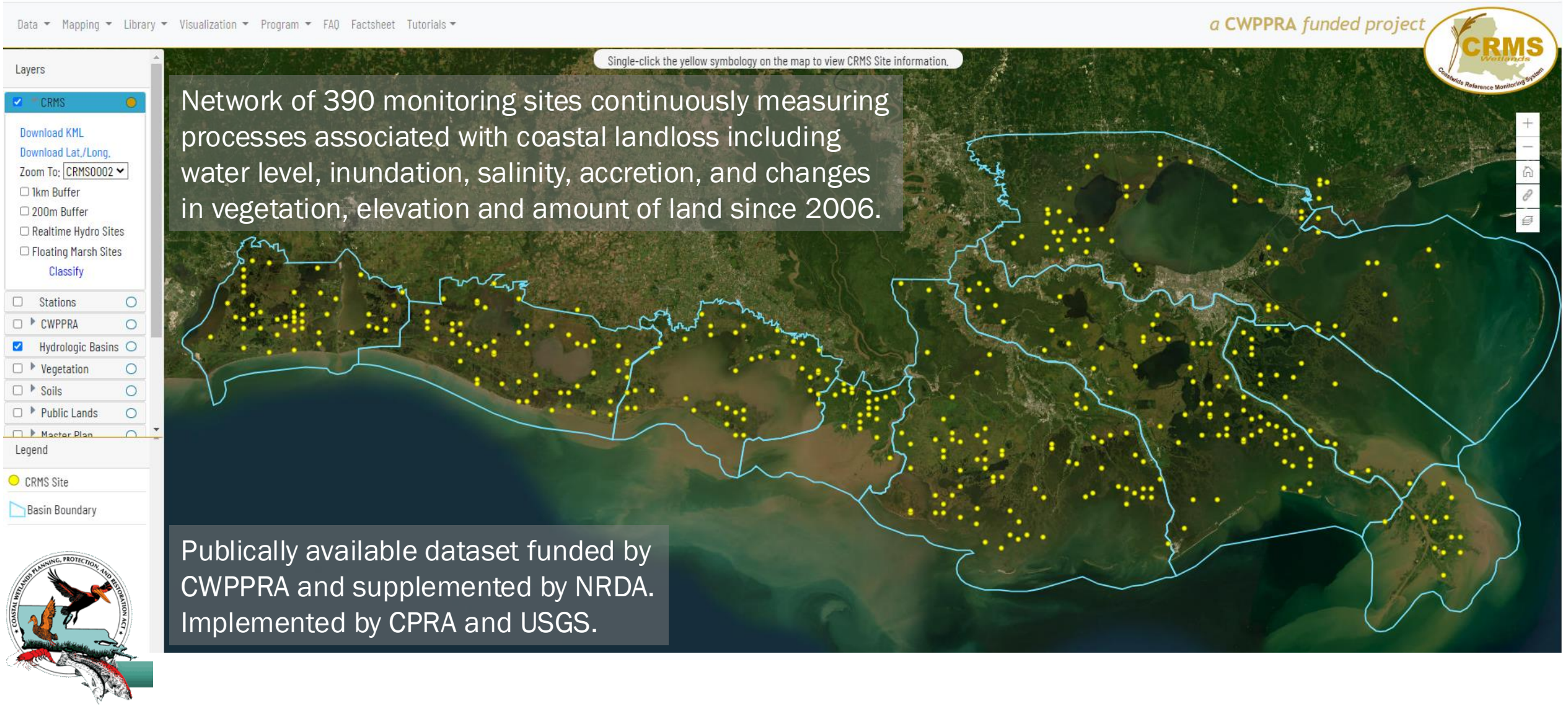
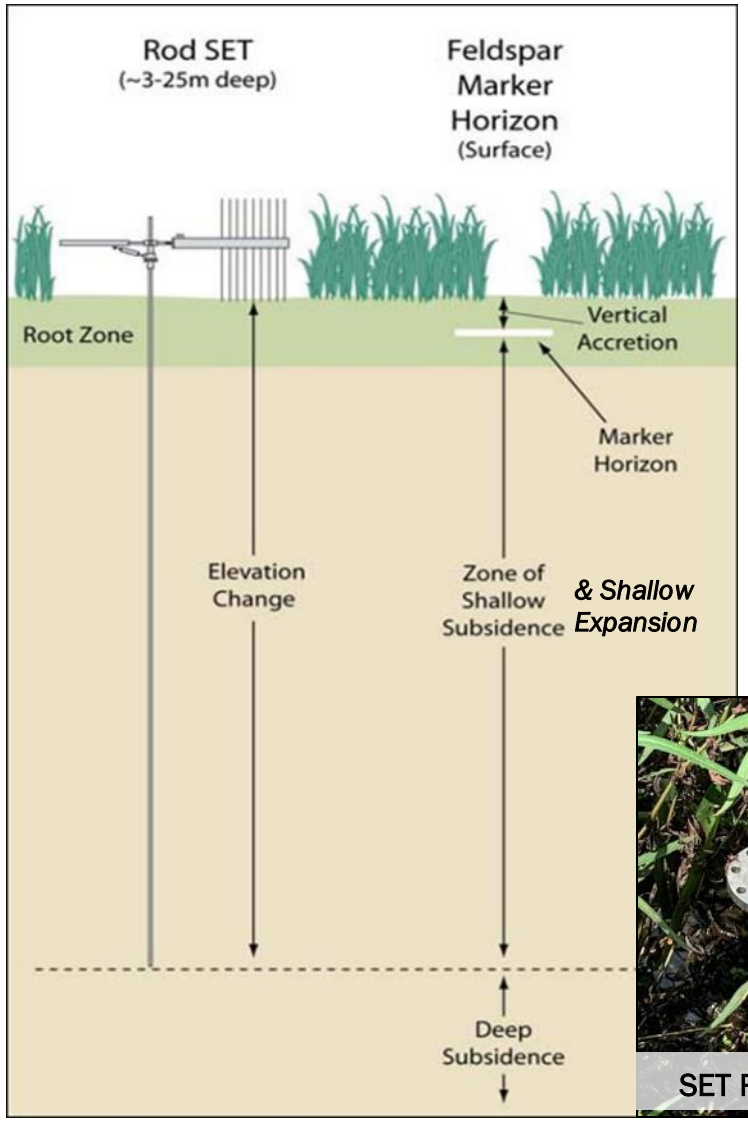
Louisiana's Coastwide Reference Monitoring System (CRMS)



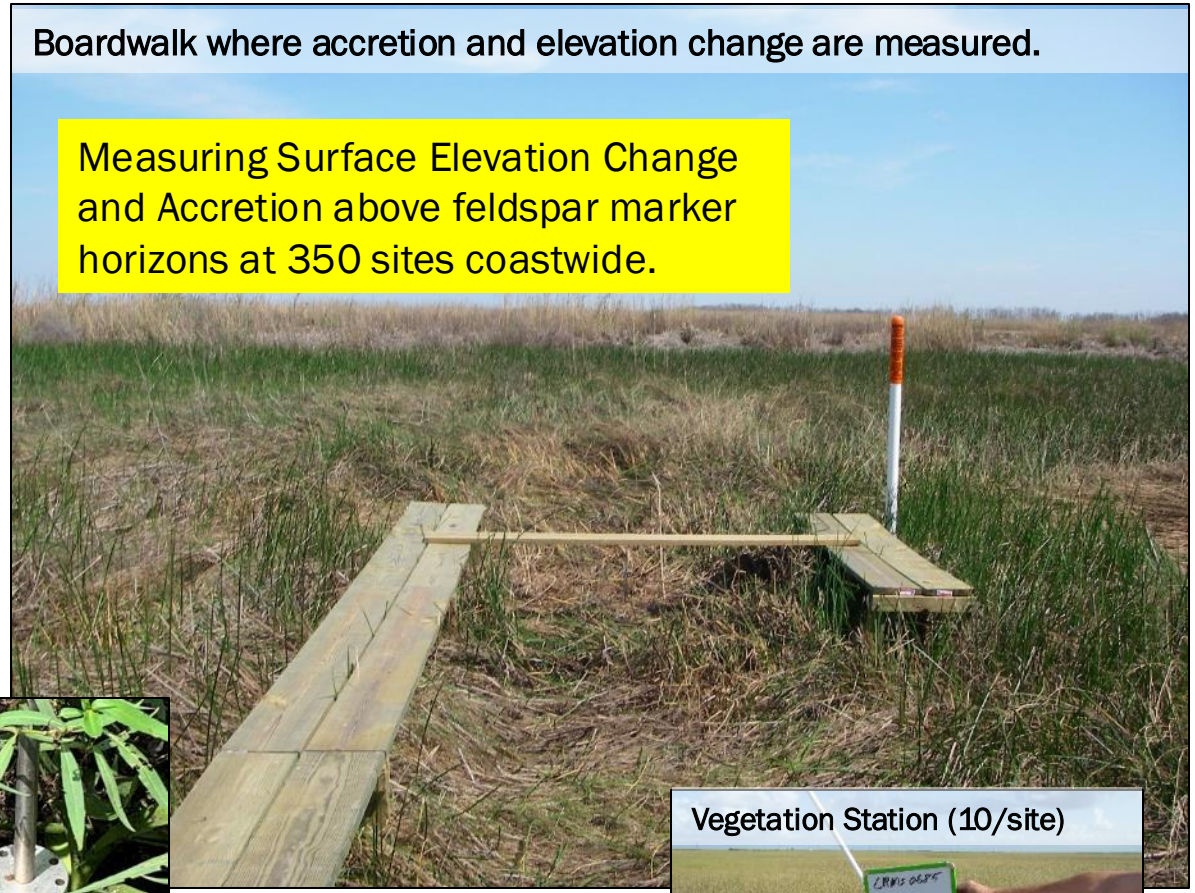
CRMS Monitoring Station Types



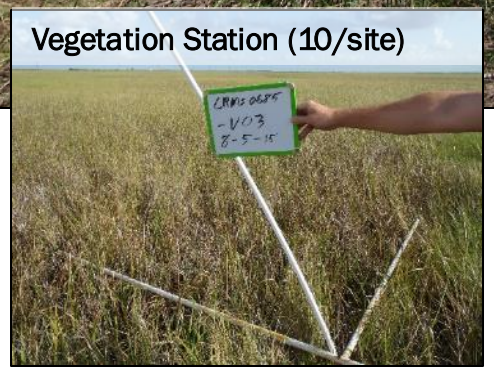
SET Rod

Boardwalk where accretion and elevation change are measured.

