Land Loss in the Mississippi Delta: Important Role of River Diversions

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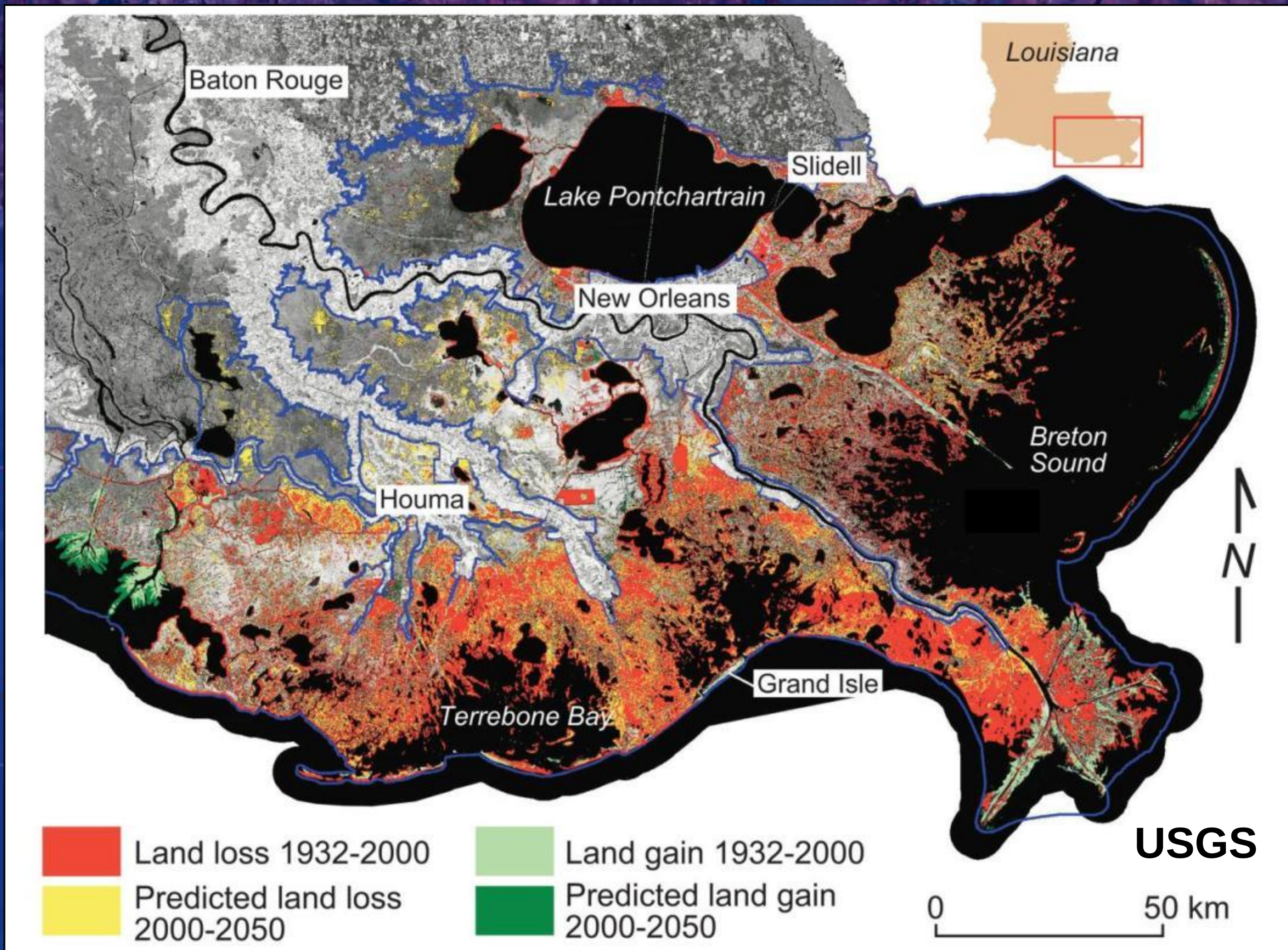
Louisiana's Coastal Land Loss: A Regional Geology Problem

Mississippi Delta Land Loss and Gain

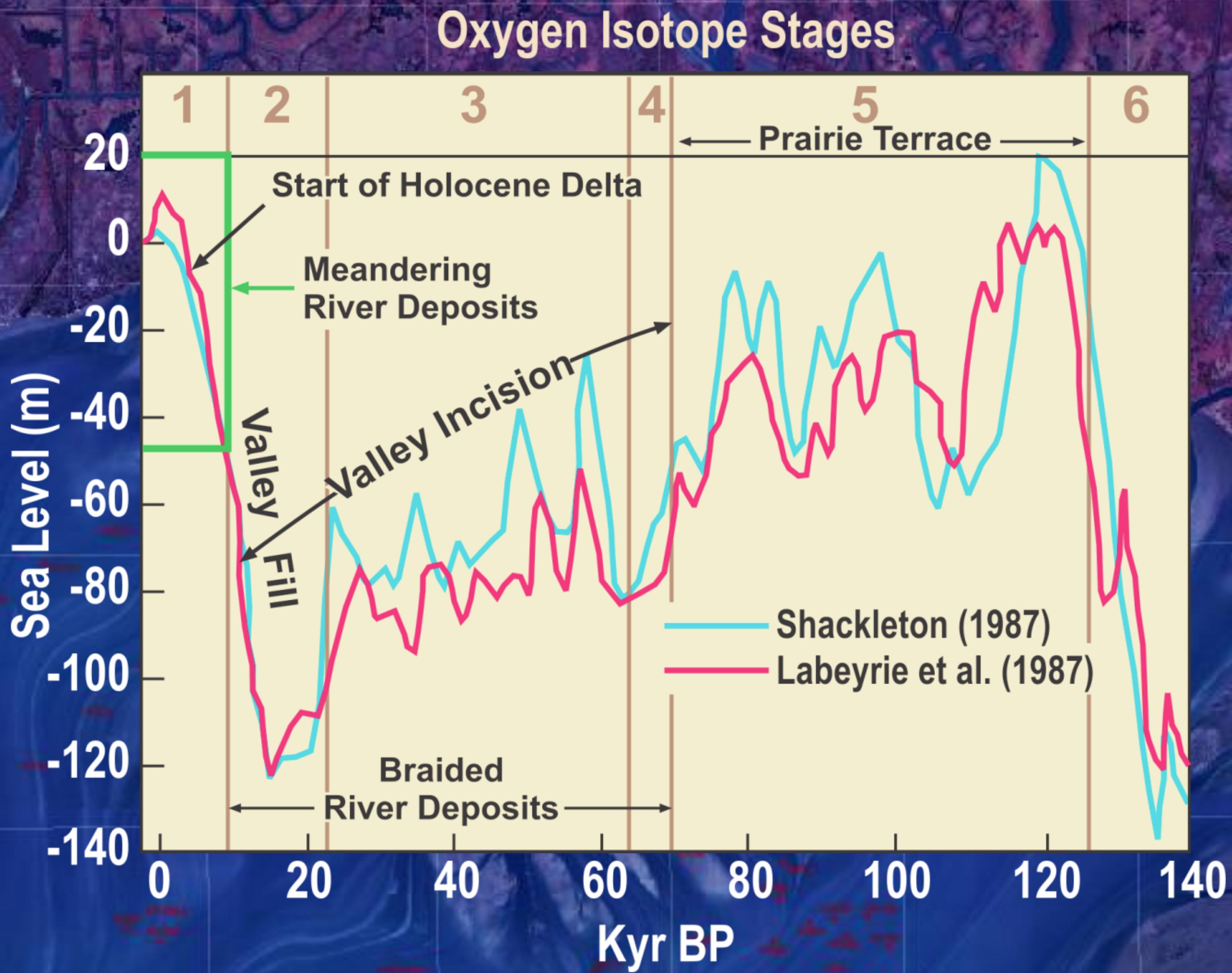


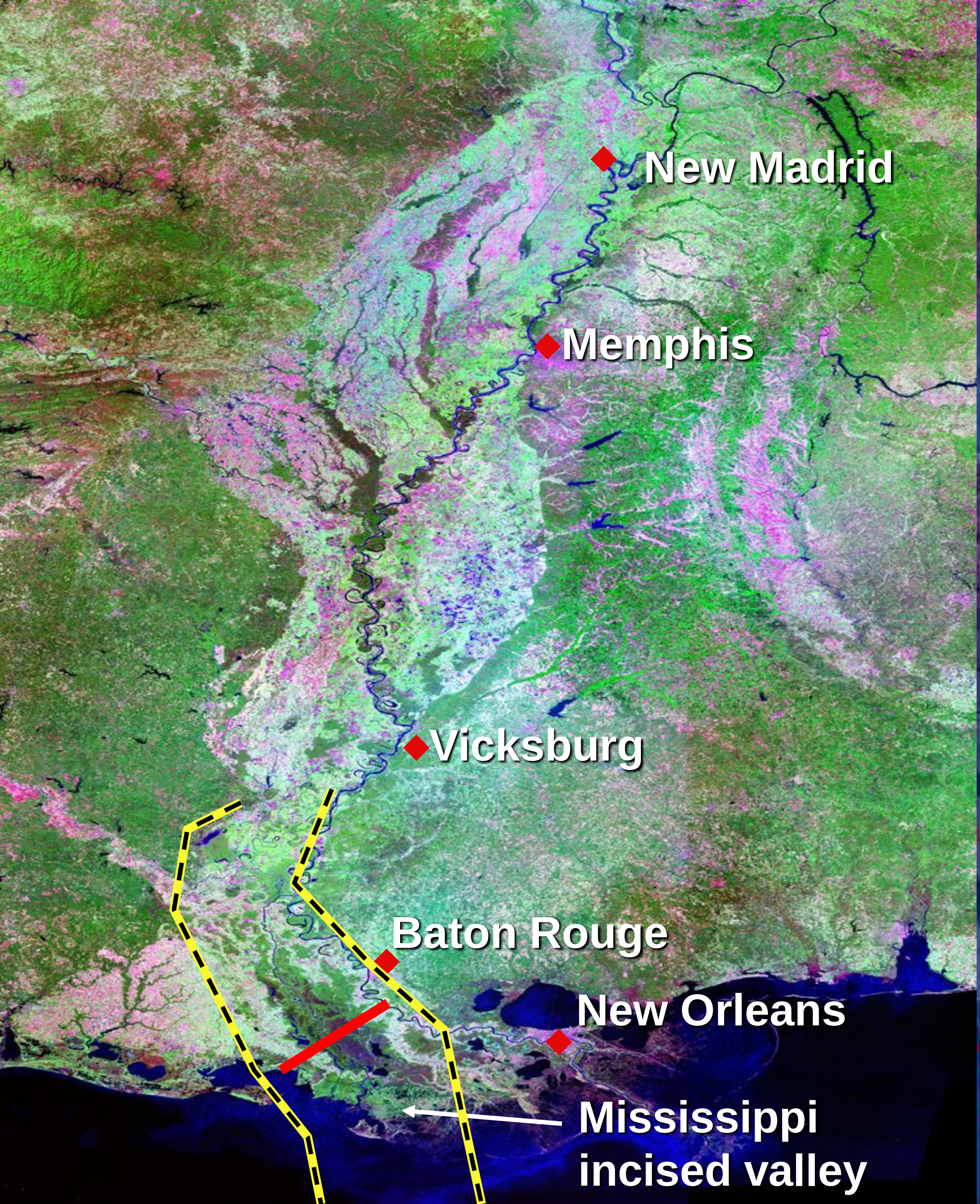
Key Geologic Factors in Land Loss

- Crustal Downwarping
- Compaction-Dewatering of Young Deposits
- Faulting
- Decreasing Sediment Supply-Increasing Accommodation

