

Background on the 2005 Hurricane Katrina Induced Flooding of New Orleans

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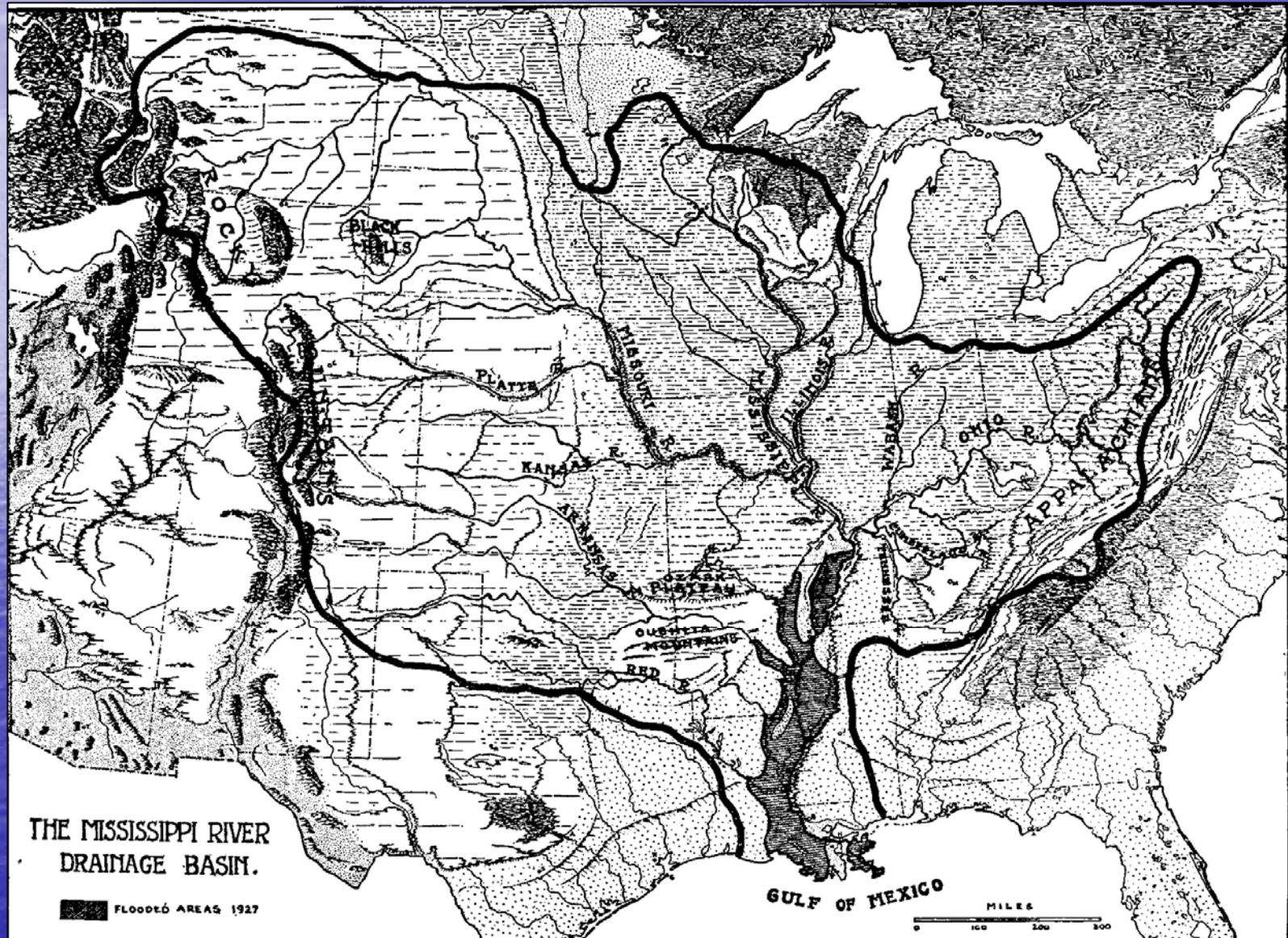
Natural Hazards Mitigation Institute

University of Missouri-Rolla

PART 1

WHY THE MISSISSIPPI RIVER AND ITS LEVEES CONTINUE TO RISE

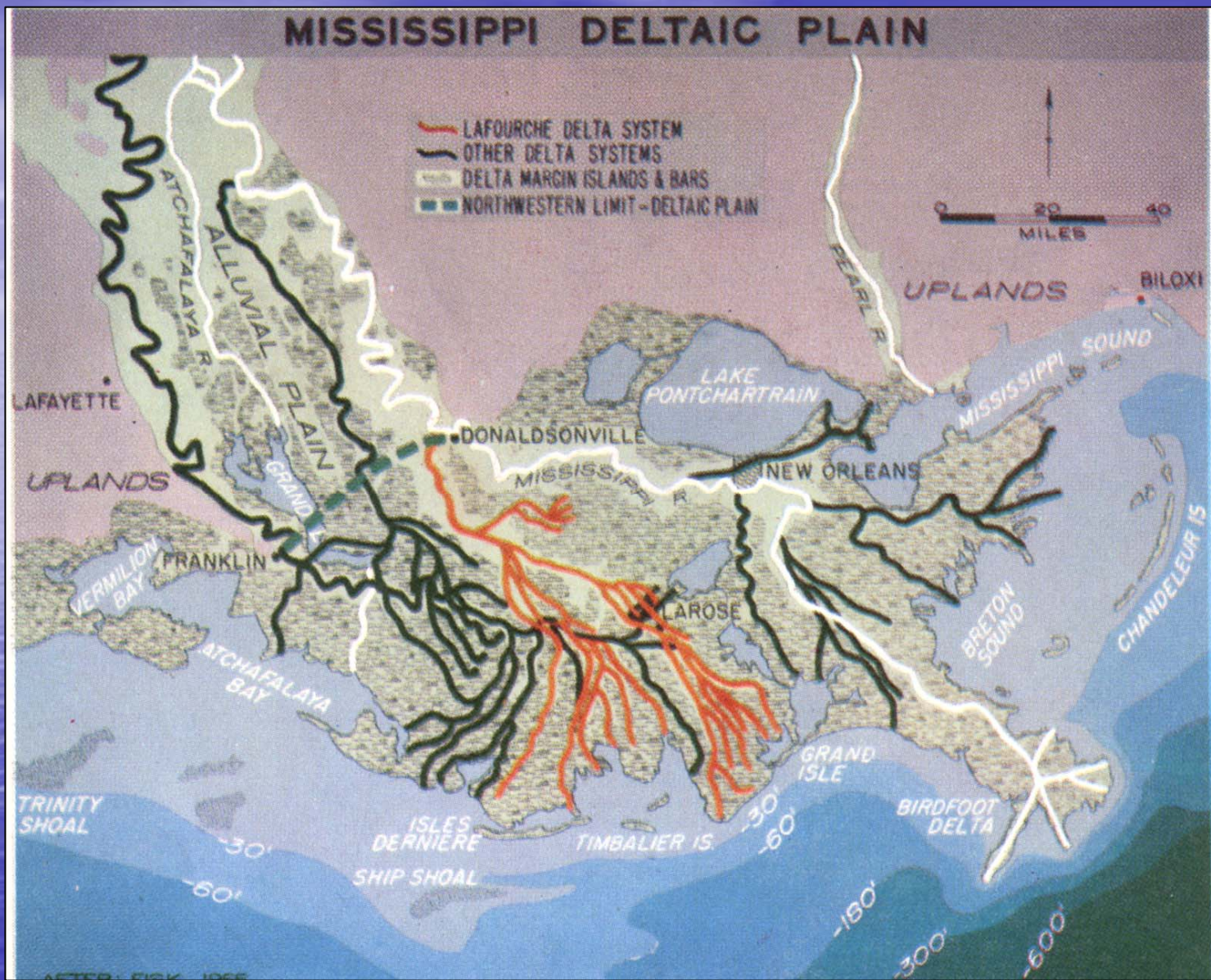
The Mighty Mississippi River drains 41% of the continental United States