Measuring Surface Elevation Change and Accretion above feldspar marker horizons at 350 sites coastwide.



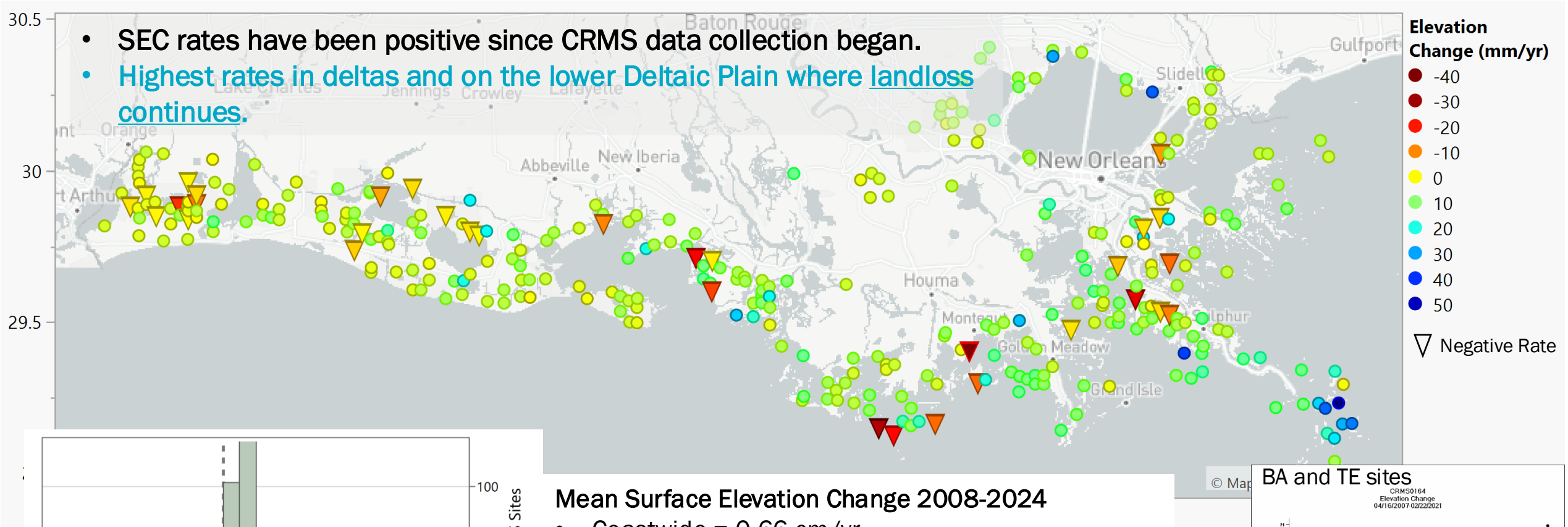
Vegetation Station (10/site)

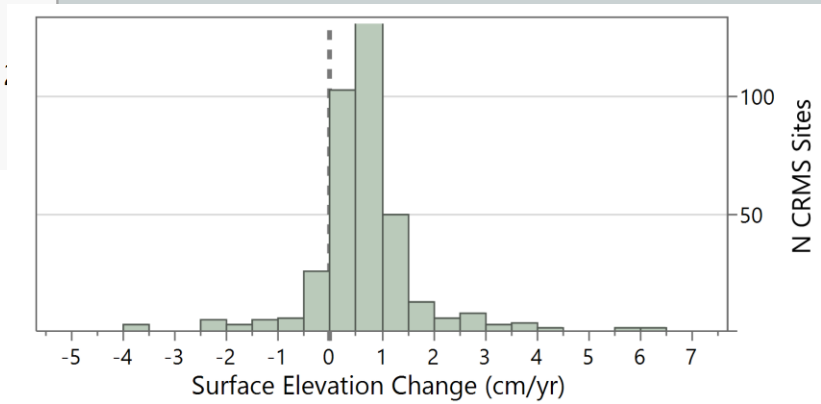


Hydro station records hourly water level, salinity and temperature.

Most CRMS sites see Surface Elevation Gain

- SEC rates have been positive since CRMS data collection began.
- Highest rates in deltas and on the lower Deltaic Plain where landloss continues.

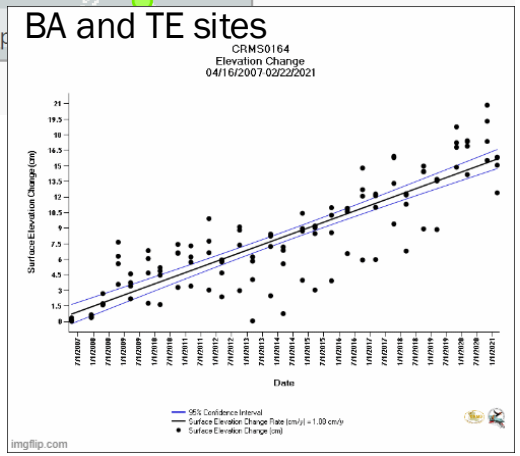




Mean Surface Elevation Change 2008-2024

- Coastwide = 0.66 cm/yr
- Deltaic Plain = 0.81 cm/yr
- Chenier Plain = 0.37 cm/yr
- Highest Basin - Mississippi River Delta = 2.4 cm/yr
- Lowest Basin - Calcasieu Sabine Basin = 0.2 cm/yr

BA and TE sites

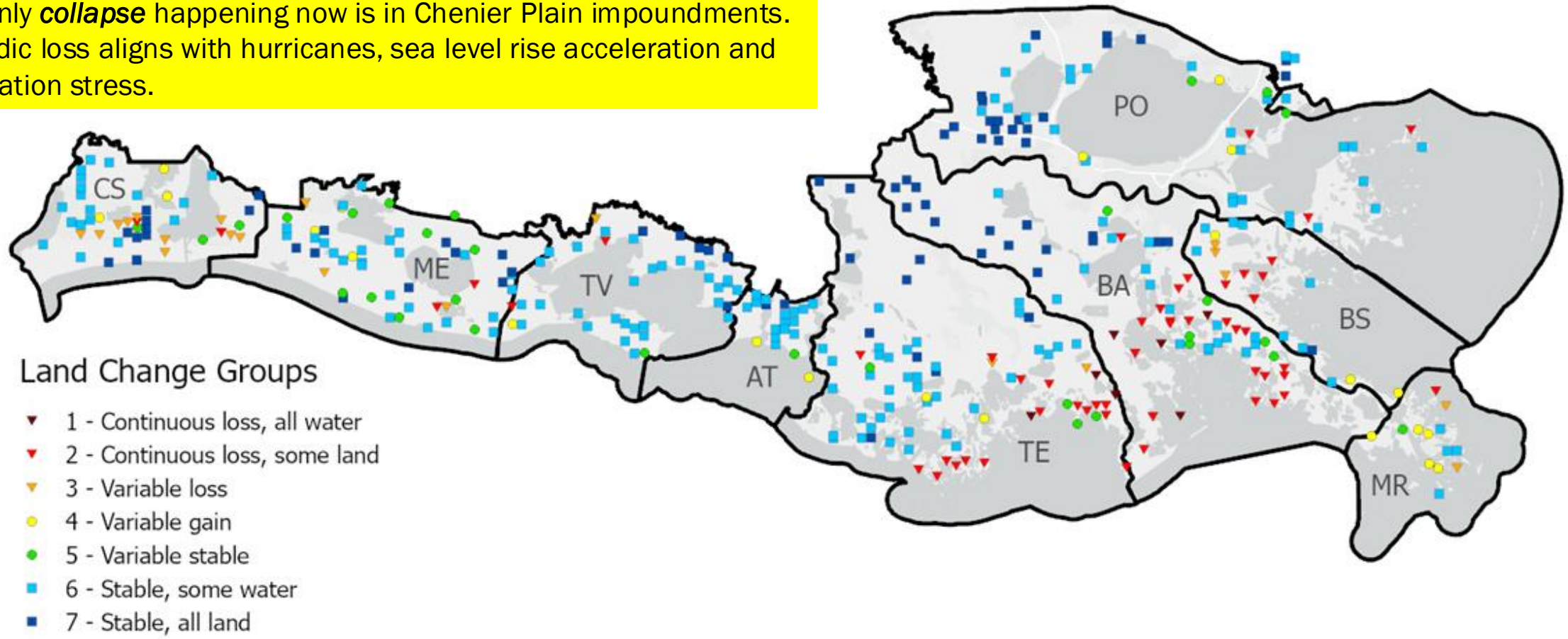


Landloss Continues

CRMS Land Change Groups: Hierarchical clustering informed by satellite derived trends (1985-2020) and CRMS 1 km spatial analyses through 2021 (post Ida).