Climate and Sea Level Change: Drivers of Late Quaternary Mississippi Alluvial Valley and Delta Geology

Sea Level History

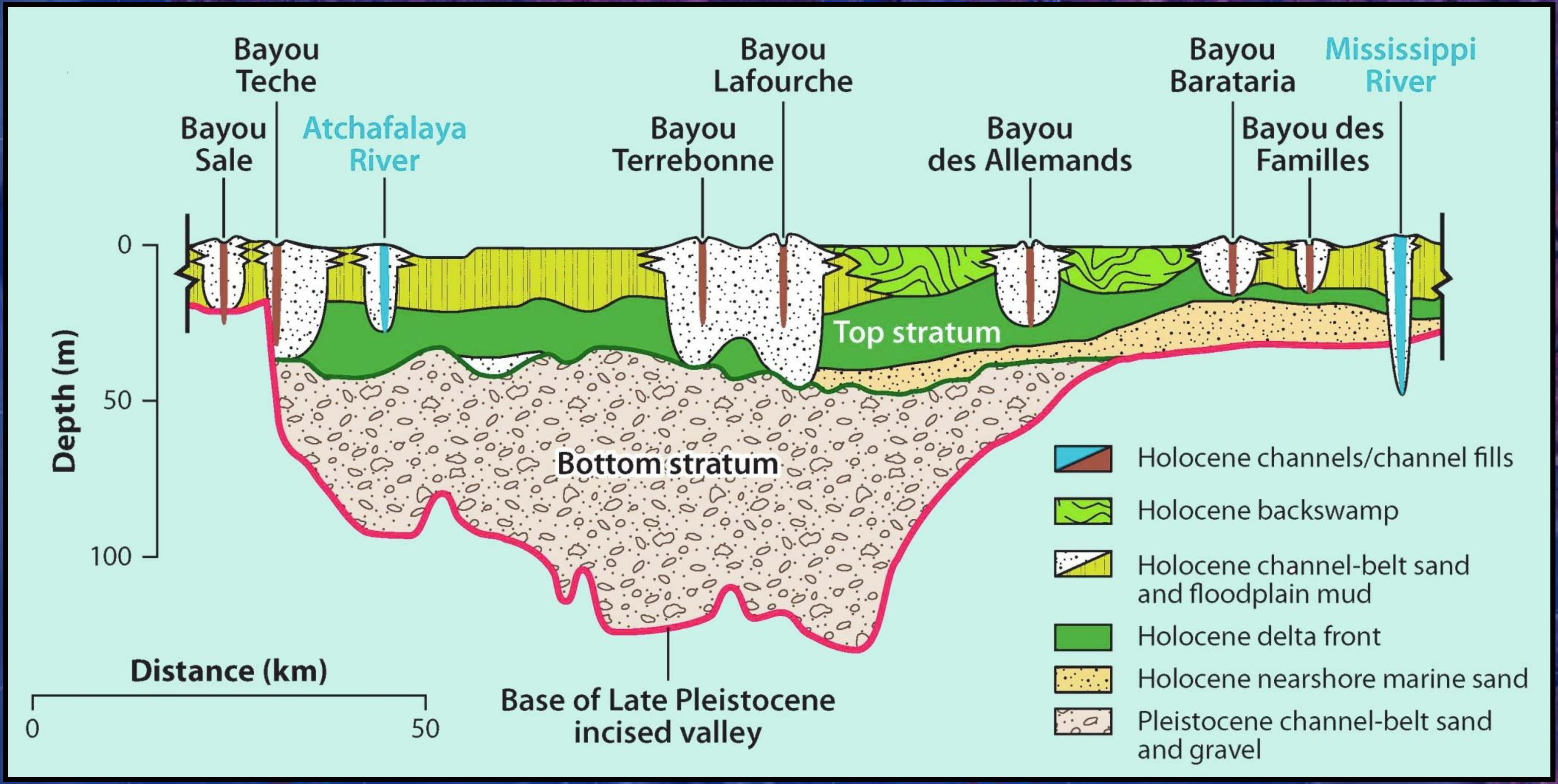




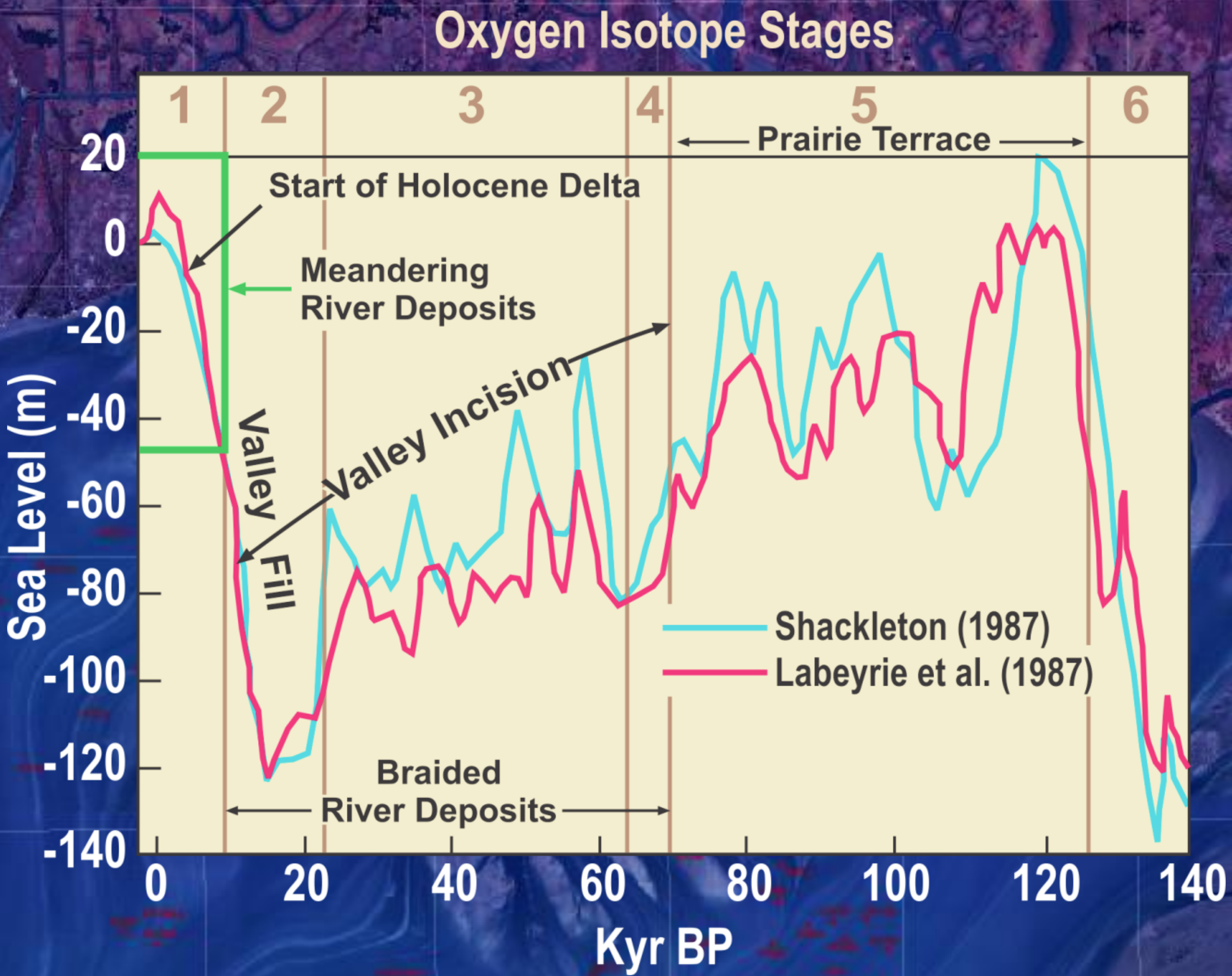
The Lower Mississippi River and Delta

- Glacial-period braided streams within incised valley
- Holocene valley filling and delta construction
- Valley fill reflects interactions between climate and sea-level change

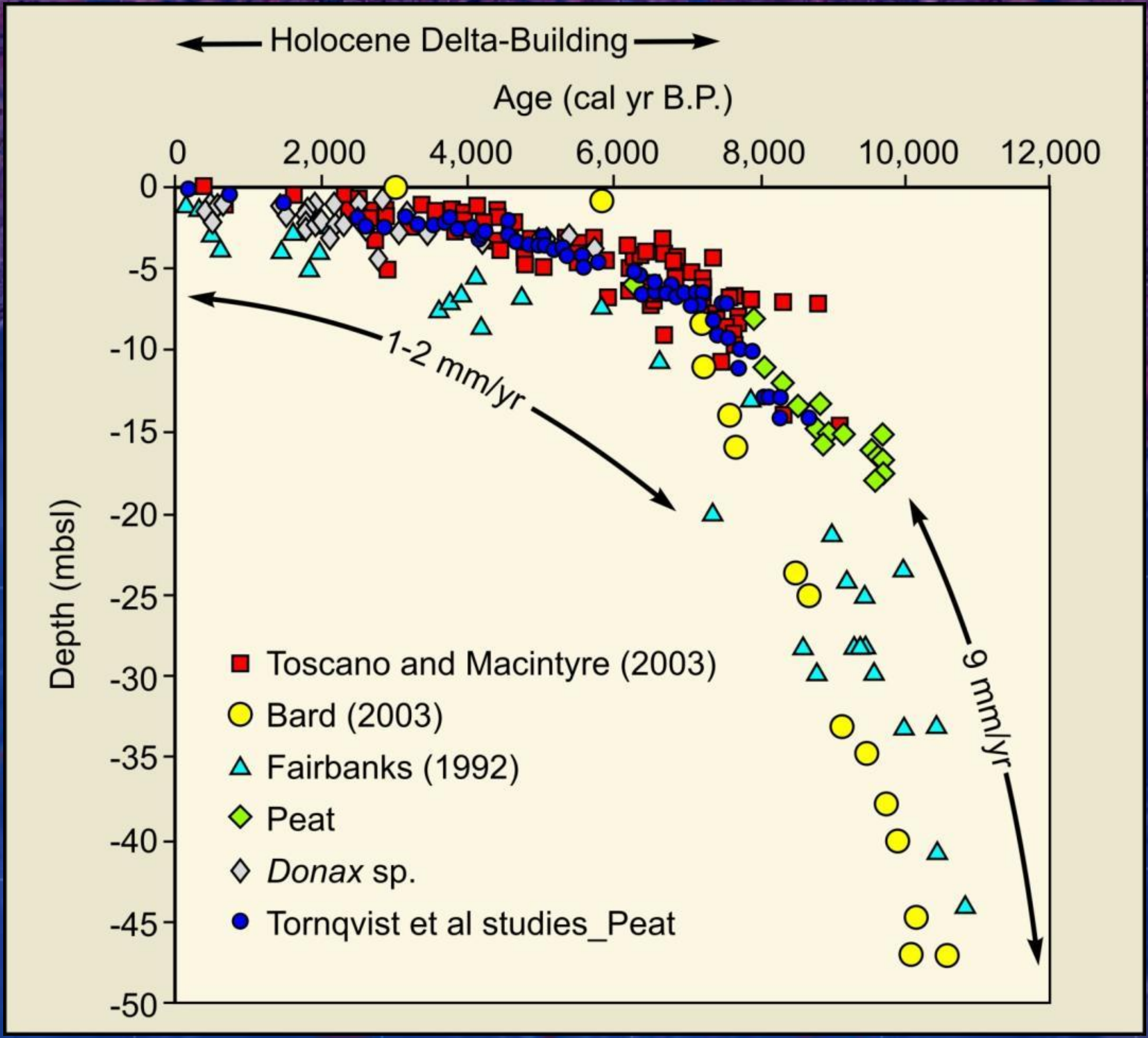
Sediment Fill of the Incised Alluvial Valley



