Understanding the future of coastal wetlands in the face of sea-level rise: Lessons from Coastal Louisiana

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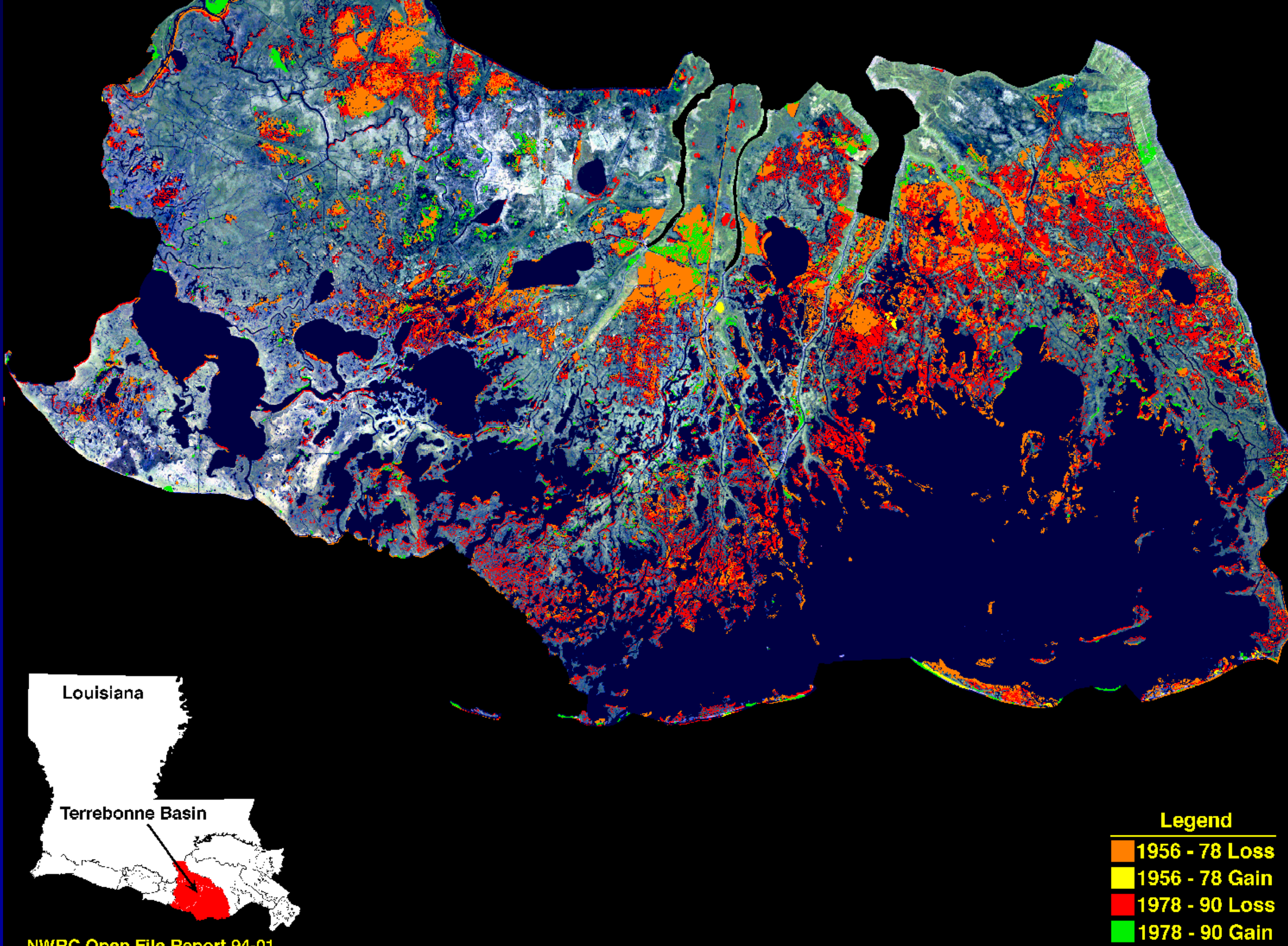
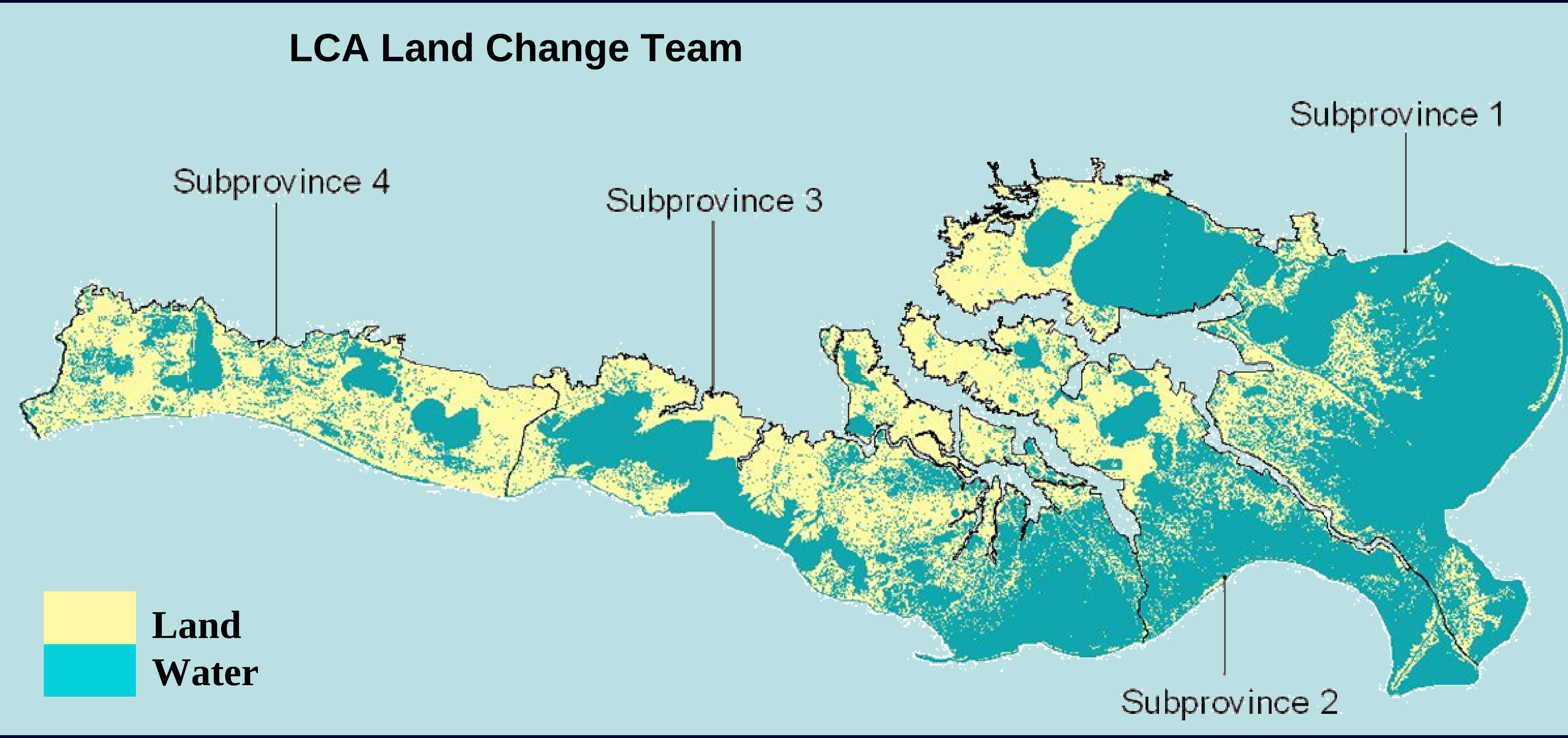
Climate Change for Decision Makers Nov 2005

Terrebonne Basin Trends
1956 - 78 Loss = 9.3 Sq Mi/Yr
1978 - 90 Loss = 10.2 Sq Mi/Yr



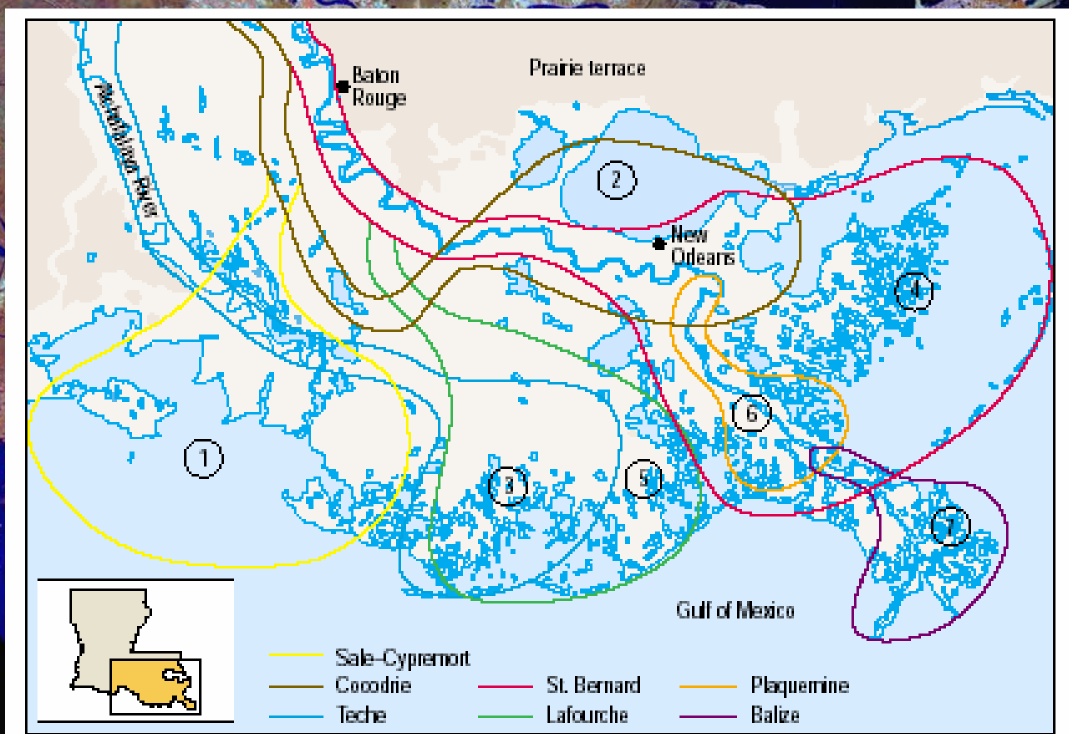
NWRC Open File Report 94-01



1956 – 2000 1525 sq. mi. lost - 35 sq.mi./yr. for 44 years
2000 – 2050 Projected loss - another 513 square miles