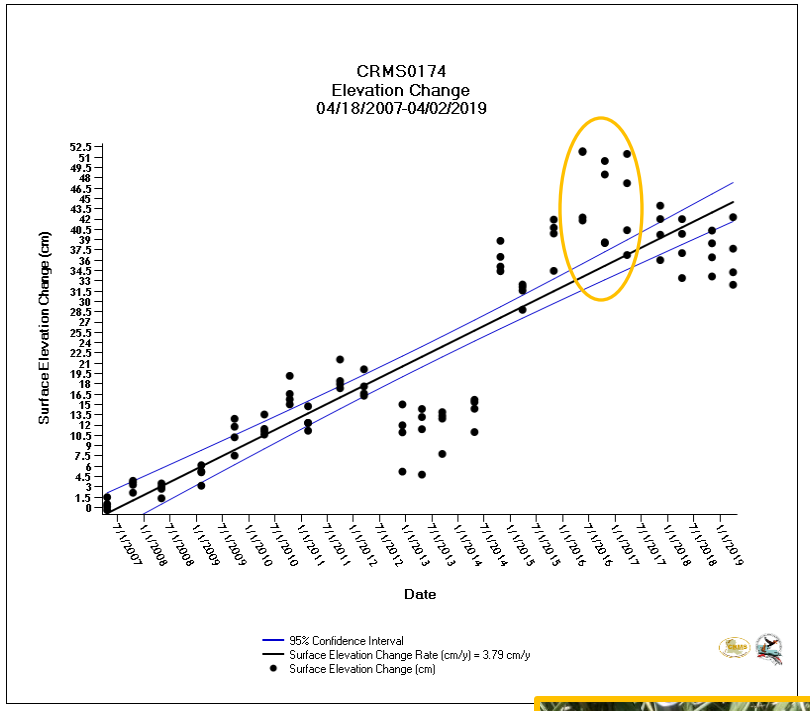
- *Continuous landloss is limited to lower Deltaic Plain tidal marshes.*
- >60% of sites are “Stable”

The only ***collapse*** happening now is in Chenier Plain impoundments. Episodic loss aligns with hurricanes, sea level rise acceleration and inundation stress.

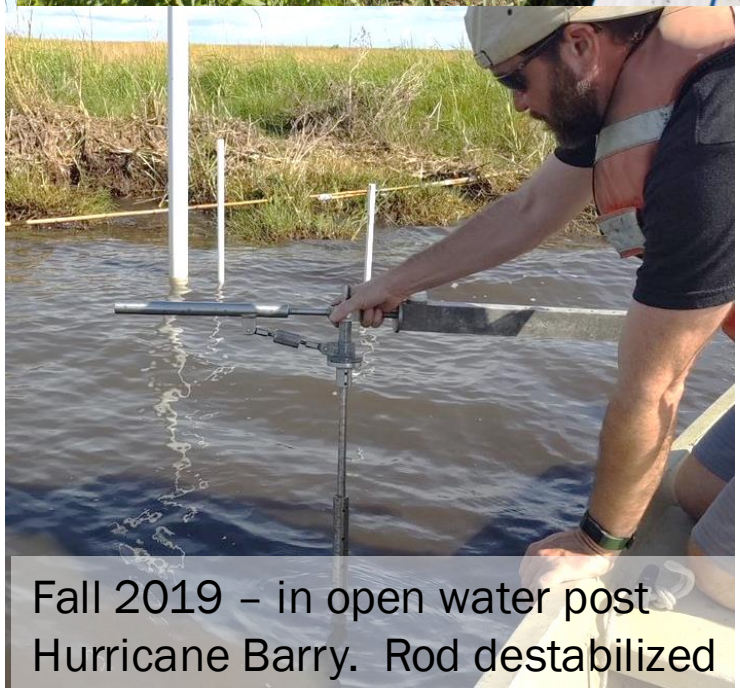


Rapid Erosion - High Elevation Gain + Landloss - BA Basin CRMS0174

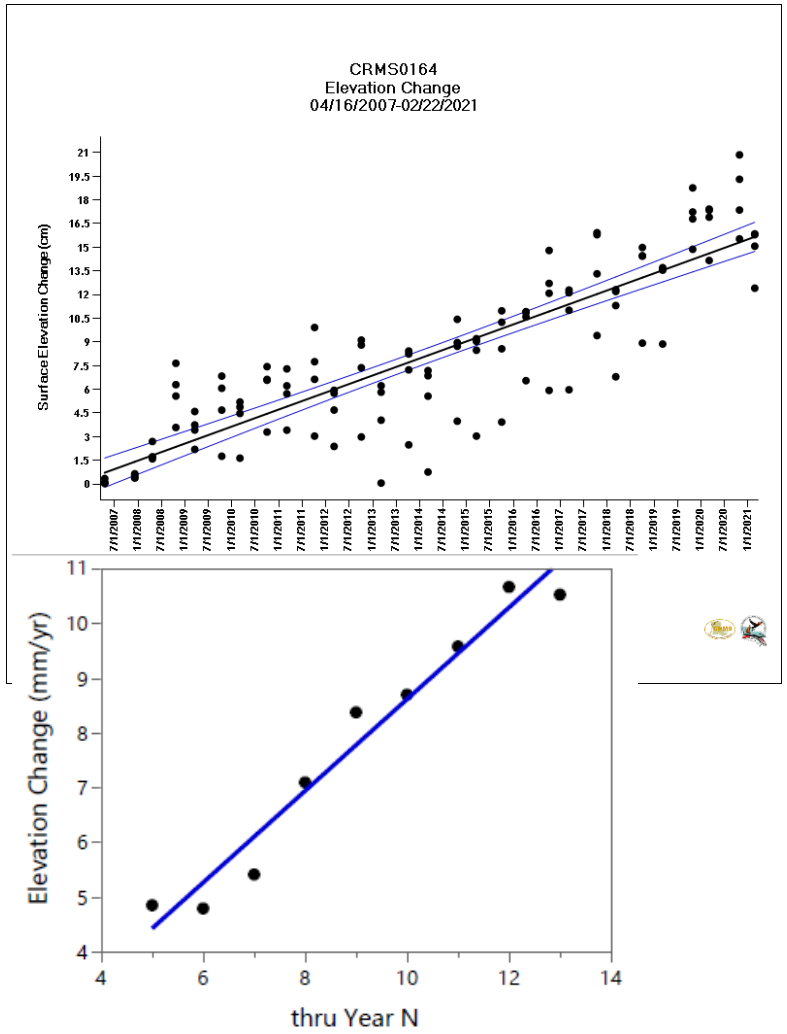
Delta Scale Elevation Gain (3.8 cm/yr)



2017 – Due to very high sediment deposition, rod extended and collar raised

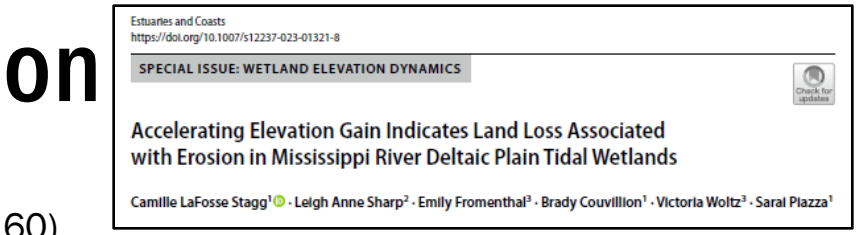


Assessed Relationship between Land Change, Elevation Change, and Elevation Change Acceleration



Inputs:

- Data from all CRMS Tidal Deltaic Plain sites (n=160)
- **Elevation Change Rates** (mm yr $^{-1}$) 2008 to 2021
  - trimmed to last vegetated date
- **Elevation Acceleration Rate** (mm yr $^{-2}$)
  - 1st derivative of elevation change
- **Land Change between 2008 to 2018**
- **Matrix values** from CRMS land change data
  - sum **Oscillating Land**
- ID'd all sites that lost all land pre Ida (n=10)


Estuaries and Coasts
https://doi.org/10.1007/s12237-023-01321-8

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Accelerating Elevation Gain Indicates Land Loss Associated with Erosion in Mississippi River Deltaic Plain Tidal Wetlands

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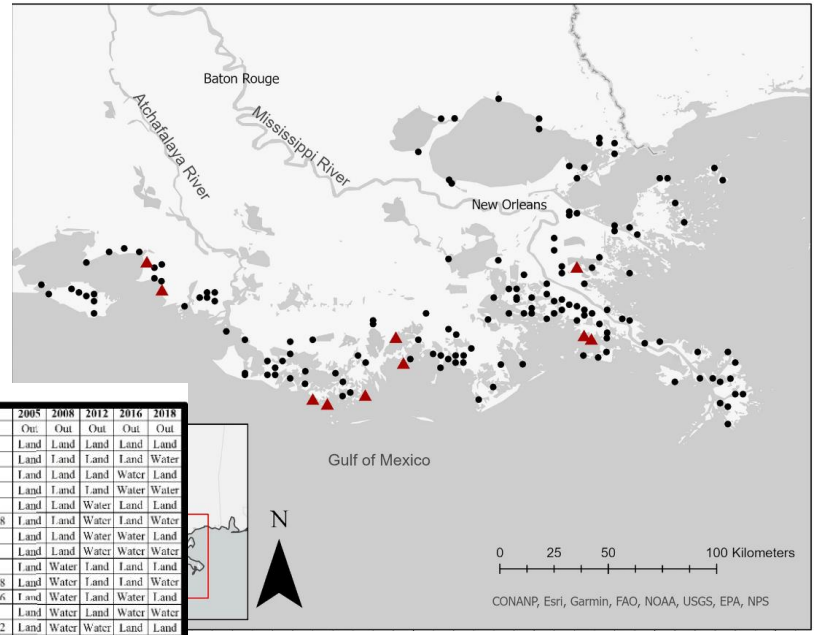
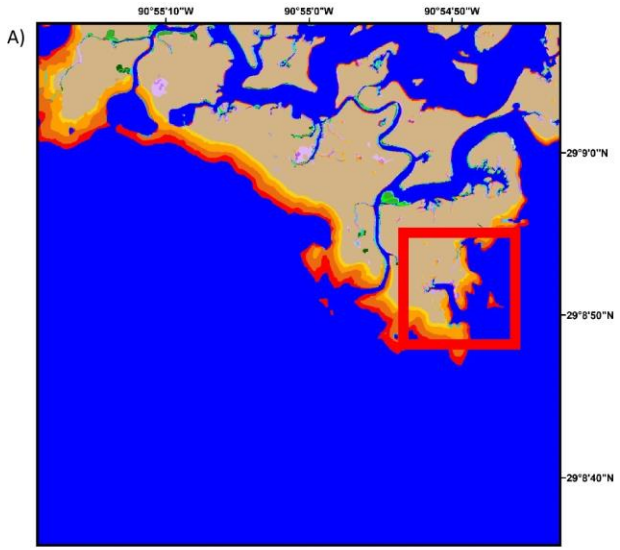
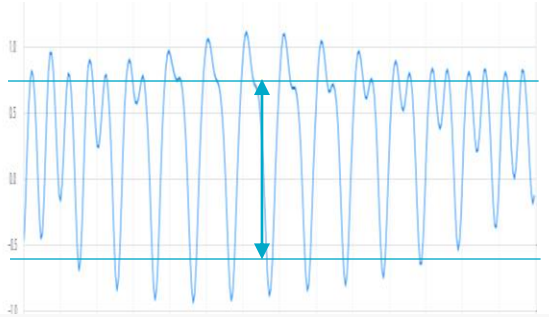


