Concepts for Re-Plumbing the Mississippi River to Curtail Coastal Land Loss in Louisiana

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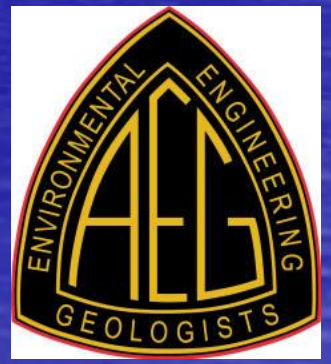

PROCESS CLASSIFICATION OF COASTAL LAND LOSS BETWEEN 1932 AND 1990 IN THE MISSISSIPPI RIVER DELTA PLAIN, SOUTHEASTERN LOUISIANA

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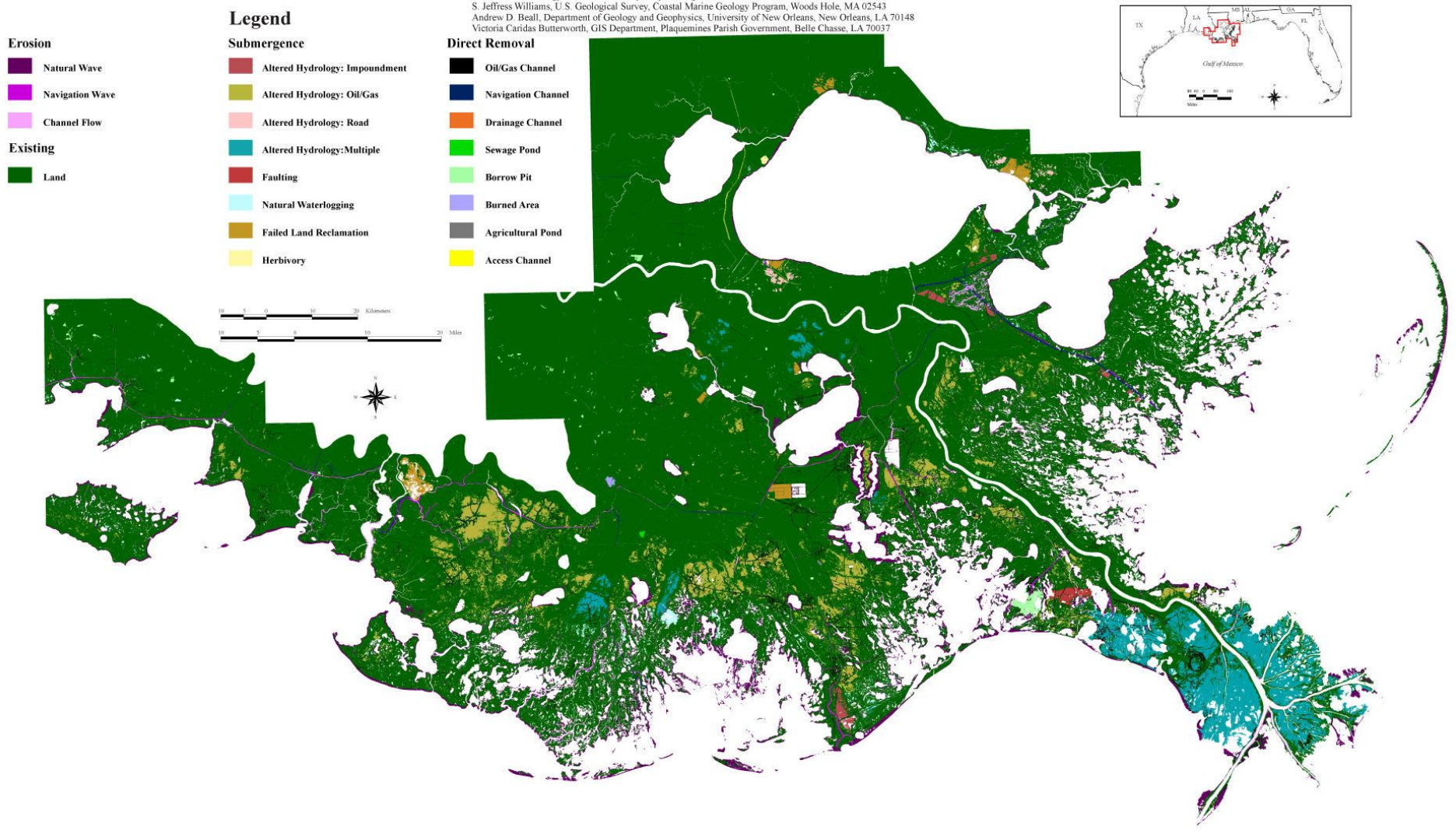
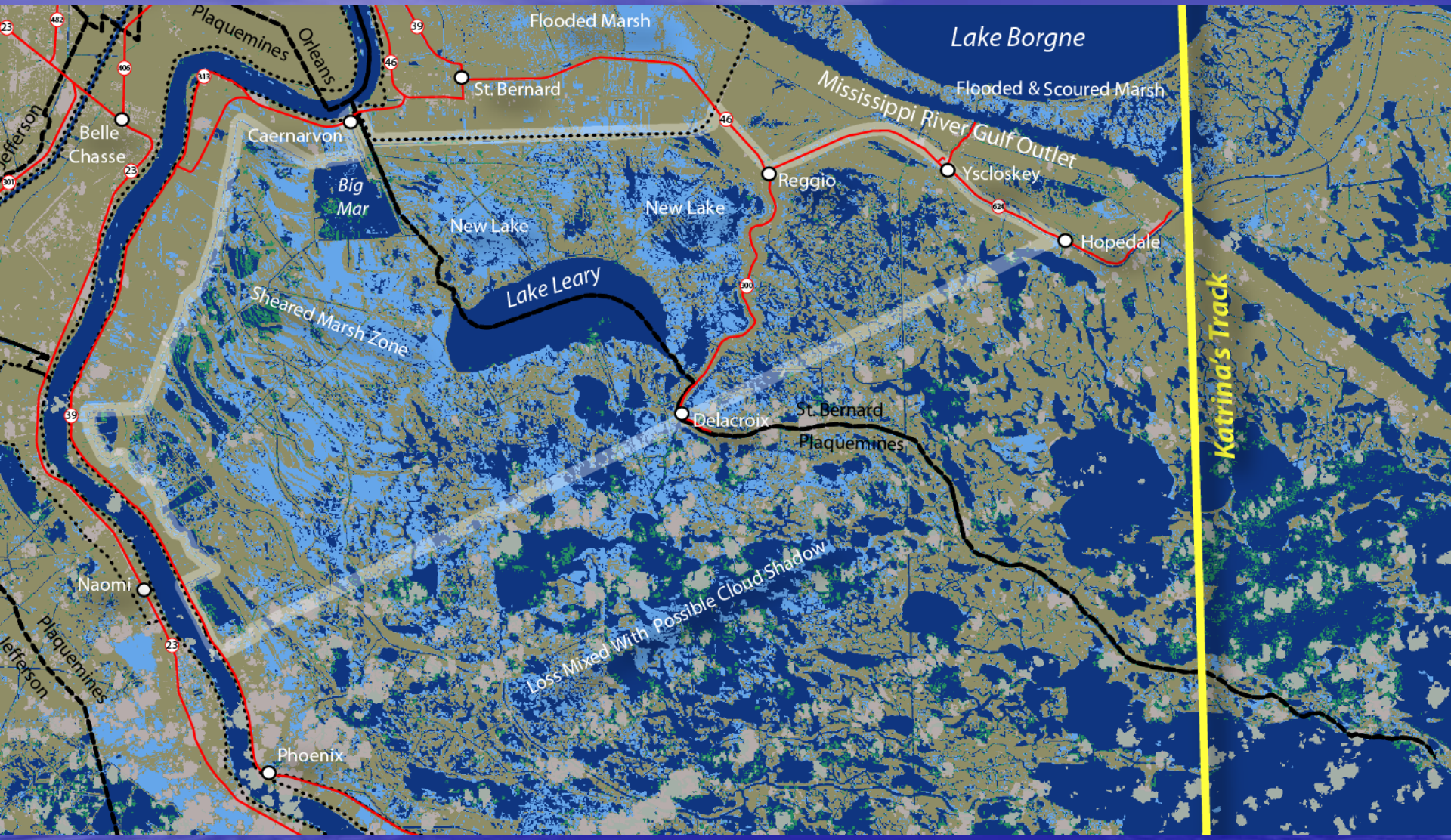
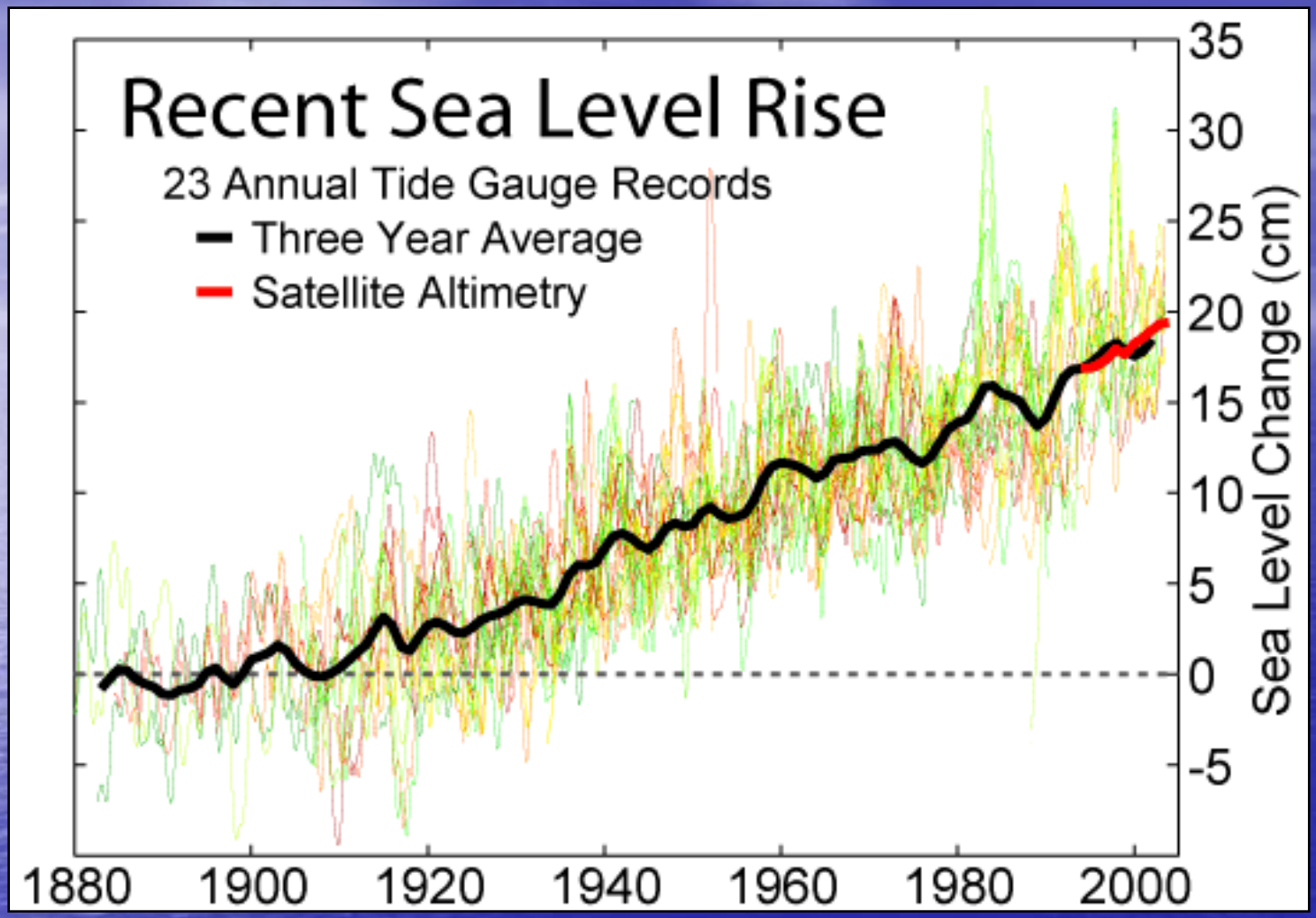