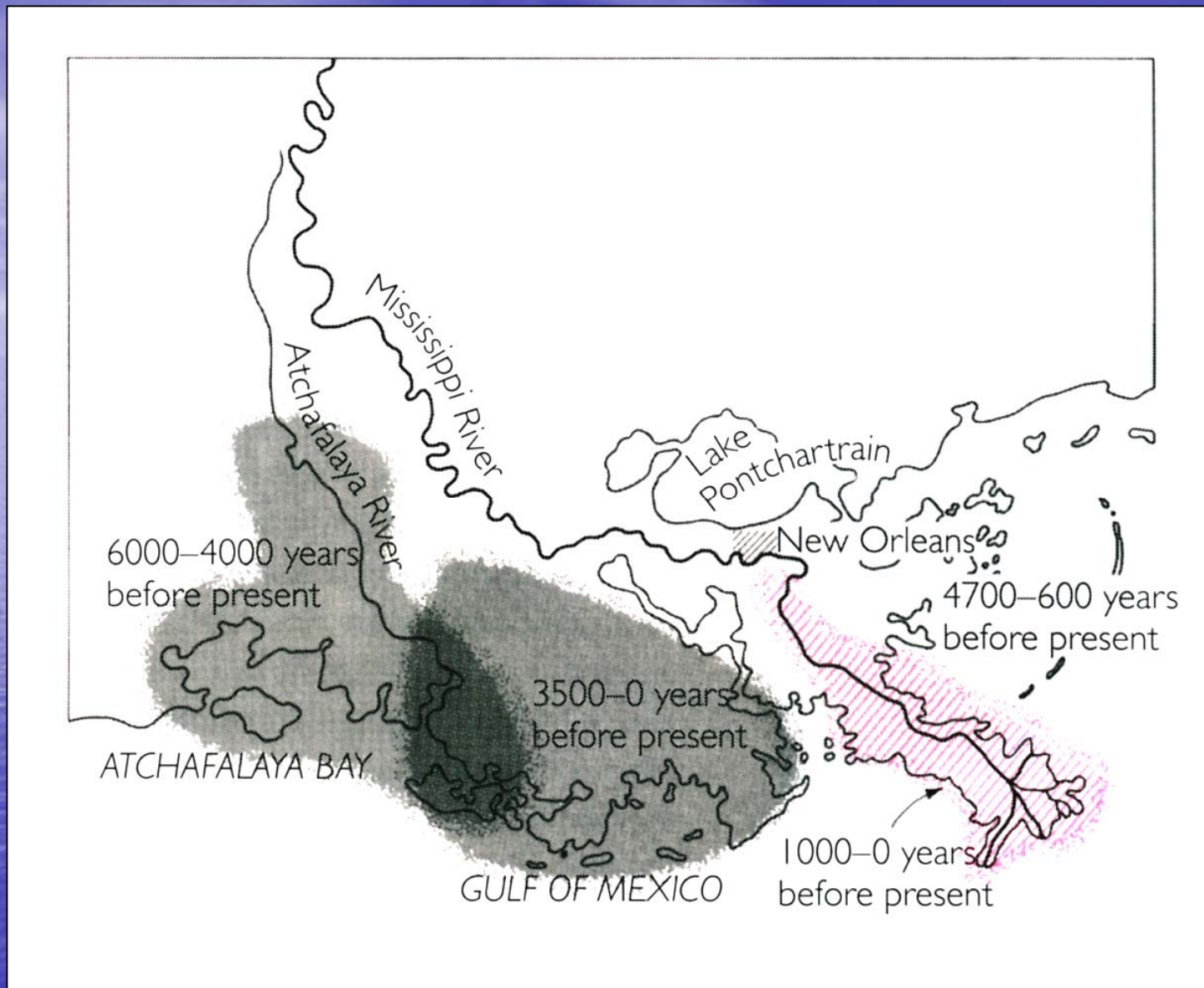
The MISSISSIPPI RIVER



- Longest river in the world; third largest watershed
- 230 million tons of sediment is transported down the river each year
- 6th largest silt load in the world

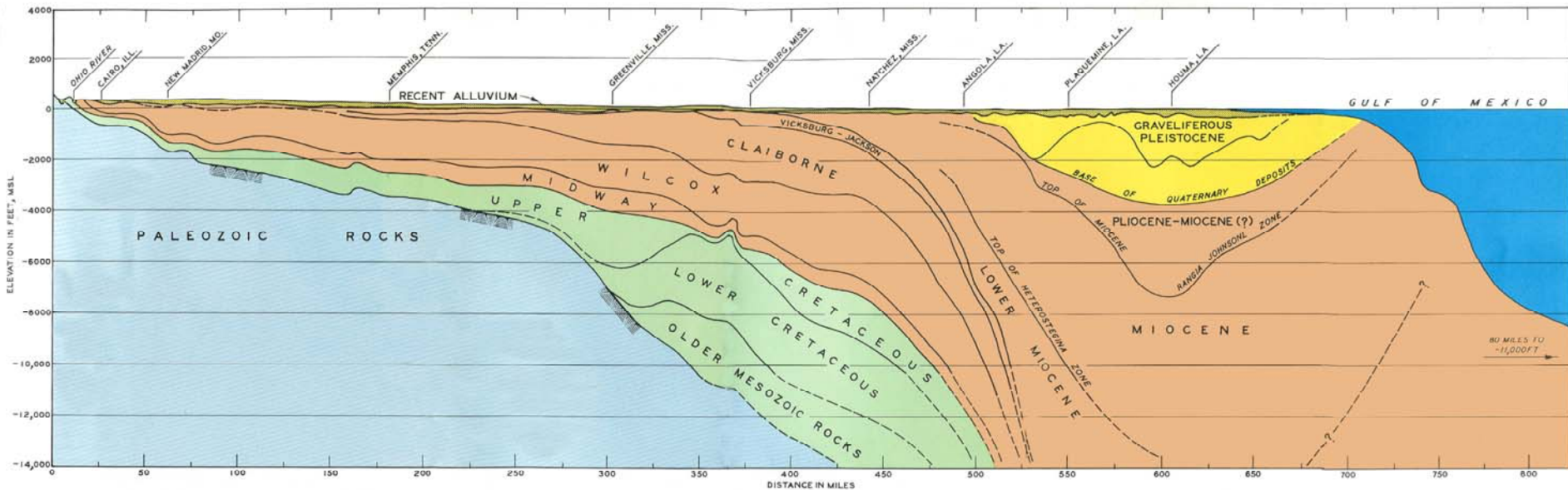


- The Mississippi Delta has been laid down by an intricate system of distributary channels



- **The modern Mississippi Delta has been deposited during the past 6000 years, in four major areas.**

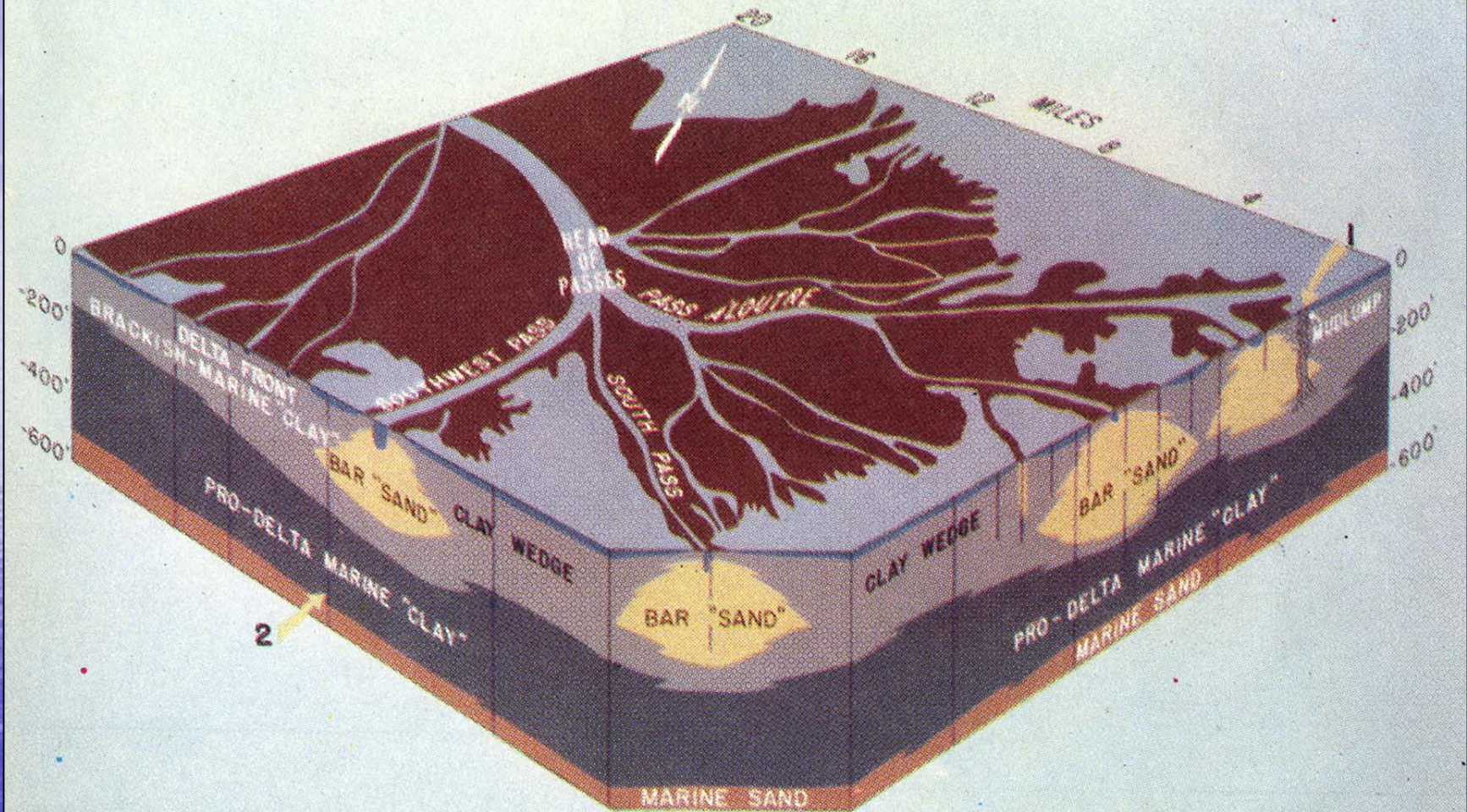
Geologic section through the Mississippi Embayment



- An enormous thickness of sediment has been deposited in the Mississippi Embayment, downstream of Cape Girardeau, Missouri.
- During the Ice Ages sea level was at -350 to -450 feet, and a substantive sequence of gravel was laid down in the delta.