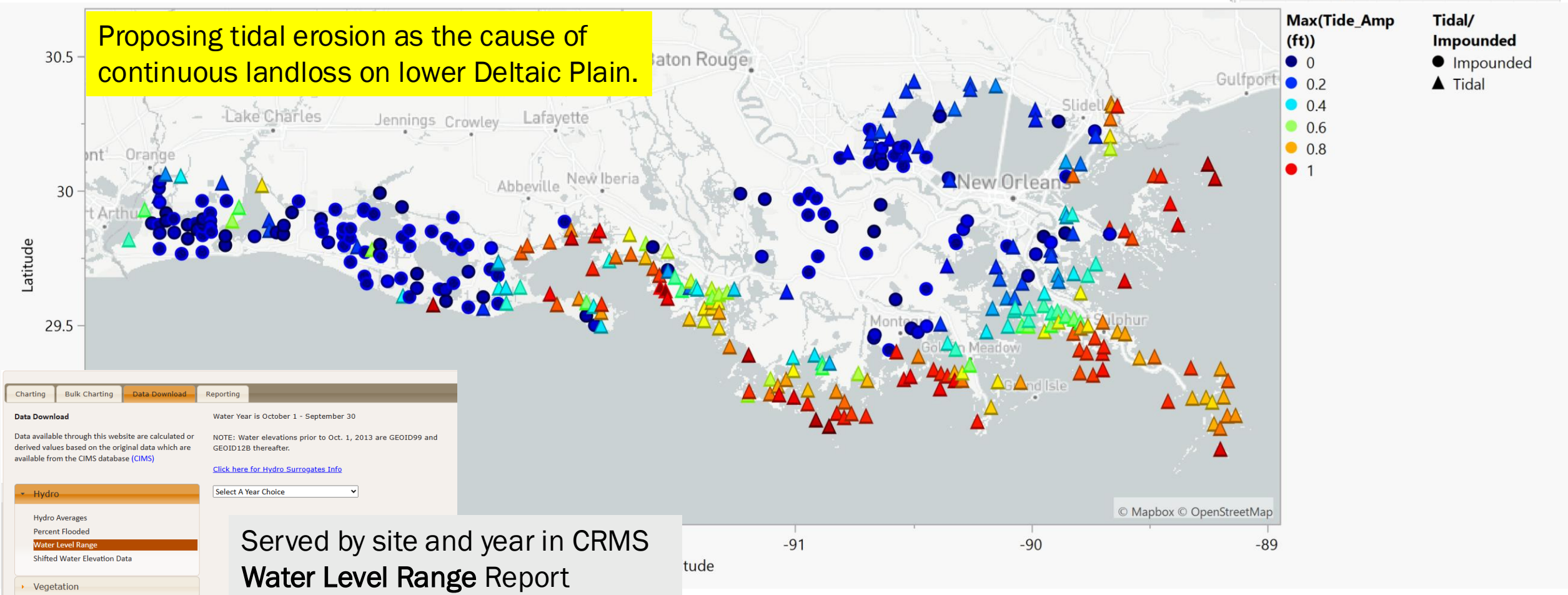


Color	Description	2005	2008	2012	2016	2018
	Out	Out	Out	Out	Out	Out
	Persistent land	Land	Land	Land	Land	Land
	New Water - 2018	Land	Land	Land	Land	Water
	Oscillating - Ephemeral water - 2016	Land	Land	Land	Water	Land
	Persistent loss - 2016	Land	Land	Land	Water	Water
	Oscillating - Ephemeral water - 2012	Land	Land	Water	Land	Land
	Oscillating - Ephemeral water - 2012, 2018	Land	Land	Water	Land	Water
	Oscillating - Water - 2012, 2016	Land	Land	Water	Water	Land
	Persistent loss - 2012	Land	Land	Water	Water	Water
	Oscillating - Ephemeral water - 2008	Land	Water	Land	Land	Land
	Oscillating - Ephemeral water - 2008, 2018	Land	Water	Land	Land	Water
	Oscillating - Ephemeral water - 2008, 2016	Land	Water	Land	Water	Land
	Oscillating - Water - 2008, 2016, 2018	Land	Water	Land	Water	Water
	Oscillating - Ephemeral water - 2008, 2012	Land	Water	Water	Land	Land
	Oscillating - Water - 2008, 2012, 2018	Land	Water	Water	Land	Water
	Oscillating - Water - 2008, 2012, 2016	Land	Water	Water	Water	Land
	Persistent loss - 2008	Land	Water	Water	Water	Water
	Persistent gain - 2008	Water	Land	Land	Land	Land
	Oscillating - Land - 2008, 2012, 2016	Water	Land	Land	Land	Water
	Oscillating - Land - 2008, 2012, 2018	Water	Land	Land	Water	Land
	Oscillating - Ephemeral land - 2008, 2012	Water	Land	Land	Water	Water
	Oscillating - Land - 2008, 2016, 2018	Water	Land	Water	Land	Land
	Oscillating - Ephemeral Land - 2008, 2016	Water	Land	Water	Land	Water
	Oscillating - Ephemeral Land - 2008, 2018	Water	Land	Water	Water	Land
	Oscillating - Ephemeral land - 2008	Water	Land	Water	Water	Water
	Persistent gain - 2012	Water	Water	Land	Land	Land
	Oscillating - Land - 2012, 2016	Water	Water	Land	Land	Water
	Oscillating - Ephemeral land - 2012, 2018	Water	Water	Land	Water	Land
	Oscillating - Ephemeral land - 2012	Water	Water	Land	Water	Water
	Persistent gain - 2016	Water	Water	Water	Land	Land
	Oscillating - Ephemeral land - 2016	Water	Water	Water	Land	Water
	New land - 2018	Water	Water	Water	Water	Land
	Persistent water	Water	Water	Water	Water	Water

Tidal Amplitude



Proposing tidal erosion as the cause of continuous landloss on lower Deltaic Plain.



Served by site and year in CRMS

Water Level Range Report

https://lacoast.gov/chart/Charting.aspx?laf=crms

Final Portraits – Last Year with Vegetation

TE_Penchant sub basin

TE_Terrebonne sub basin

BA_High energy shoreline

TV_Bay shoreline and Fresh Marsh

Final Portraits – Open Water

TE_Penchant sub basin

TE_Terrebonne sub basin

BA_High energy shoreline

TV_Bay shoreline and Fresh Marsh

Eroding Surfaces

CRMS0302 Soil surface 2014
– Note shell hash and hearty stems

CRMS0302 Soil surface 2015
– Note exposed roots and broken stems

Land Change Classification

- Identified sites that had lost all vegetation pre Ida (n=10 sites; red triangles).
  - Most had tidal amplitude > 0.7'; outlier in Breton Sound
- Classified sites as Gaining Land, Losing Land or Oscillating using 2008 and 2018 USGS spatial analyses.
- Explored relationships between elevation gain, acceleration, and land change.