- **Between 1932-1990 an average of 35 square miles of land was being lost to the sea each year in the Mississippi Delta; and an average loss of 44 square miles/year of wetlands.**

- **Acute wind shear from Hurricane Katrina stripped off large tracts of floating marsh across the Mississippi Delta. *Can we construct sustainable levees on these kinds of materials?***



- **During Hurricane Katrina, 115 square miles of land area was lost. This shows "land loss" in Breton Sound (in light blue) after the 2005 hurricane season.**



Coastal land loss in Louisiana is also exacerbated by sea level rise, which averaged about 1 foot during the last 100 years. This value could accelerate during the 21st Century, to as much as 3 feet.

What awaits coastal Louisiana if we do nothing…

The National Debate that has erupted since Katrina….

- Can we build levees that won't fail?
- Should we, as a society, allow or encourage urban development of lands that are either: 1) below sea level; or, 2) barely above sea level?
- People who choose to live in high risk areas should pay greater insurance premiums for the privilege of living in those areas
- Should we bother trying to save the Mississippi Delta? Why? *New Orleans ships the greatest volume of exported goods from the USA, mostly wheat, corn, and soy.*

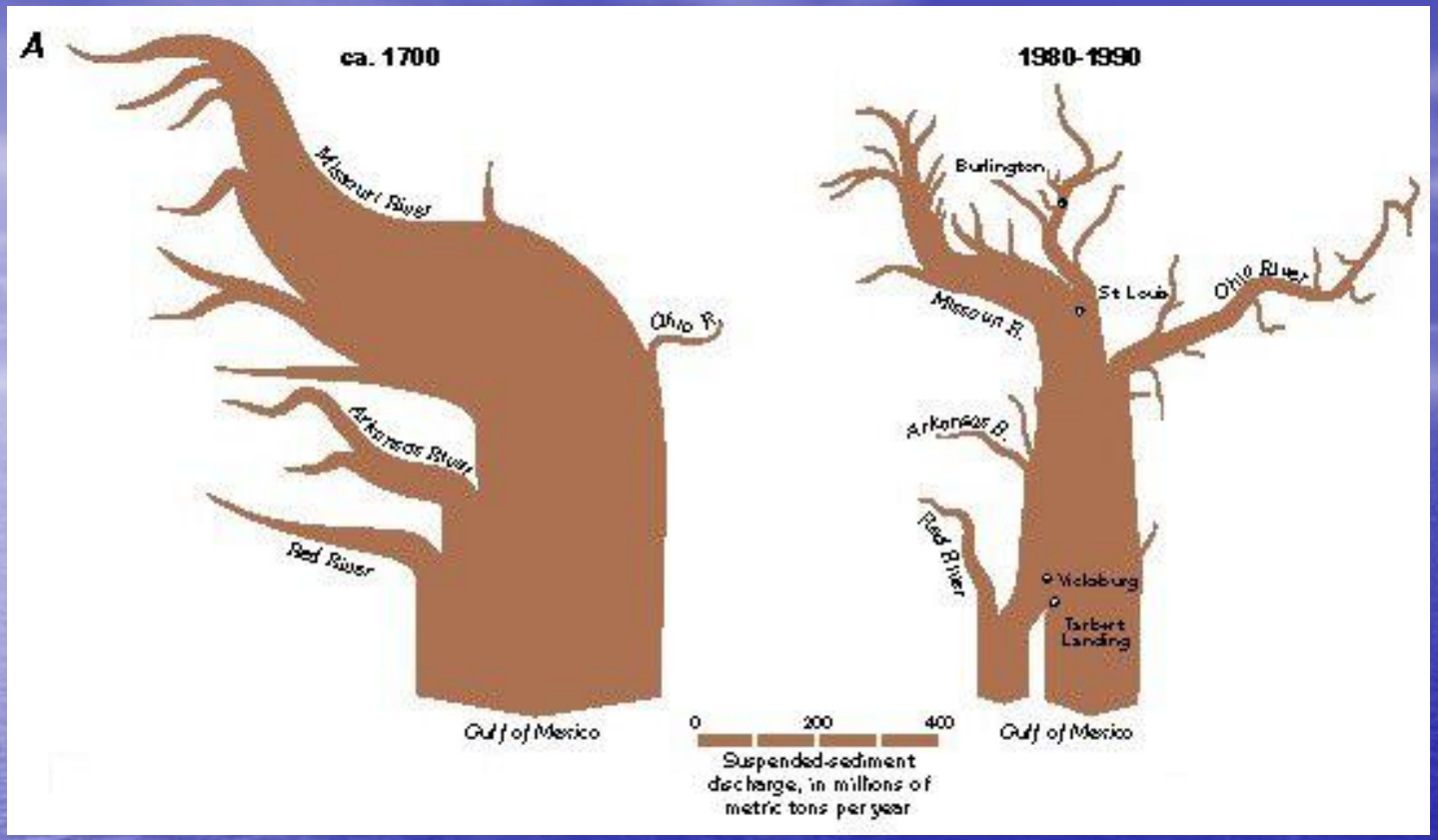
Is it within the grasp of our society to save the Mississippi Delta?

