Soils and sea-level rise: Are our youngest soils also the most vulnerable?

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THE WATER INSTITUTE OF THE GULF

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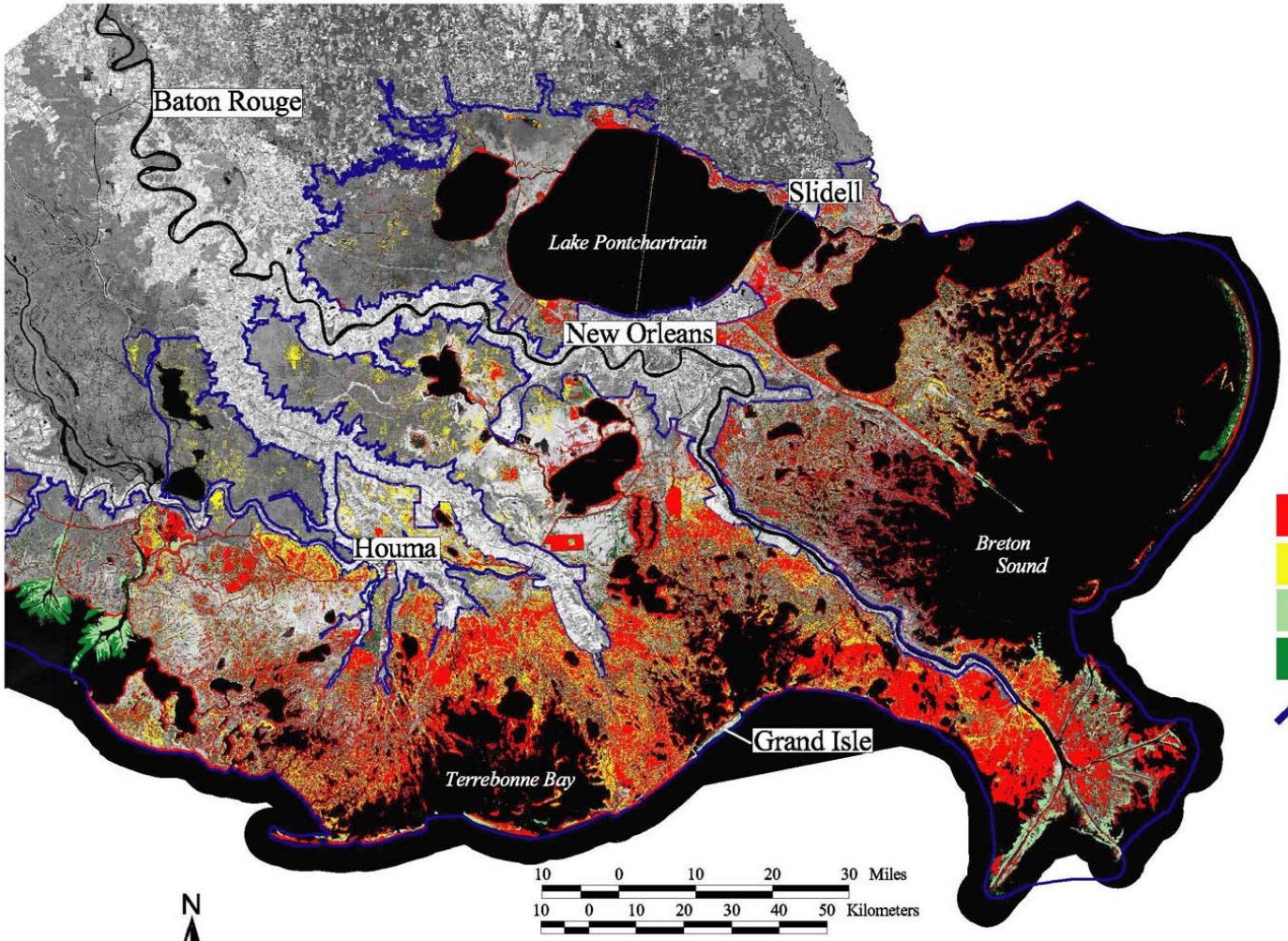
USGS science for a changing world

100+ Years of Land Change for Southeast Coastal Louisiana



LEGEND

- Land Loss 1932 - 2000
- Predicted Land Loss 2000 - 2050
- Land Gain 1932 - 2000
- Predicted Land Gain 2000 - 2050
- Louisiana Land Change Study Boundary

SUMMARY

Coastal Louisiana has lost an average of 34 square miles of land, primarily marsh, per year for the last 50 years. From 1932 to 2000, coastal Louisiana has lost 1,900 square miles of land, roughly an area the size of the state of Delaware. If nothing is done to stop this land loss, Louisiana could potentially lose approximately 700 square miles of land, or about equal to the size of the greater Washington D.C.-Baltimore area, in the next 50 years. Further, Louisiana accounted for an estimated 90 percent of the coastal marsh loss in the lower 48 states during the 1990s. The area shown on this map represents over 75 percent of the total land loss for coastal Louisiana.

Backdrop is 2000 TM panchromatic band.

Prepared By:
U.S. Geological Survey
National Wetlands Research Center
Lafayette, LA