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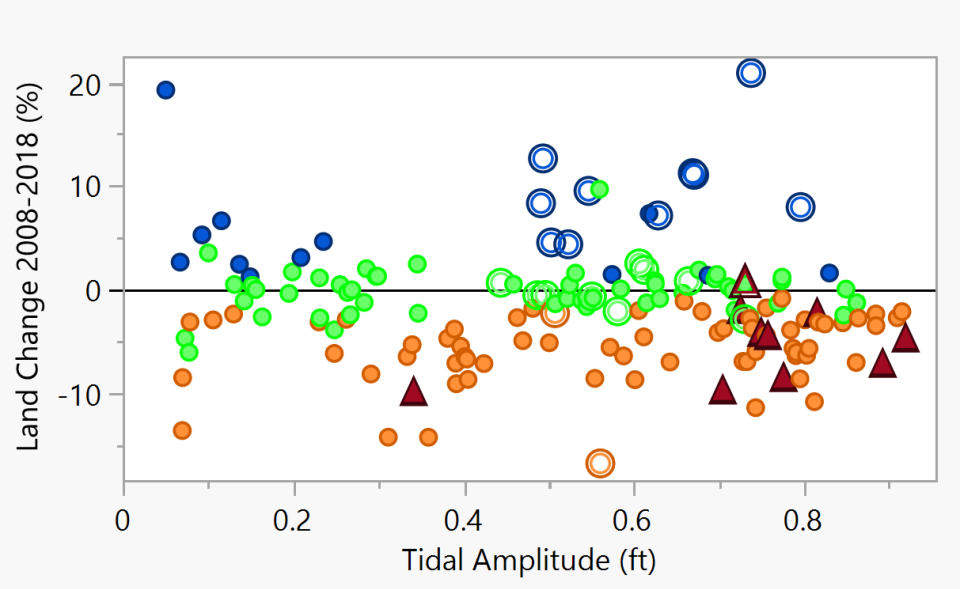
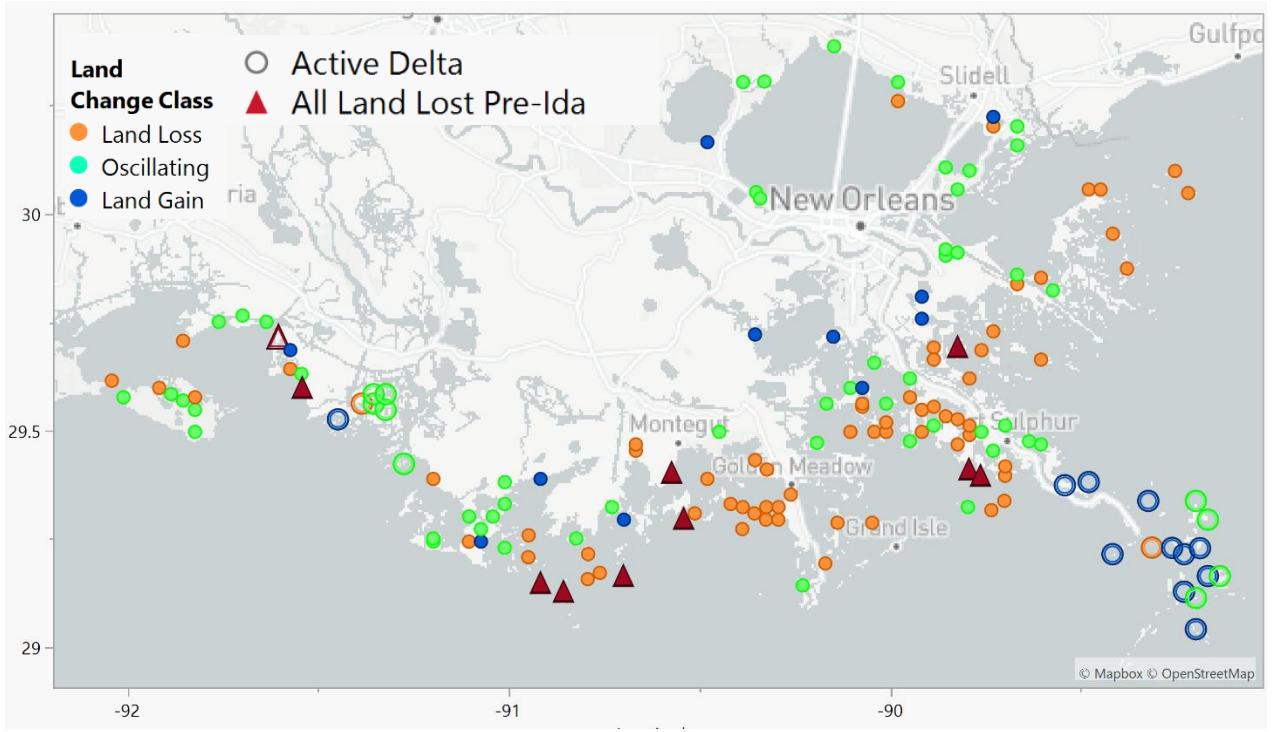
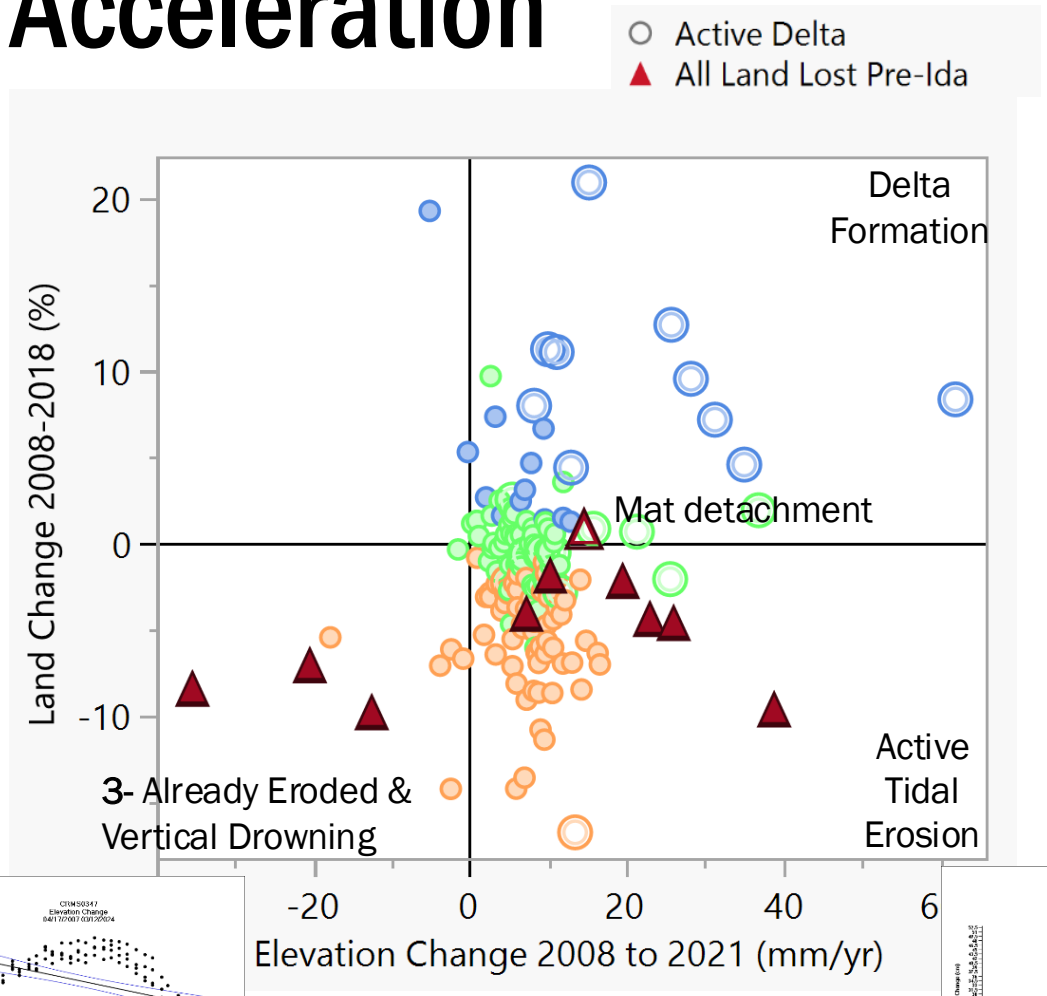
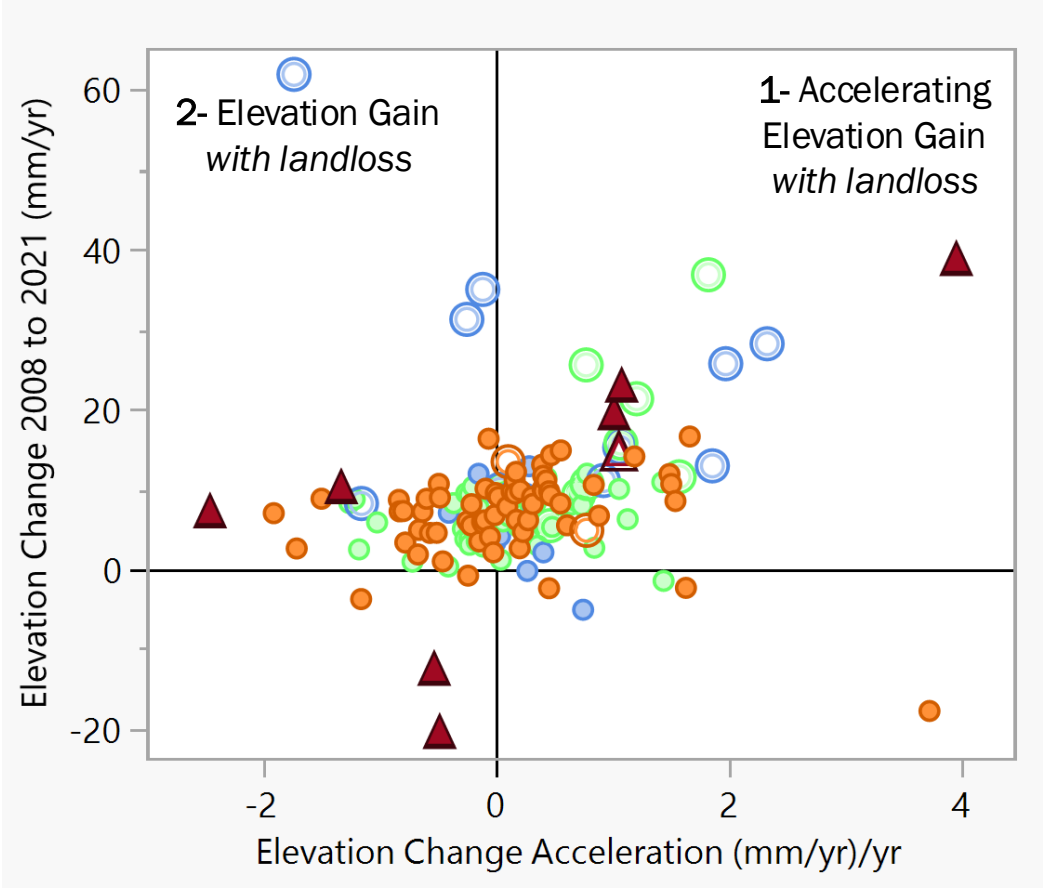