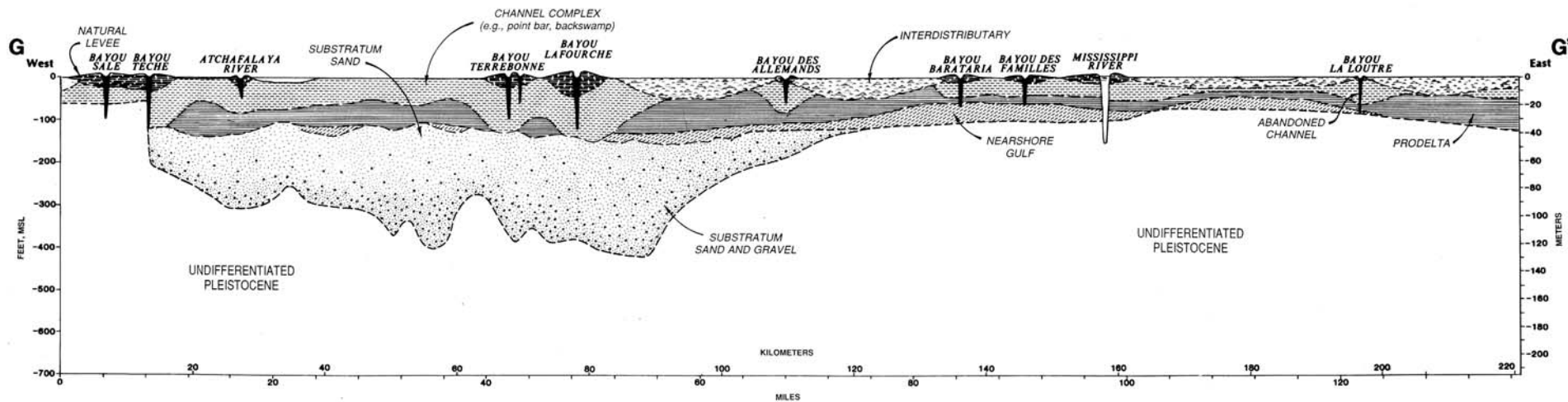
SEDIMENTARY FRAMEWORK- MISSISSIPPI DELTA

AFTER: FISK, McFARLAN, KOLB & WILBERT, 1954

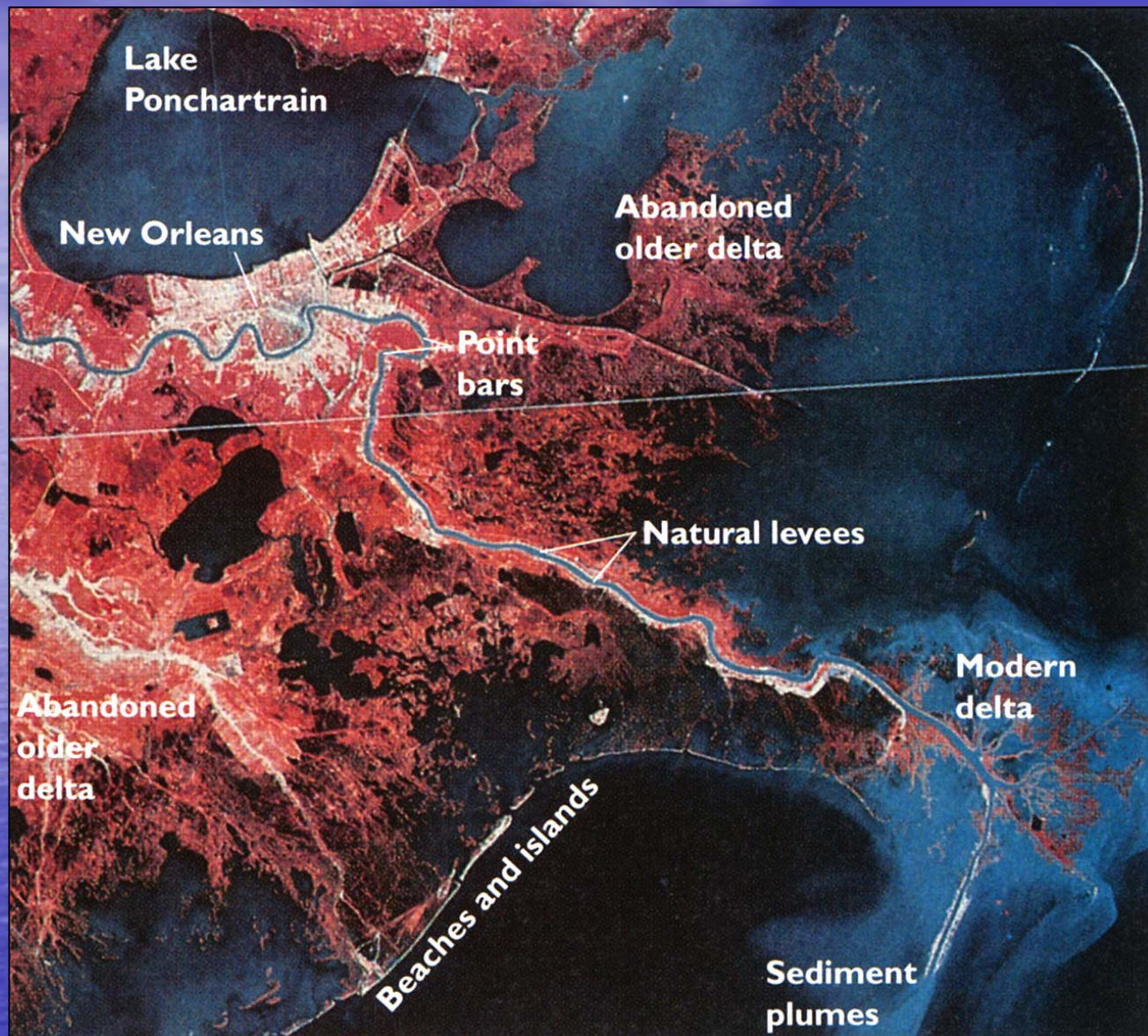


- During the last 11,000 years sea level has risen 350 feet, and the grade of the river has flattened.
- Note how sands are laterally restricted to major distributary channels, or "passes"