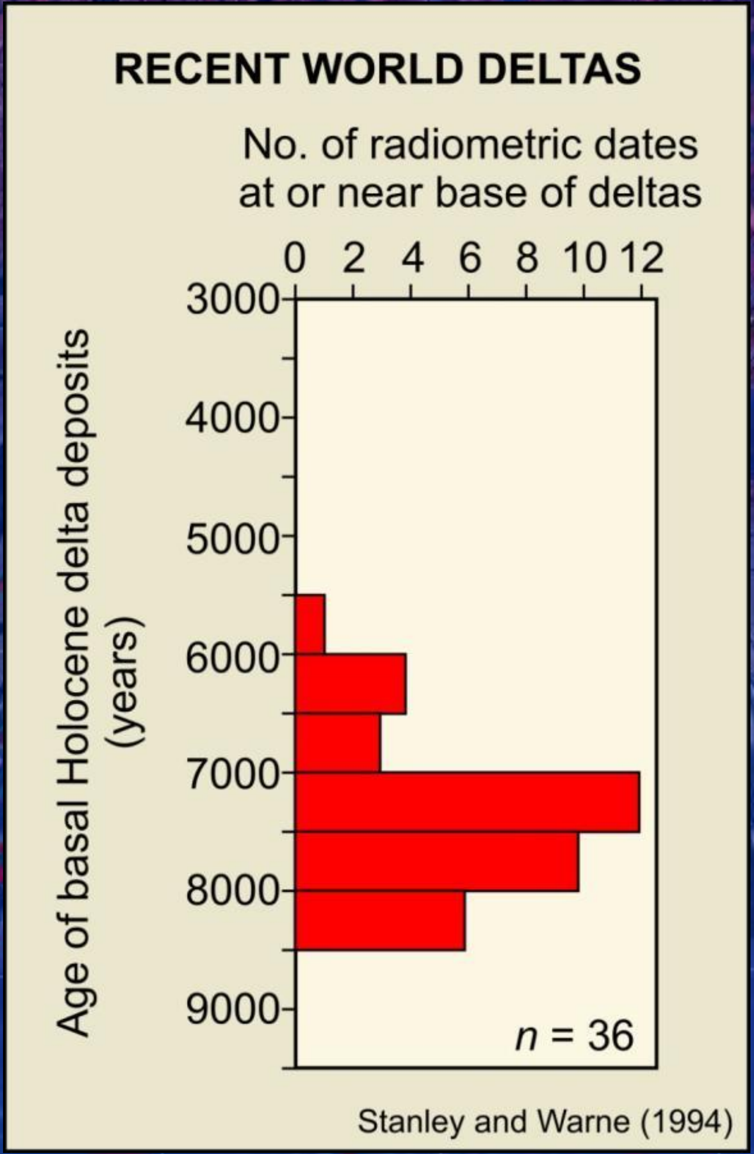
Sea Level History



Holocene Sea Level

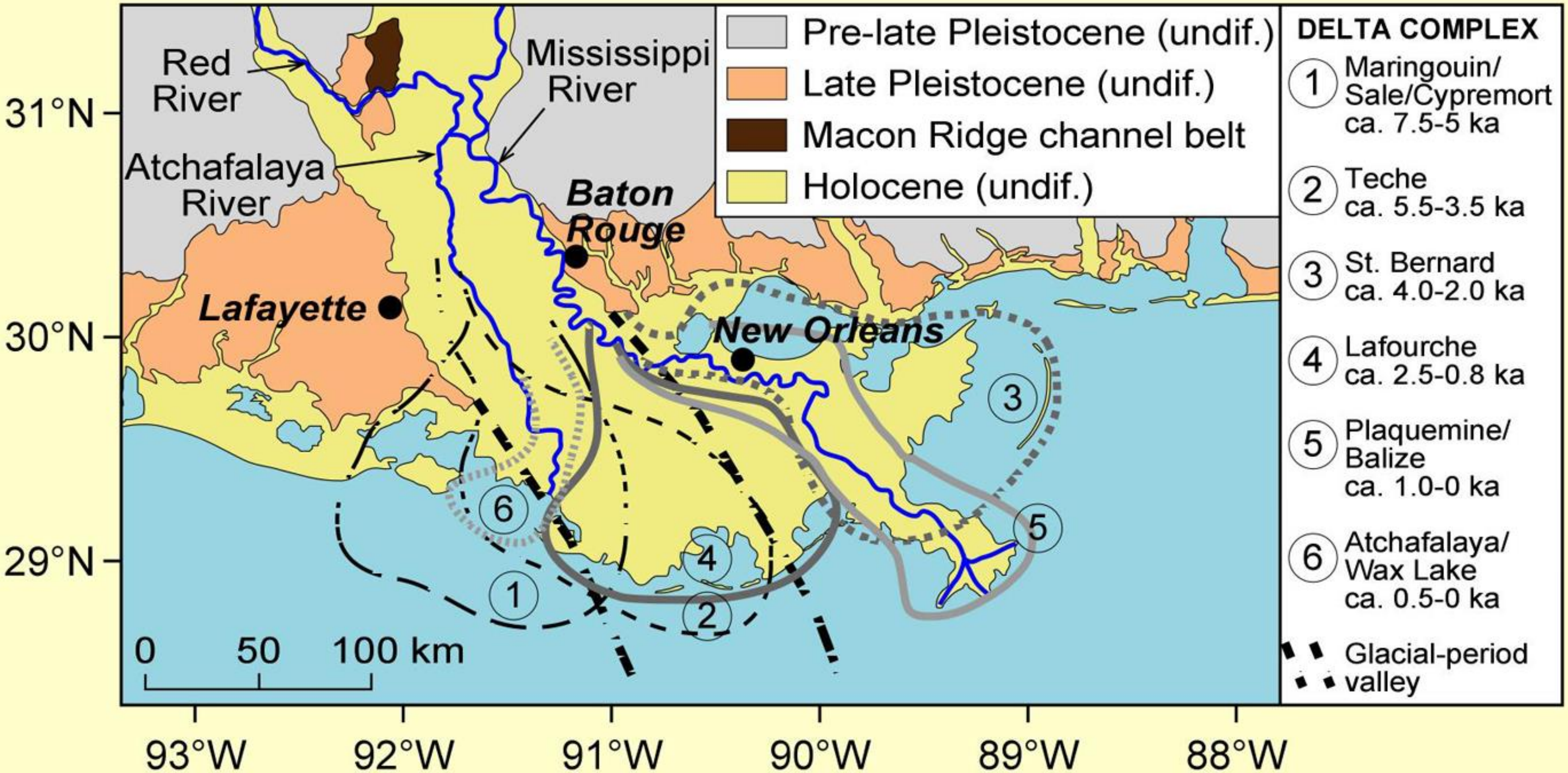


Initiation of Holocene World Deltas



Mississippi River Delta

Holocene History of Delta Growth

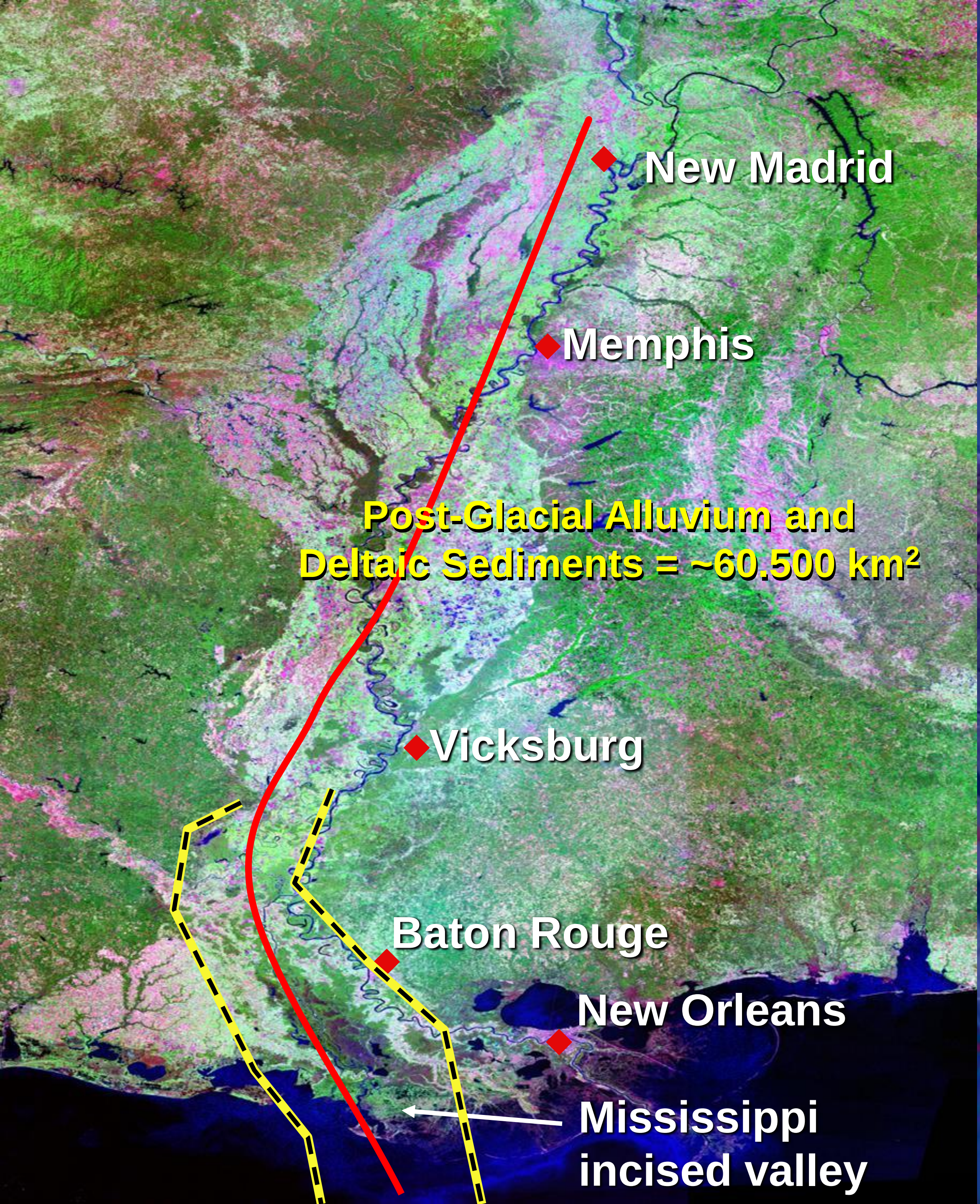


from Roberts (1997)

- ***6 major coupled channel belts and delta complexes***
- ***like most major deltas, growth occurred after ca. 7000 yrs BP***