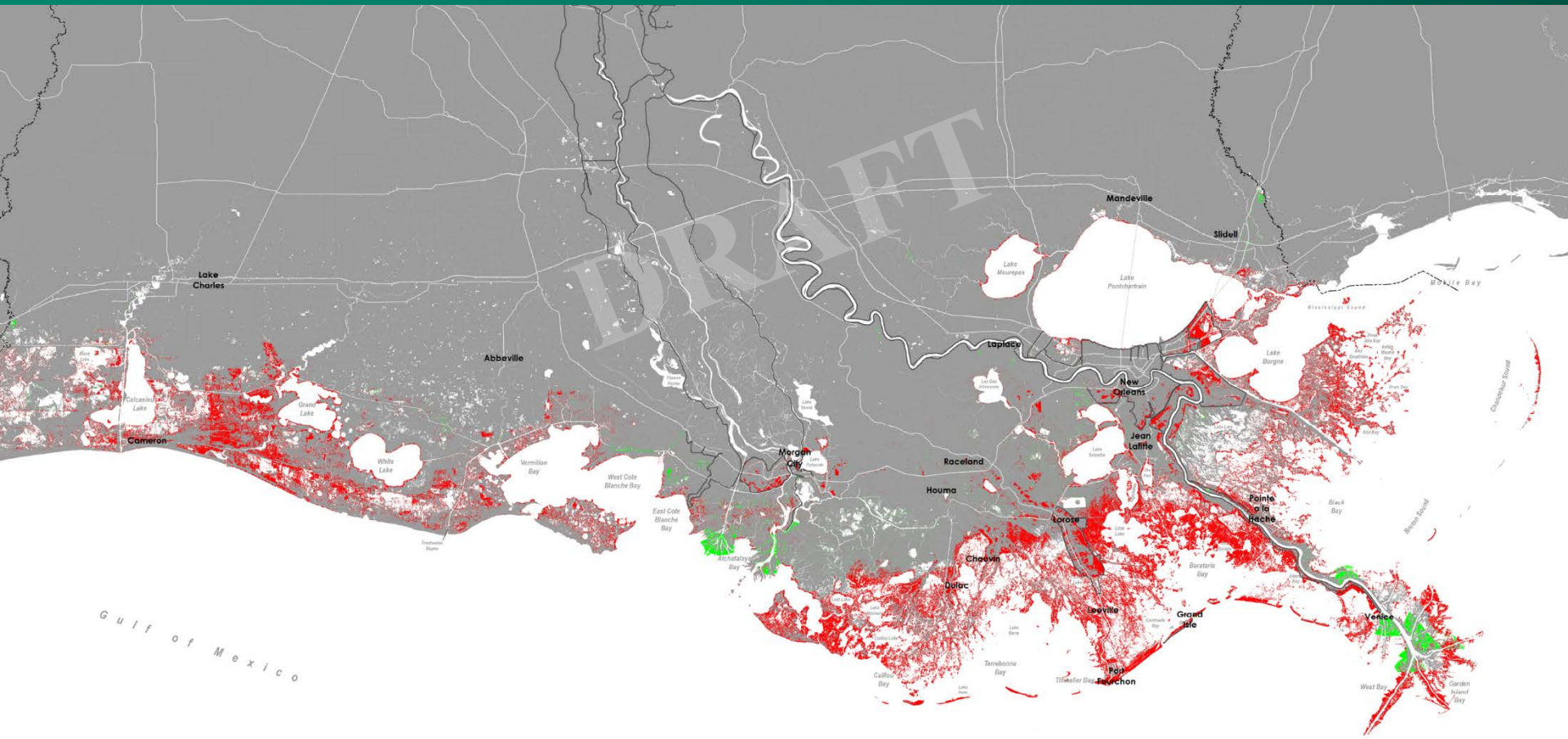
Map ID: USGS-NWRC 2003-02-0373

Louisiana's coastal wetland soils are in trouble...

- Louisiana is home to 40% of coastal wetlands in the contiguous United States
- Louisiana has suffered 80% of the coastal wetland loss
- Rates of wetland loss amount to about one football field per hour

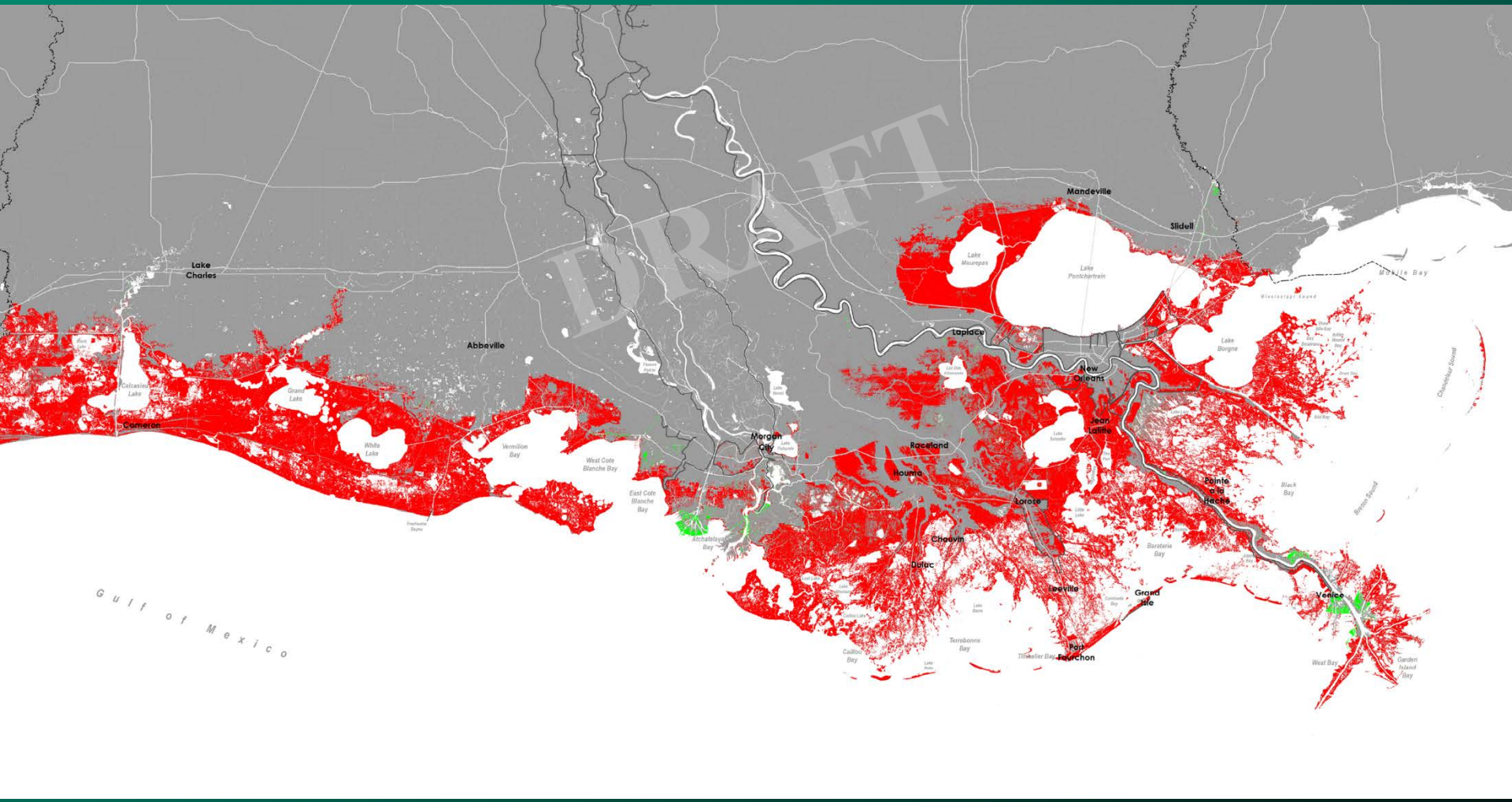
Predicted Land Change

Future Without Action - Year 50, Low Scenario



Predicted Land Change

Future Without Action - Year 50, High Scenario



Coastal wetland soils as a foundation of life...