Mississippi Delta Plain

7000 years of sediment deposition
Land loss balanced by land gain

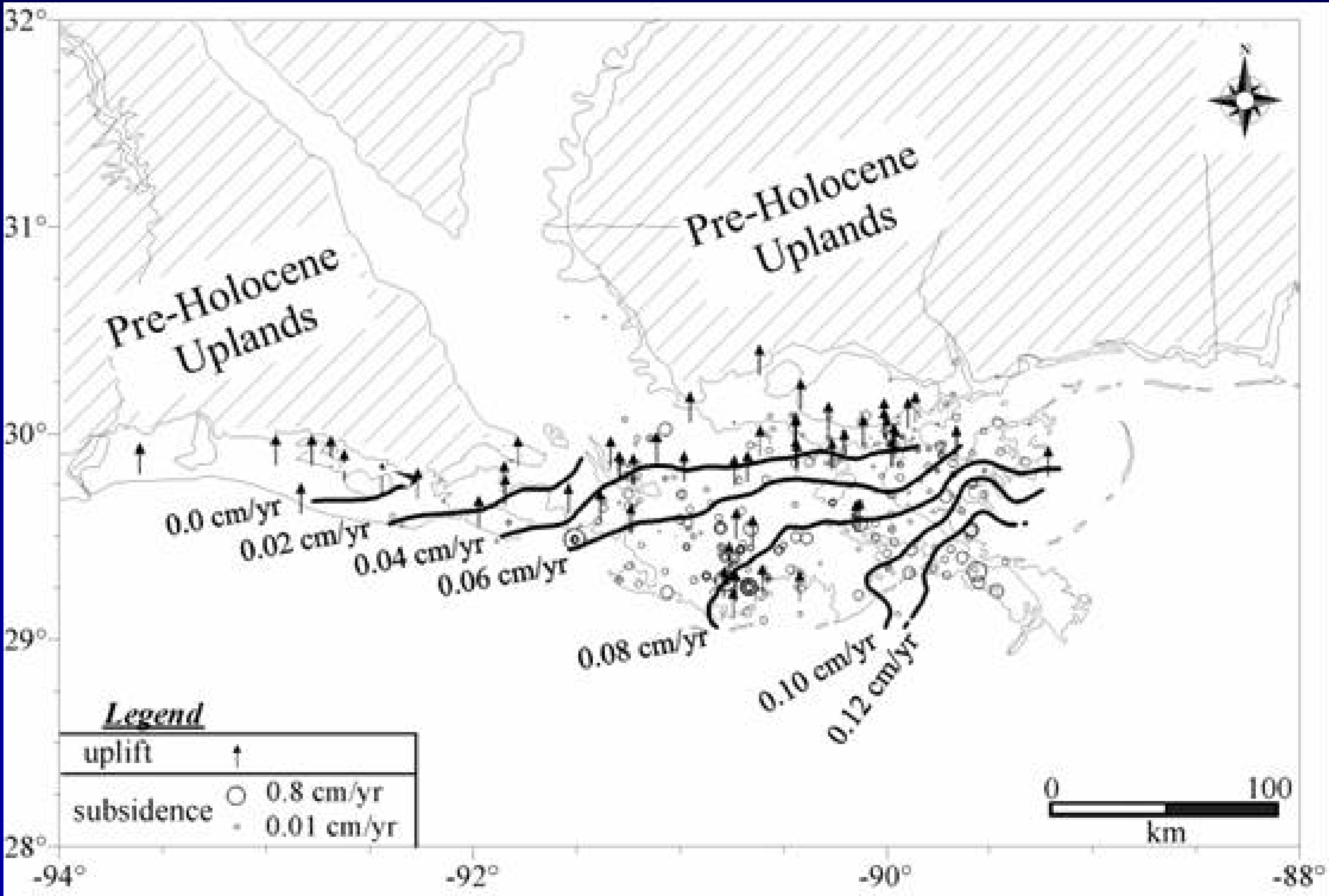


3000-4000 yrs old

Thickest and youngest

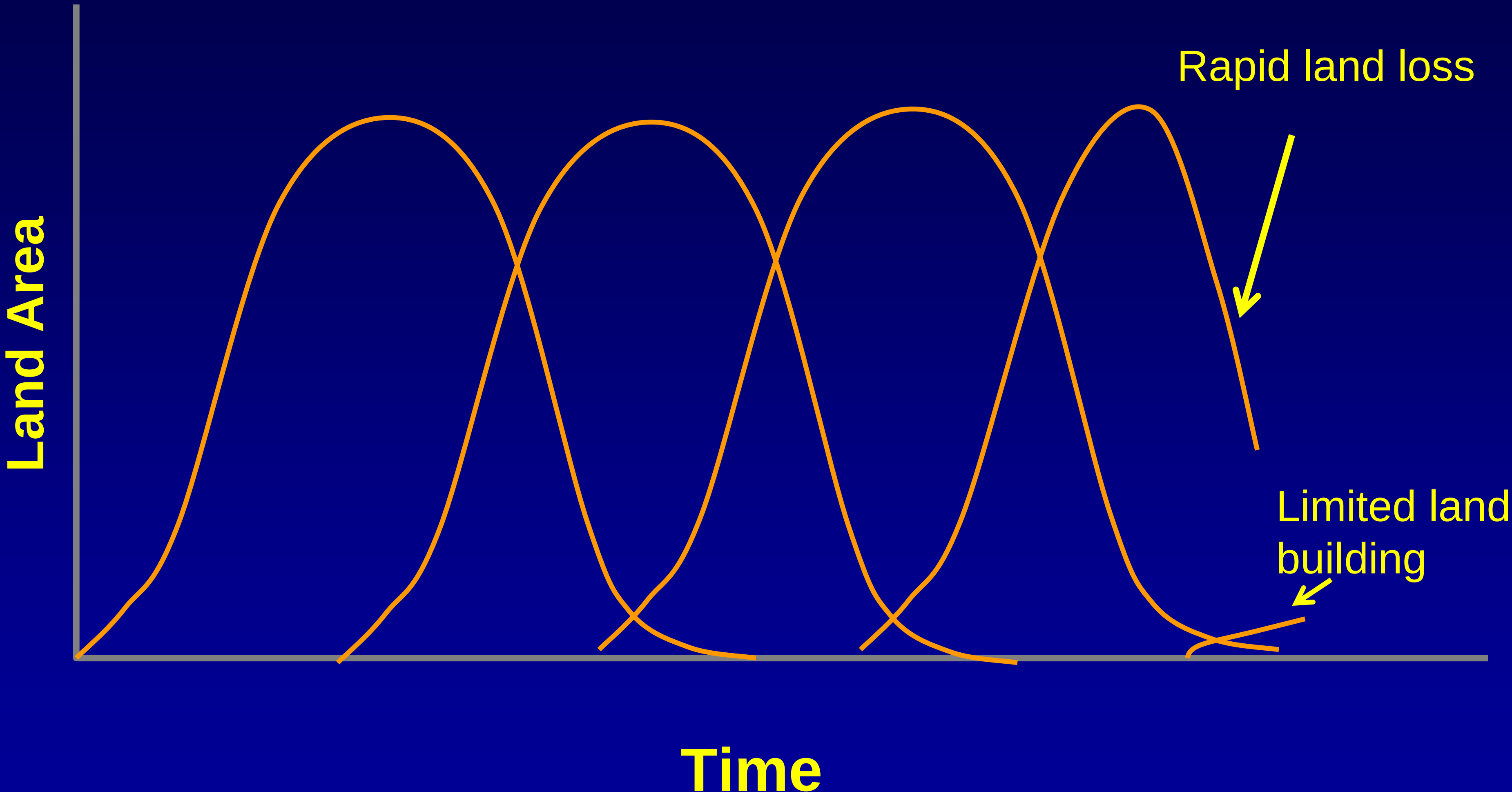
Varying sediment thickness

Subsidence – a natural component of long-term landscape change



Natural cycles

20th century



So what about the 20th century?