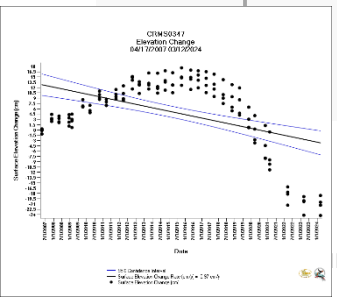


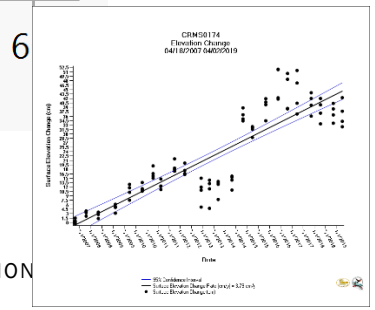
Land Change, Elevation Change and Elevation Change Acceleration



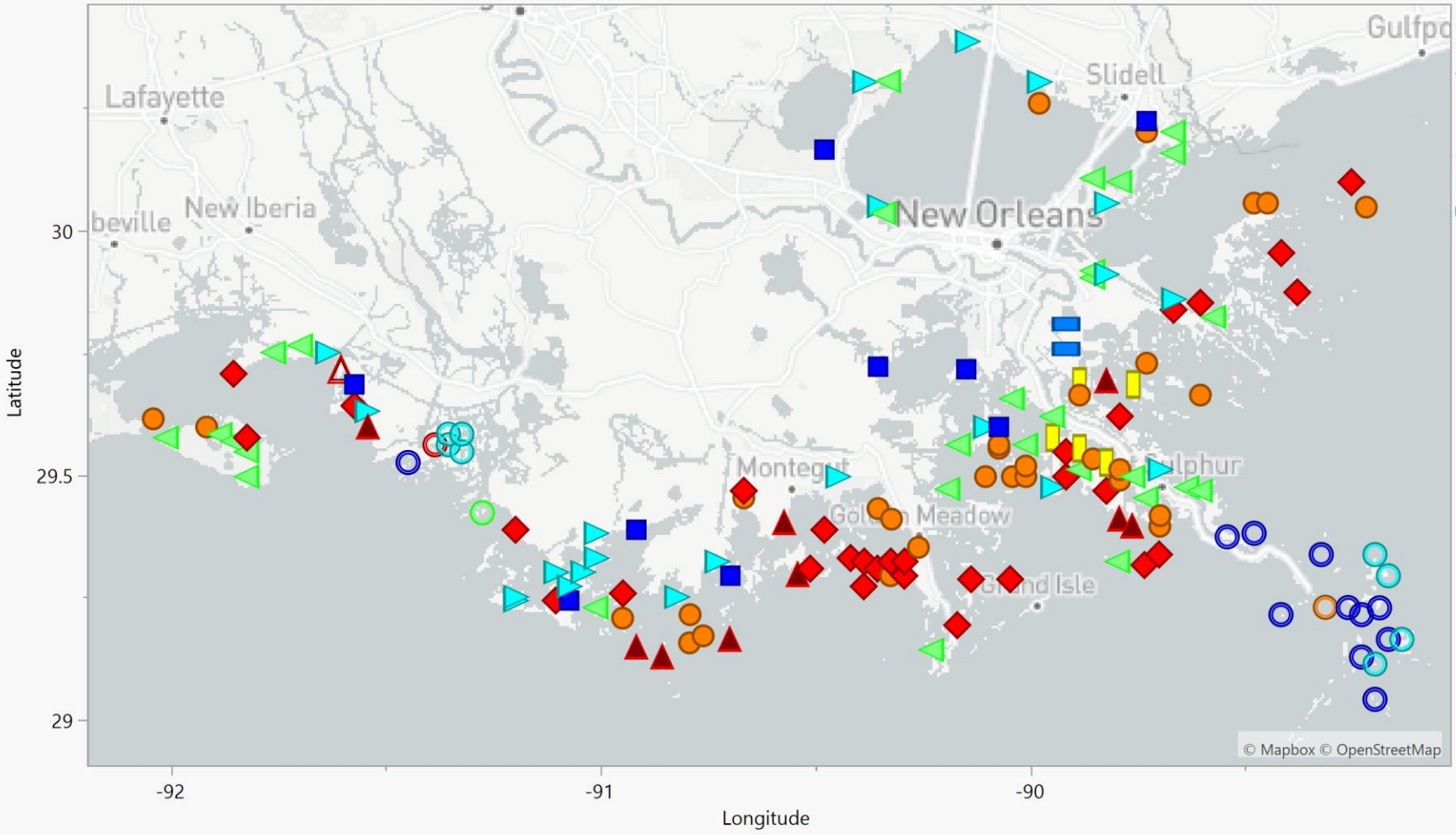
1- Most Vulnerable to Erosion: Landloss with accelerating elevation gain (20%)
2- Vulnerable to Erosion: Landloss with elevation gain (20%)
3- Vulnerable to Drowning: Landloss with elevation loss (<5%)