- Wide range of services:
  - Disturbance regulation (storm surge reduction)
  - Biogeochemical cycling (carbon sink)
  - Nursery for marine life (fisheries)
  - Infrastructure support (pipelines)
  - Recreation

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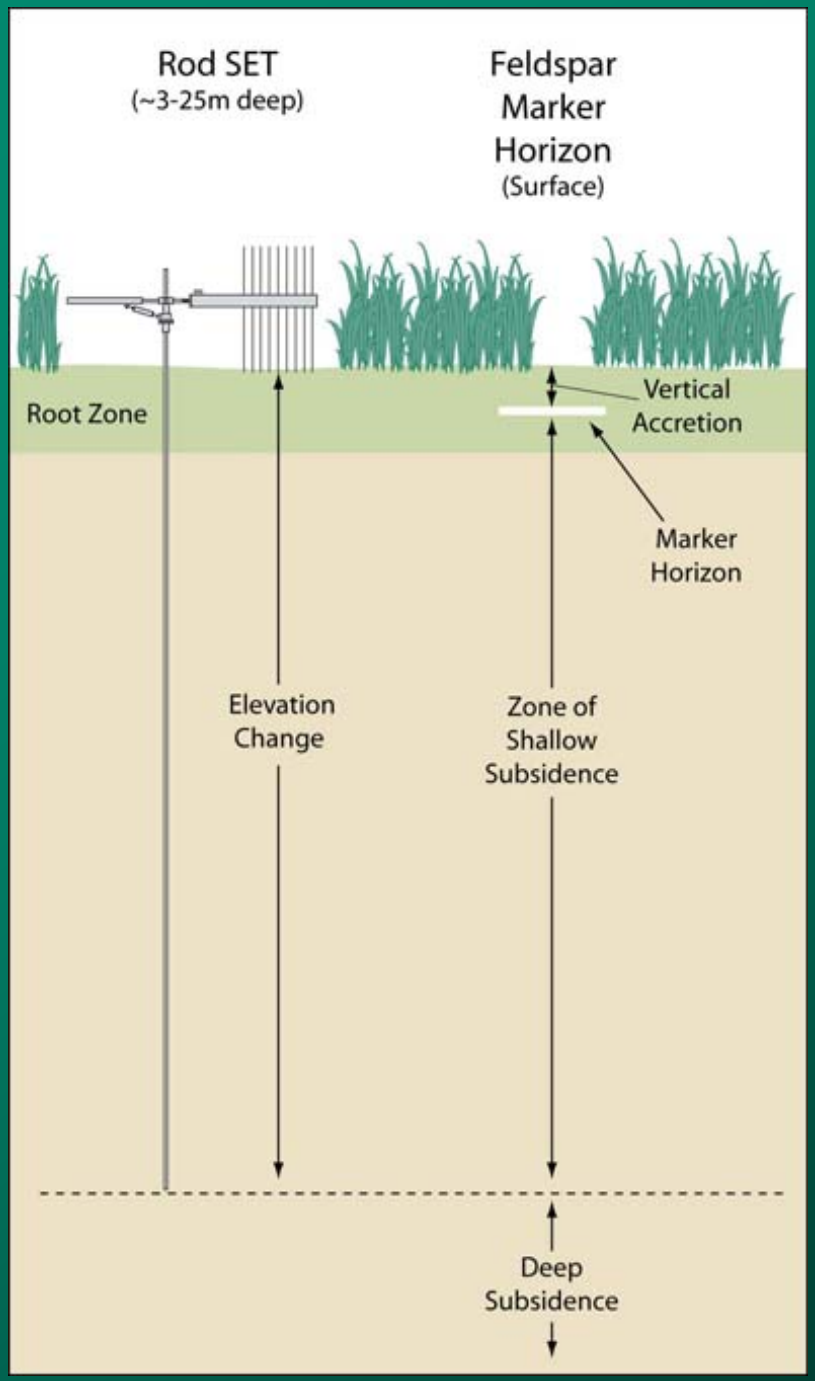
- Economic value of coastal wetland ecosystems estimated at almost \$200,000 ha^{-1} yr^{-1} (in \$2007, second only to coral reefs)