- One modern analog – The Netherlands, following the 1953 floods; but this also involved a substantial investment, almost 30% of their GNP for 20 years.
- Can we apply 21st Century technology to help solve these immense challenges?
- Diverting sediments onto the land will require a much greater investment in operations and maintenance, several orders of magnitude more than we've spent heretofore.

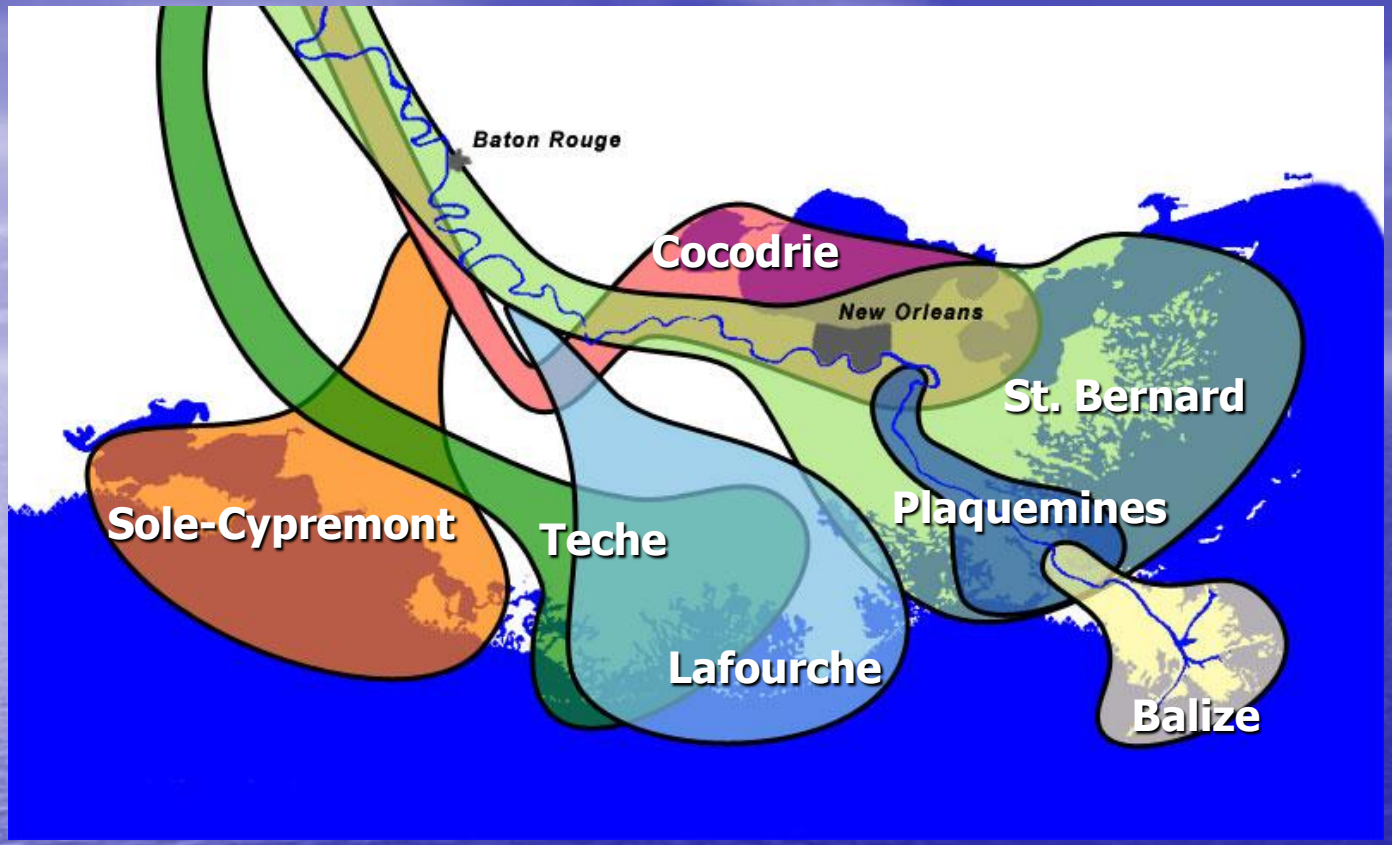
Can we do a better job of retarding land loss in the Mississippi Delta?

We need to think outside the box…

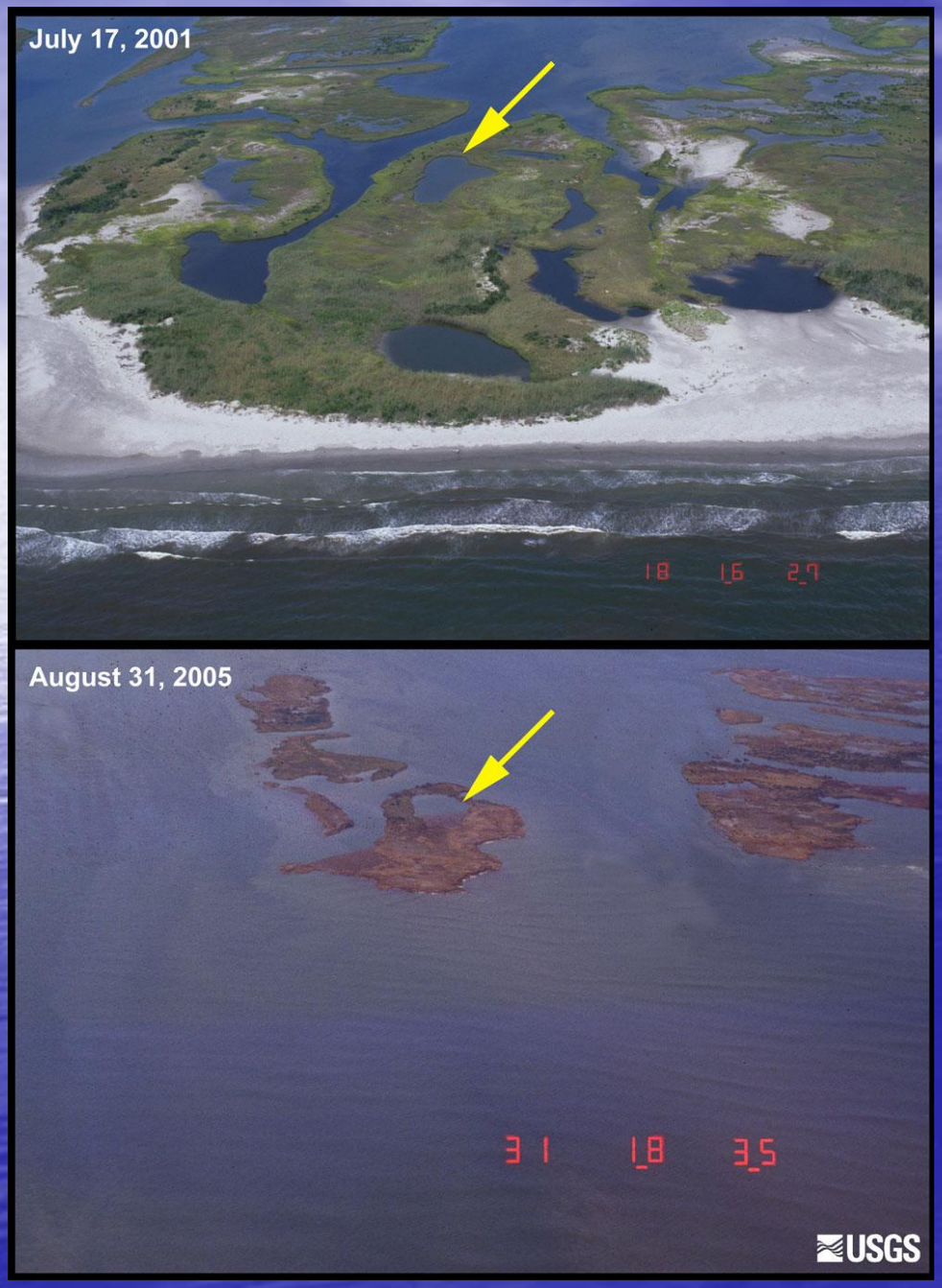
- **The Mississippi River drains approximately 41% of the continental United States, discharging about 580 km^3 of water each year (420 billion gpd).**
- **Almost 50% of the water comes from the Ohio River, which has 1/6th of the watershed.**
- **The Missouri River encompasses 43% of total watershed area, but only contributes 12% of the discharge.**