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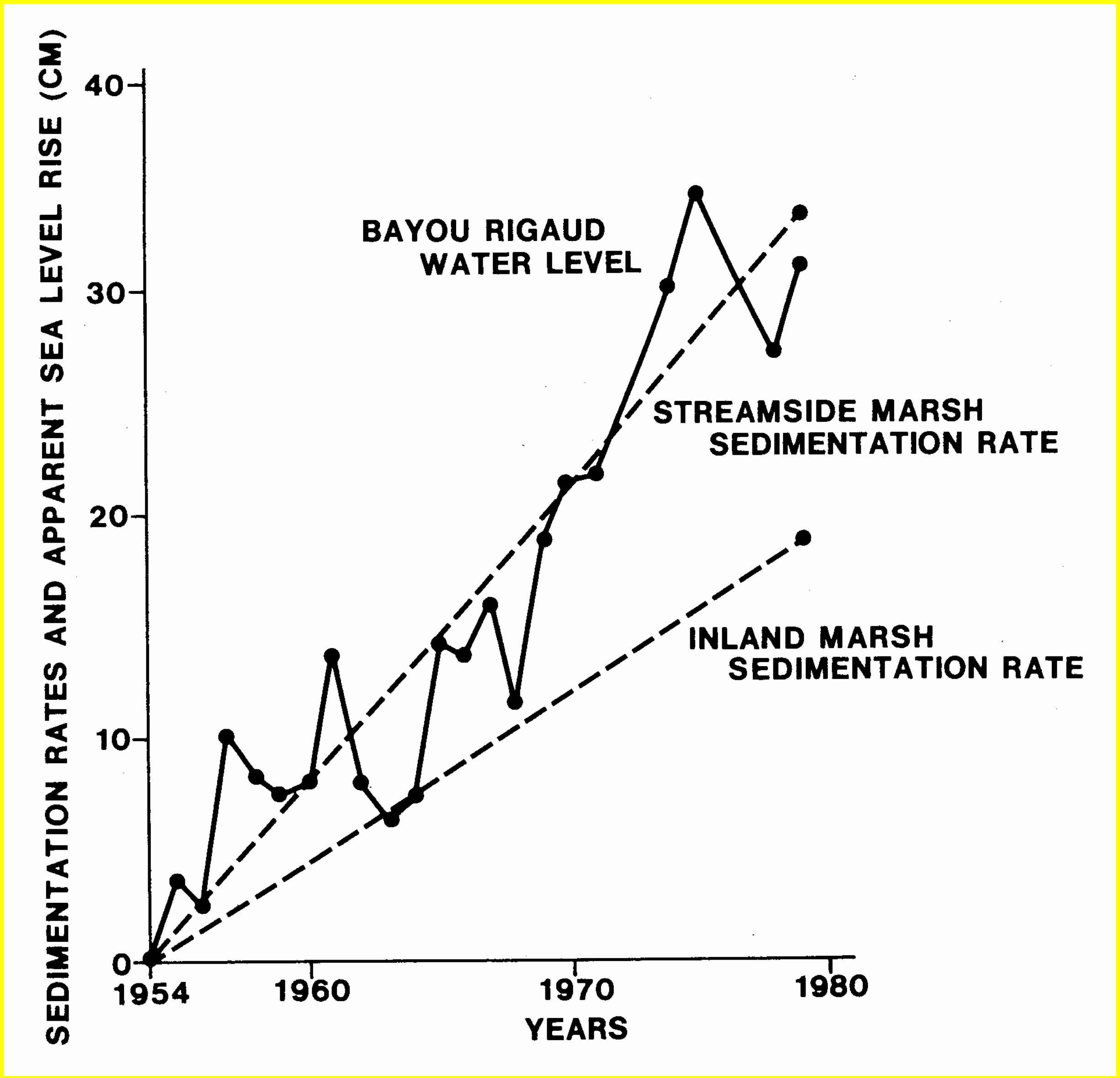
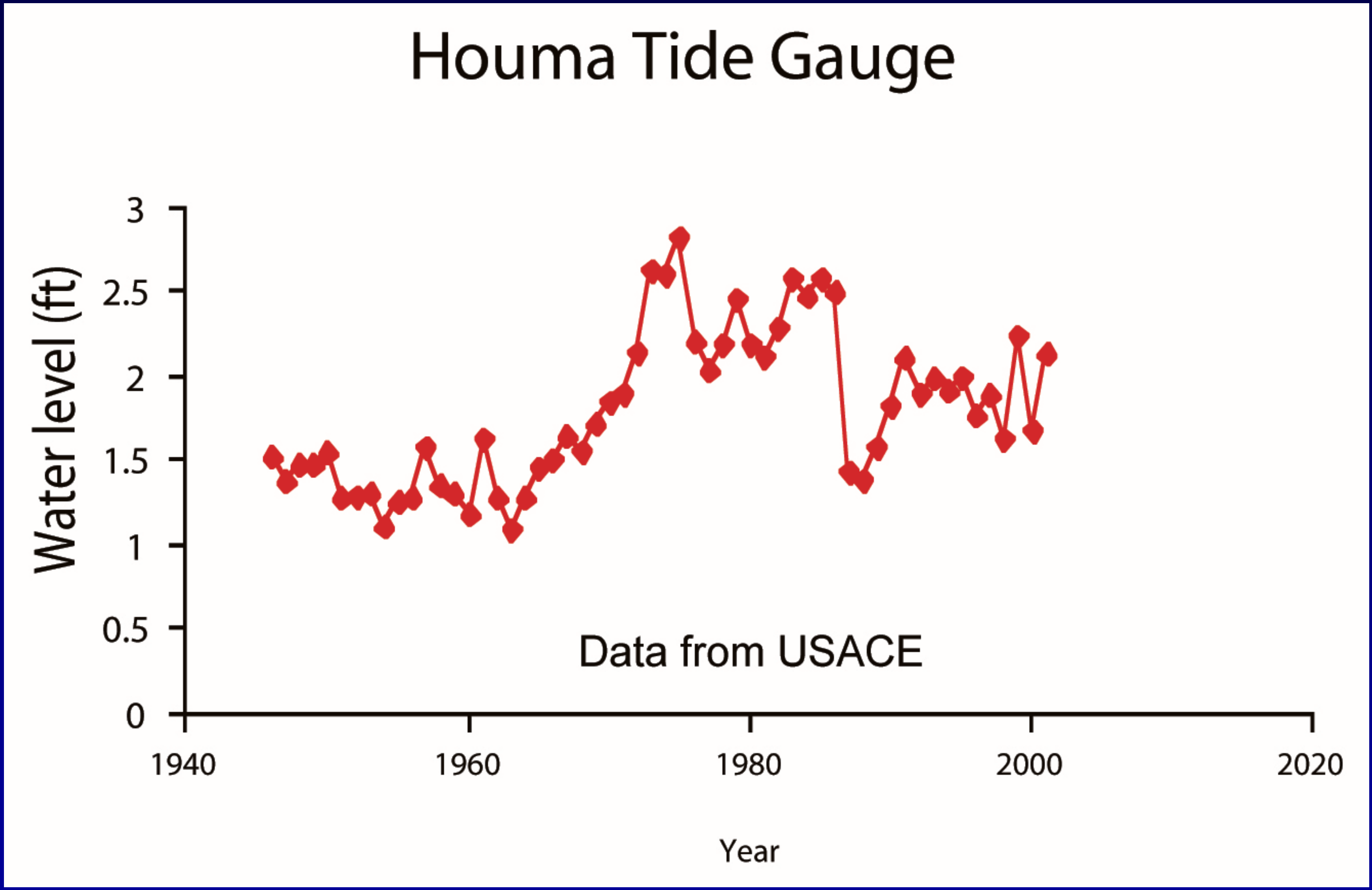
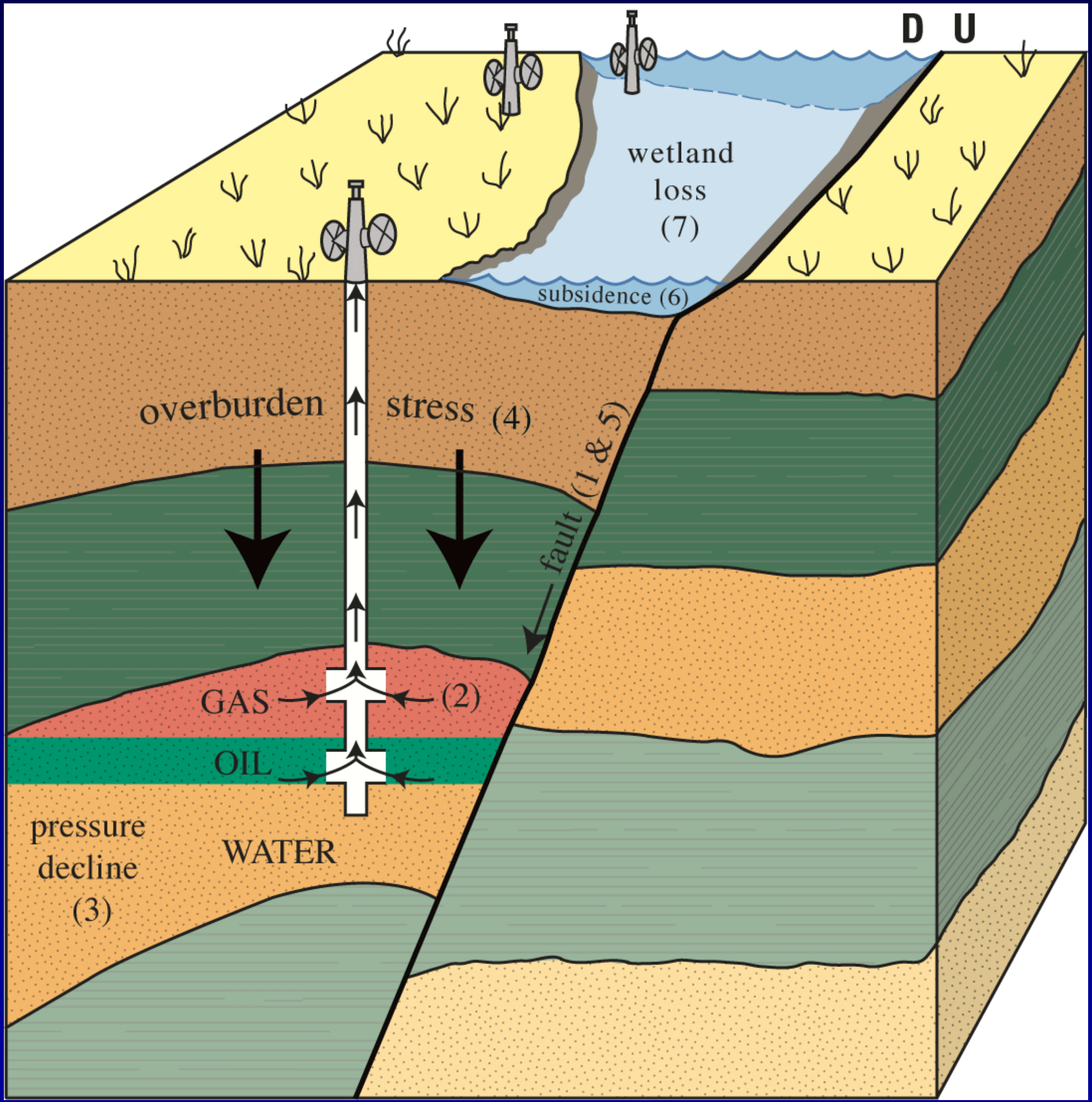


Classic 'sediment deficit'?

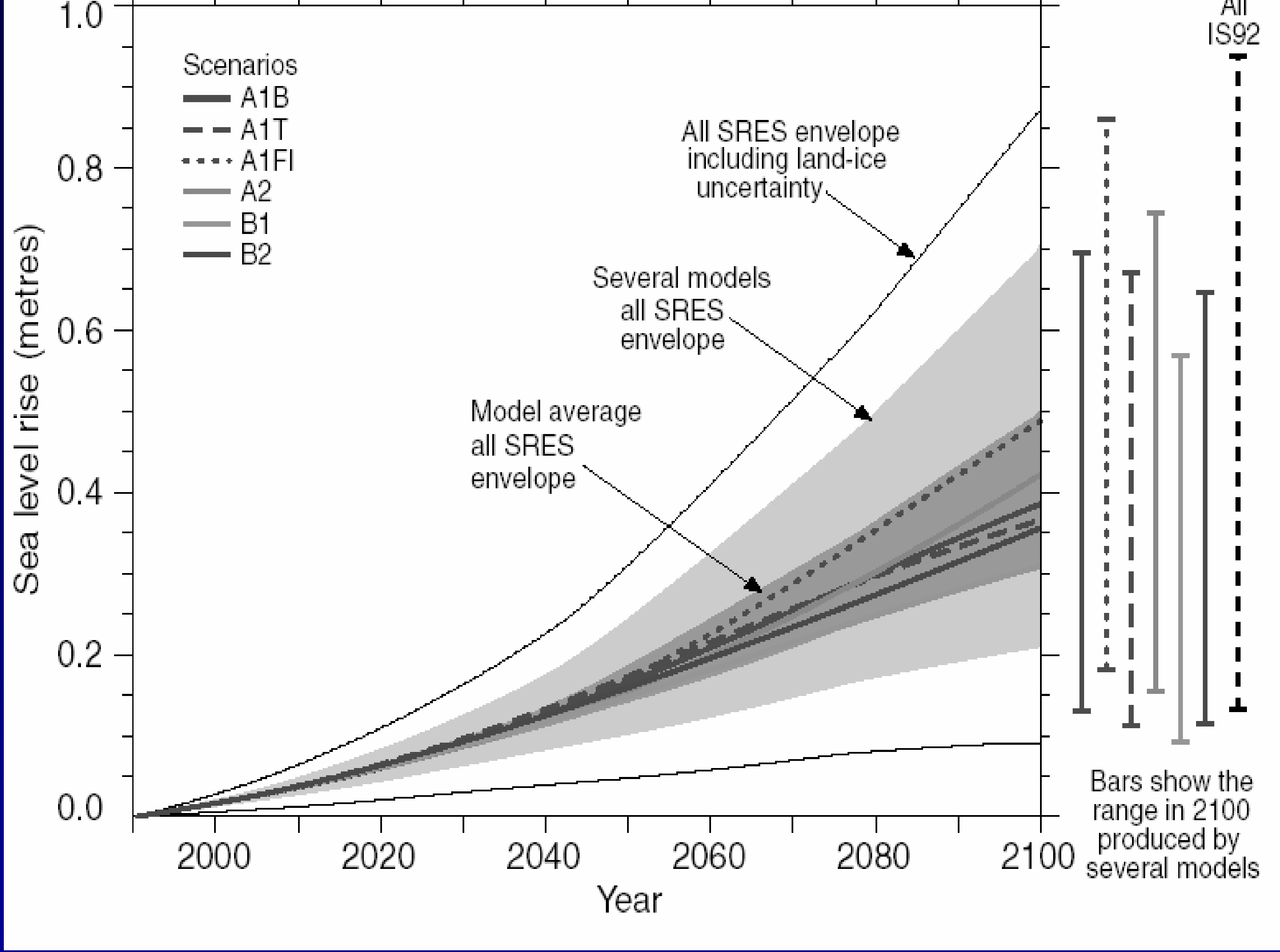
Baumann & DeLaune, 1982


Houma Tide Gauge
Water level (ft)
3
2.5
2
1.5
1
0.5
0
Data from USACE
1940
1960
1980
2000
2020
Year