USGS
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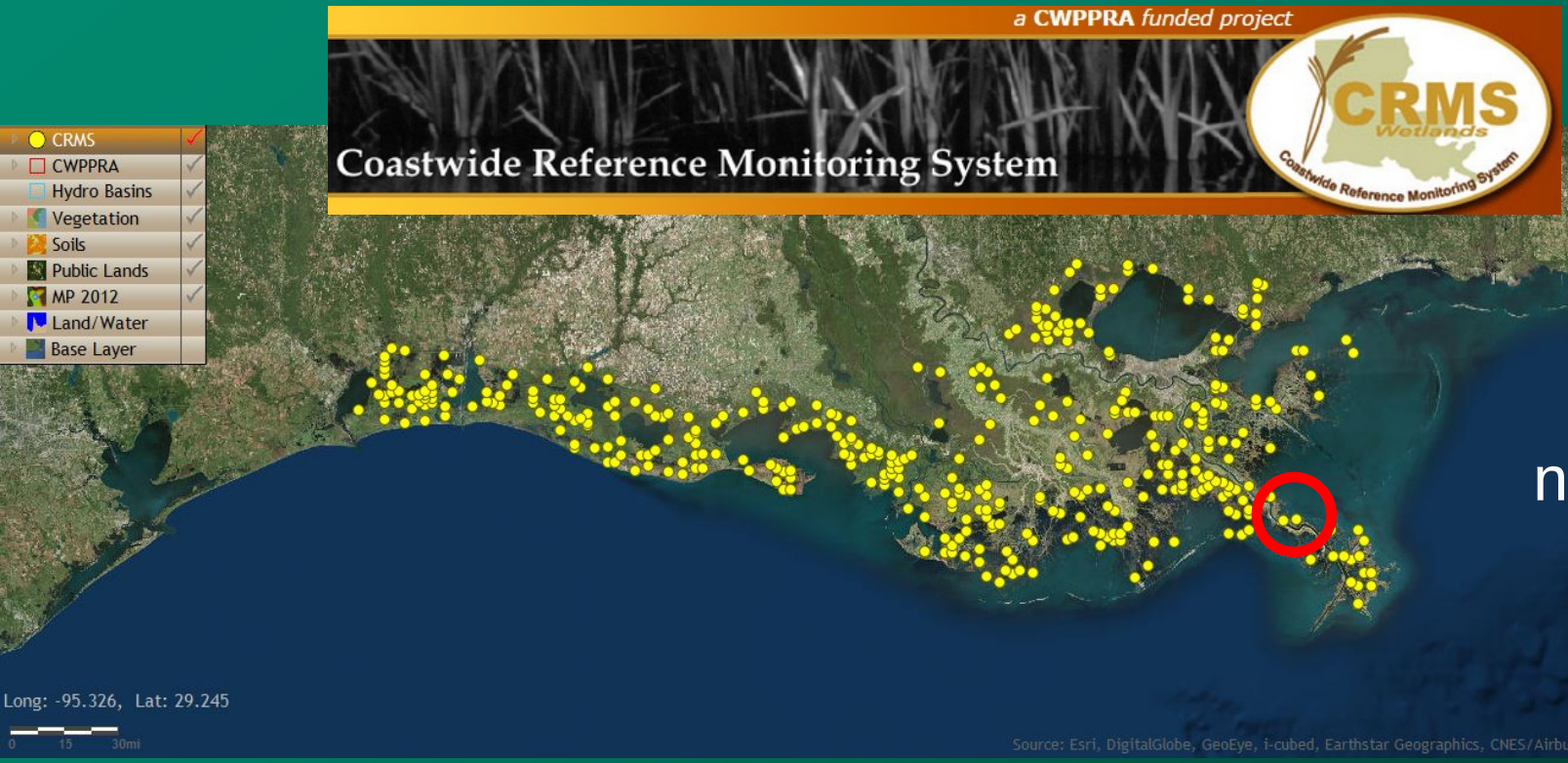
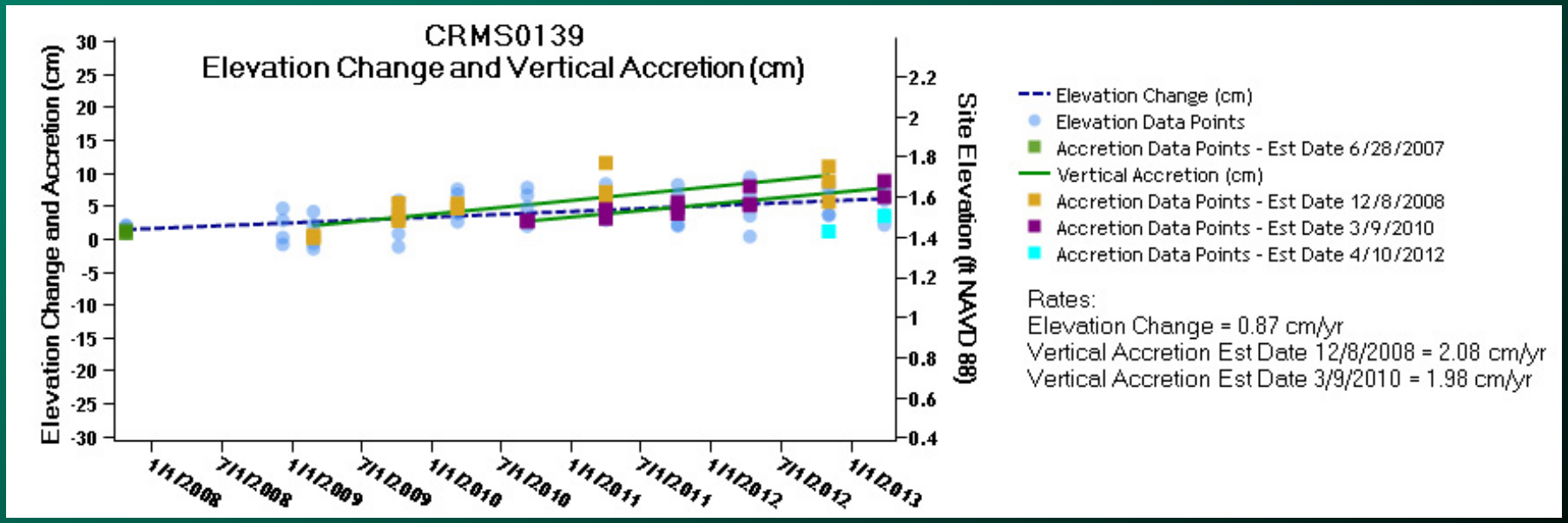
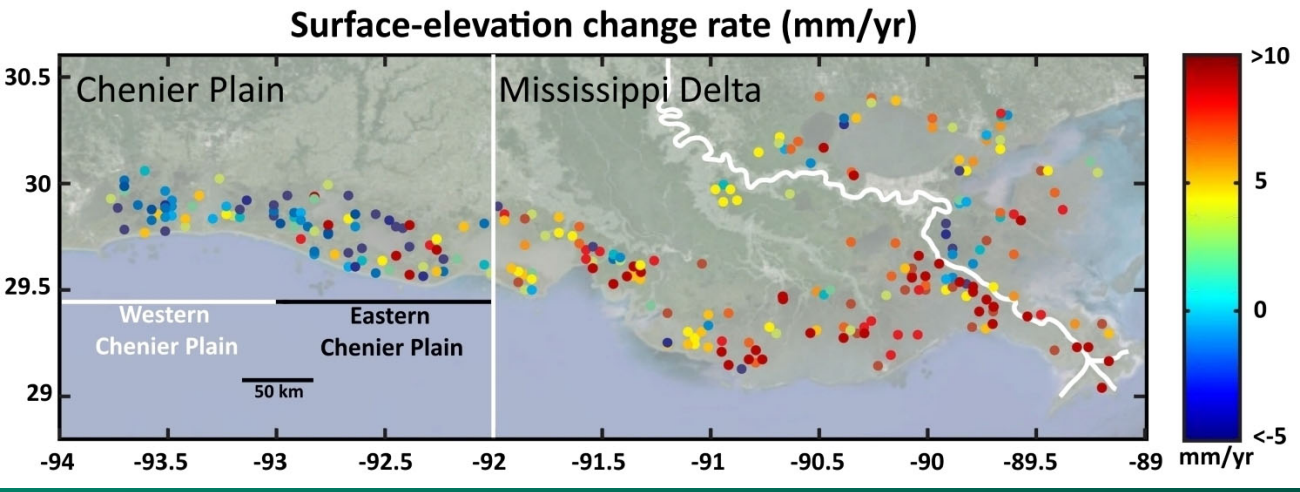
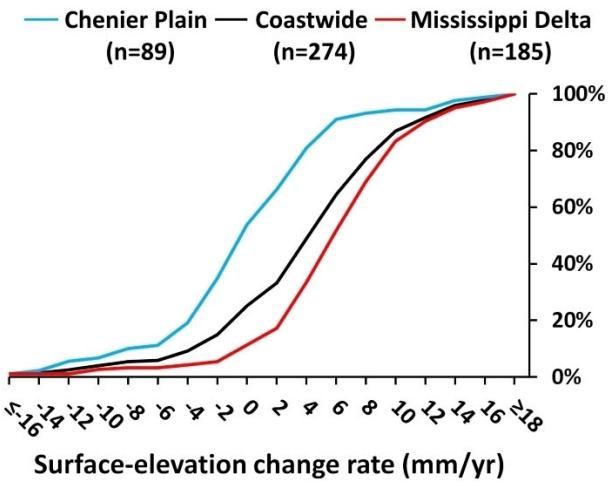
Rod surface-elevation table – marker horizon method (RSET-MH)