- Prior to 1700, the average sediment discharge was about 440 million tons/year, mostly from the Missouri River watershed.
- This figure has decreased about 50% since 1950, because of dams constructed on Missouri and Arkansas Rivers.
- This loss somewhat compensated by 5 to 10 fold increase in sediment load carried down the Ohio River, because of row farming and deforestation.

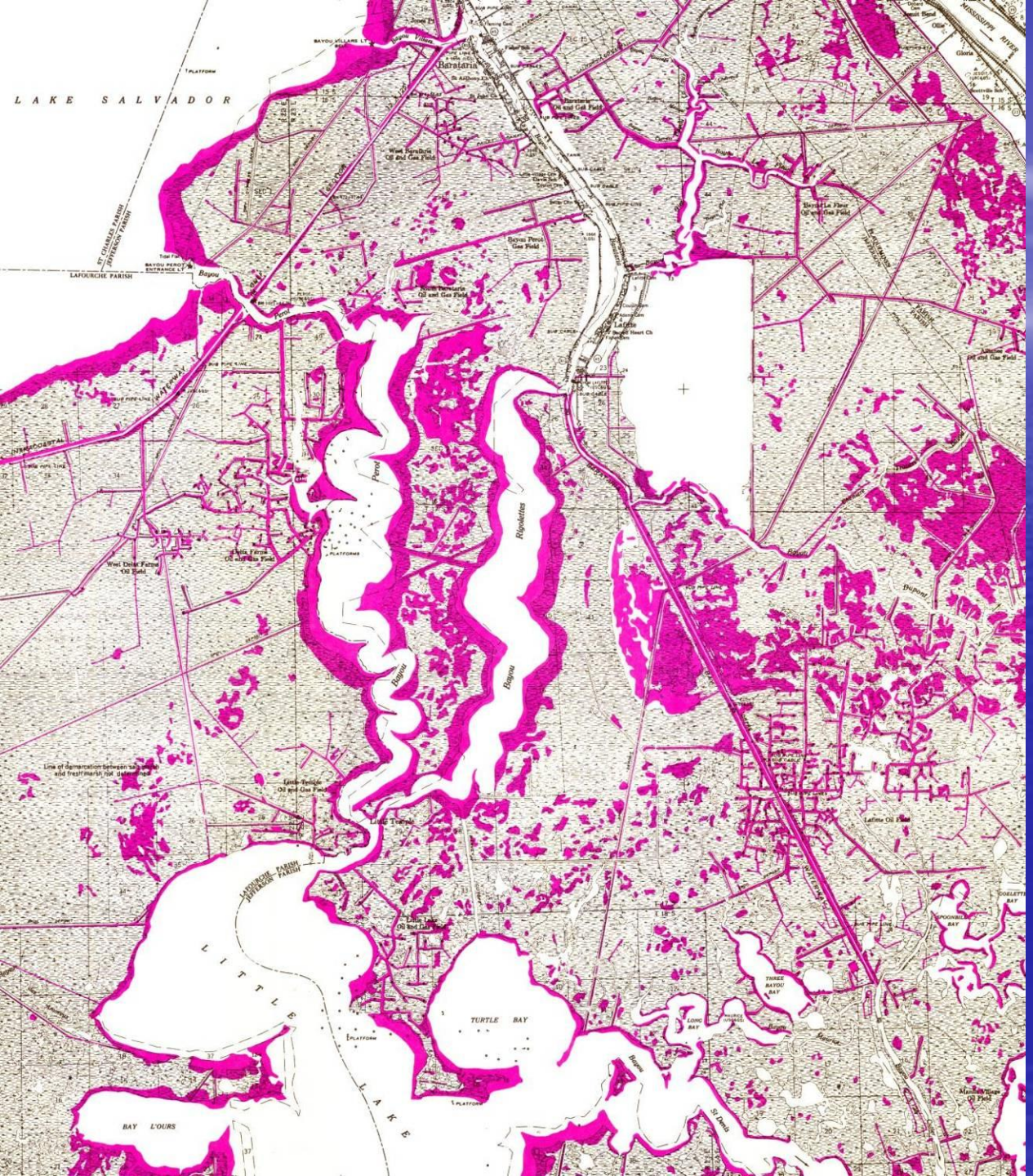


- The river has deposited enormous deltaic lobes during the late Holocene: Balize (550 yrs); Plaquemines (750-500); Lafourche (1000-3000); St. Bernard (2500-1000); Teche (3500-2800); Cocodrie (4600-3500); and Sole-Cypremont (>4600).



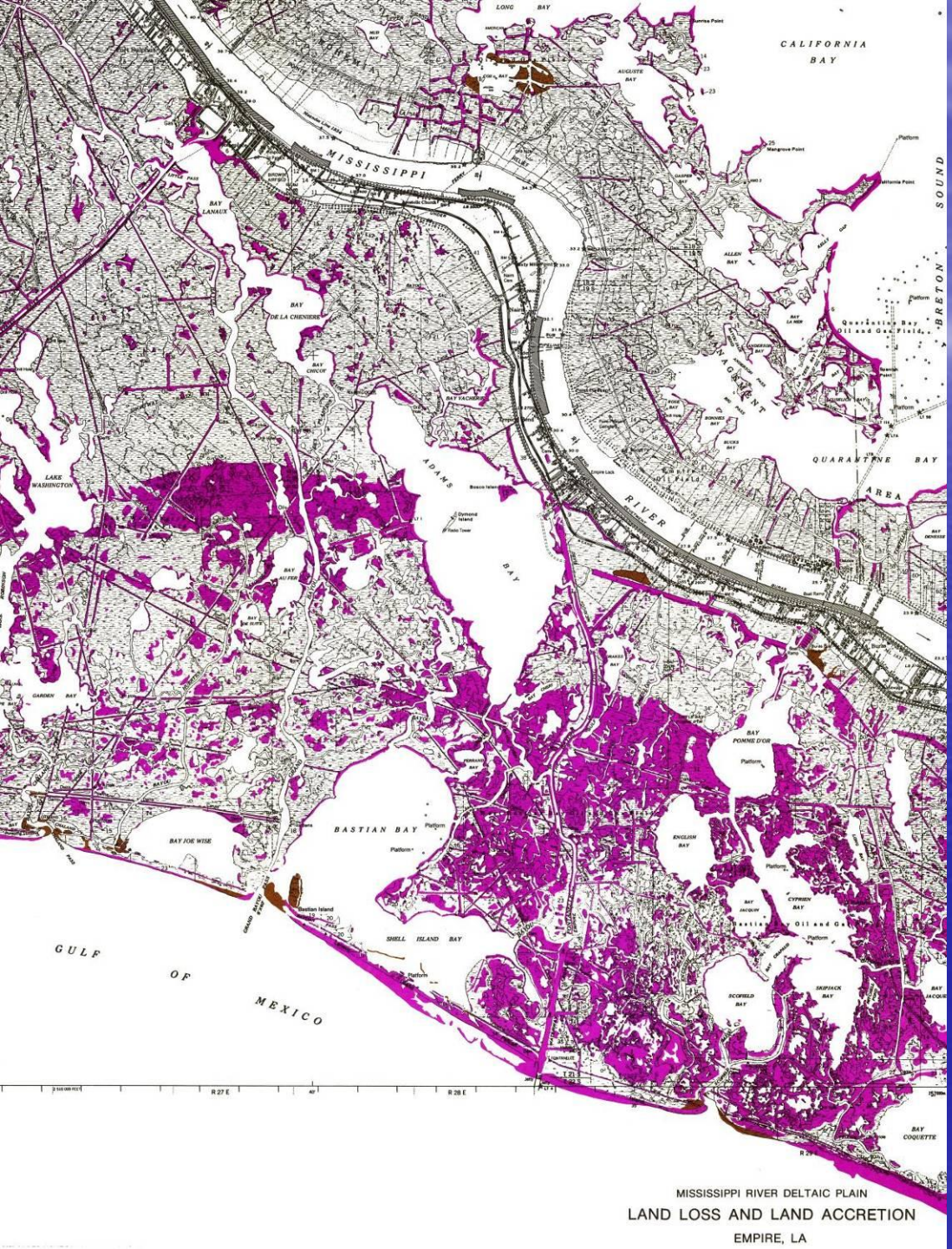
Dynamic Environment: Chandelier Islands; before and after Katrina