New Evidence for Catastrophic Localized Subsidence



Morton et al., 2003

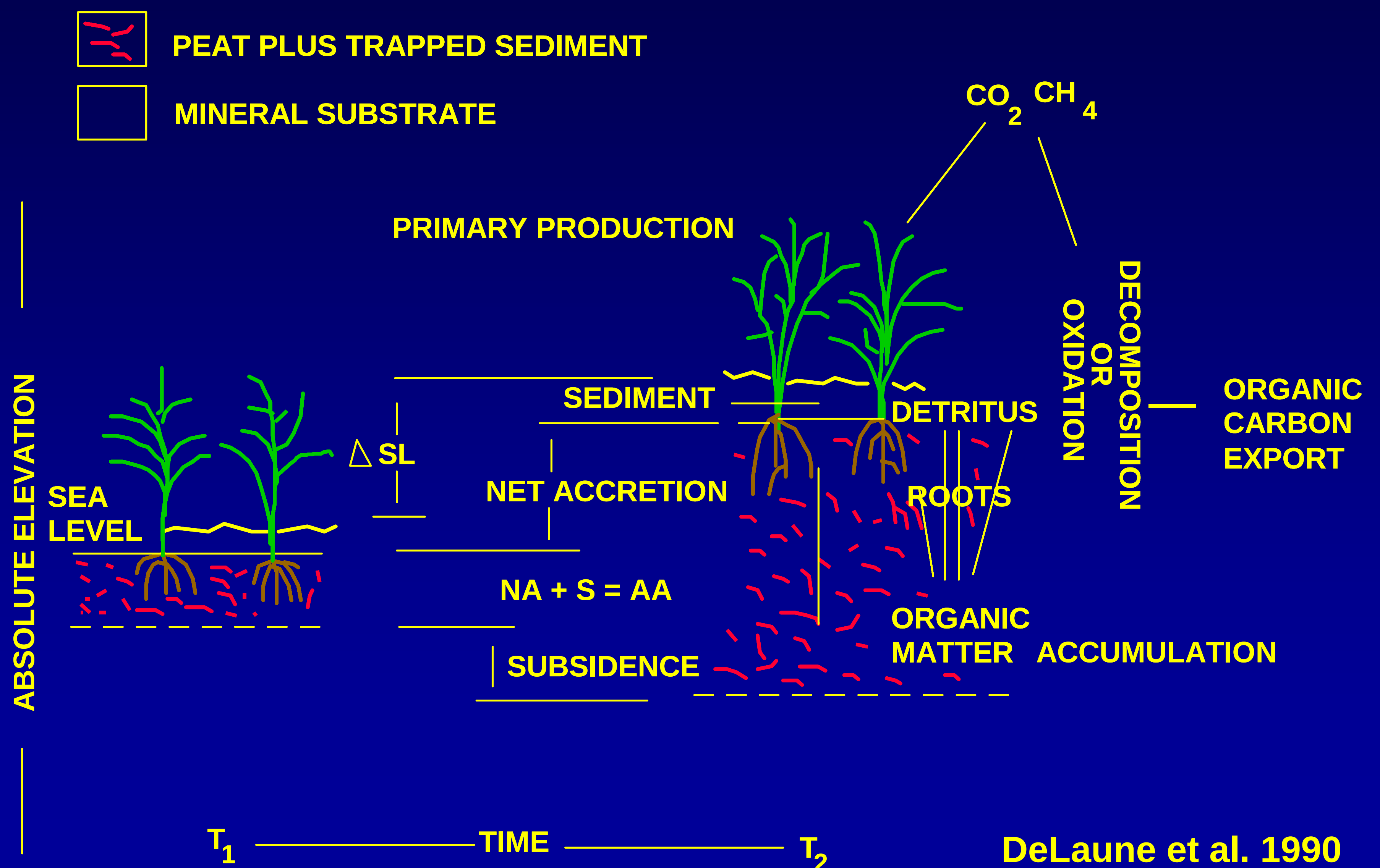


Subsidence + Sea-level rise = Increased water levels

Marshes must build up to survive

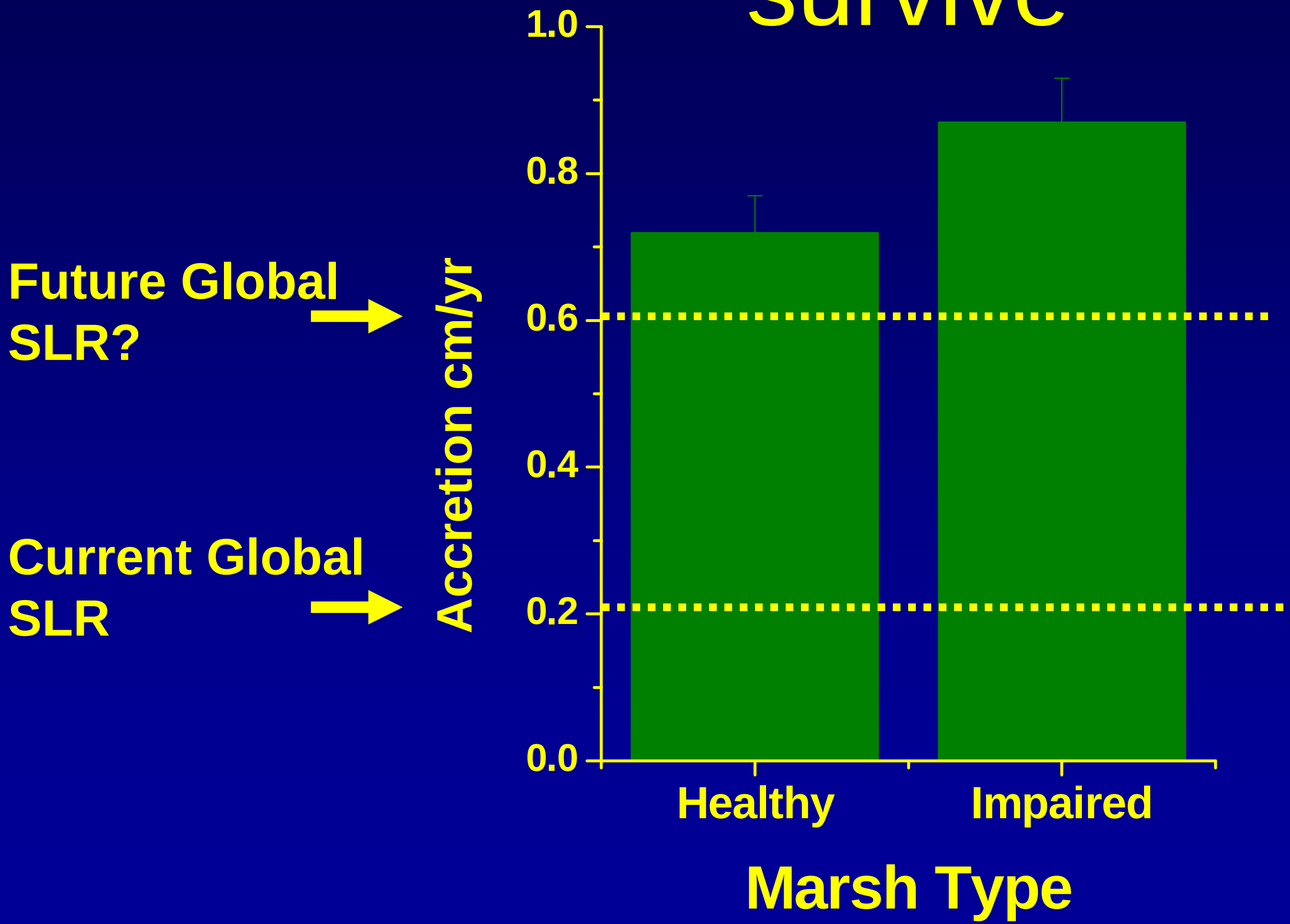
Can marshes keep pace with subsidence and sea-level rise?