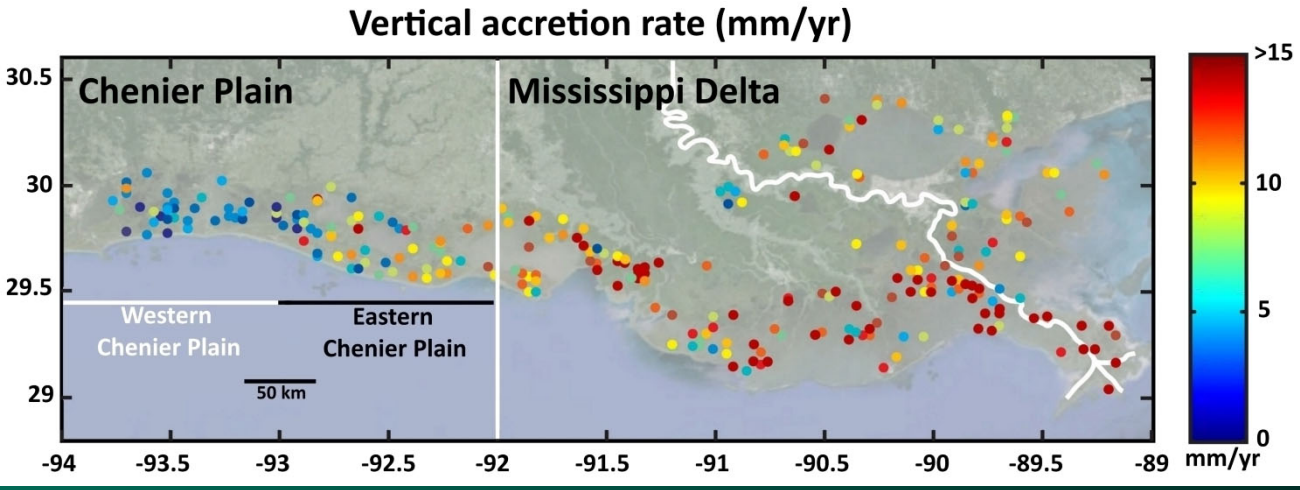

a CWPPRA funded project
Coastwide Reference Monitoring System
CRMS Wetlands
Coastwide Reference Monitoring System
CRMS
CWPPRA
Hydro Basins
Vegetation
Soils
Public Lands
MP 2012
Land/Water
Base Layer
n = 391
Long: -95.326, Lat: 29.245
0 15 30mi
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Ae...

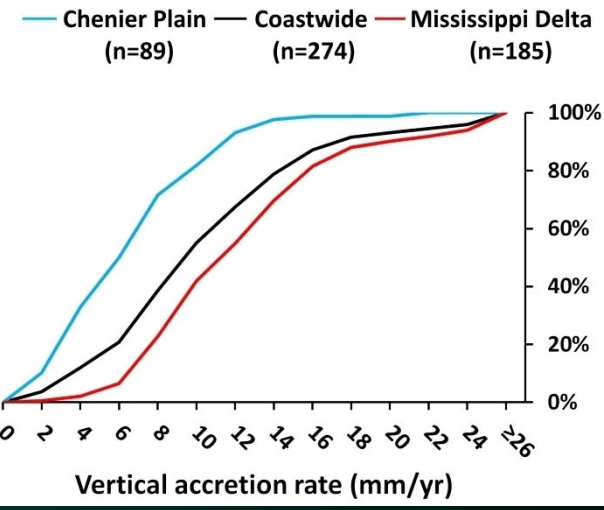

CRMS0139
Elevation Change and Vertical Accretion (cm)
Elevation Change and Accretion (cm)
Site Elevation (ft NAVD 88)
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
1/1/2008
7/1/2008
1/1/2009
7/1/2009
1/1/2010
7/1/2010
1/1/2011
7/1/2011
1/1/2012
7/1/2012
1/1/2013
Elevation Change (cm)
Elevation Data Points
Accretion Data Points - Est Date 6/28/2007
Vertical Accretion (cm)
Accretion Data Points - Est Date 12/8/2008
Accretion Data Points - Est Date 3/9/2010
Accretion Data Points - Est Date 4/10/2012
Rates:
Elevation Change = 0.87 cm/yr
Vertical Accretion Est Date 12/8/2008 = 2.08 cm/yr
Vertical Accretion Est Date 3/9/2010 = 1.98 cm/yr