- Wave erosion stripped off sandy cohensionless deposits during Hurricane Katrina
- 4000 people were killed in this area in the 1915 hurricane



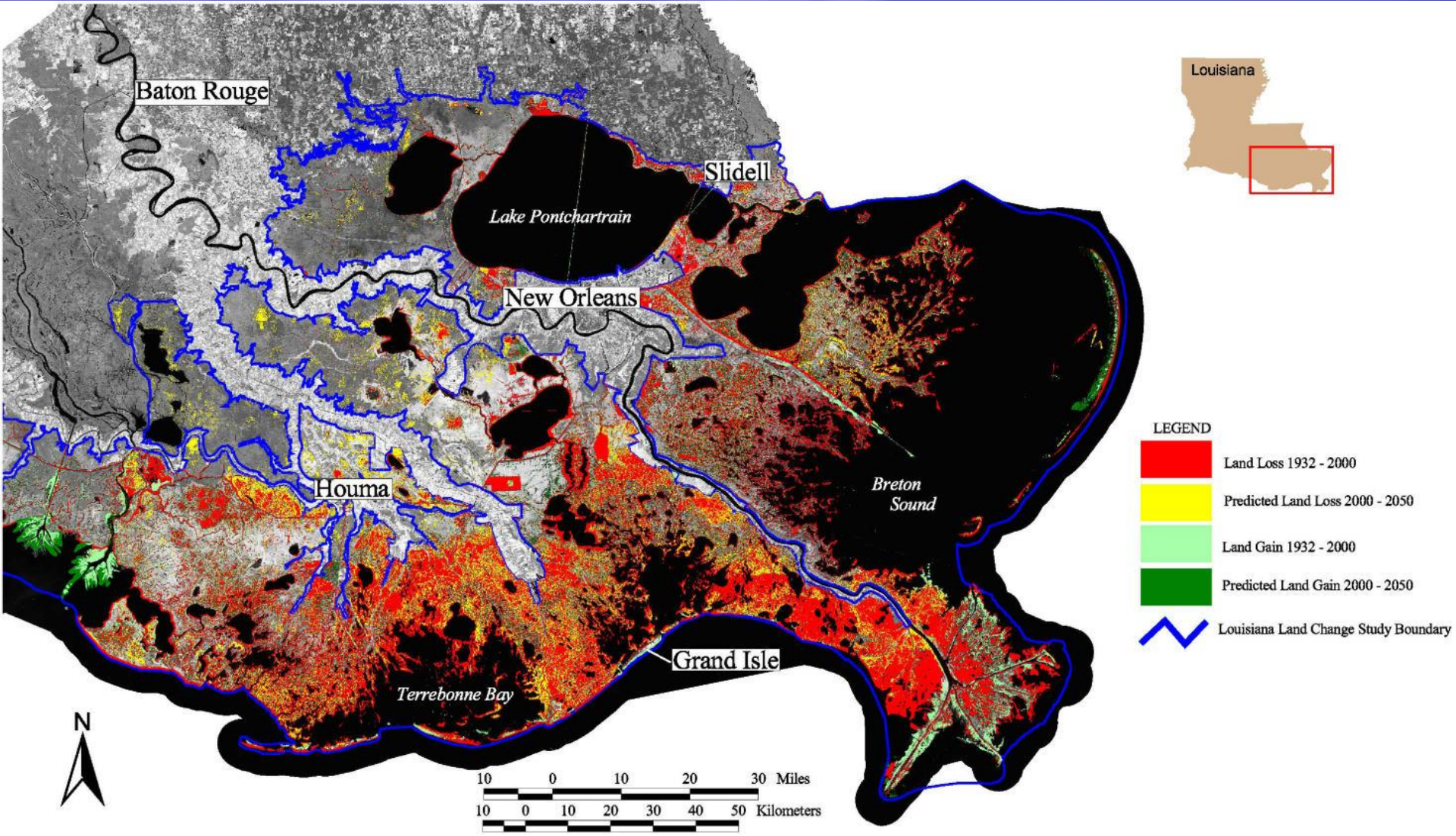
Land Loss Barataria Quadrangle

- Coastal land loss has been accelerating since 1950
- Annual sediment volume averaged ~440 million tons/yr prior to 1950



Coastal land Loss – Empire quadrangle

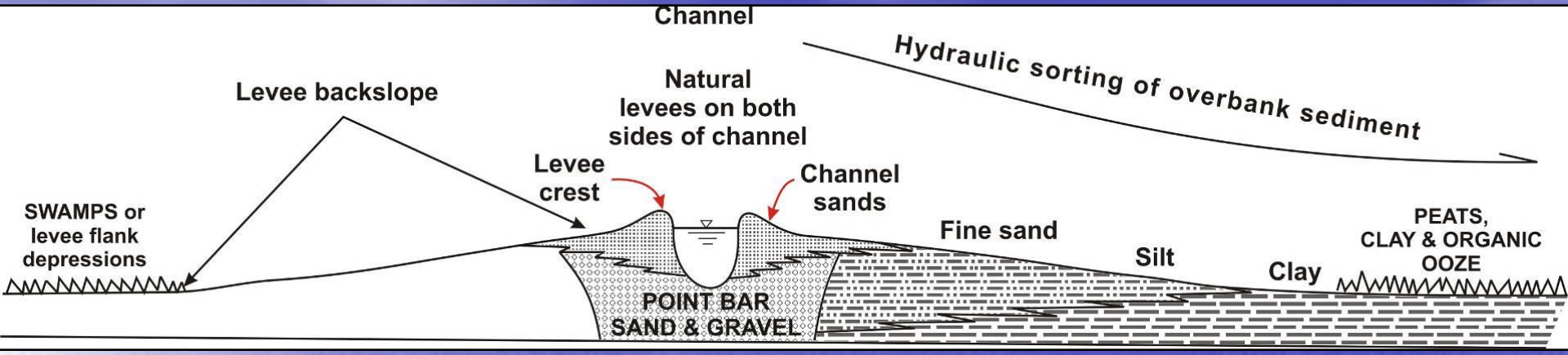
- Since 1950, the average sediment load of the Mississippi River has been reduced to about ~215 million tons per year.
- But, most of this is lost out the jetties