Marsh Building Processes



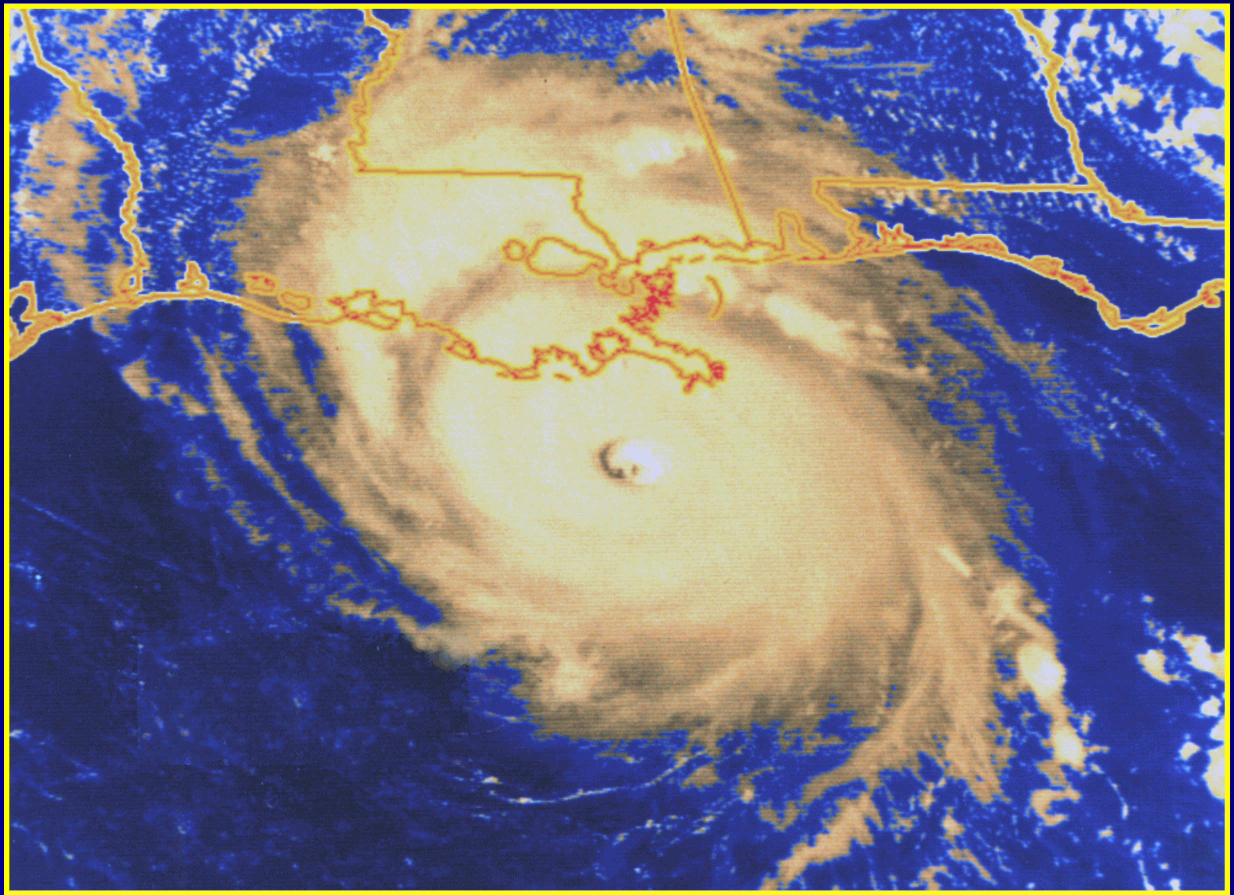
DeLaune et al. 1990

In the face of sea-level rise and subsidence – marshes can still survive



EMAP Study
Turner, Swenson & Summers 1995

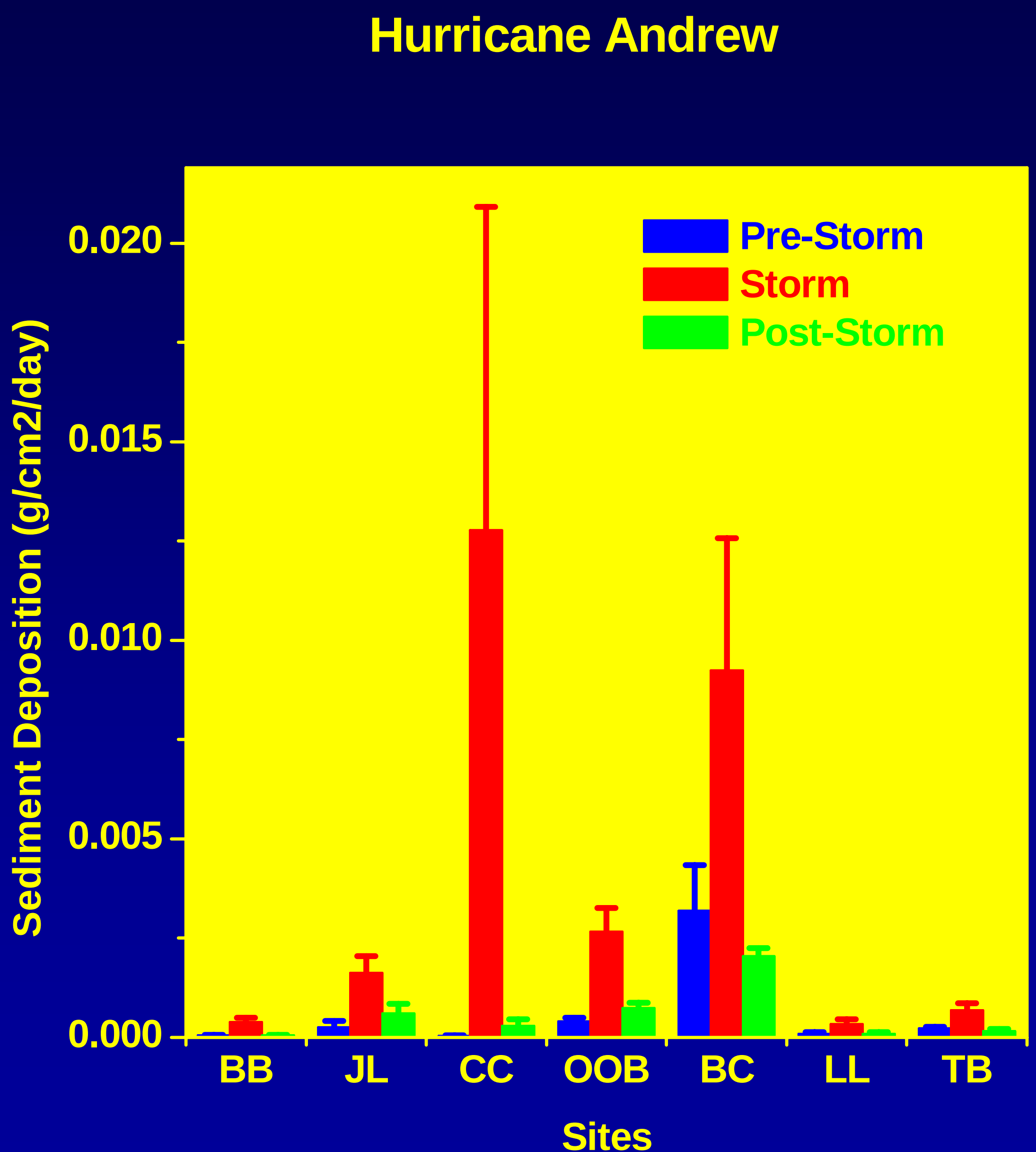
How do marshes in Louisiana build without sediments from the river?



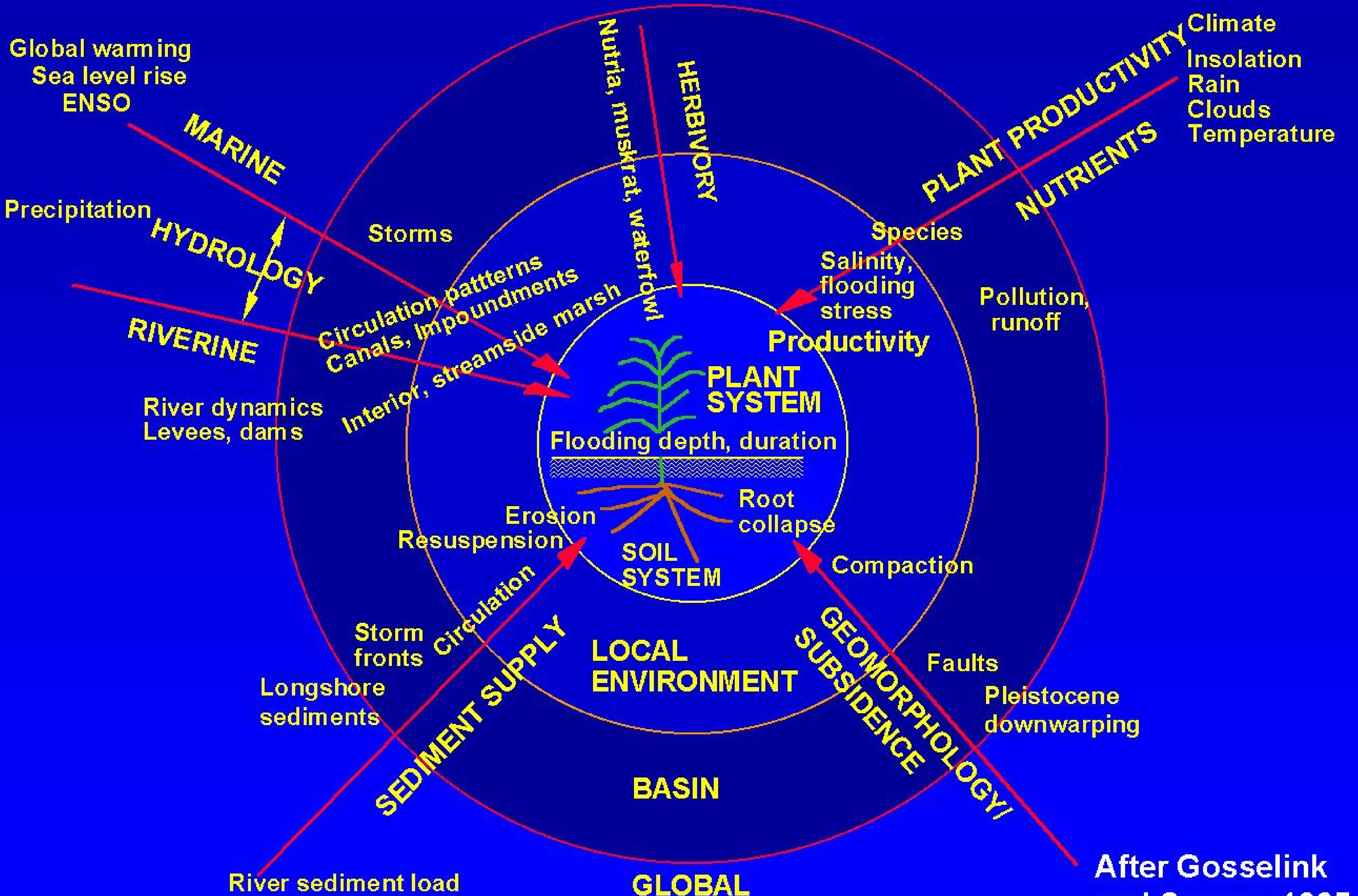
Storms!

Increase water levels and mobilize sediment

Increased water level = Increased sediment deposition



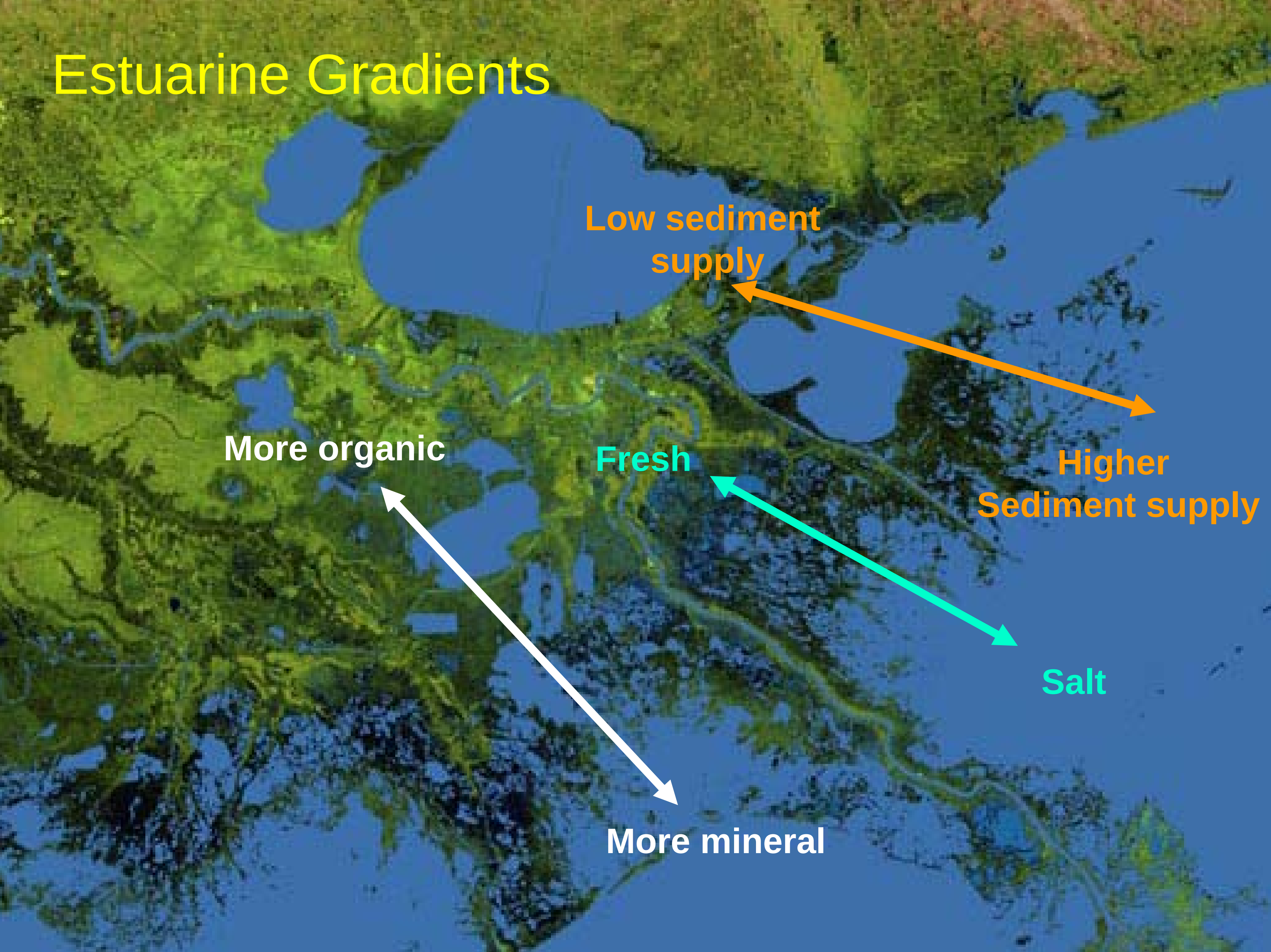
So what causes marsh loss?