Sedimento Storage in the System Before Human Intervention

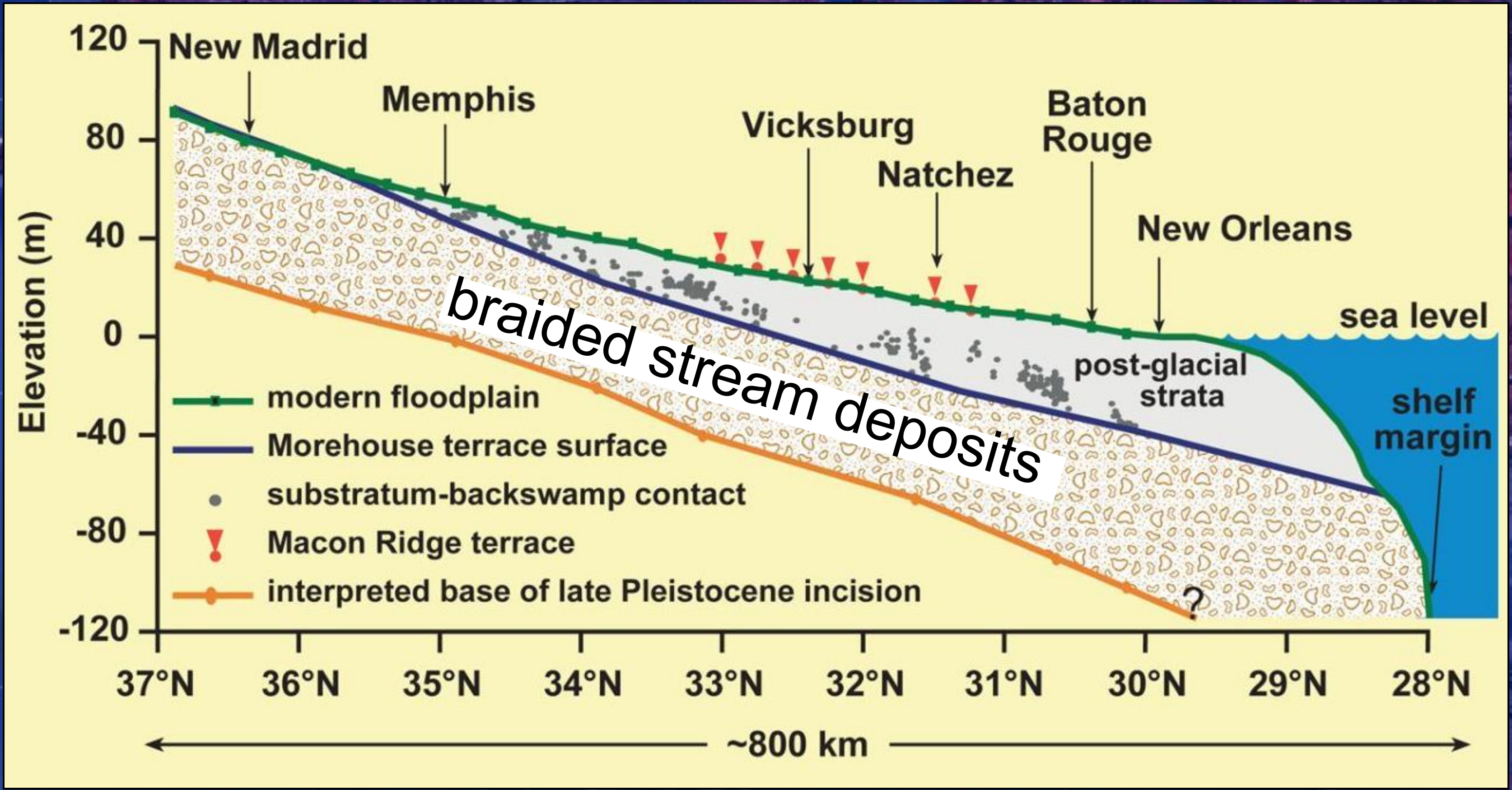
The Lower Mississippi River and Delta



- Glacial-period braided streams within incised valley
- Holocene valley filling and delta construction
- Valley fill reflects interactions between climate and sea-level change

Longitudinal Profile of the Lower Mississippi Valley and Delta

Tracing Late Pleistocene Braided Streams into the Subsurface Using Base of Backswamp Deposits

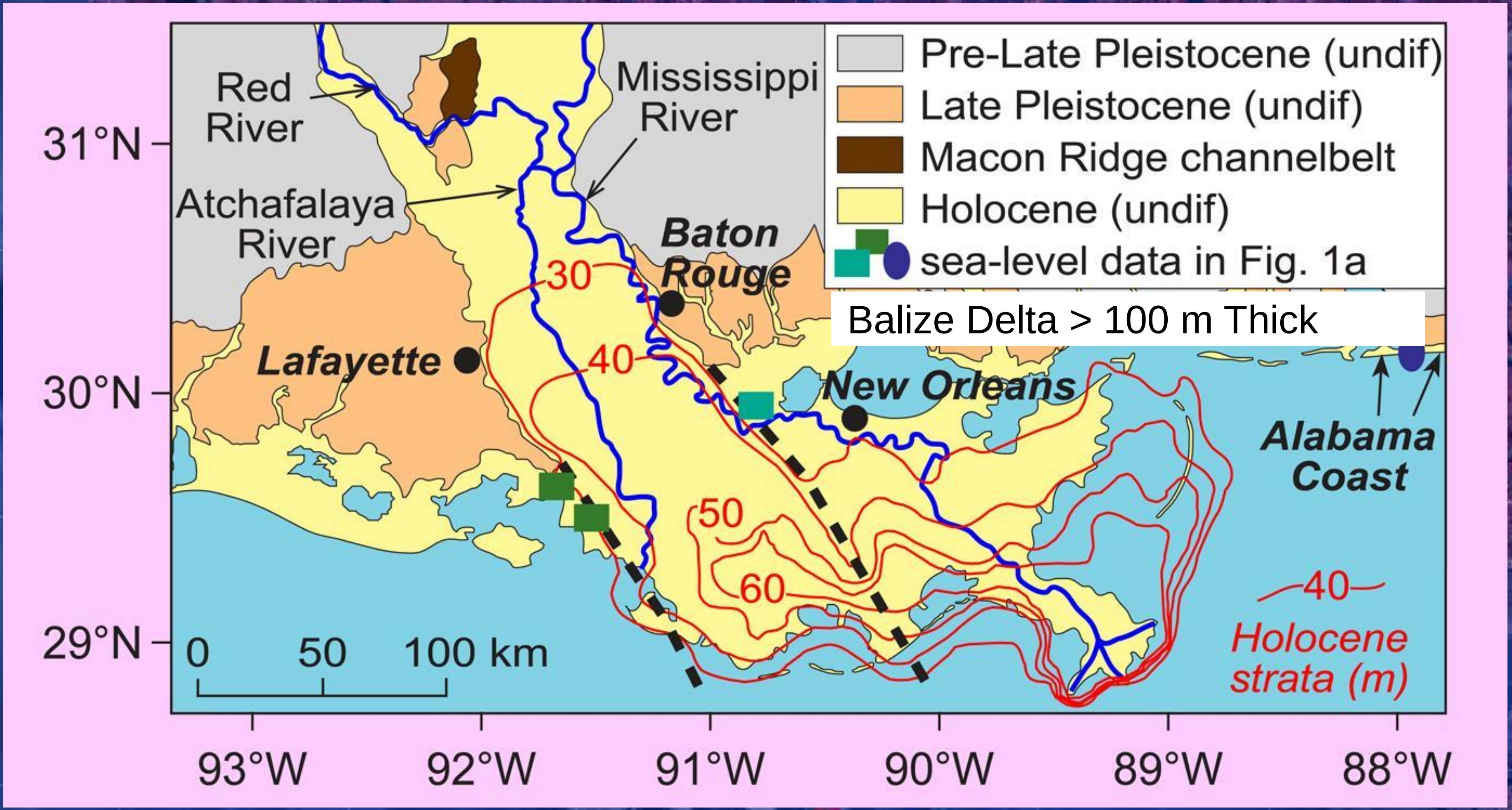


Based on 325 USACE boreholes

from Blum et al. (2008)

Lower Mississippi Valley and Delta

Magnitude of Post-Glacial Deposition



Total storage = 1860-2300 km^3 or 2790-3450 BT of sediment

Storage rate = ~230-290 MT/yr over 12,000 yr post-glacial period

sediment isopachs adapted from Kulp (2000)

Mississippi River Discharges and Sediment Storage

Pre-Dam

Sediment Load*: ~400 – 500 MT/yr

Mean Sediment Storage**:

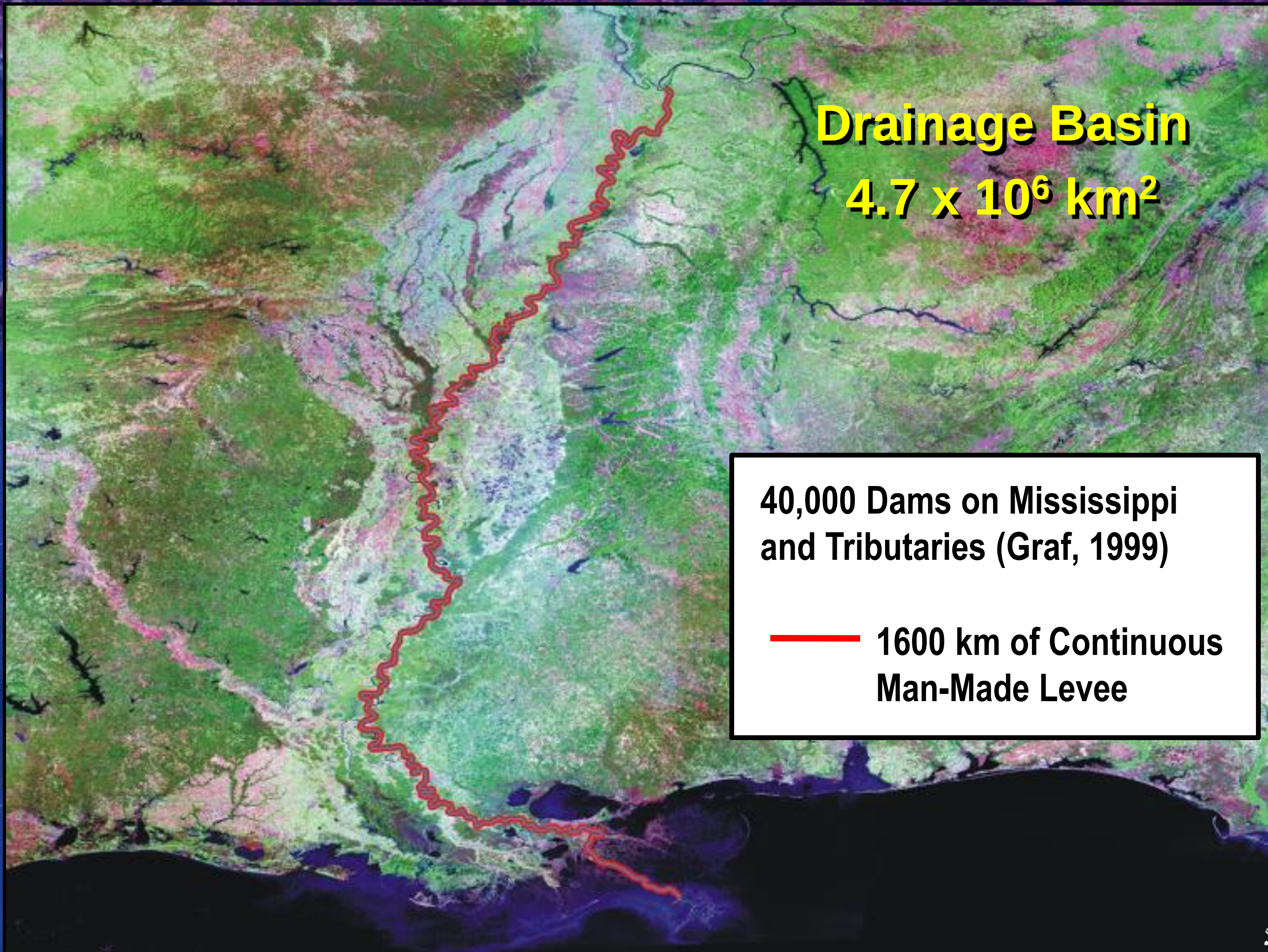
230 – 290 MT/yr

1976-2006

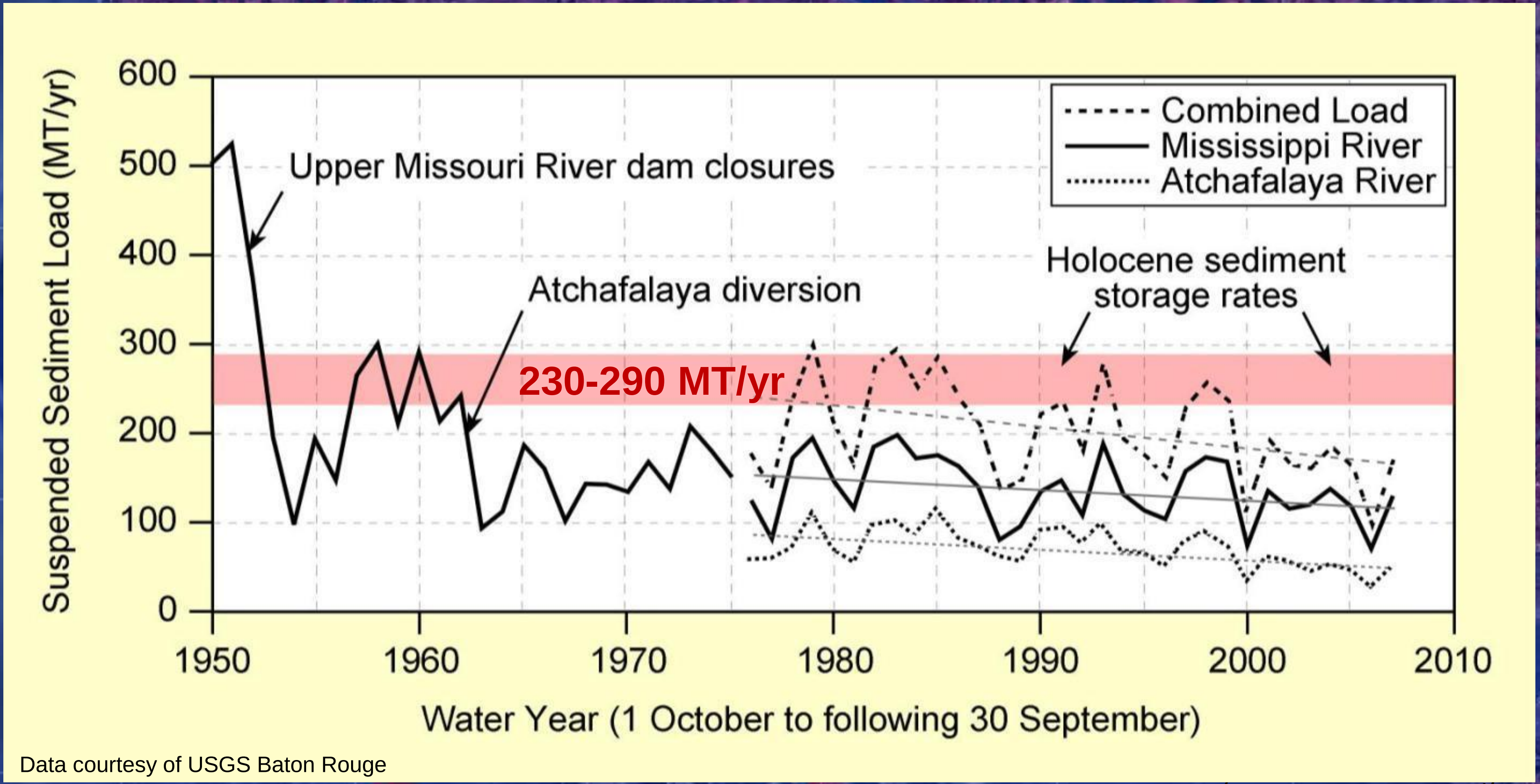
Mississippi & Atchafalaya Sediment Load: ~205 MT/yr

*Suspended Sediment Load Meade et al. (1990); Kesel et al. (1992)   **Avg. over 12 kyrs

Mississippi River Alluvial Valley



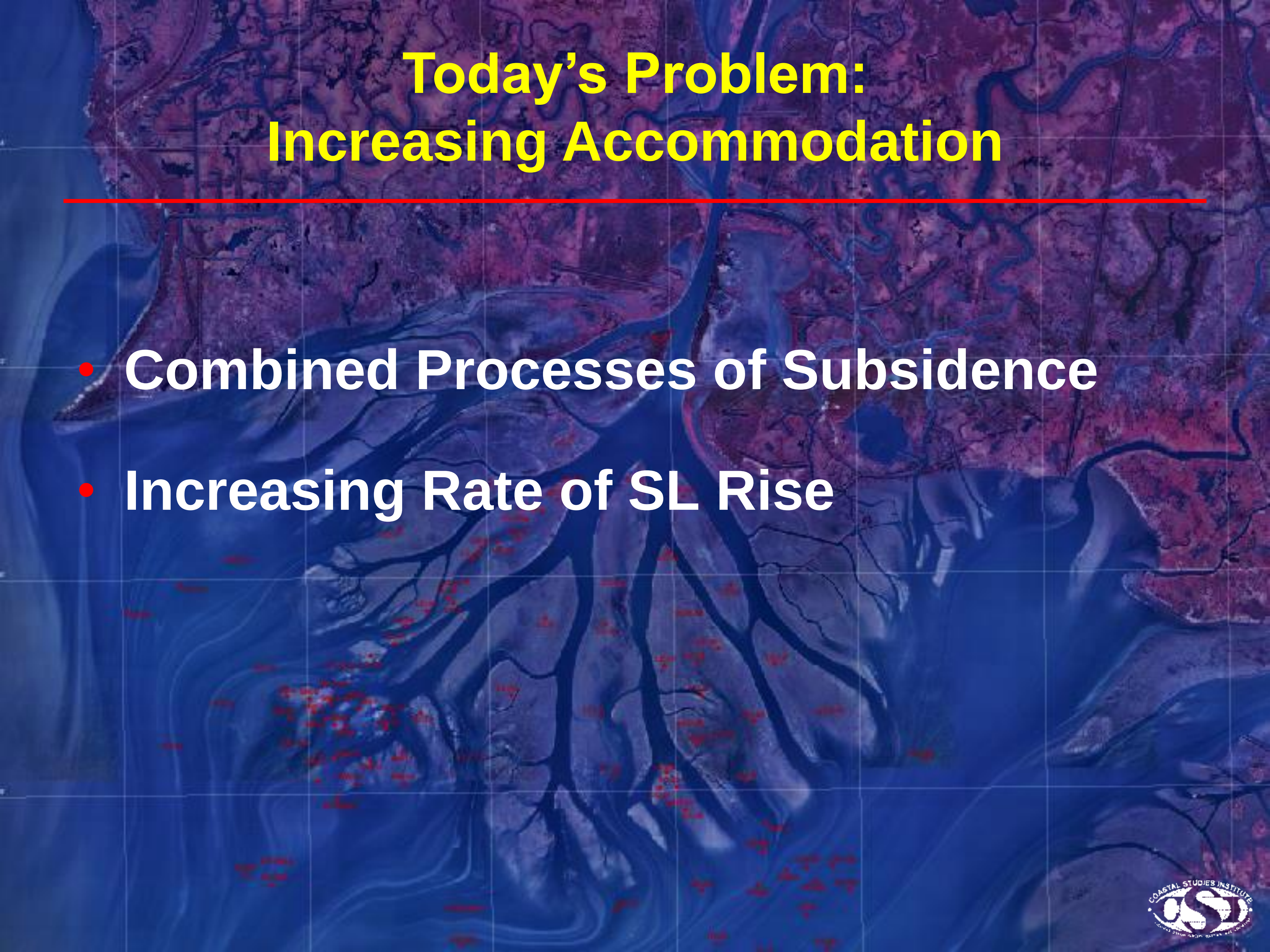
Lower Mississippi River Sediment Load
Pre- and Post-Dam Loads



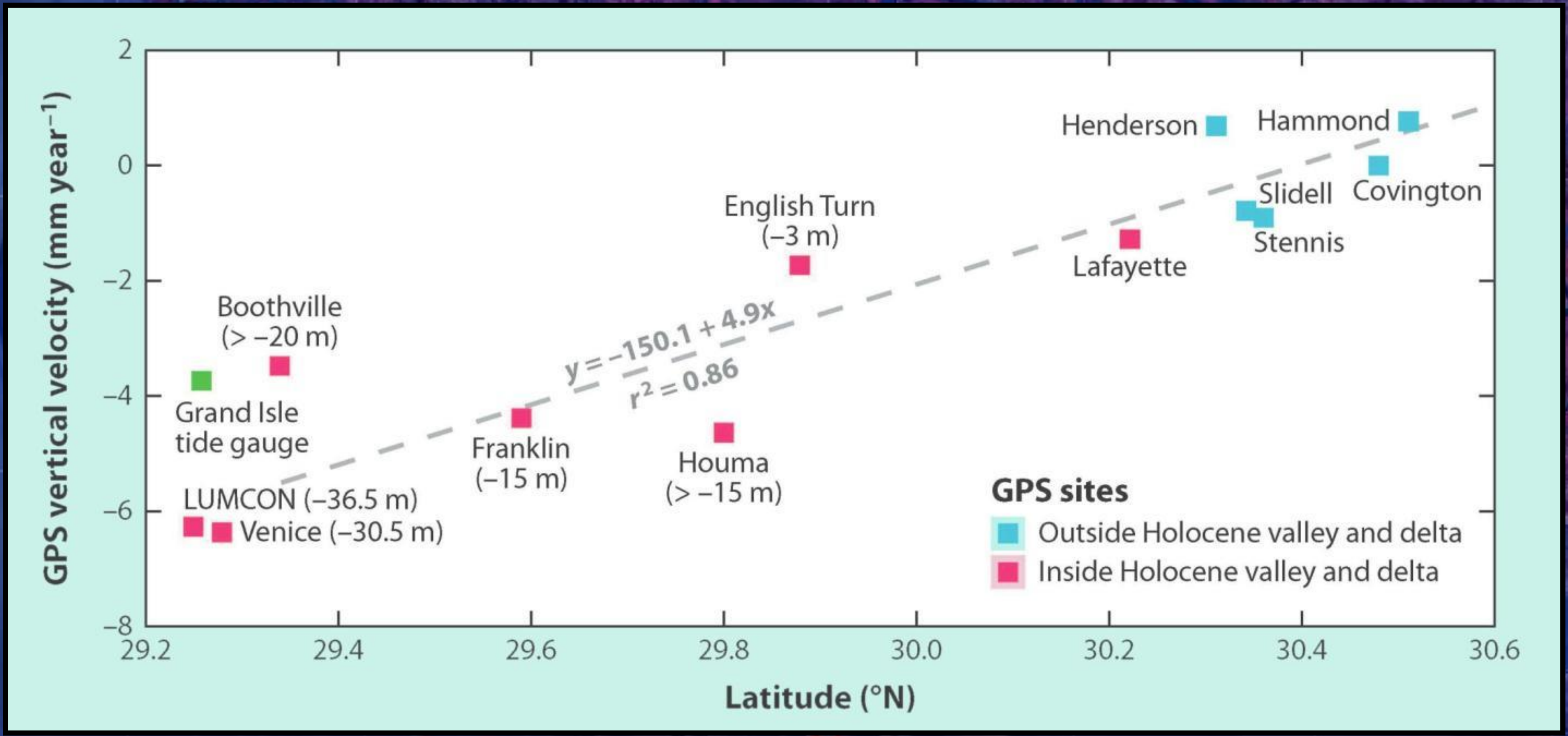
Modern post-dam sediment loads are ~65% of the long-term mean storage component alone