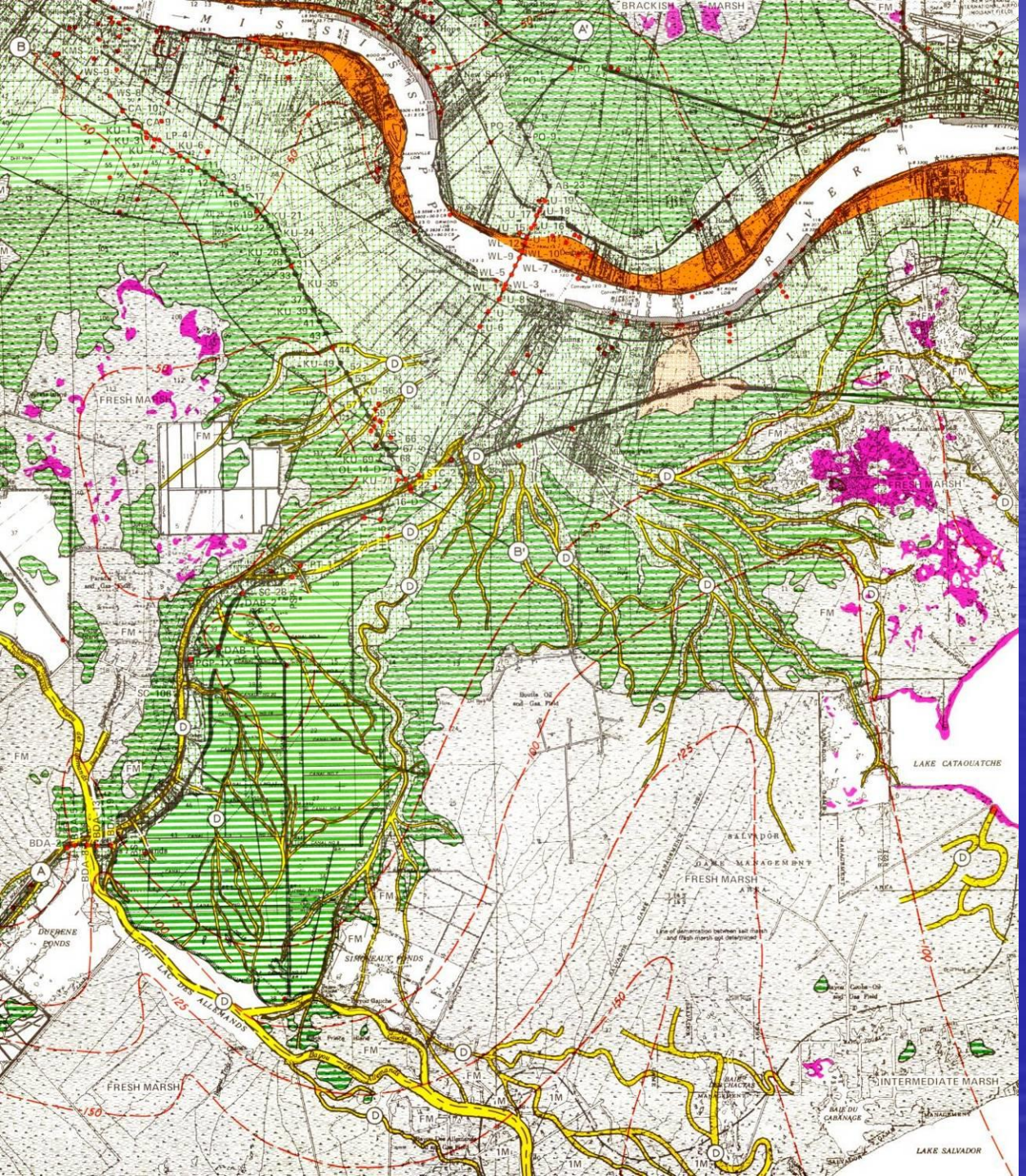
- **Coastal Land Loss since 1932 (red) and land gain (green). We are losing about 50X more land mass than we are saving at present, even with the 2050 plan. (data from Ray Dokka at LSU).**

The physical situation: ***the river runs down in a deep hole…***

The design problem: ***how can we lift sediment from a below sea level channel onto the subsiding land surface?***



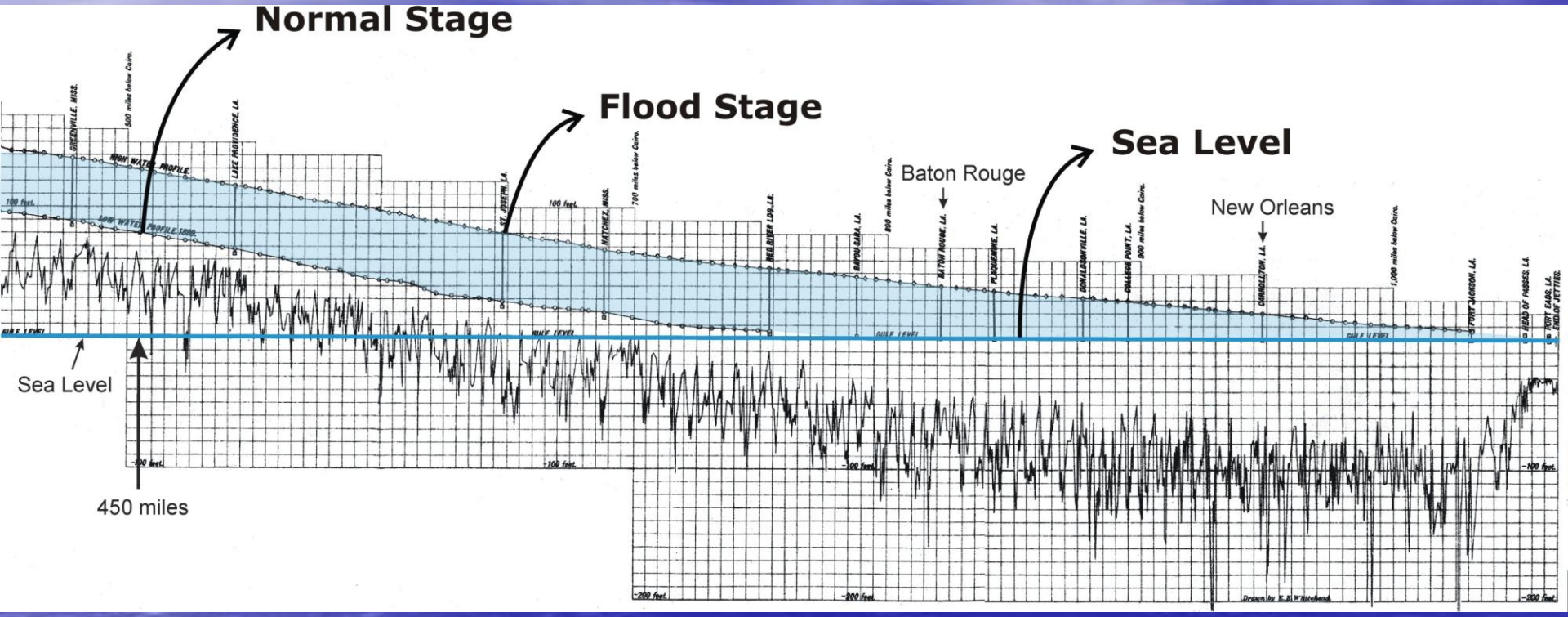
- There is significant *hydraulic sorting* of materials deposited on either side of the river.
- Most of the sediment is deposited during brief periods of flood flow; with great percentage occurring only 5 to 10 times per century
- We will have to become much *more opportunistic* about how we manage the river



Hahnville is just upstream of New Orleans

- Note classic birdfoot pattern of sand-filled distributary channels, shown in yellow
- Note development