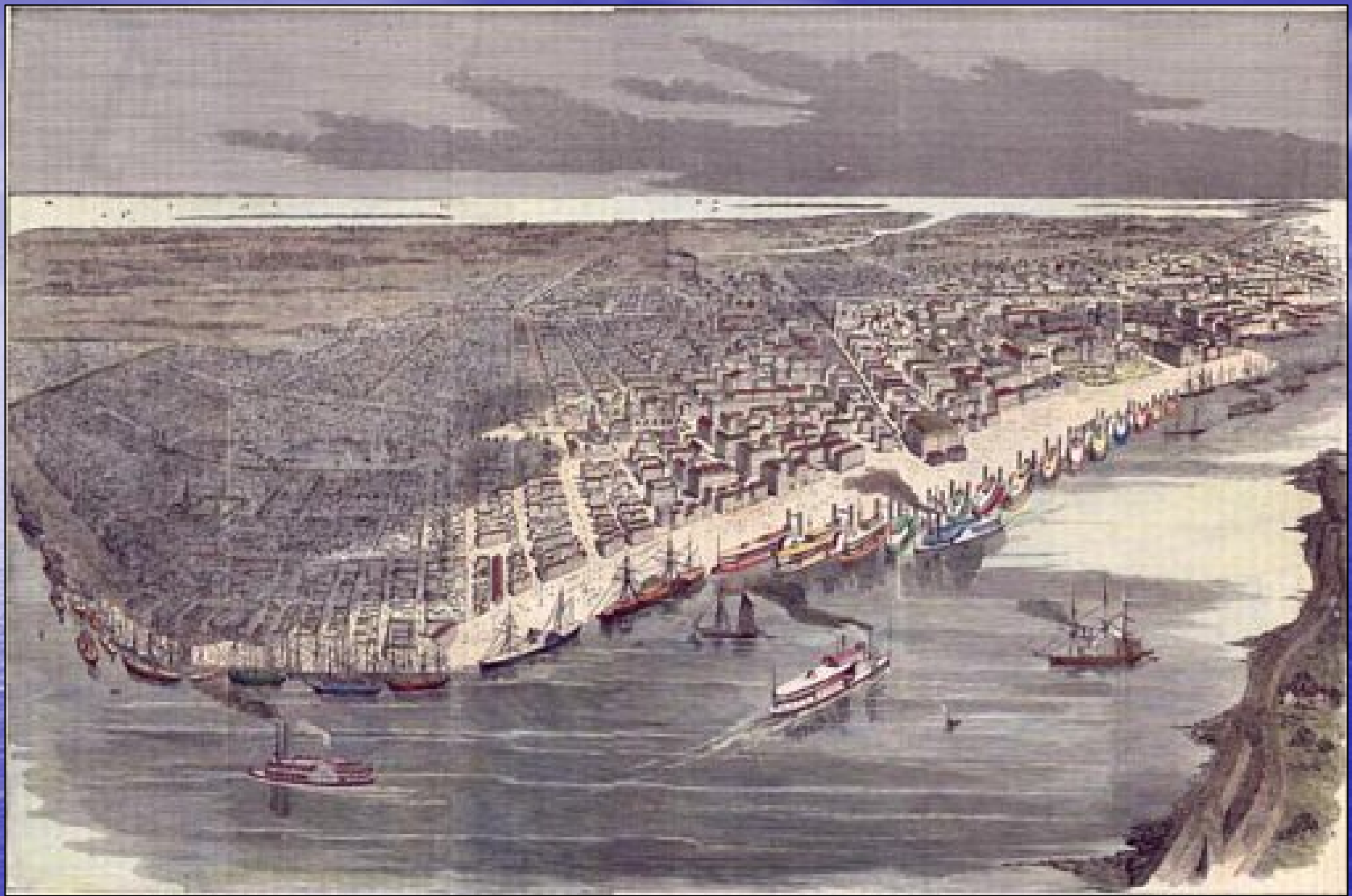
Transverse cross section thru the Mississippi Delta



- Sedimentation of the Mississippi Delta during the past 11 ka has seen a progressive fining of the sediment; dominated by fine-grained overbank silt. Sand is laterally confined along the major distributary channels, shown here in black.

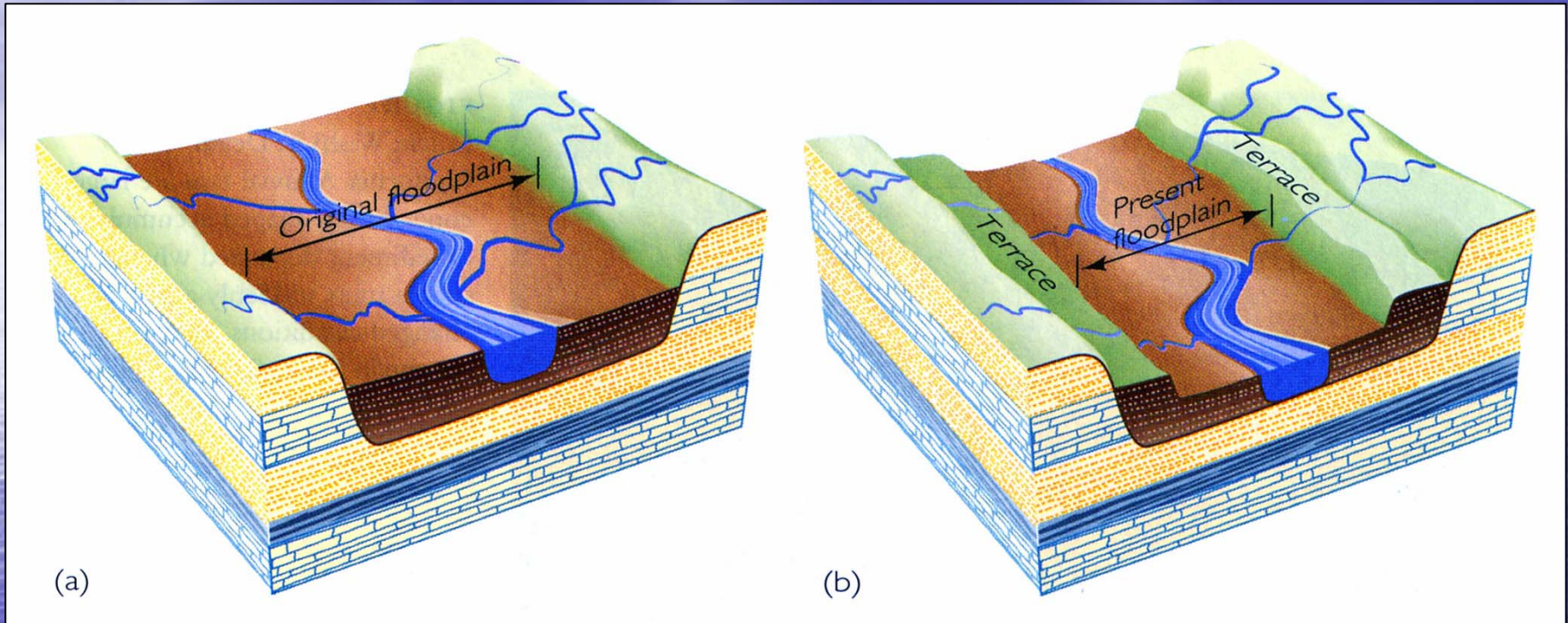


- Since 1973, satellites have allowed monitoring of sediment expulsion from the delta and the nefarious shoreline, which is continuously sinking.

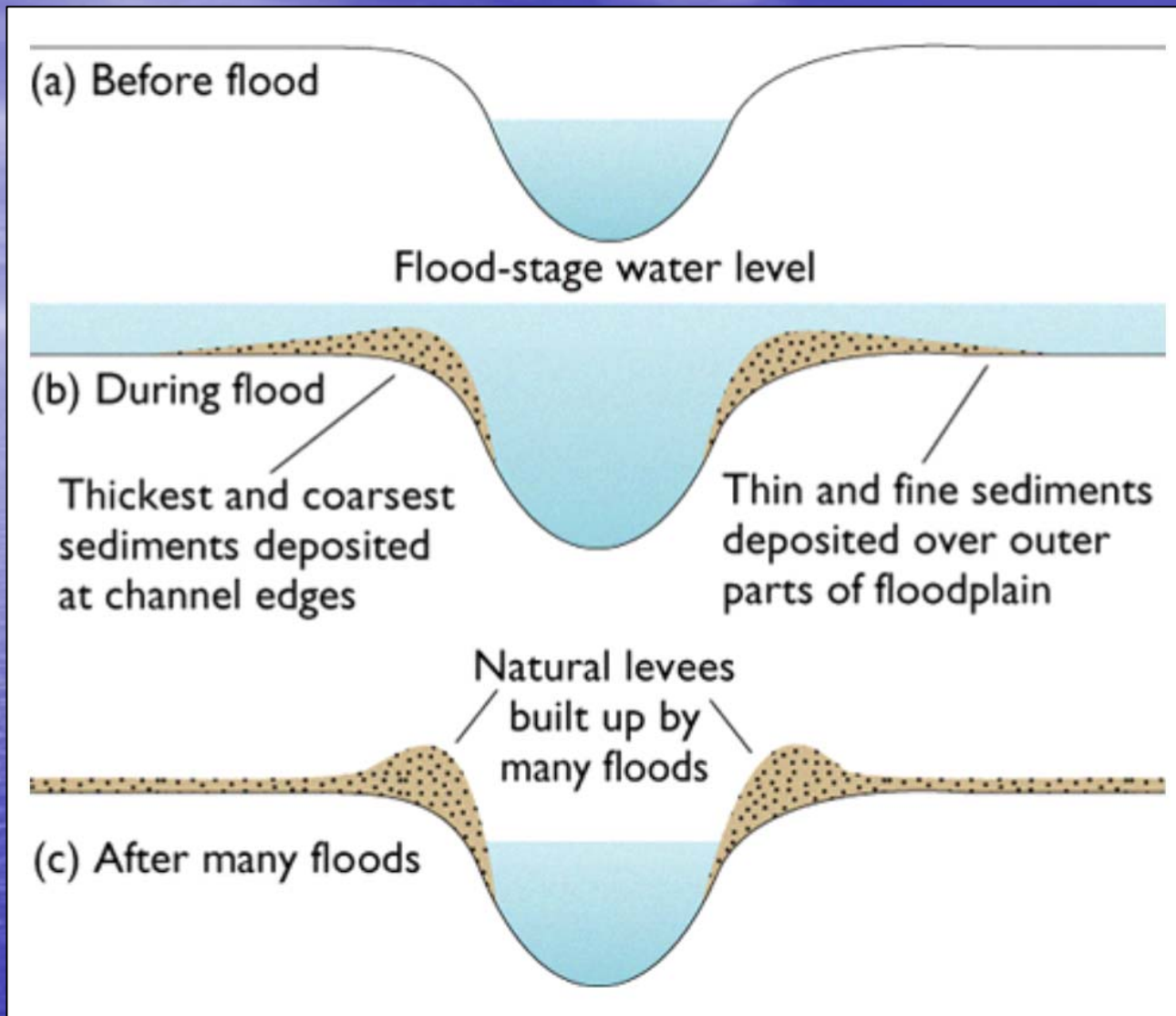


- **Founded in 1718, New Orleans has served as the major trans-shipment center for river-borne to sea-borne commerce, about 50 miles from the Gulf of Mexico.**