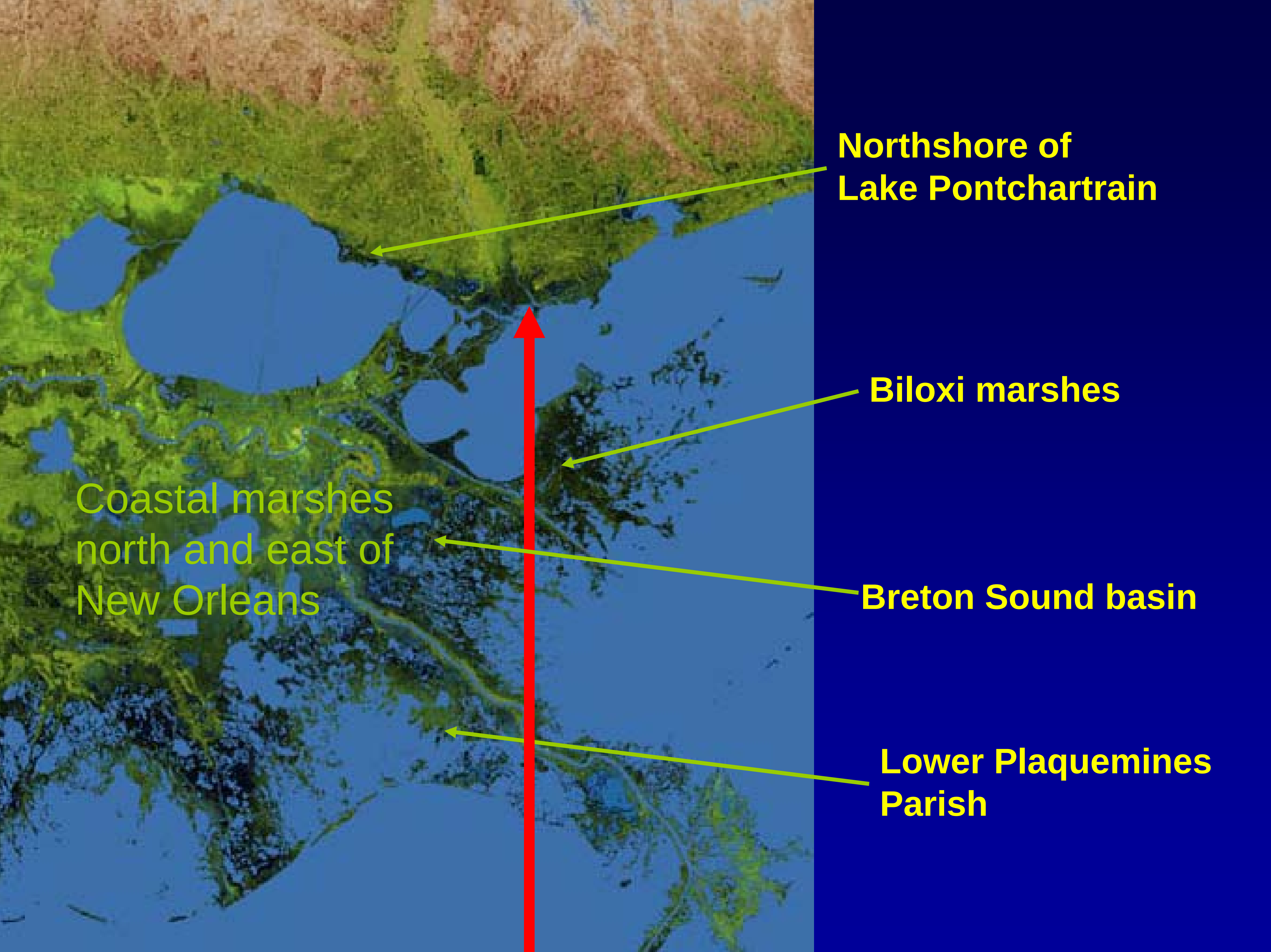


After Gosselink and Sasser, 1995

Impacts of Hurricanes Katrina to the Louisiana Wetlands

Estuarine Gradients




Northshore of
Lake Pontchartrain
Biloxi marshes
Coastal marshes
north and east of
New Orleans
Breton Sound basin
Lower Plaquemines
Parish

Northshore Lake Pontchartrain

Low salinity marshes, organic soils
‘Slabs’ of soil rafted around landscape
Marshes mostly intact

Shallow open water
High in Breton Sound basin

“Marsh balls” mostly composed of brackish veg

Low-salinity brackish with organic soil
High in Breton Sound basin

Physical disruption
Generation of ‘marsh balls’
Rafting of marsh mats
Mud layer over remaining marsh

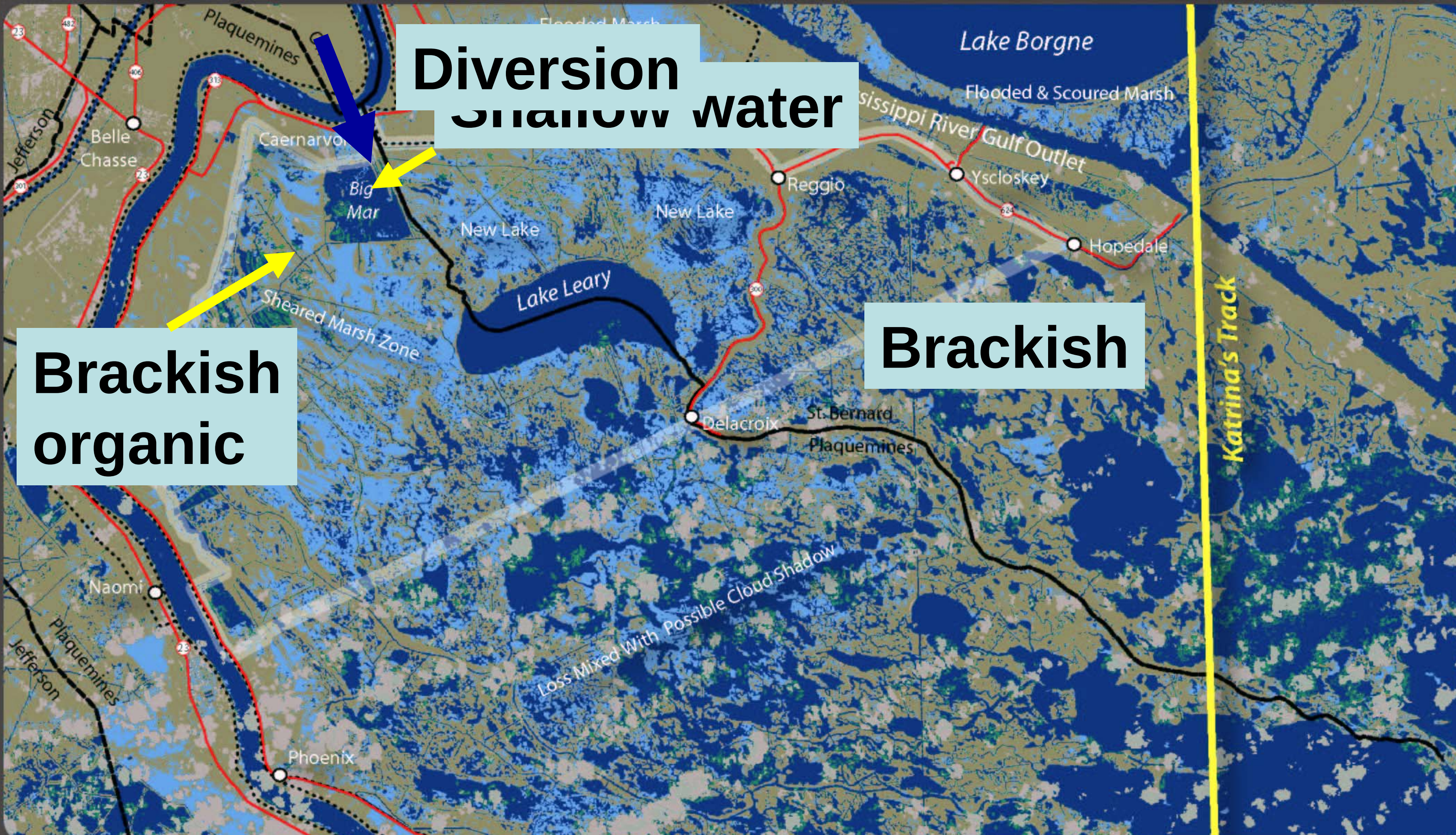
Moderate salinity brackish marsh
More sediment rich soils
Mid-Breton Sound basin

Fewer marsh balls,
Little evidence of physical disruption
Expect mud layer

Salt marshes

Little change in marsh configuration
Evidence of bare mud in ponds
Expect thick sediment deposit

Upper Breton Sound Potential Land Loss After Hurricane Katrina



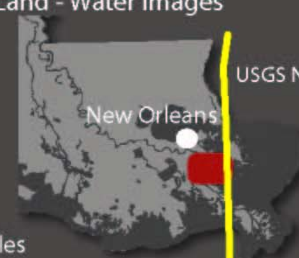
Change Map November 7, 2004 to September 7, 2005 Based on Classified Landsat Thematic Mapper 5 Satellite Land - Water Images

- Trend Area
- Land
- Water
- Potential Land Loss - Includes flooded marsh, sheared/eroded marsh, and scoured marsh
- Land Gain or Clouds
- Unvegetated Area and Clouds
- Main Levees
- Parish Boundary
- Towns
- State Highways