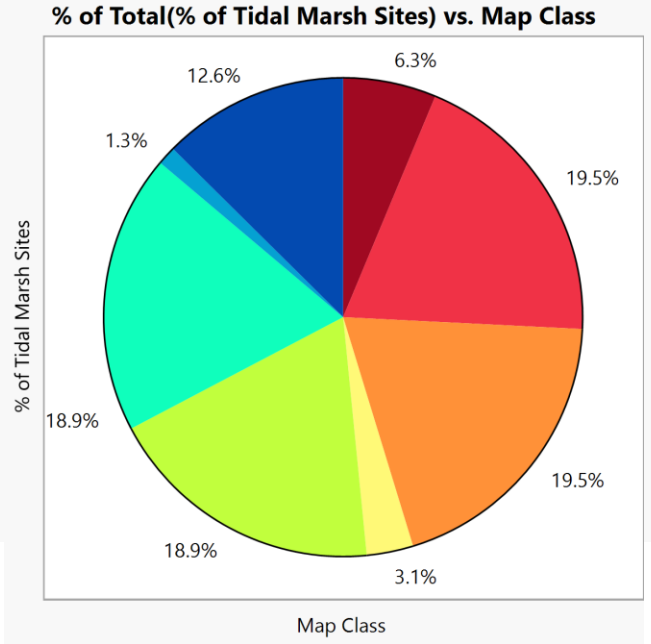


Vulnerability to Erosion Classified

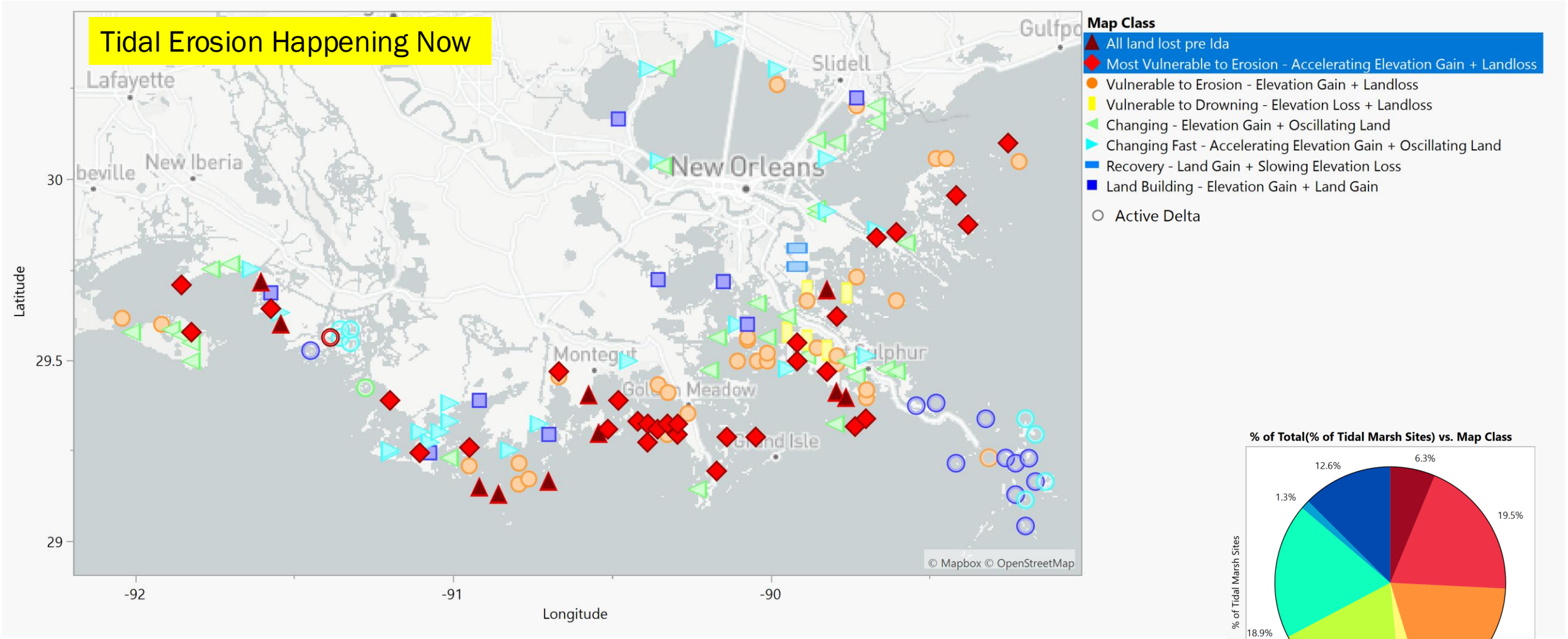


Map Class

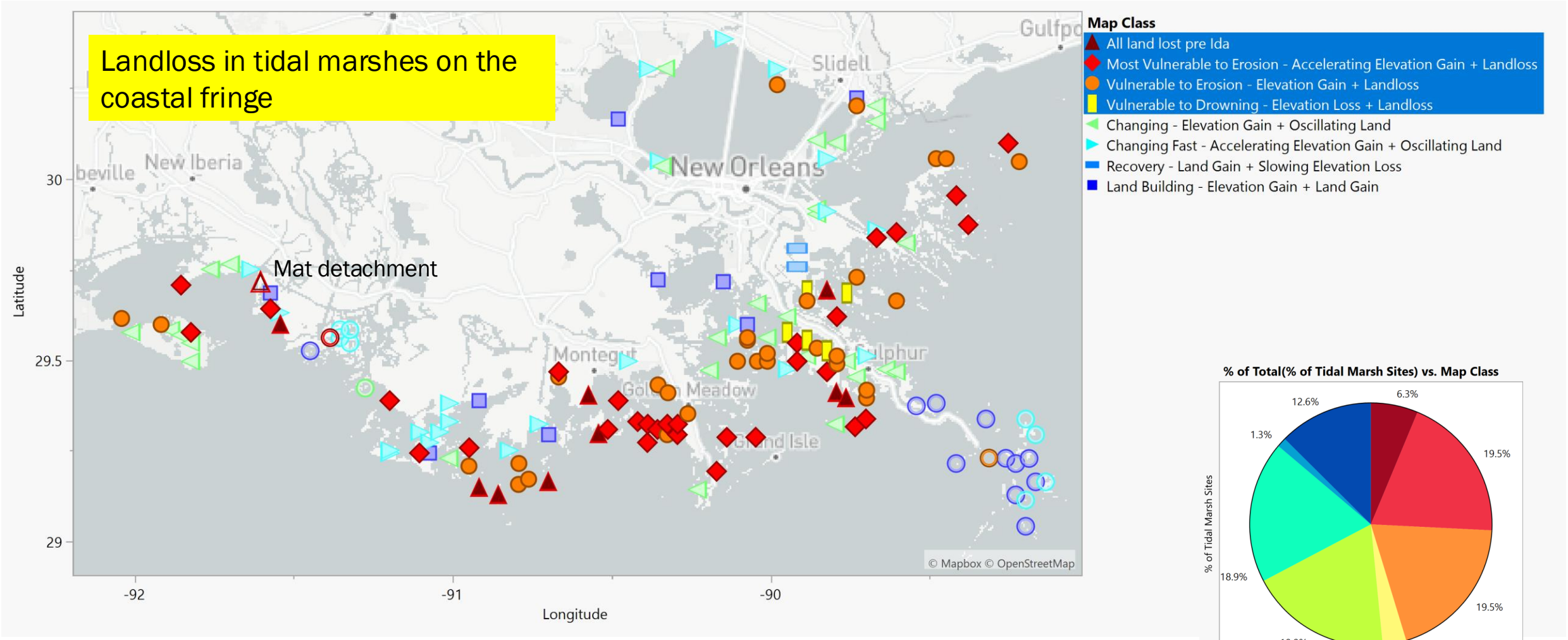
- All land lost pre Ida
- Most Vulnerable to Erosion - Accelerating Elevation Gain + Landloss
- Vulnerable to Erosion - Elevation Gain + Landloss
- Vulnerable to Drowning - Elevation Loss + Landloss
- Changing - Elevation Gain + Oscillating Land
- Changing Fast - Accelerating Elevation Gain + Oscillating Land
- Recovery - Land Gain + Slowing Elevation Loss
- Land Building - Elevation Gain + Land Gain



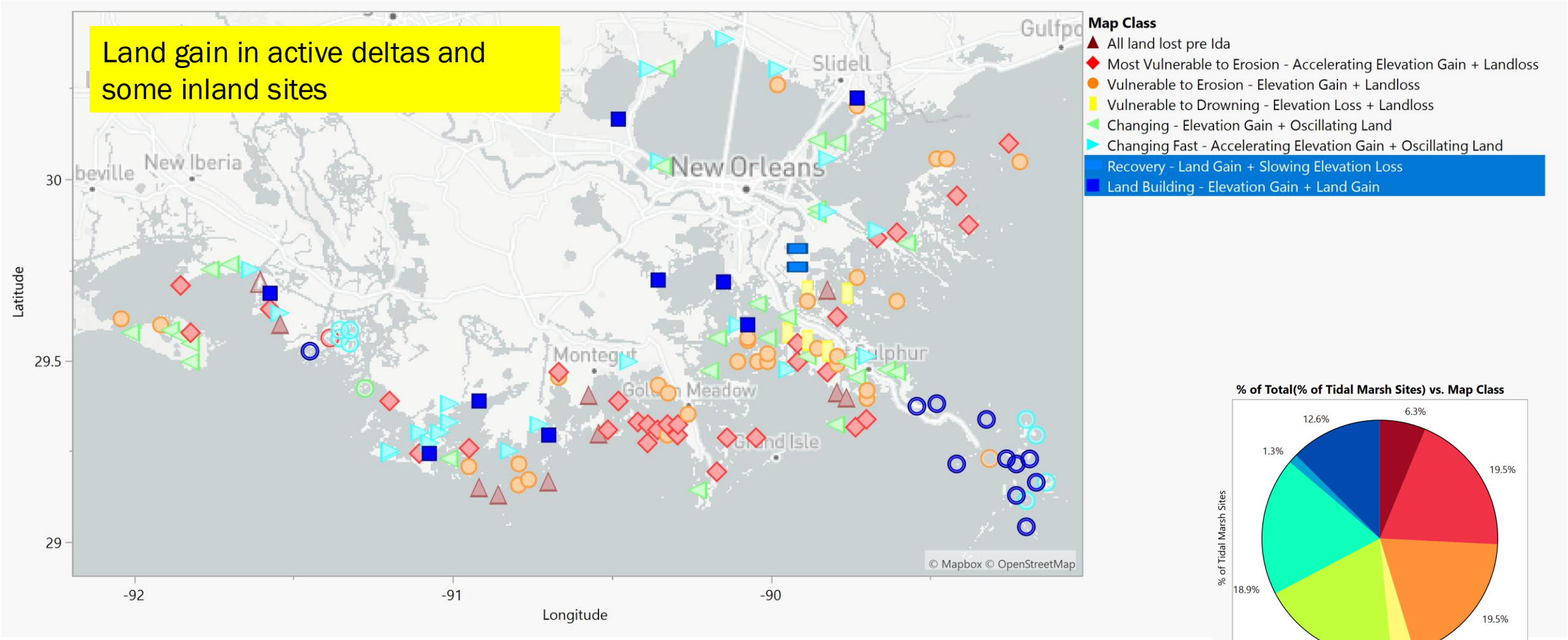
Land Loss with Accelerating Elevation Gain