Today’s Problem: Increasing Accommodation

- Combined Processes of Subsidence
- Increasing Rate of SL Rise

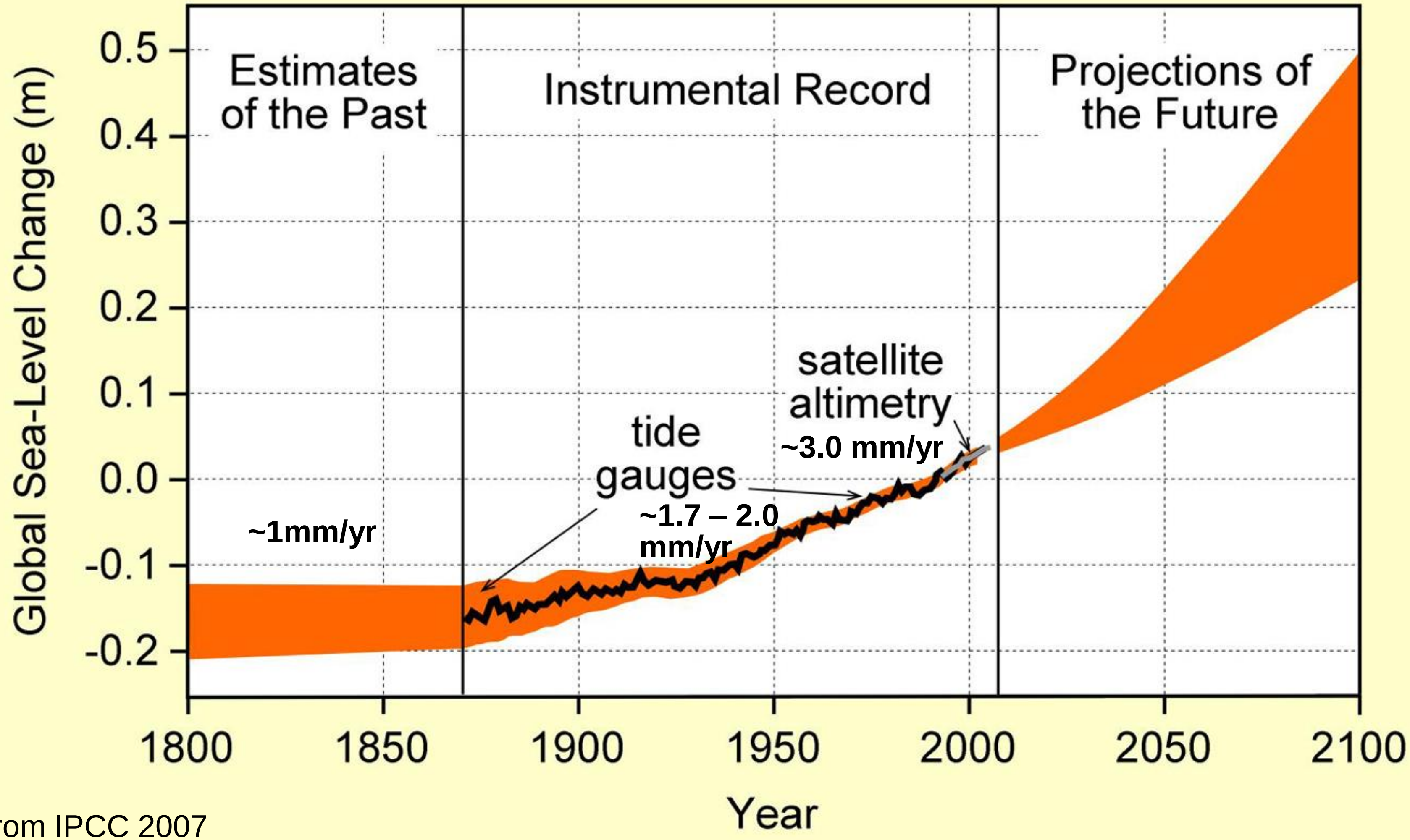


Coastal Plain GPS Vertical Velocities



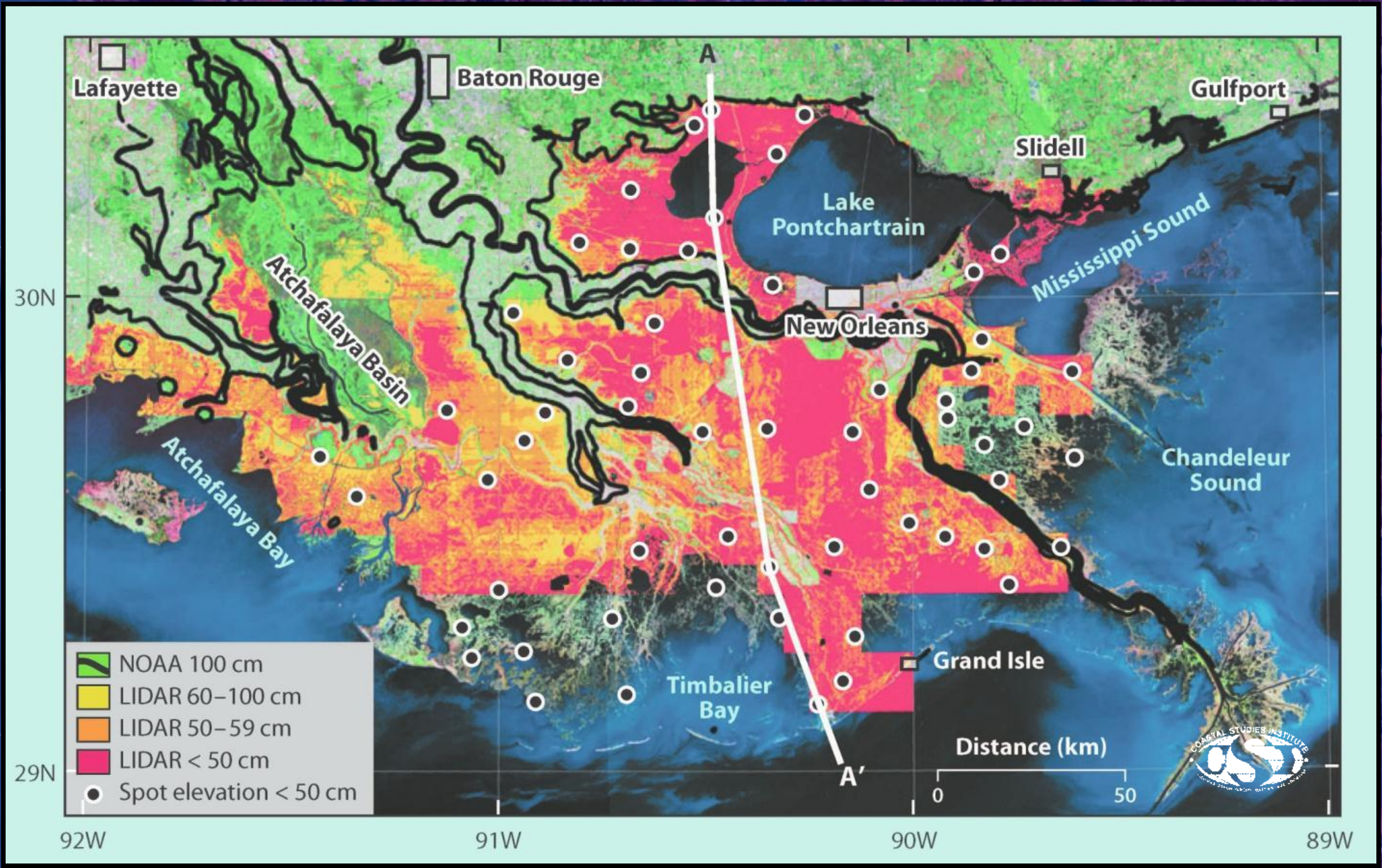
Global Sea-Level Rise

Sea-Level Change Data and Projections

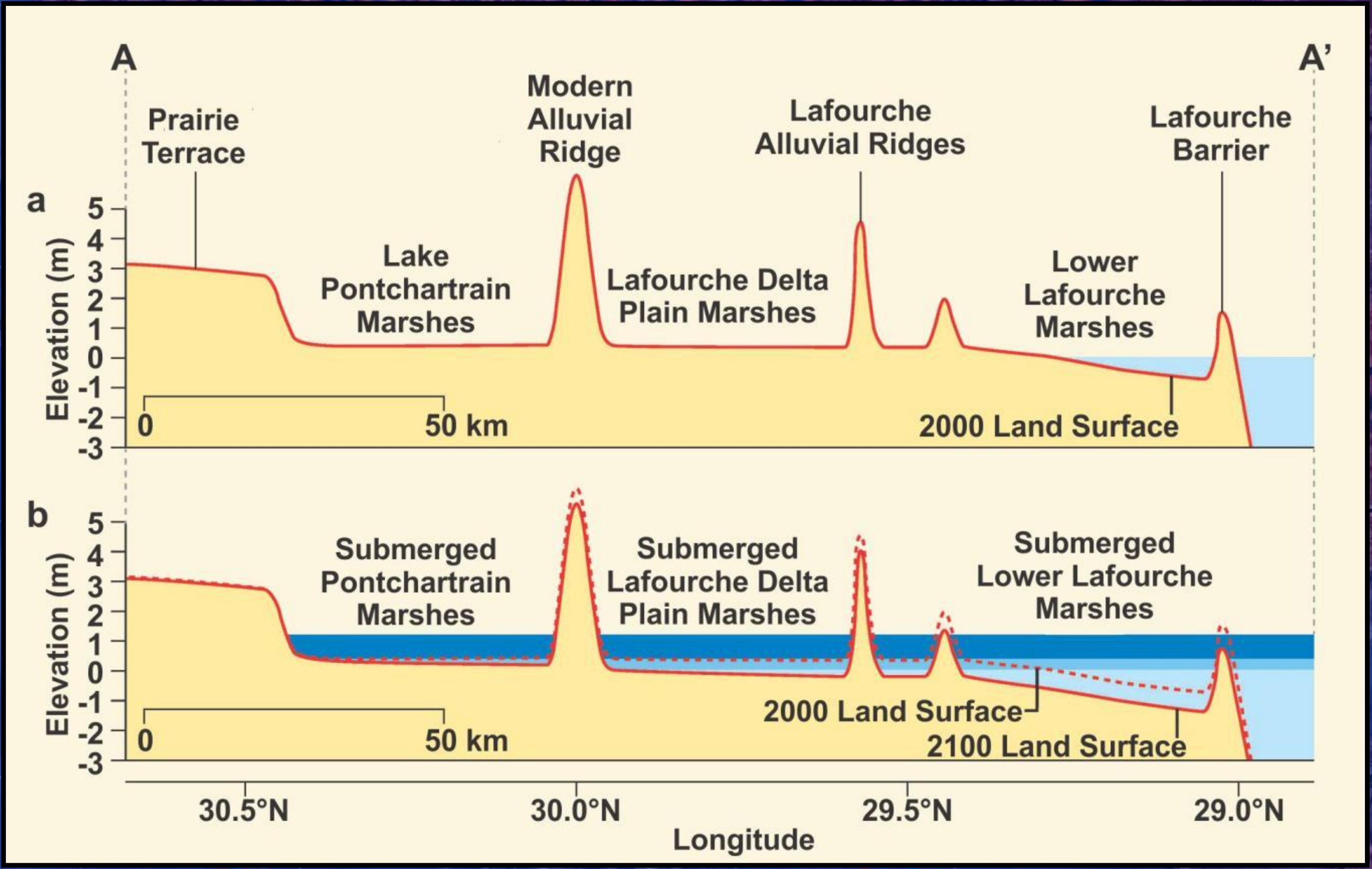


from IPCC 2007

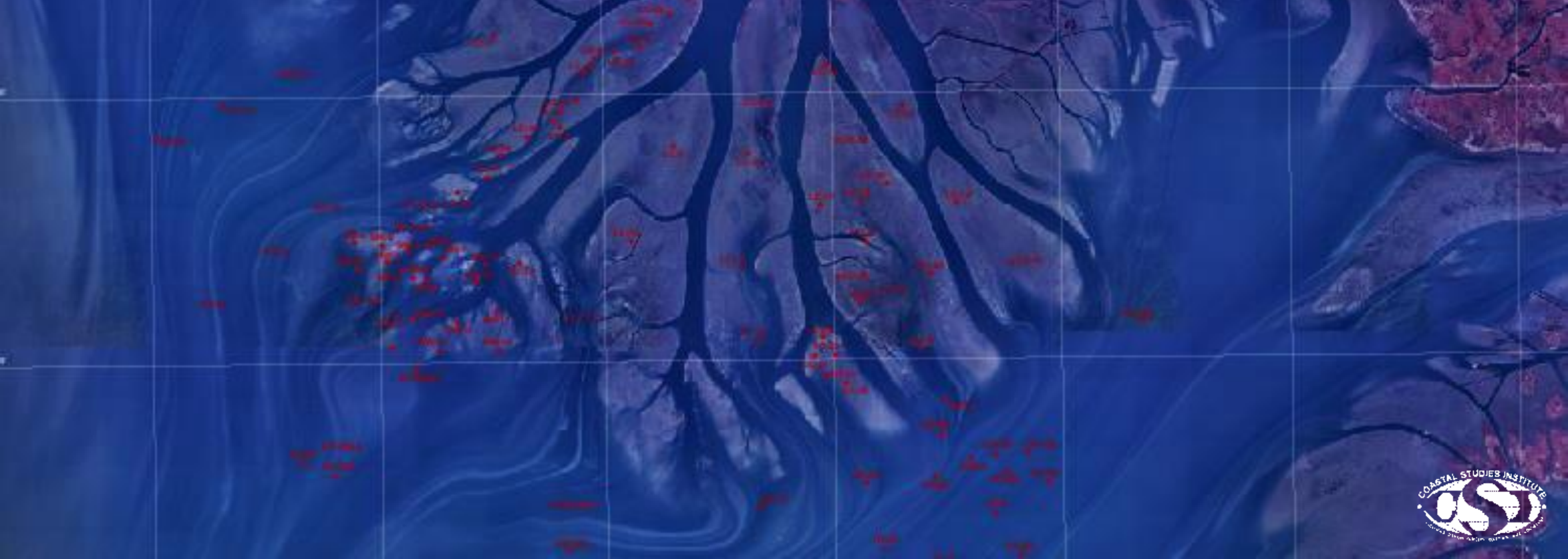