N

Scale 1:200,000

0 1 2 3 Miles

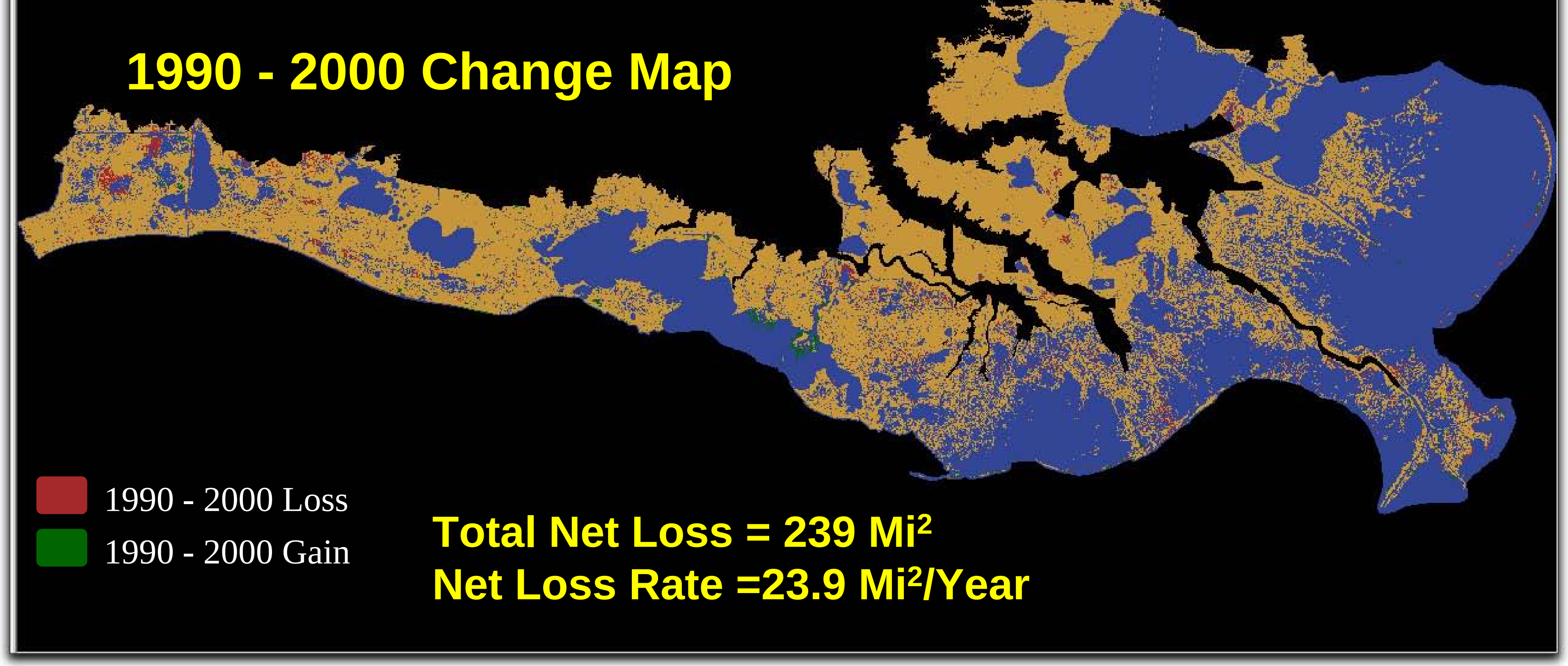


USGS National Wetlands Research Center
Coastal Restoration Field Station
Draft: September 13, 2005

Caernarvon Freshwater Diversion – fresh marsh, high sed.

Sediment rich substrates undisturbed
4-5 inches unconsolidated mud
Arrowhead and alligator weed regrowth already


Long-term effects?

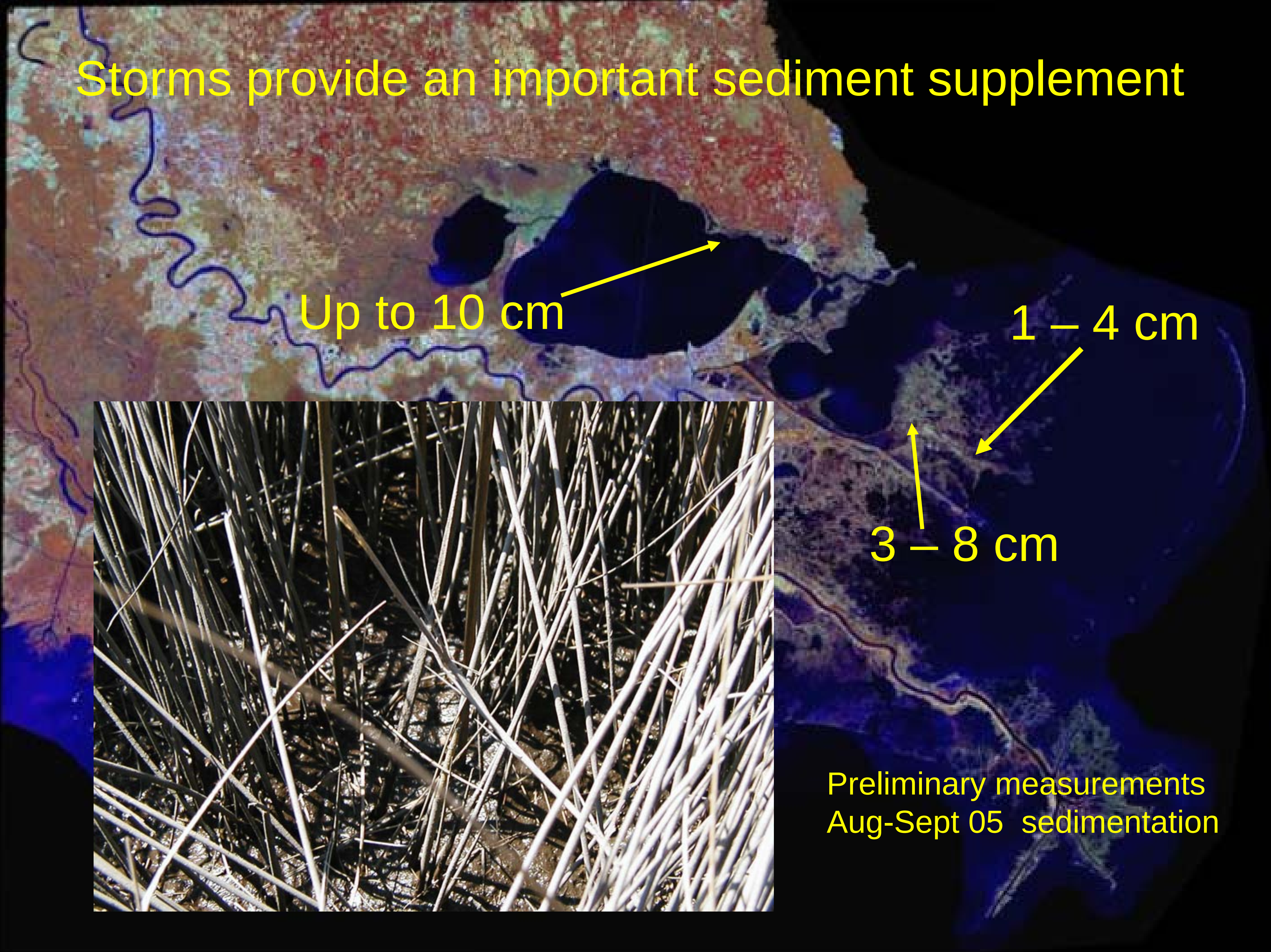


Storm impacts are a natural part of the system dynamic

20th century estimates of loss and 2050 projections encompass these effects (Audrey, Camille, Betsy, Andrew…)

Effects both erosive and accretionary.

Storms provide an important sediment supplement



Preliminary measurements
Aug-Sept 05 sedimentation

Closing Thoughts

- **Coastal marshes can survive high rates of sea-level rise (> 1 cm/yr)**
- **Contributions from mineral and organic vary within and among systems**
- **Hurricanes provide sediment – a key limiting resource in many areas**
- **Fresh marshes benefiting from river sediments were more robust**

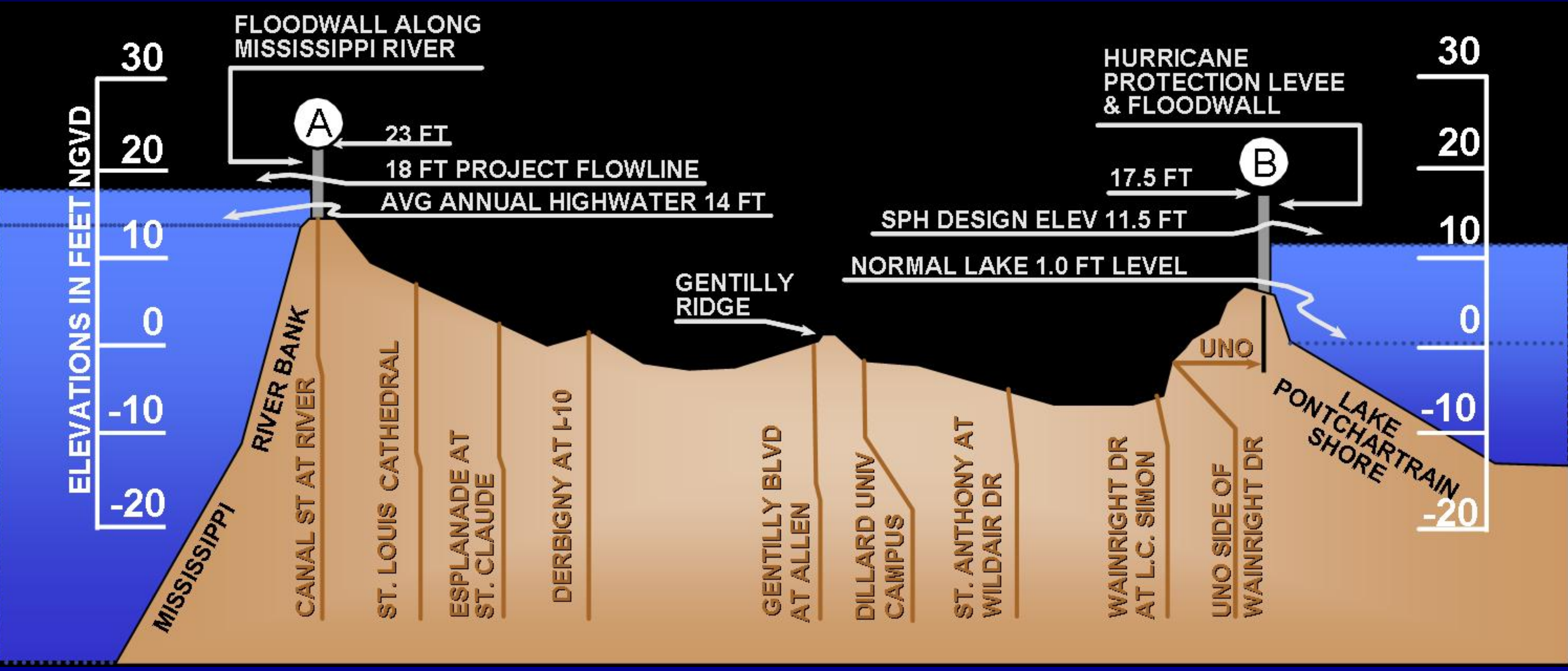

UNIVERSITY OF NEW ORLEANS
1718
1958
uno
LOUISIANA STATE UNIVERSITY SYSTEM
University of
New Orleans
Lakefront Campus