FLOOD PLAINS

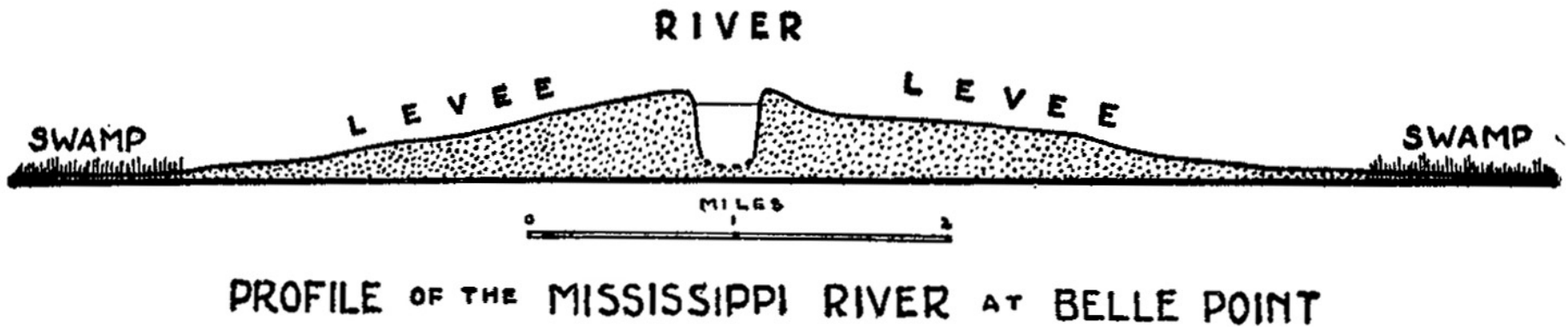


- Flood plains are those alluvial valleys that are periodically subject to inundation by flooding of a natural river. 75% of the sediment deposited on our continent is flood plain silt.

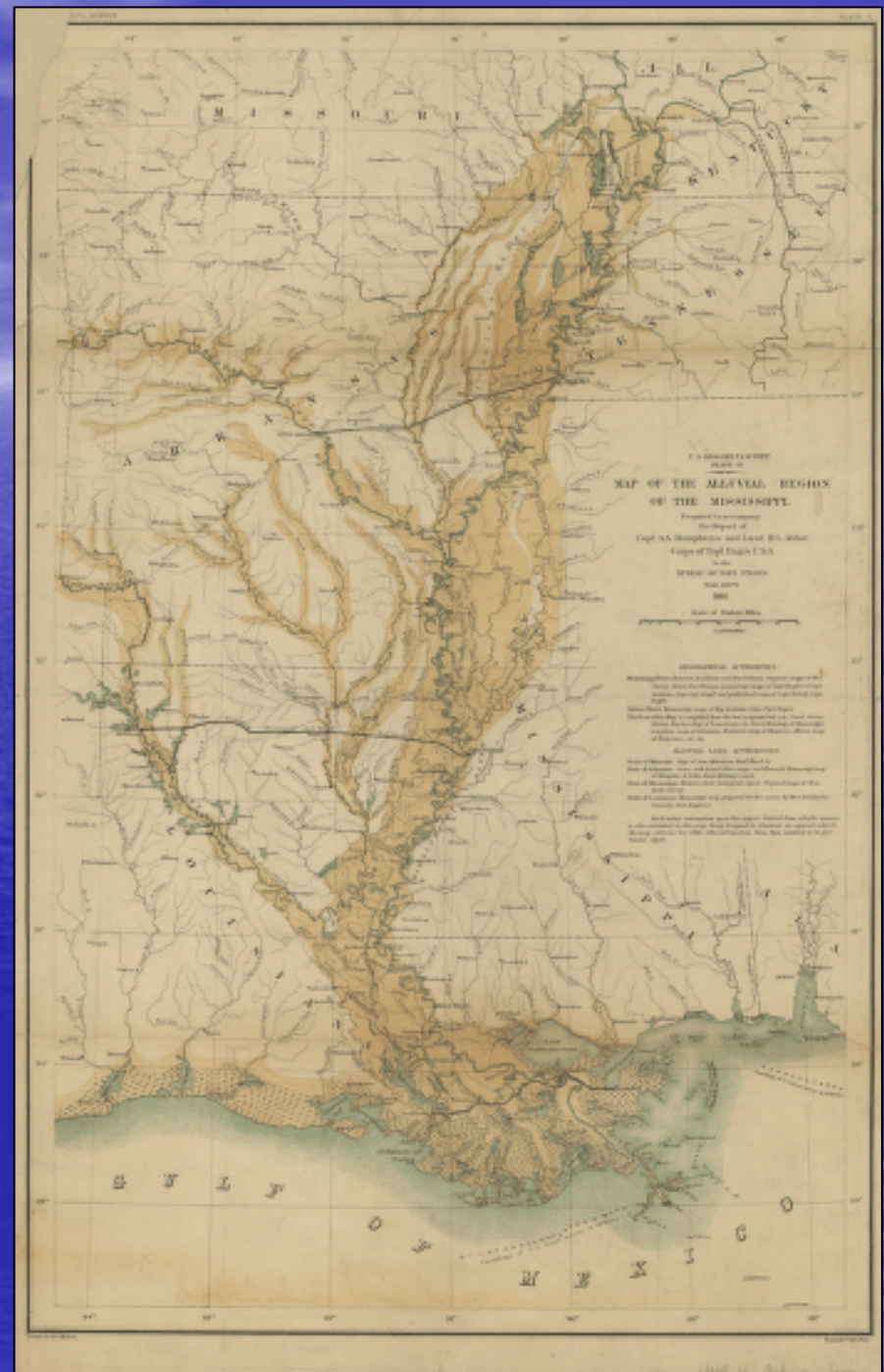
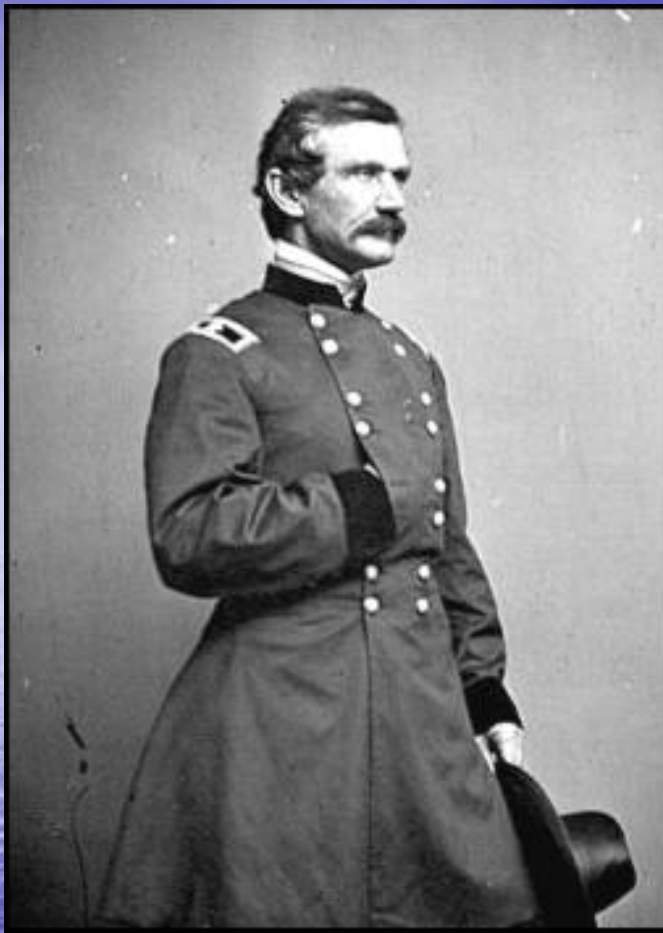


- **Levees** are a natural features that form along low gradient streams subject to overbank flooding