Coastal Plain Elevations



Projected Submergence: 2000 vs 2100



River Diversions: Best Hope for Off-Setting Coastal Land Loss

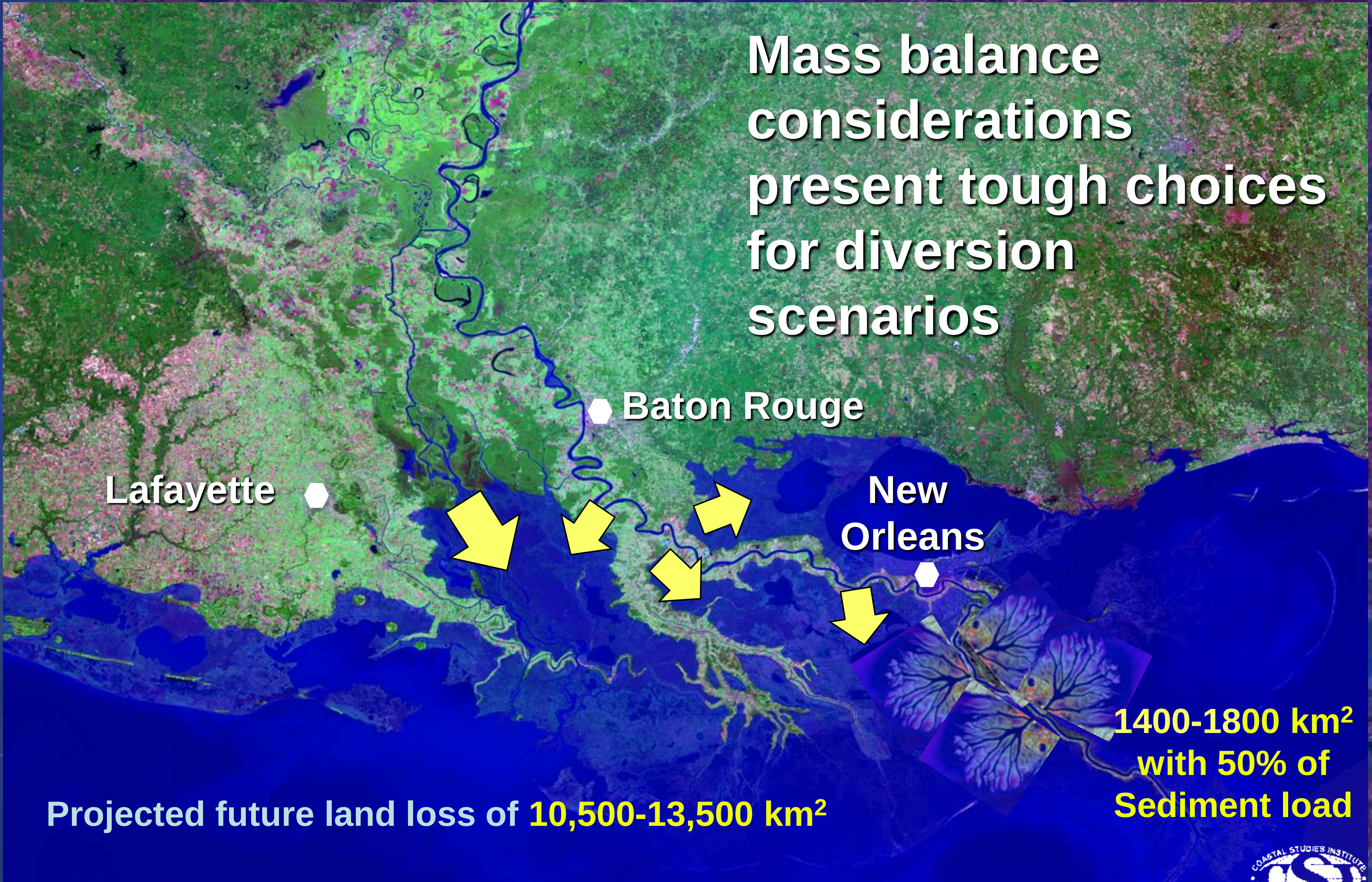


THE LOUISIANA COAST IN 2000

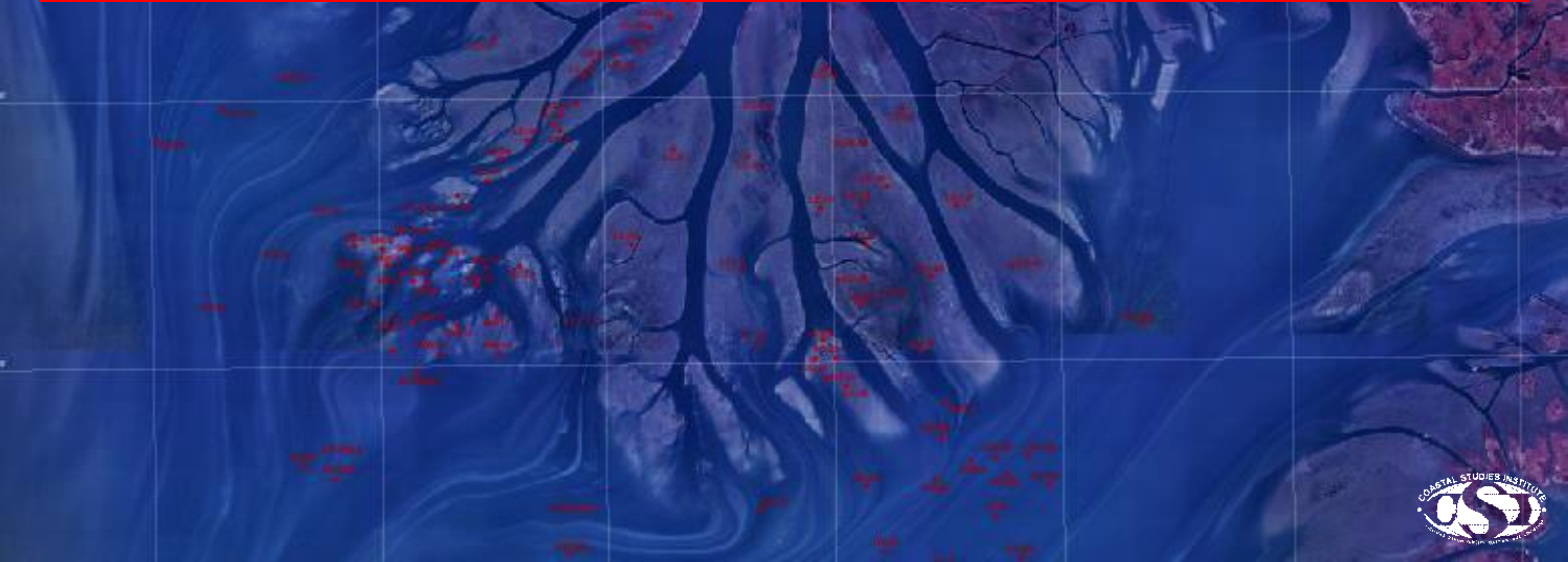
THE LOUISIANA COAST IN 2100?

Projected future land loss of 10,500-13,500 km^2

The Louisiana Coast in 2100?