DELTA PLAIN COASTAL LAND LOSS RANKING

CLASS NAME	ACREAGE	PERCENT
Oil and Gas	249,152	36.06%
Natural Waves	181,090	26.21%
Alt. Hydro Multiple	148,668	21.52%
Navigation	33,114	4.79%
Natural Waterlogging	21,069	3.05%
Failed Land Reclamation	16,403	2.37%
Borrow Pits	11,130	1.61%
Channel Flow	10,369	1.50%
Alt. Hydro Impoundment	7,992	1.16%
Alt. Hydro Road	4,825	0.70%
Faulting	3,921	0.57%
Access Channel	1,312	0.19%
Burned Area	729	0.11%
Herbivory	561	0.07%
Sewage Pond	308	0.04%
Agricultural Pond	179	0.03%
Drainage Channel	109	0.02%
TOTAL	690,931	100.00%

Great Vulnerability



Direct Effects on infrastructure…

Exposes pipelines which were previously buried - Leaving them exposed damage…

Examples of Impacts to Shell's Pipelines due to Coastal Erosion

➢ **Odyssey/Pompano Reburial in 2001**	**- $1 MM**
➢ **Ship Shoal Reburial in 2002**	**- $300M**
➢ **West Delta Reburial in 1995**	**- $500M**
➢ **Cobia Reburial in 1996**	**- $300M**
➢ **Golden Meadow Reburial in 2002**	**- $200M**
➢ **HoHo - $500M (for 2002); $1 MM (2003-2004)**	**- $1.5 MM**
➢ **Barataria 12" in 2002**	**- $100M**
➢ **Terrebonne Bay 8 & 10" Replacement in 1999**	**- $2MM**
➢ **Clovelly Farms Rip Rap in 2001**	**- $270M**
➢ **Bulkhead Repair over 3 yrs.**	**- $ 1 MM**
	Total = $ 7+ MM

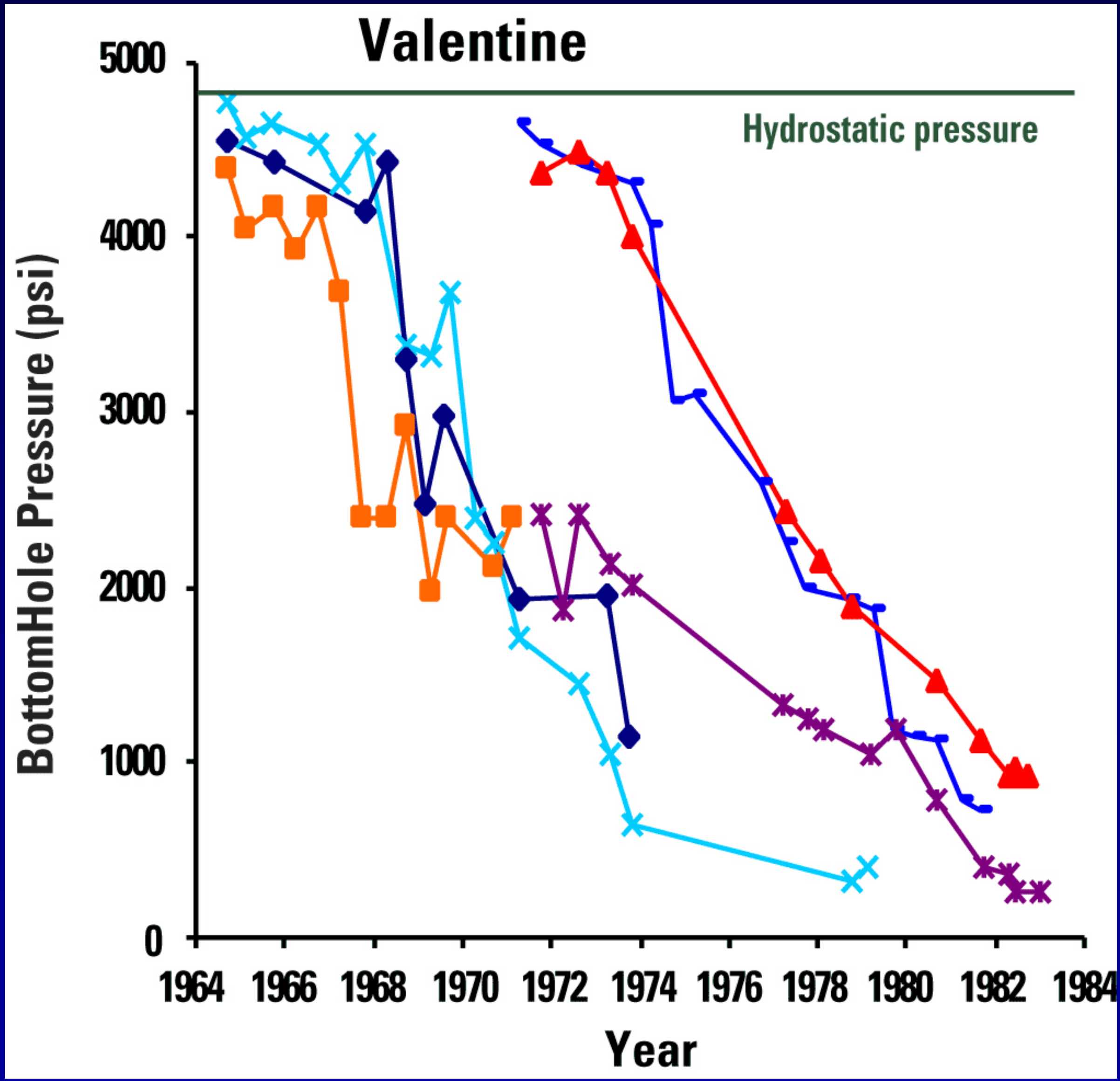
- **M = Thousand; MM = Million**
- Expect an increase in pipeline maintenance/repair as coastal erosion effects increase.
- Future spending estimates are budgeted at $ 5 MM a year for various line reburial, line replacements, bulkhead replacement/ repairs, line marking, line surveying, and crossing repairs.

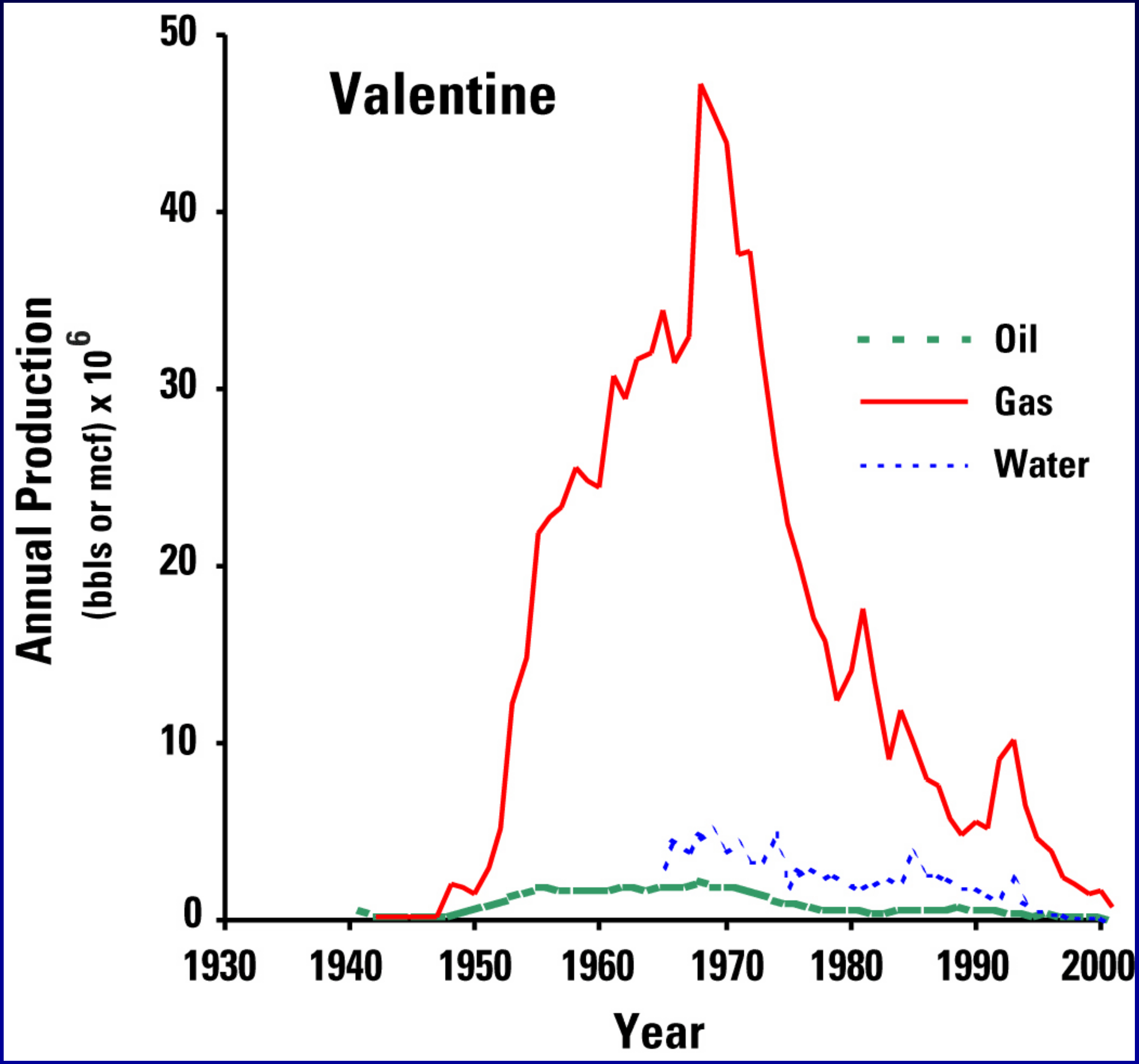
Representative Release Repair Cost Analysis from Coastal Erosion

September 3, 2001 - Labor Day- Golden Meadow 12" pipeline, Catfish Lake Release description and cost of incident.

- **Amount released -** approximately 70 bbls. Crude oil
- **Cause -** Eroded section marsh promoted a NEW path for boat travel. When the marsh eroded along with the water bottom the pipeline became exposed in that area. A - 2-inch gouge was found on the top of the pipeline. The damage, external in nature due to a "third party" source, damaged appeared to be caused by boat/ boat propeller. This line, when originally installed was buried over its 3 ft. minimum required depth.
- **Repair - *Estimated at $750,000*** – this does not include revenue lost from down time (approx. 3days) & the production downtime
- **Clean up – *Estimated at $10,714 per bbl.***
- **Production Loss** – ***Estimated at $573,700*** based on 24,900 bbls. (8300 bbls/day x 3 days) at $23/bbl – lost in 2001.

Field	Discovery	Cumulative Gas	Cumulative Oil	Cumulative Water
Valentine	1936	920 Bcf	55 MMbbl	87 MMbbl
Houma	1945	851 Bcf	7 MMbbl	21 MMbbl
Lirette	1937	1.3 Tcf	18 MMbbl	59 MMbbl
Lapeyrouse	1941	624 Bcf	18 MMbbl	39 MMbbl


Valentine
Hydrostatic pressure
BottomHole Pressure (psi)
5000
4000
3000
2000
1000
0
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
Year



Valentine
Annual Production
(bbls or mcf) x 10^6
50
40
30
20
10
0
1930
1940
1950
1960
1970
1980
1990
2000
Year
Oil
Gas
Water