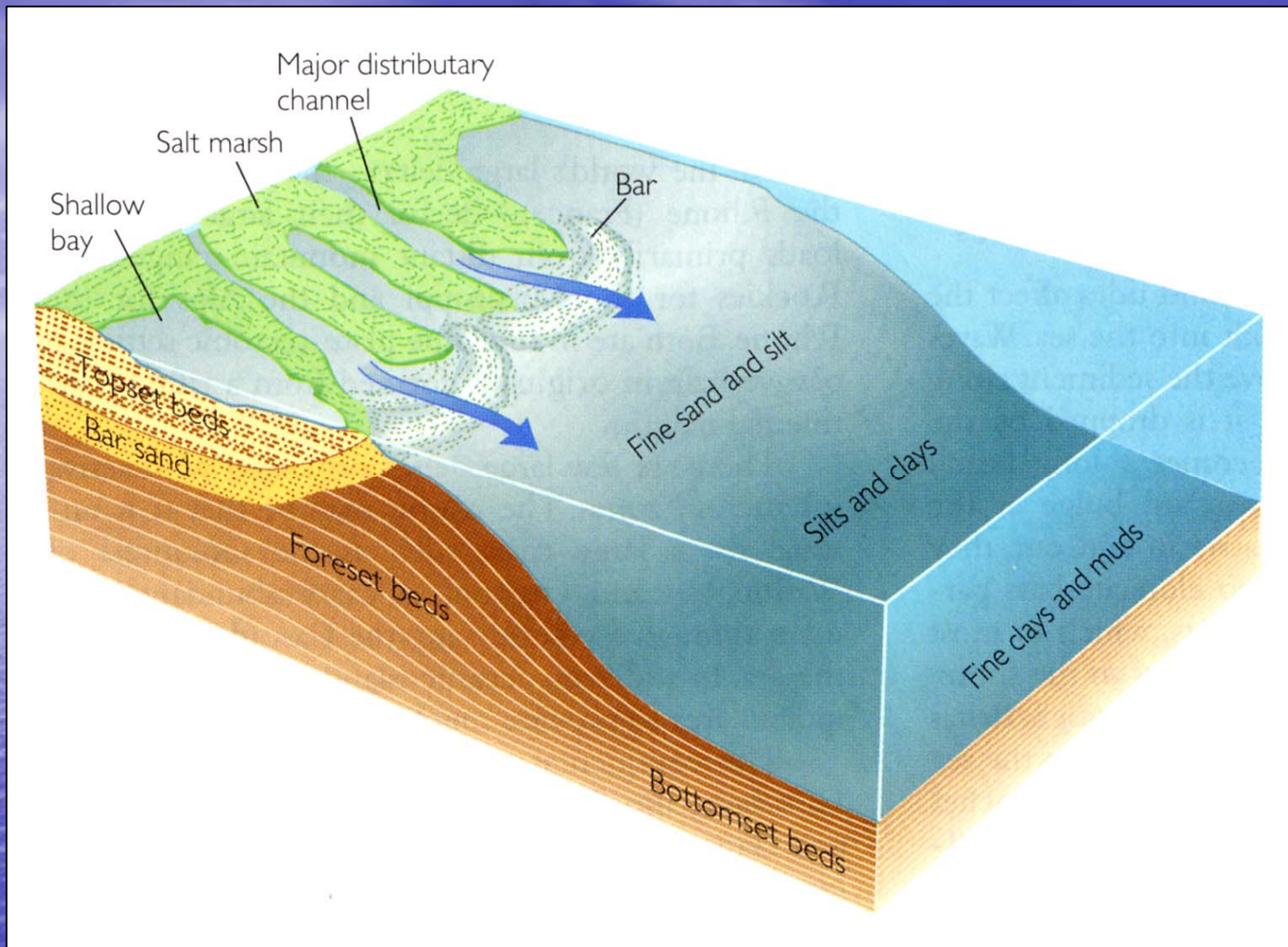
The river is the high ground in the Mississippi Embayment



- A vexing problem with a high silt load river is that it tends to build up its own bed, which prevents drainage of the adjoining flood plains. Millions of acres of swamp land was reclaimed by drainage along the Mississippi River, beginning around 1910.



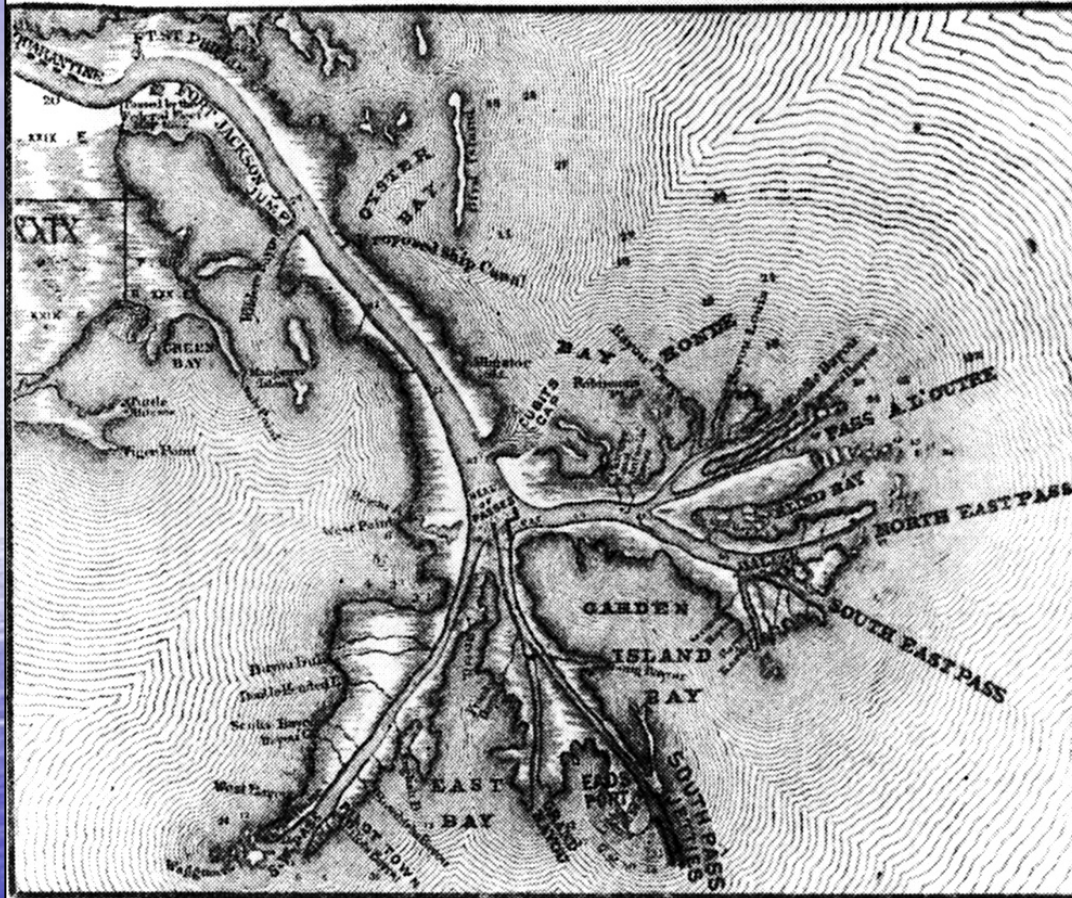
- **Army Engineer A.A. Humphreys** began studying the river in 1850, and virtually controlled it as Chief of Engineers between 1866-1879. He was the father of the Corps' flawed "levees only" policy of flood control.



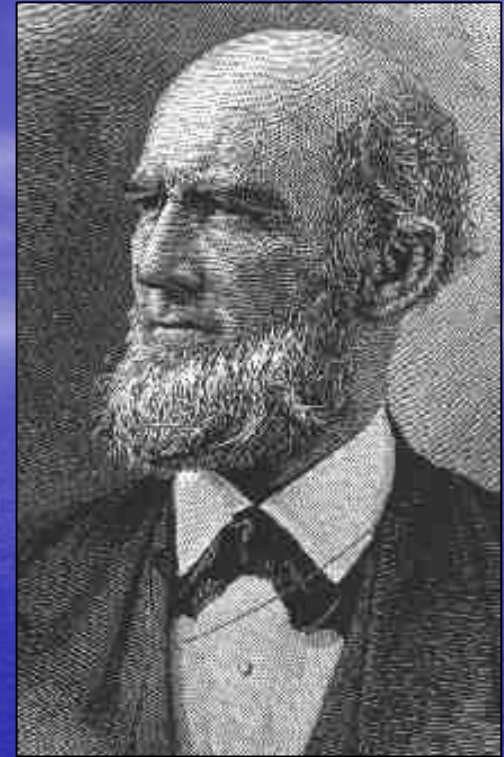
- Sand Bars closed off the mouth of the Mississippi River each year for as much as 3 months at a time following high flows.

EADS JETTIES

AT SOUTH PASS OF THE MISSISSIPPI.