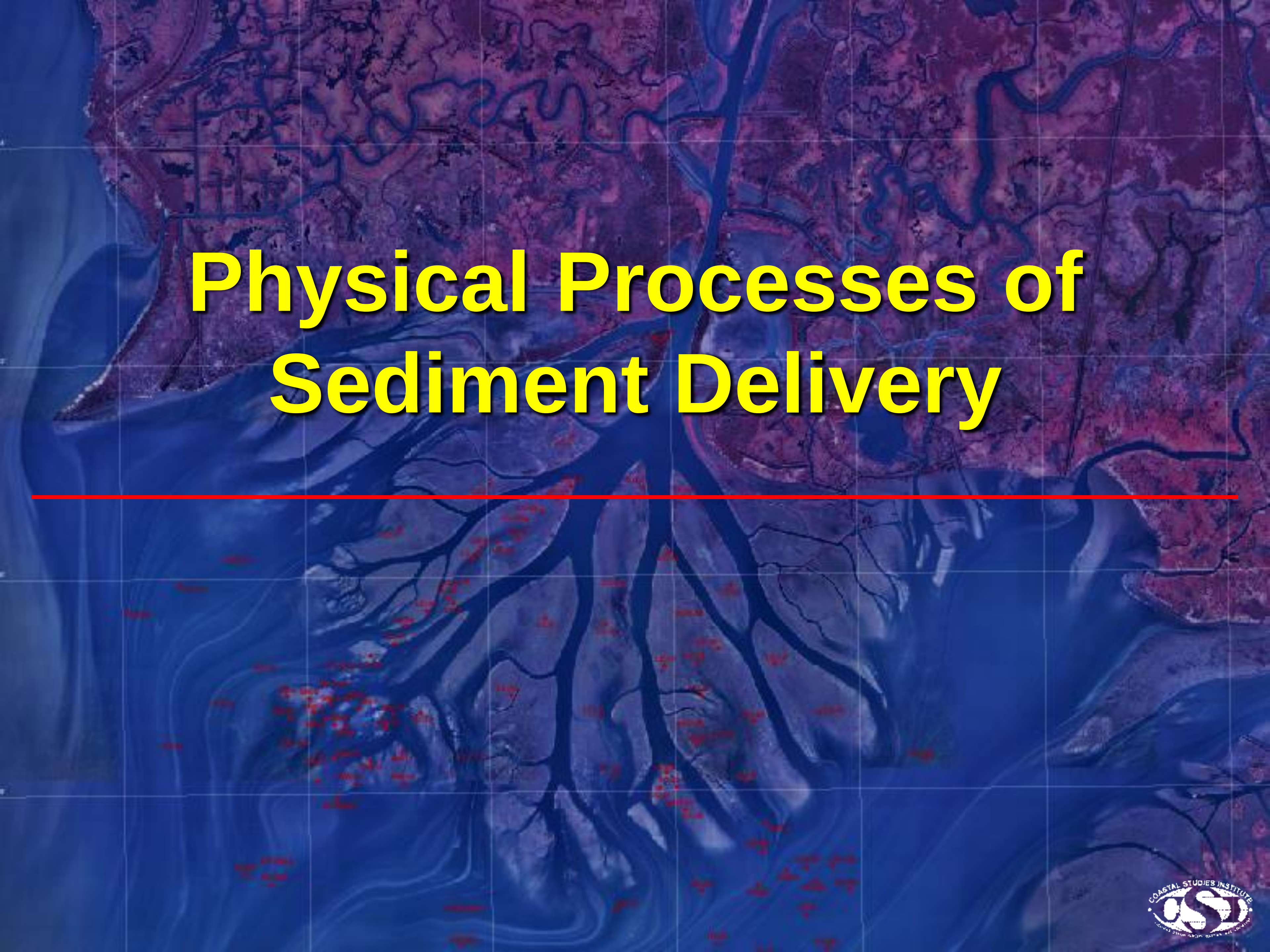
A Goal of River Diversions: Maximize Retention of Sediment Within the Coastal Plain



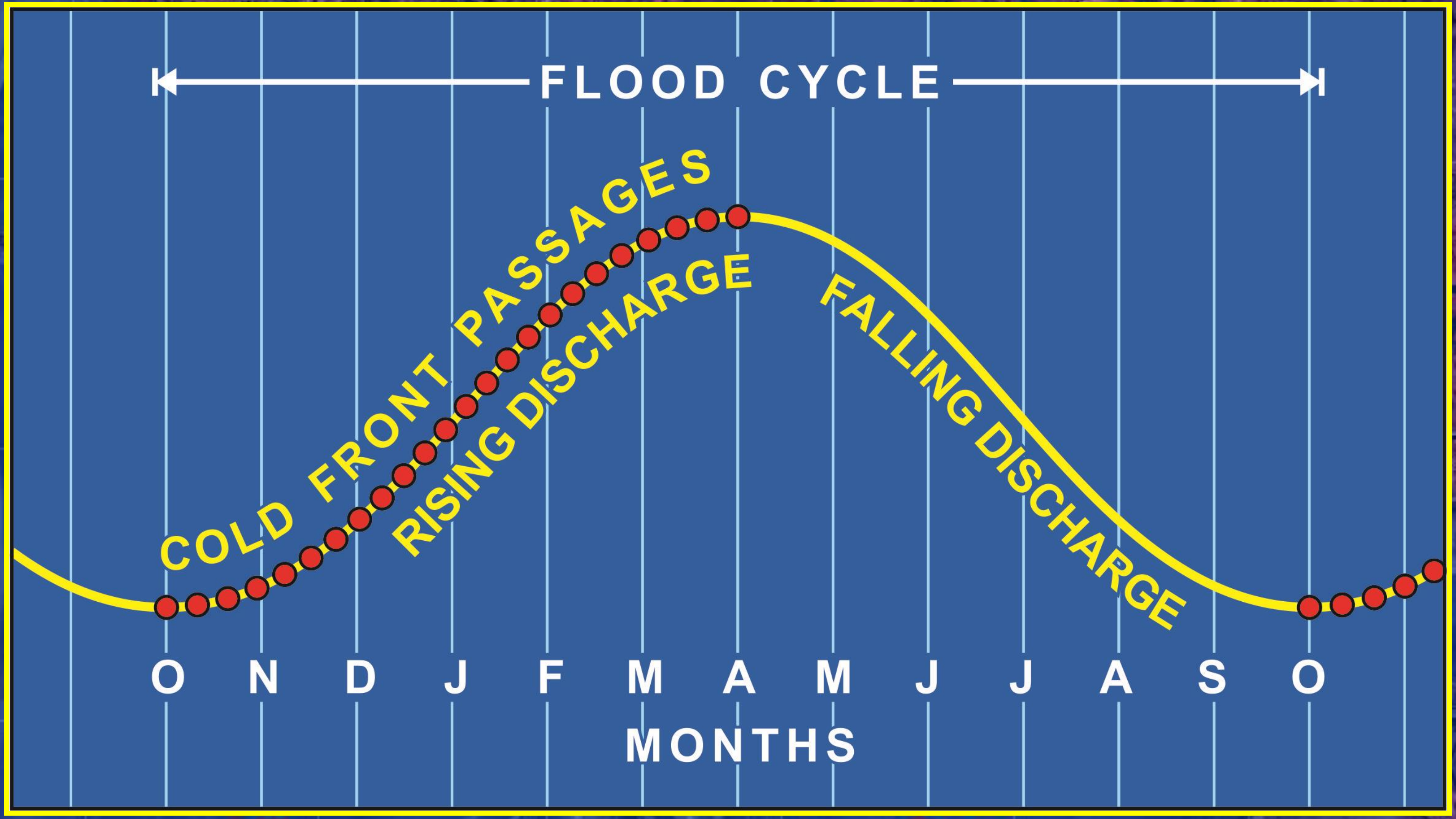
Fundamental Questions: River Diversions

- How are the sediments partitioned within the coastal-shelf system?
- What is the sediment retention capability in the delta and adjacent marshland?
- What are the important processes linked to sediment transport to the delta-marsh-offshore?

Physical Processes of Sediment Delivery



Rising Flood and Cold Fronts Form Synergistic Sediment Delivery Processes

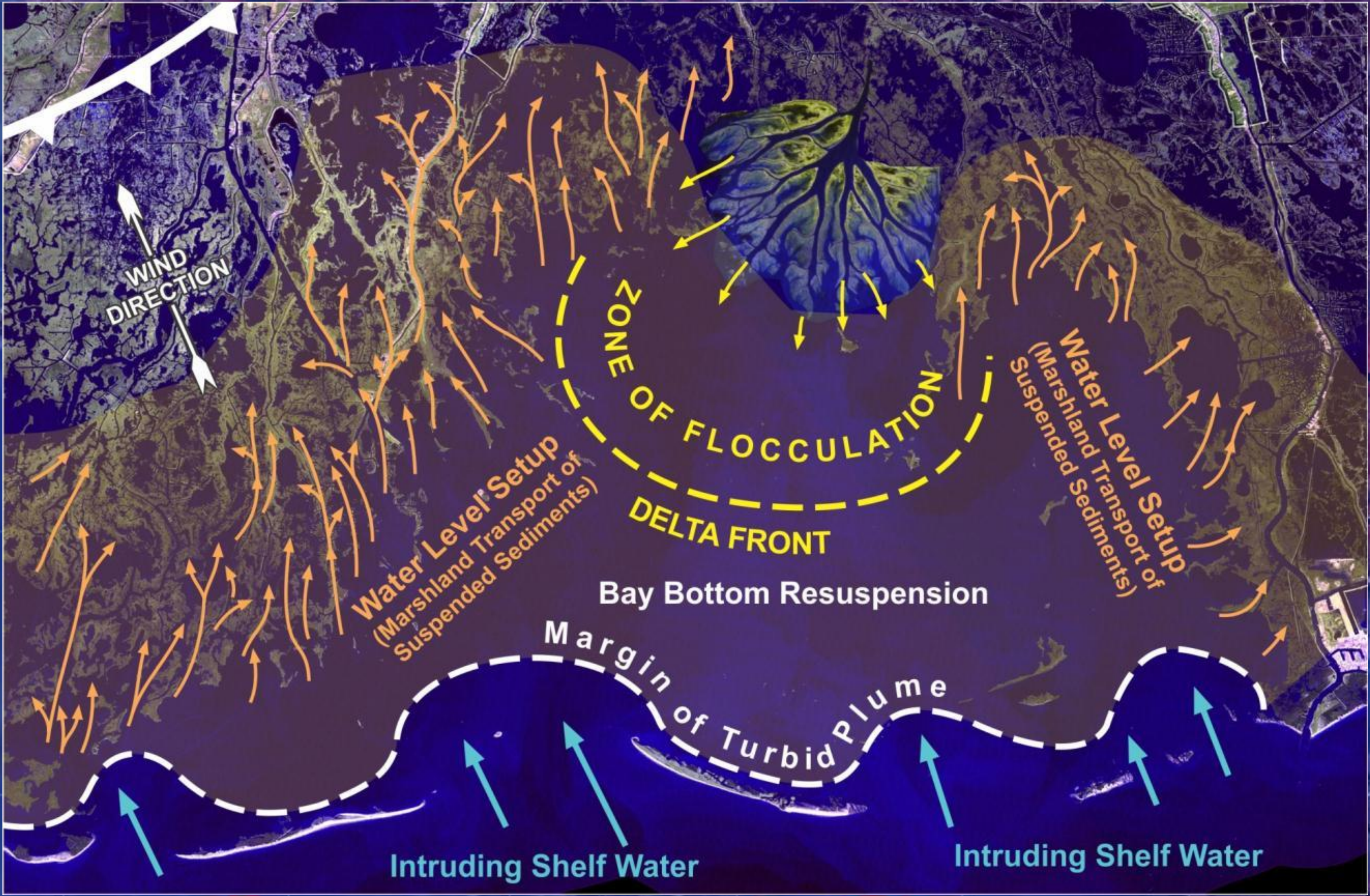


Important Positive Impacts of Tropical Storms and Cold Fronts

Cold Front Modulation of Sediment Transport

- **Prefrontal:**
  - Onshore Winds
  - Water Level Set-Up
  - Onshore Sediment Transport
- **Postfrontal:**
  - Offshore Winds
  - Water Level Set-Down
  - Offshore Sediment Transport

Prefrontal Conditions



RESULT: Marshward Transport of Sediment (20-30 times/year)

Placement of River Diversions in Landward Parts of Interdistributary Basins Will Maximize Sediment Retention Through Landward Suspended Sediment Transport by Cold-Front-Related Processes.