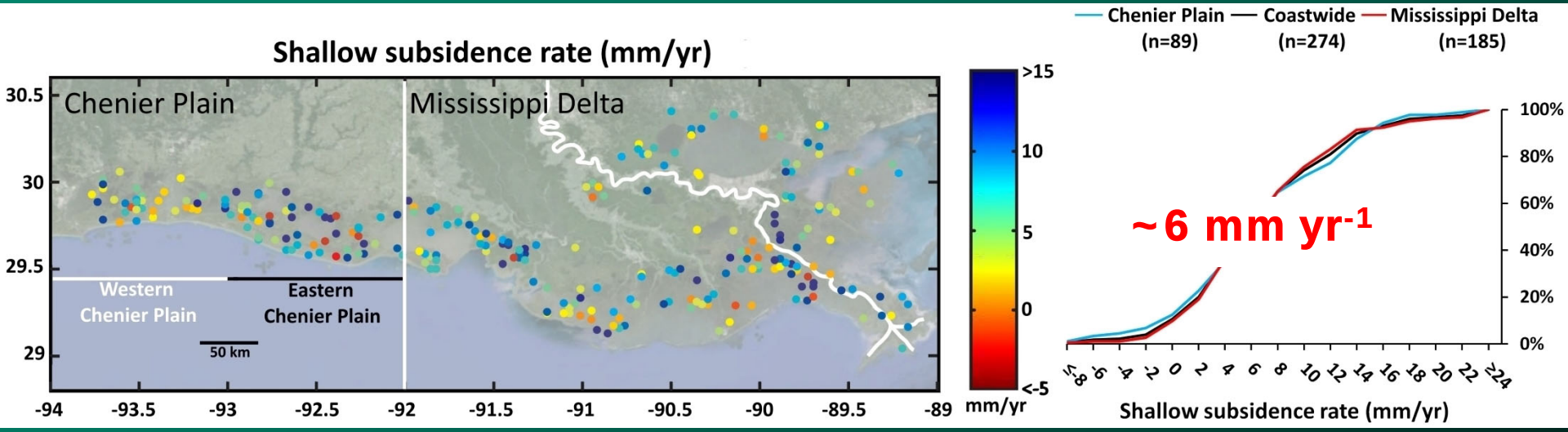
RSET-MH records ≥5 years in length



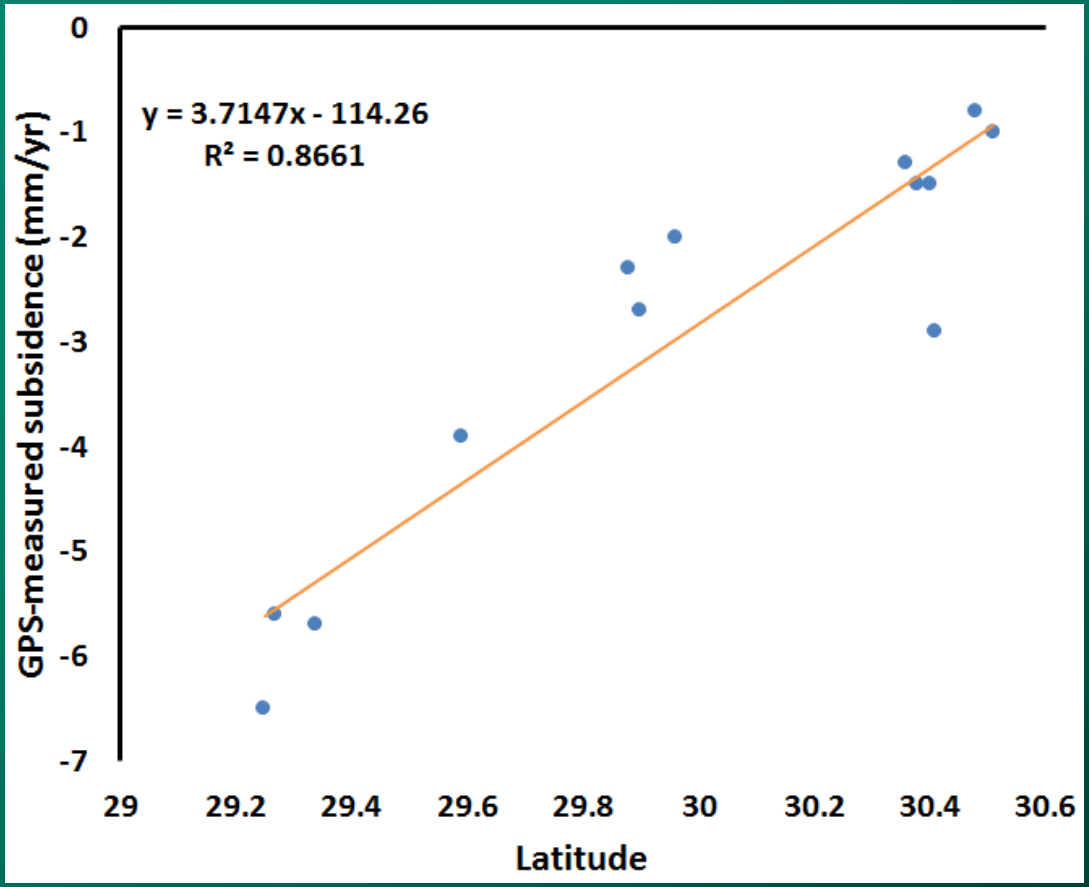


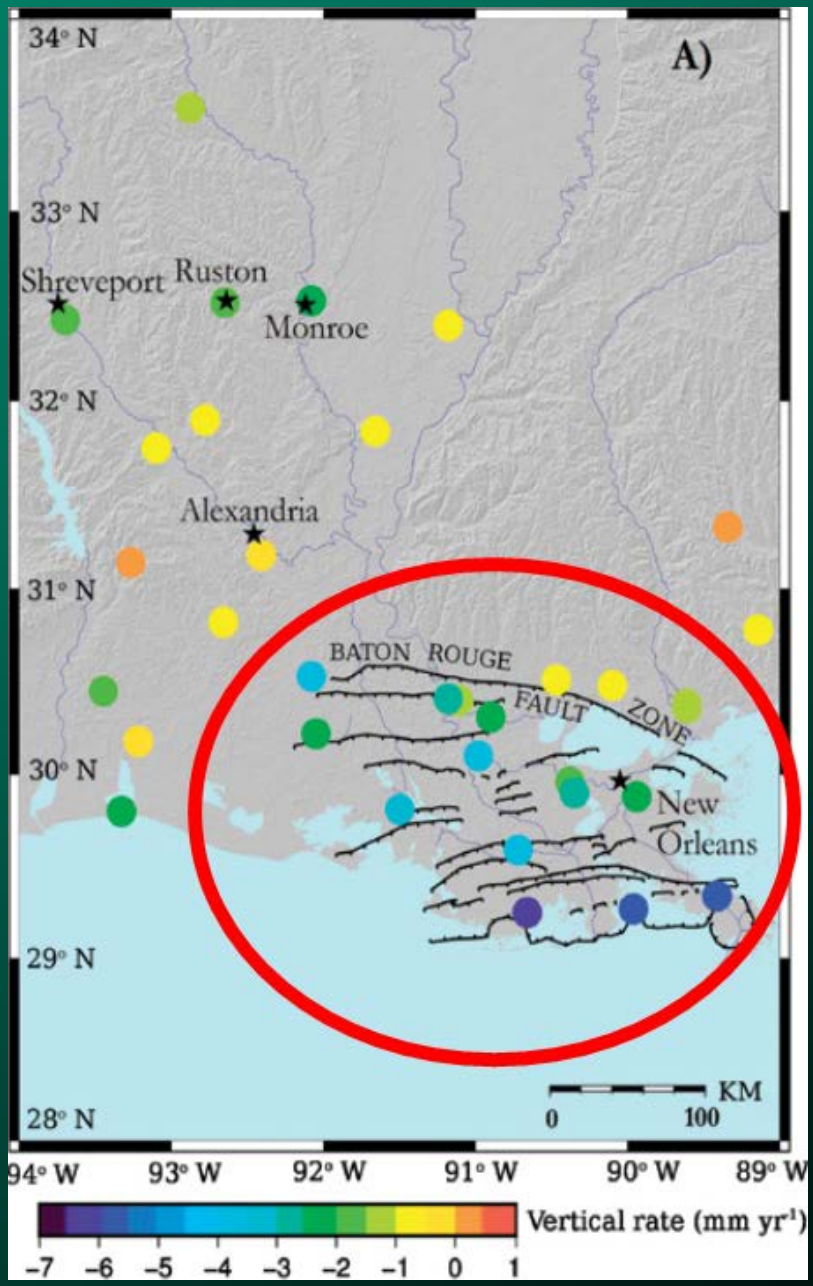





Shallow subsidence rate (mm/yr)
Chenier Plain
Mississippi Delta
Western Chenier Plain
Eastern Chenier Plain
50 km
30.5
30
29.5
29
-94
-93.5
-93
-92.5
-92
-91.5
-91
-90.5
-90
-89.5
-89
>15
10
5
0
<-5
mm/yr
Chenier Plain (n=89)
Coastwide (n=274)
Mississippi Delta (n=185)
~6 mm yr-1
100%
80%
60%
40%
20%
0%
≤-8
-6
-4
-2
0
2
4
6
8
10
12
14
16
18
20
22
≥24
Shallow subsidence rate (mm/yr)

Deep subsidence rates from GPS-records ≥5 years in length





Karegar et al. (2015)

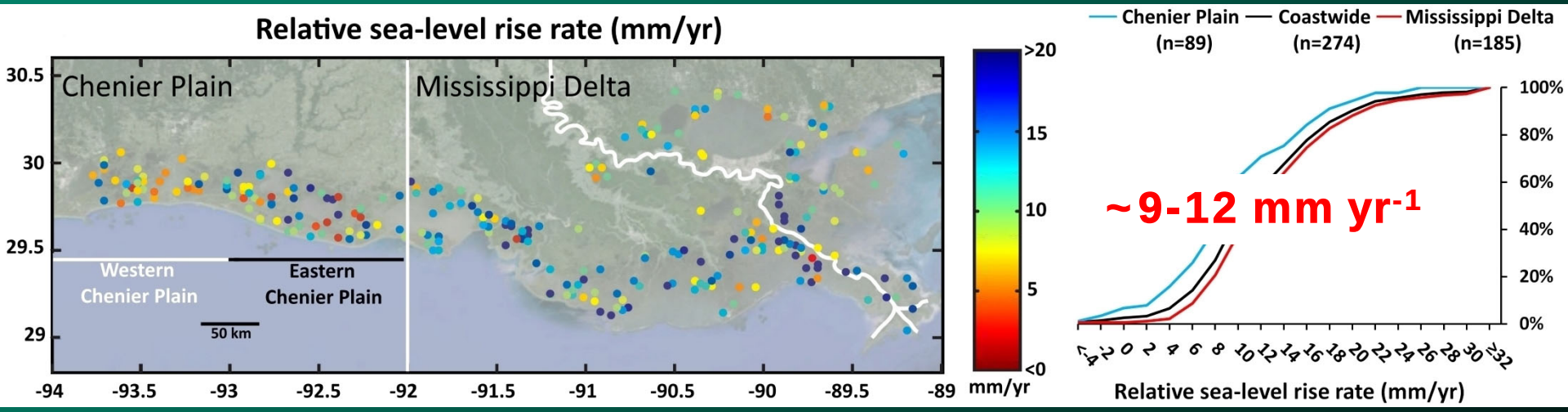
Shallow subsidence (RSET-MH)