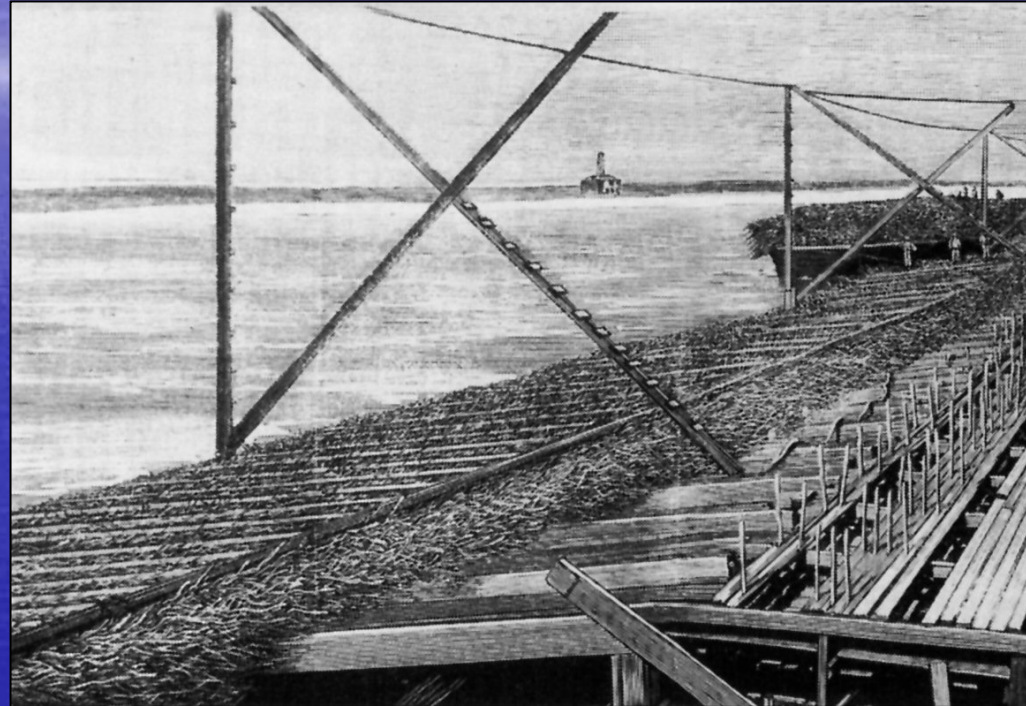
BIRDS EYE VIEW



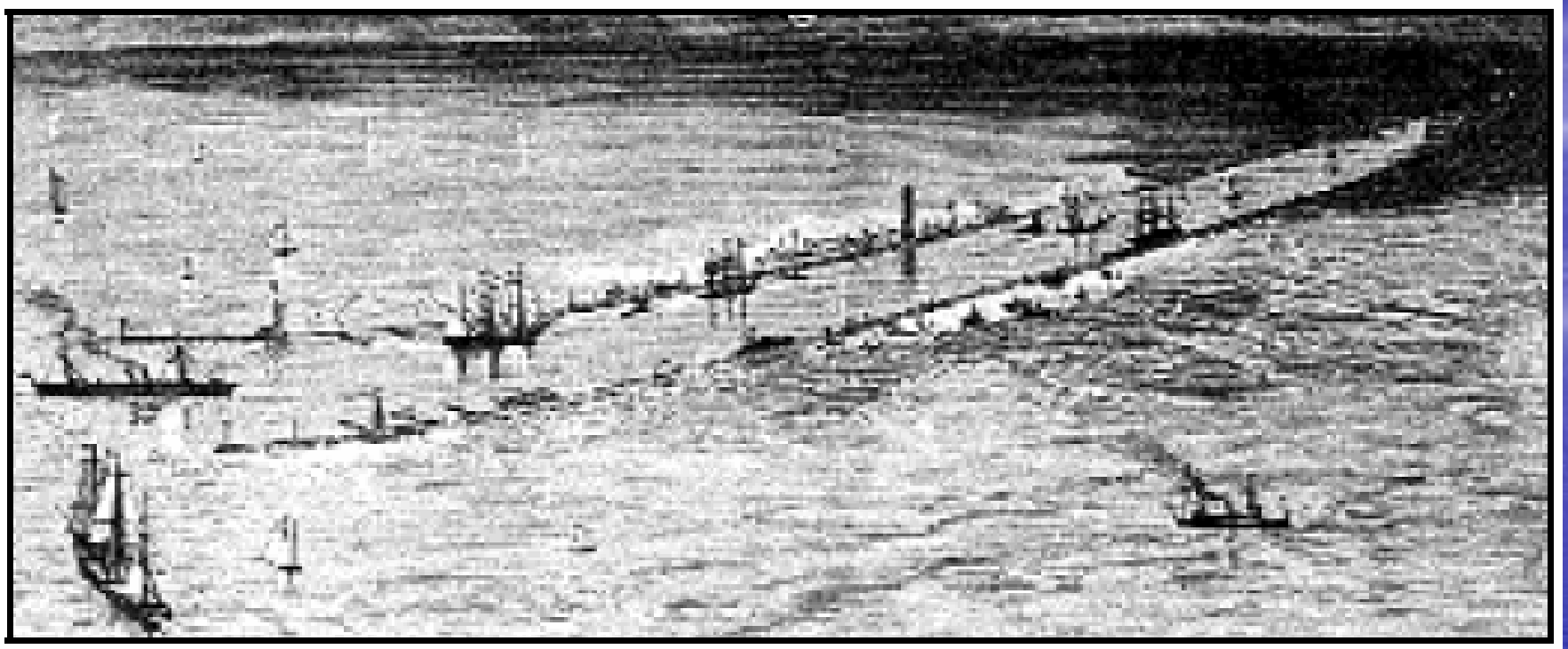
James Buchanan Eads –
inventor of the Mississippi
jetties

- The Corps of Engineers searched for an engineering solution that would provide a 30 foot deep navigational channel at the mouth of the Mississippi Delta.