Profile of the Lower Mississippi

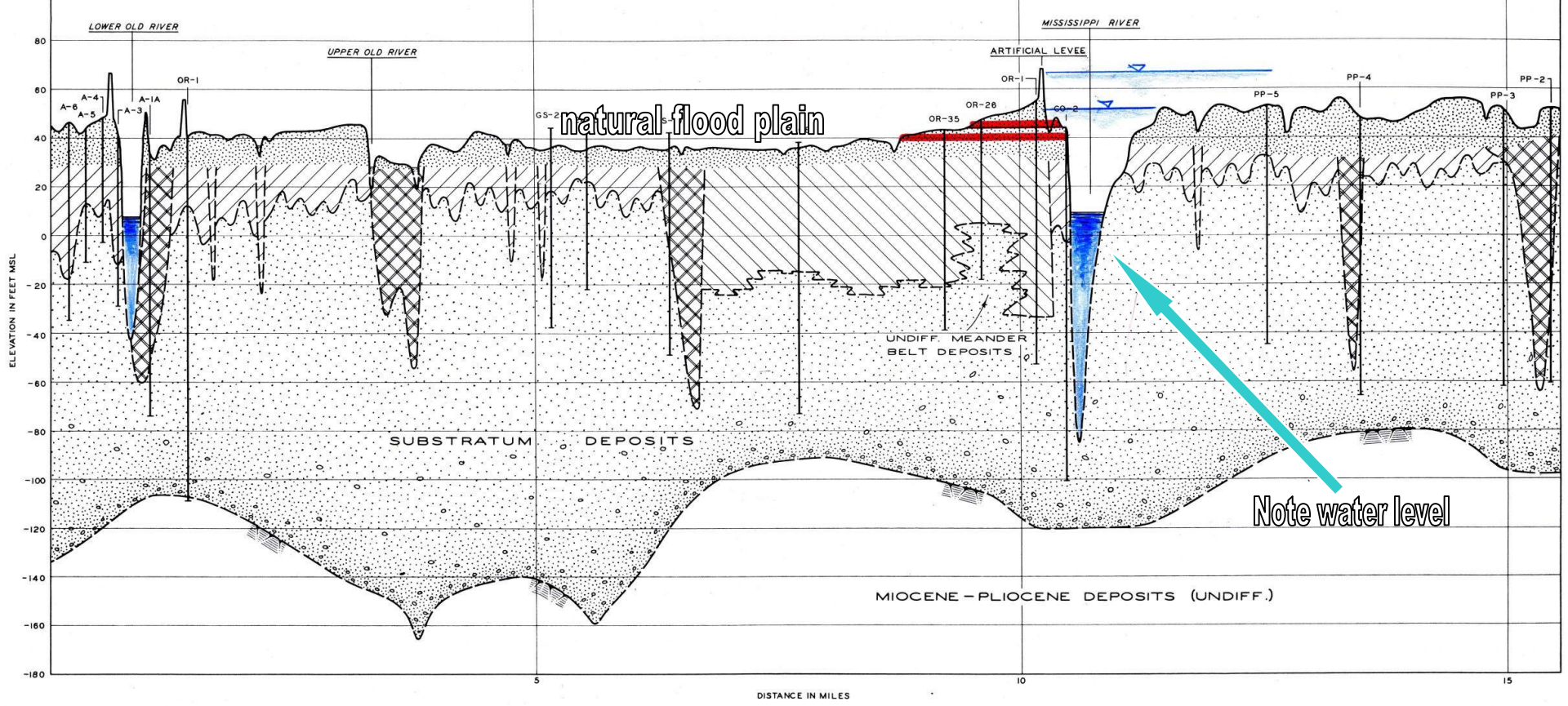


The bed of the Mississippi River is *below sea level* during the last 450 miles of its course, up to Greenville, Mississippi. We can only extract meaningful amounts of sediment during short-lived periods of high flow.

Can we come up with a viable scheme for diverting *silt-laden waters* during brief periods of high flow?

One idea is to divert the flow of the river during high flows This map shows Artonish, Louisiana

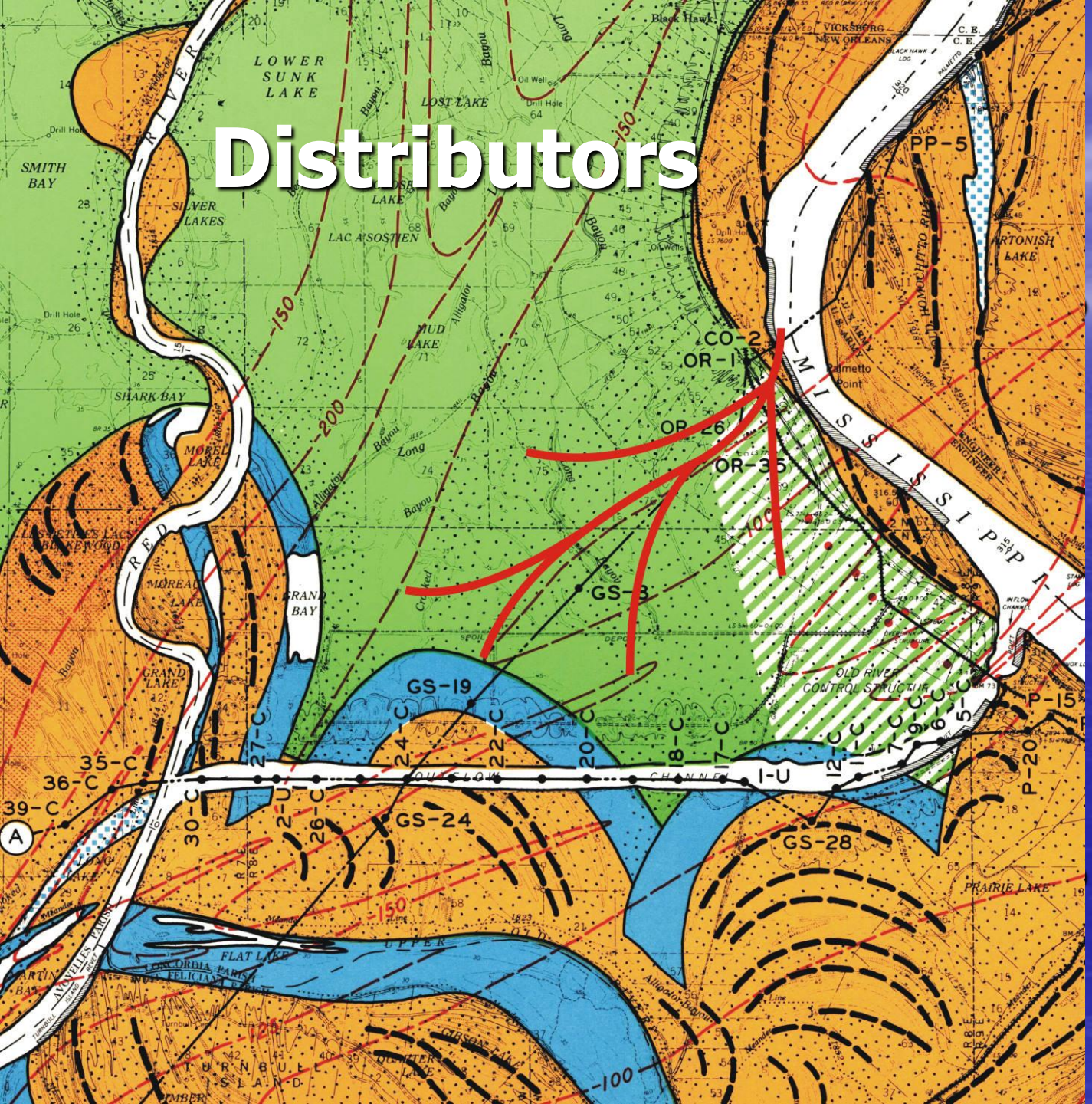
- Artonish is typical of the Mississippi River's flood plain *upstream of Baton Rouge*
- Note multiple meander belts



- This section shows a pair of proposed "tunnel taps" 1 and 1.8 miles long,
- Precast concrete liners could be jacked through the overbank sediments, beneath the river's levees, similar to the Boston Big Dig.

Jacking of precast concrete tunnel boxes

- During the Boston Big Dig, the world's largest precast concrete box tunnel section, for Interstate 90, was hydraulically jacked into position, beneath existing rail lines and bridges



Ability to shift lines

Distributor alignments would need to be flexible, to accommodate even distribution of sediment