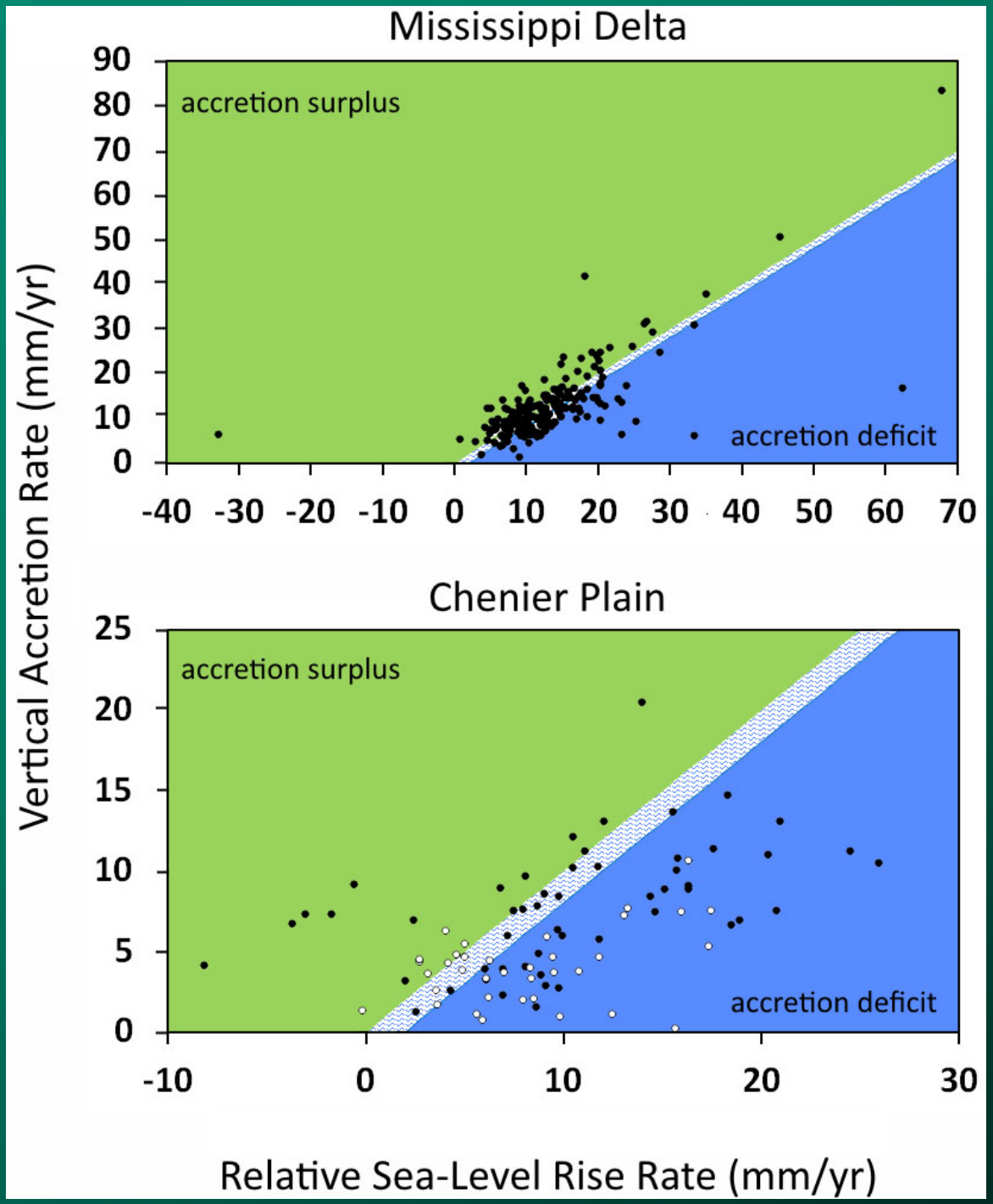
+

Deep subsidence (GPS)

+

Sea-level rise (satellite altimetry, 2 mm yr^{-1})





Mississippi Delta:
36% accretion deficit

Chenier Plain:
58% accretion deficit

Western Chenier Plain:
68% accretion deficit

Are Louisiana's coastal wetland soils sustainable?...

- The present-day rate of relative sea-level rise **at the land surface** in coastal Louisiana is 11±8 mm yr^{-1}, far exceeding the global mean of ~3 mm yr^{-1}