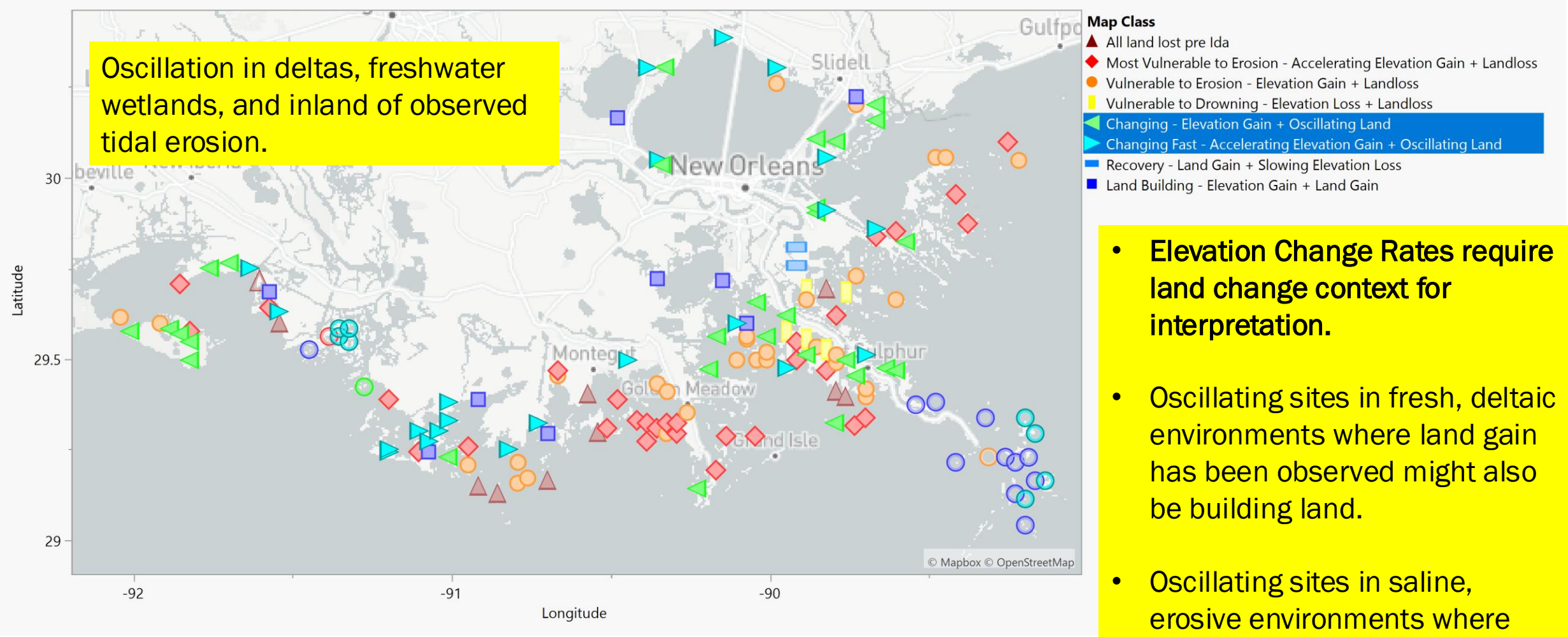
Groups Losing Land



Groups Gaining Land



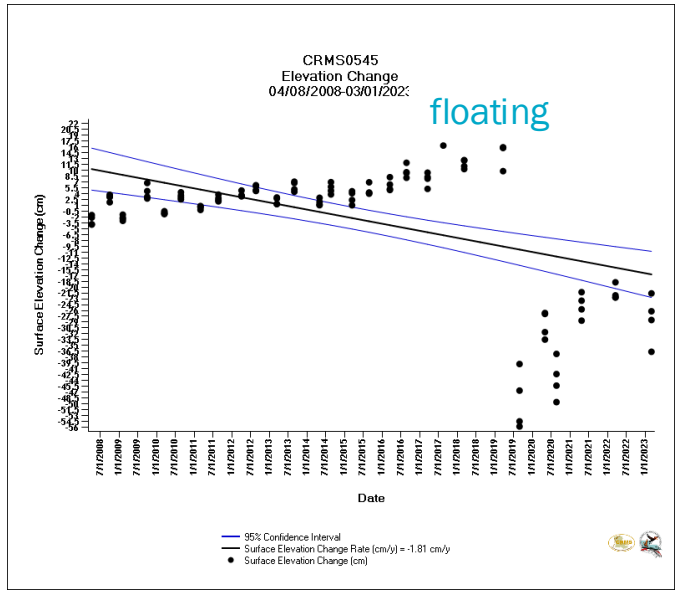
Oscillating Groups

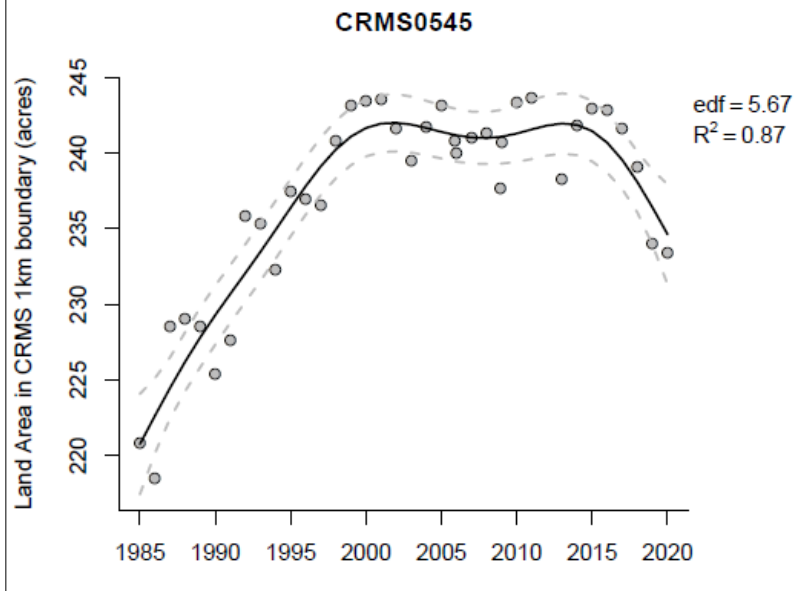


- **Elevation Change Rates require land change context for interpretation.**
- Oscillating sites in fresh, deltaic environments where land gain has been observed might also be building land.
- Oscillating sites in saline, erosive environments where land loss has been observed are probably beginning to erode.

Mat Detachment and Landloss - TV Basin Intermediate Marsh

- The marsh surface at CRMS0545 was observed to detach (began to float) in 2017.
- Land remained stable.
- The floating vegetation was removed by H. Barry in 2019 and hasn't recovered.
- *This can also be characterized as accelerating elevation gain with landloss though it is not tidal erosion.*
- Mat detachment and related vulnerability contributes to landloss during hurricanes.
- Shallow expansion contributes to elevation gain and is observed more frequently in high water years.





Final Thoughts

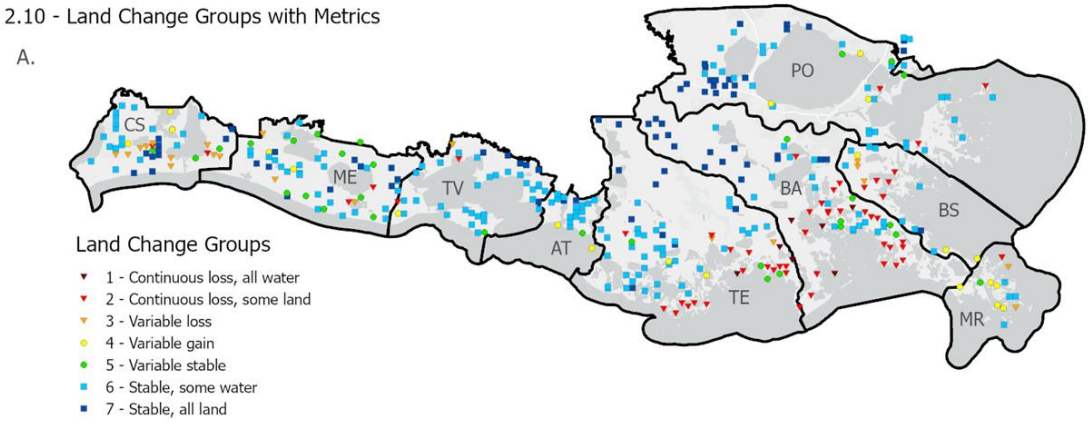
- Since 2005, ongoing Deltaic Plain landloss has been due to tidal erosion and hurricane damage.

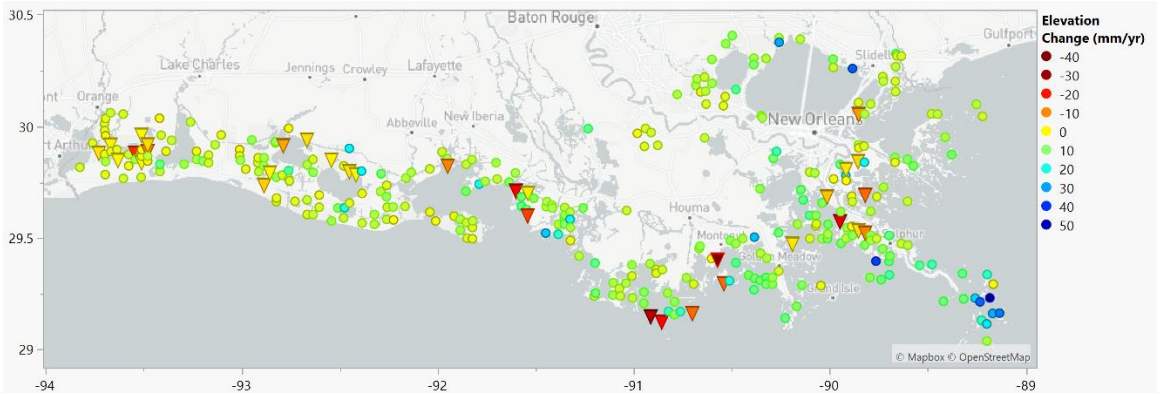
- Most CRMS sites are gaining elevation and there are multiple pathways to elevation gain.

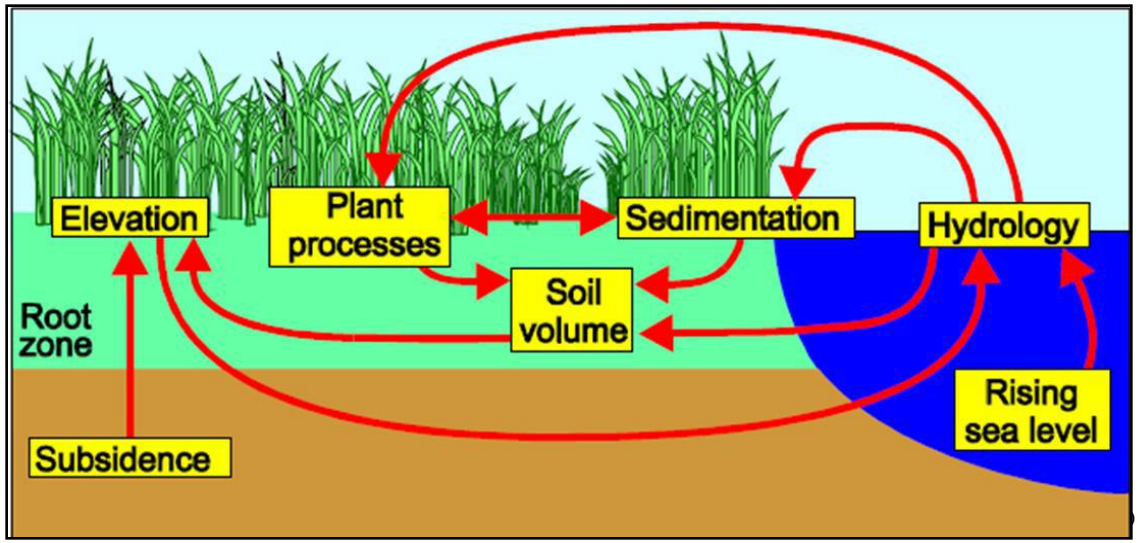
- **A sudden increase in elevation gain outside of an active delta is cause for concern.**
  - Could be due to an advancing shoreline.
  - Could also indicate shallow expansion and mat detachment.
    - *Landscape trends can help interpret change.*

- We may be able to restore more coastal area with erosion control techniques than previously assumed.

- **The CRMS dataset is replete with examples of ecosystem feedback.**
  - Increasing sedimentation with rising sea level
  - Elevation gain from within the mat in response to increased inundation (shallow expansion).
  - Ecosystem resilience despite increasing sea level







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