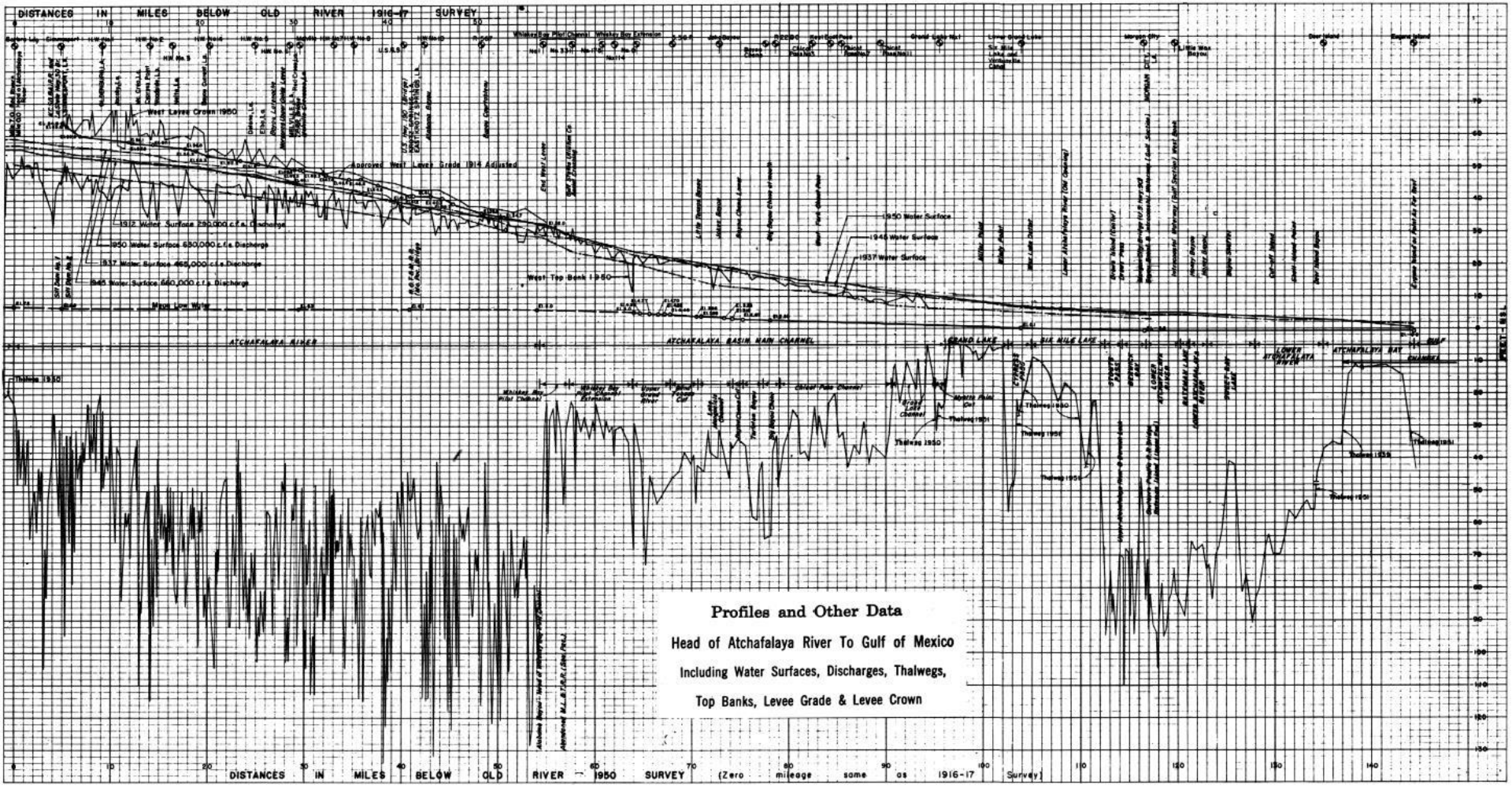
Flexibility will be key aspect

So, what portion of the *lower Mississippi River* could be targeted for massive flow diversions and be a receptacle for new sediment ?

Atchafalaya River

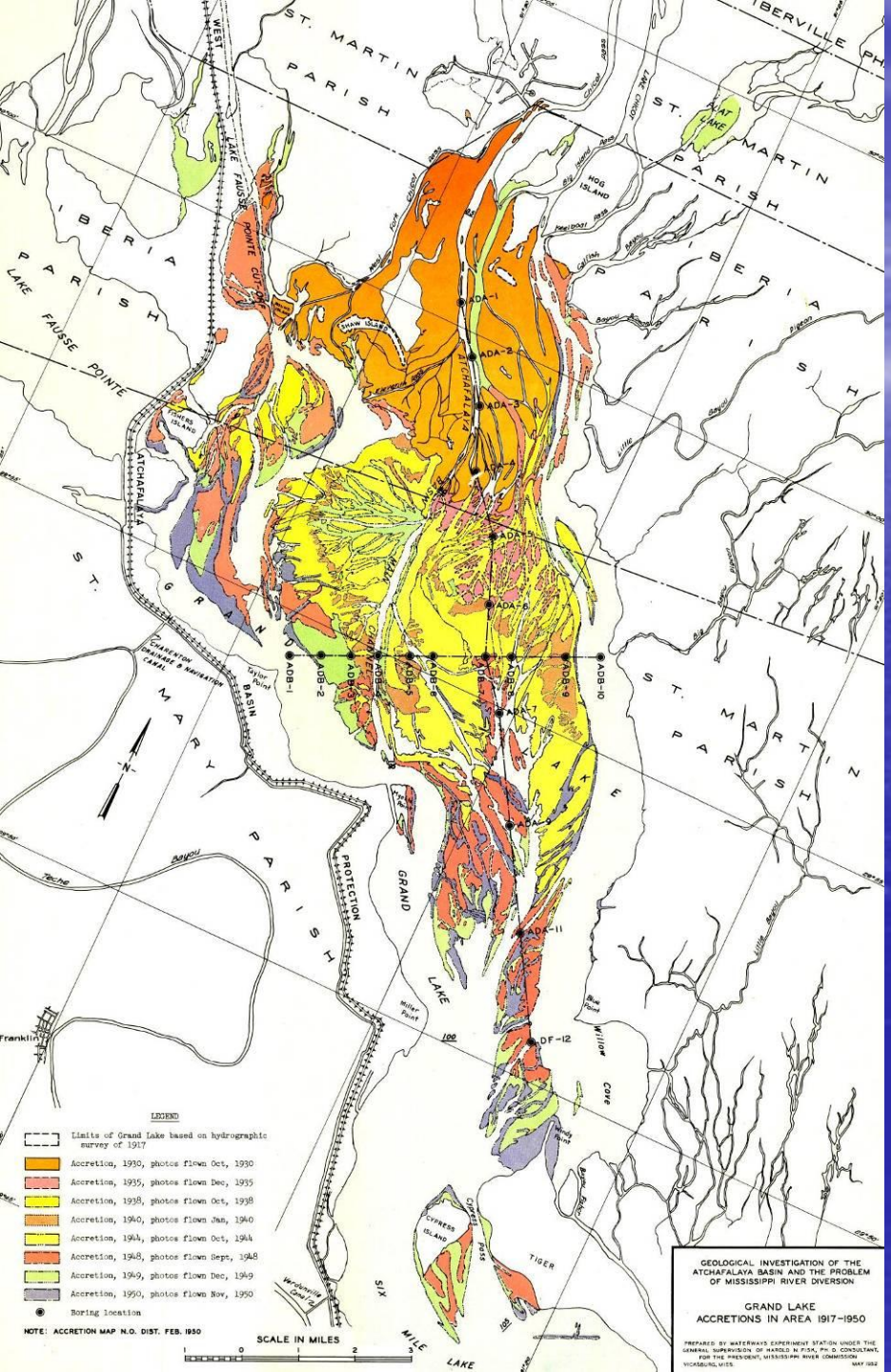
The Atchafalaya River is both steeper than the Mississippi (3:1 ratio in bed slope) and shorter (225 kilometers to the Gulf of Mexico from the Red River entrance versus 480 kilometers for the Mississippi).

- Under natural conditions, the Mississippi River would probably have switched its course to the Gulf of Mexico via the Atchafalaya distributary between 1965 and 1975, if not for the levees.
- The Atchafalaya now drains about 30% of the combined flows of the Mississippi and Red rivers to the Gulf of Mexico.



- **Profiles of the Atchafalaya River. Its steeper gradient would be much *more efficient* for sediment diversion, transport, and distribution than the lower Mississippi River.**

Sediment Accretion at Grand Lake 1917-1950



- The Atchafalaya Basin is our best analog model for sediment accretion in the delta
- Historic data on sediment accretion here needs to be analyzed and thoroughly understood
- Have to monitor subaqueous deposition

The Likely Target

- Every physical factor save one, would seem to favor the Atchafalaya River for a prototype sediment deposition scheme involving the lower Mississippi River
- The sediment has be diverted from the Mississippi channel.
- We should probably begin by evaluating enhancements; options that would use existing facilities, like the Old River Diversion Structures

This lecture will be posted at

www.mst.edu/~rogersda/levees

in .pdf format for easy downloading and use by others.

It is also posted on the LSU Levee School website at

http://www.laseagrant.org/leveeschool/pdfs/LeveeSchool_Program.pdf