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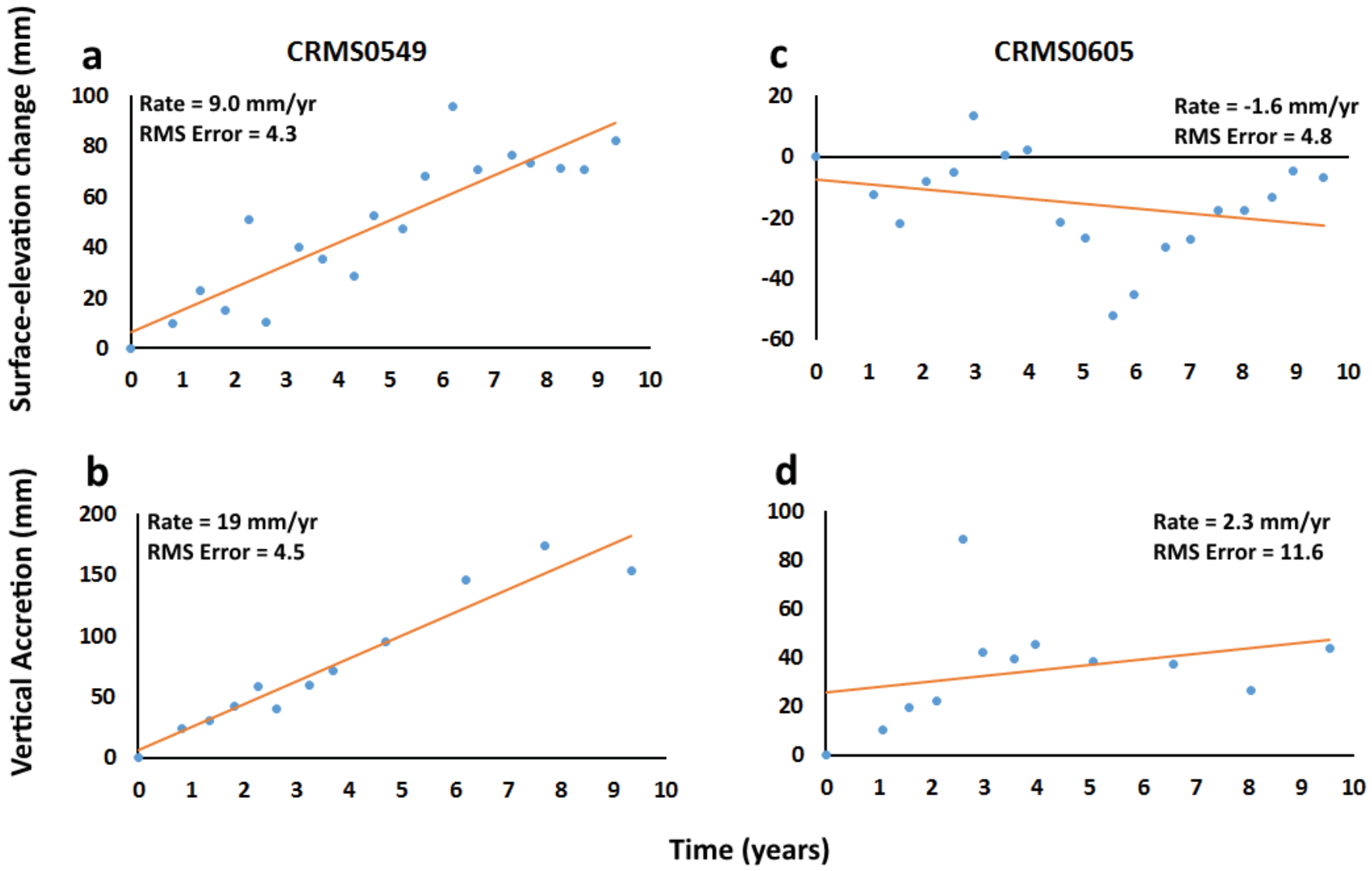
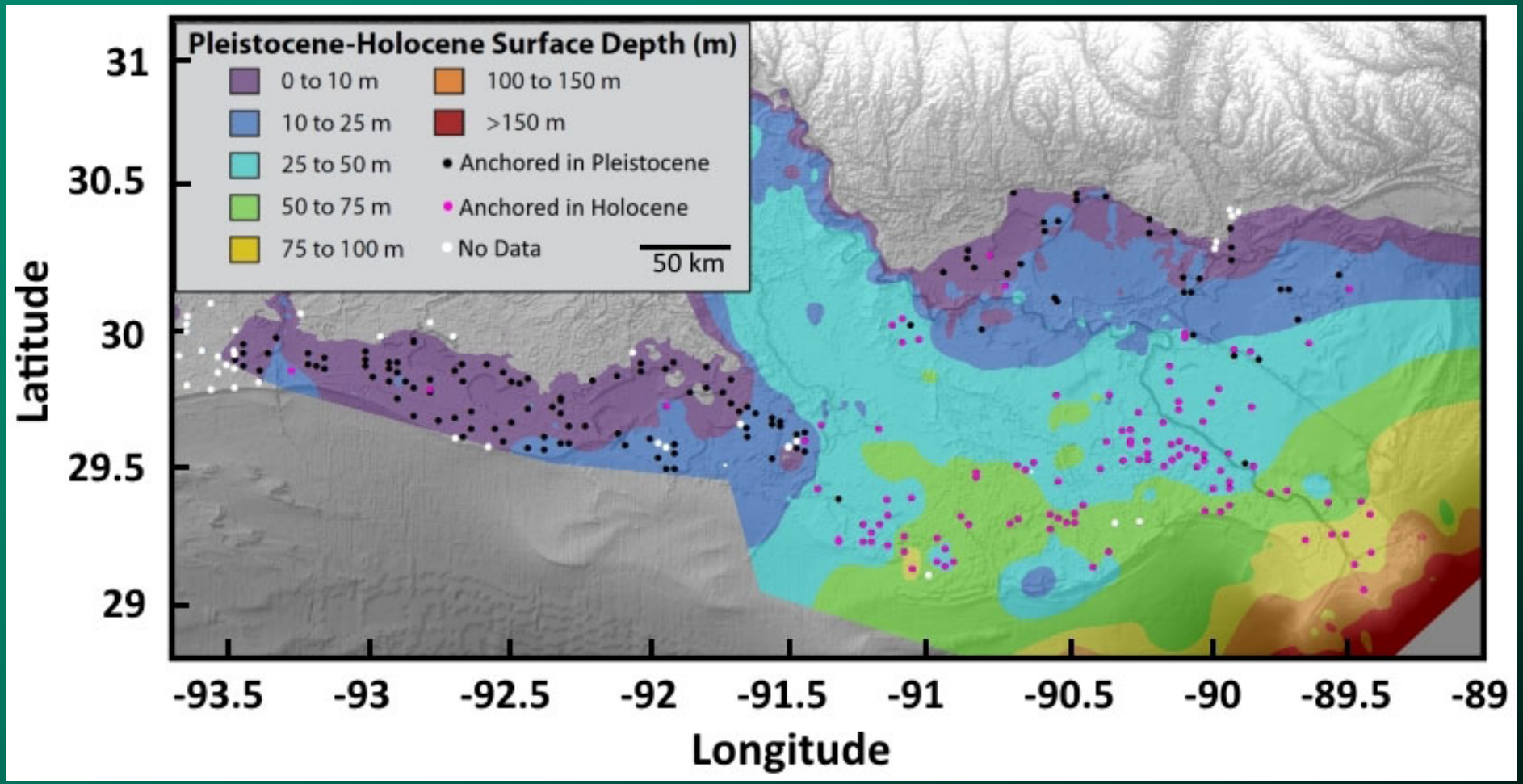
- The present-day rate of relative sea-level rise **at the land surface** in coastal Louisiana is 11±8 mm yr^{-1}, far exceeding the global mean of ~3 mm yr^{-1}
- Areas with limited sediment input (Chenier Plain) are drowning rapidly and will probably disappear entirely with accelerated sea-level rise
- Areas with high sediment input (Mississippi Delta) show some promise and may see increased vertical accretion in response to higher rates of sea-level rise, but resilience is likely to be limited


a
CRMS0549
Rate = 9.0 mm/yr
RMS Error = 4.3
c
CRMS0605
Rate = -1.6 mm/yr
RMS Error = 4.8
b
Rate = 19 mm/yr
RMS Error = 4.5
d
Rate = 2.3 mm/yr
RMS Error = 11.6
Surface-elevation change (mm)
Vertical Accretion (mm)
Time (years)



Base map from Louisiana Geological Survey

So what's the matter with tide gauges?