Eads and Andrews constructed their novel jetties between 1875-79



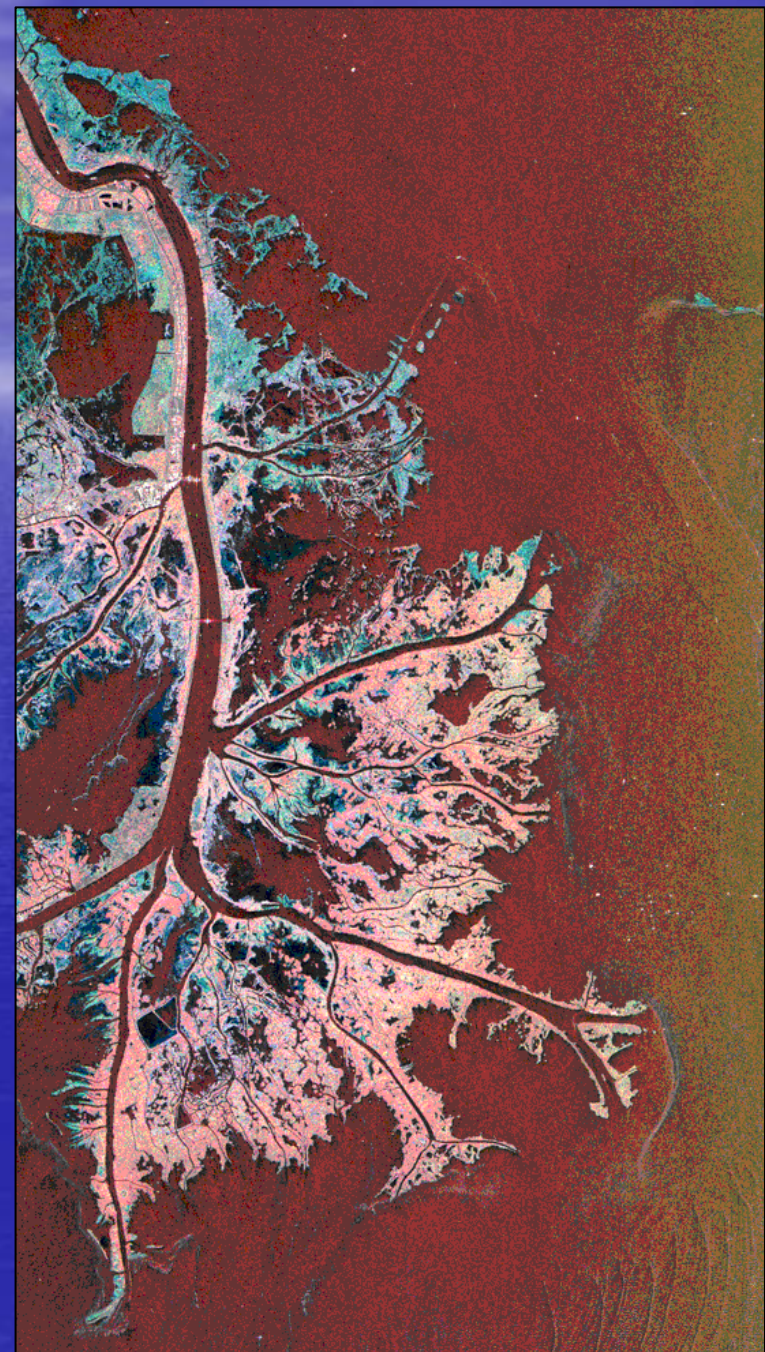
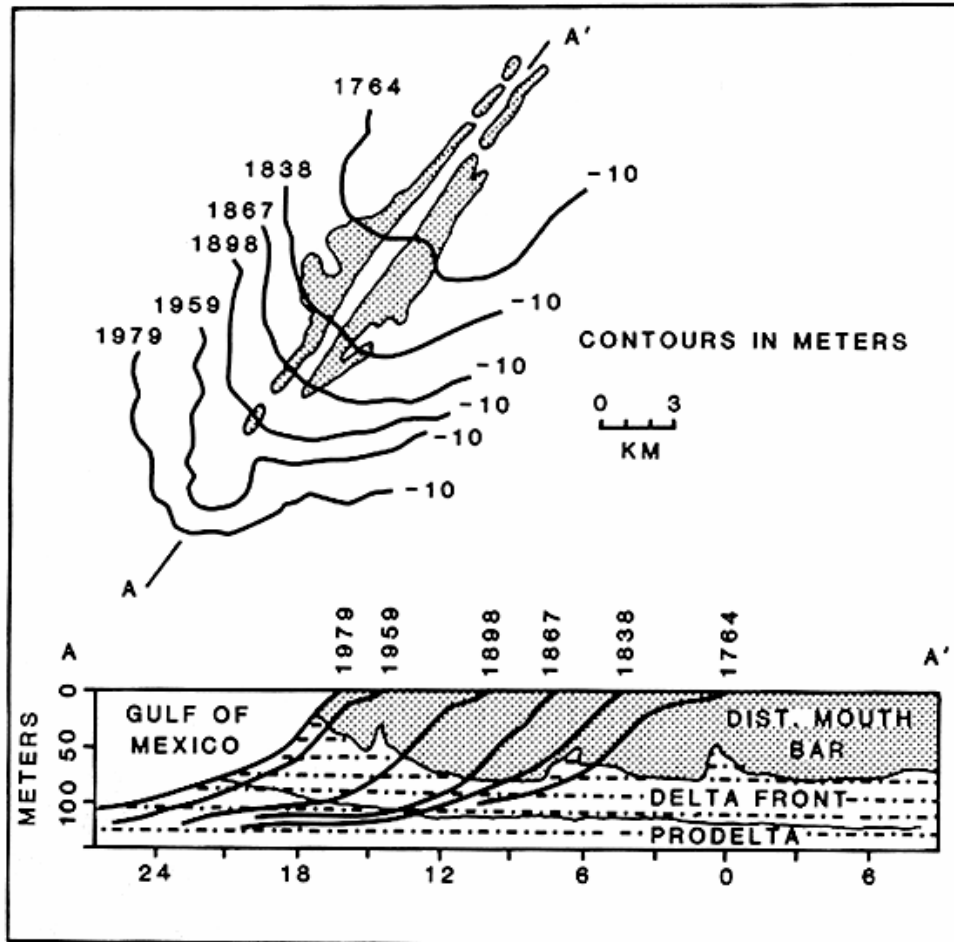
Eads and James Andrews employed woven willow mattresses using a novel patented method, laid over wooden piers 2.33 miles long, and faced with quarried rock to form the jetties. They were designed to constrain river flow past the sand bars, to the continental slope. Eads and his investors were to be paid in increments, 20 ft channel October 1876; 24 ft by March 1877, and so on; reaching 30 feet by mid 1879.



General Humphreys and the Army Corps of Engineers did everything they could to stymie Eads and his jetties. The project was on the verge of bankruptcy, when on May 12, 1876, the 280 ft long steamer *Hudson* became the first deep draft ship to pass through South Pass jetties, sailing upriver to New Orleans. The jetties succeeded beyond anyone's expectations, reaching a depth of 30 feet by June 1879.



- In 1875 **7,000 tons** of goods were shipped between St. Louis and Europe, via the Mississippi River through New Orleans.
- By 1880, this figure had jumped to **450,000 tons** per annum, 65X the pre-jetty level.
- New Orleans went from being the 9th largest to 2nd largest port in the United States; second only to New York.



- The mouth of the Mississippi River has extended 16 km since 1764; 11 km since the jetties were emplaced.

Mississippi River Commission

- Idea conceived by James B. Eads, beginning in 1877. Bill passed by Congress in 1879.
- The Mississippi River Commission (MRC) was staffed by Army Engineers 3 to 2 over civilian members.
- Opposed outlets or offstream storage.
- Opposed channel cutoffs at meanders
- Embraced “levees only concept”, hoping main channel would scour deeper

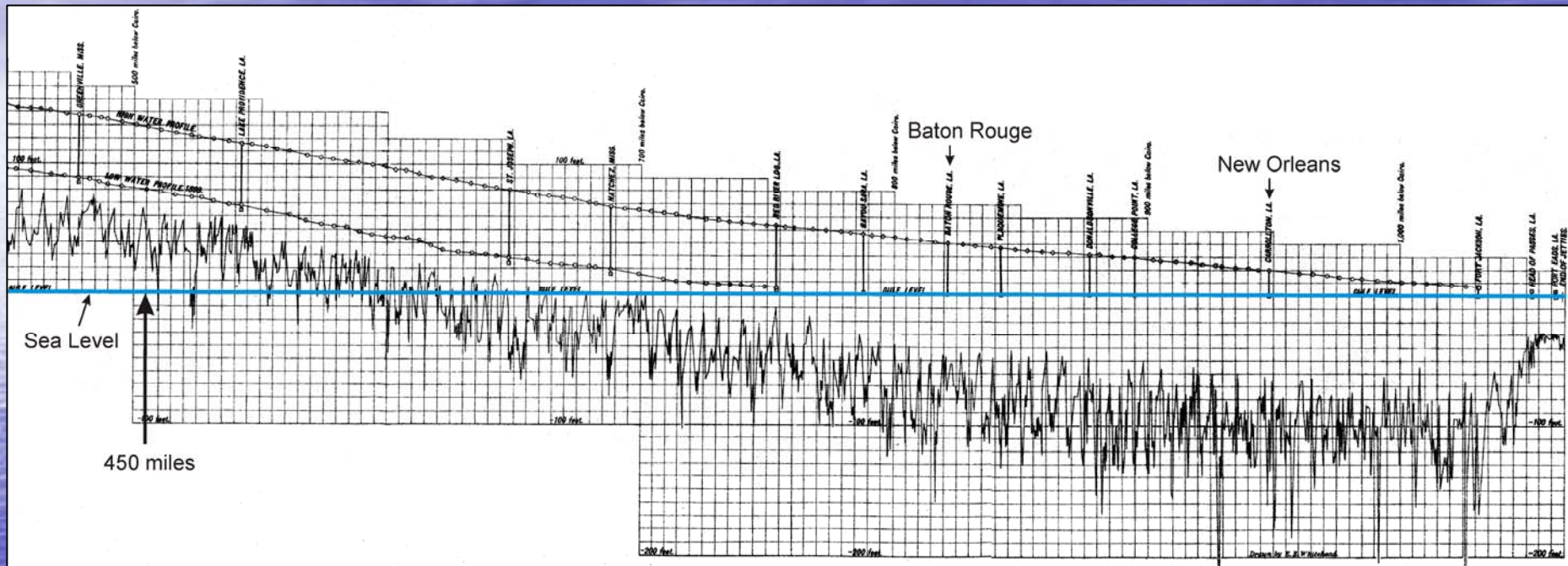


The employment of dual levees, lengthening of the jetties, and silt load of the river have combined to **heighten the channel bed** and **lower the hydraulic grade** of the river. This means the river surface is **RISING**, so levees have to be heightened. This has been an ongoing problem since the late 19th Century.

NAVIGATION CHANNELS – MISSISSIPPI RIVER BELOW BATON ROUGE

- After the mouths of the Mississippi River had been opened and maintained in a navigable state, Congress authorized in **1945** the development of a navigation channel for oceangoing traffic in the lower reaches of the river. **The depths and widths of the channel between Baton Rouge and the Gulf of Mexico are:**
- Baton Rouge to New Orleans - 40 by 500 feet
- Port of New Orleans - 35 by 1,500 feet, with portion 40 by 500 feet
- New Orleans to Head of Passes - 40 by 1,000 feet
- In Southwest Pass - 40 by 800 feet
- In Southwest Pass Bar Channel - 40 by 600 feet
- In South Pass - 30 by 450 feet
- In South Pass Bar Channel - 30 by 600 feet
- Mississippi River-Gulf Outlet - 36 by 500 feet
- Mississippi River-Gulf Outlet Bar Channel - 38 by 600 feet

Profile of the Lower Mississippi

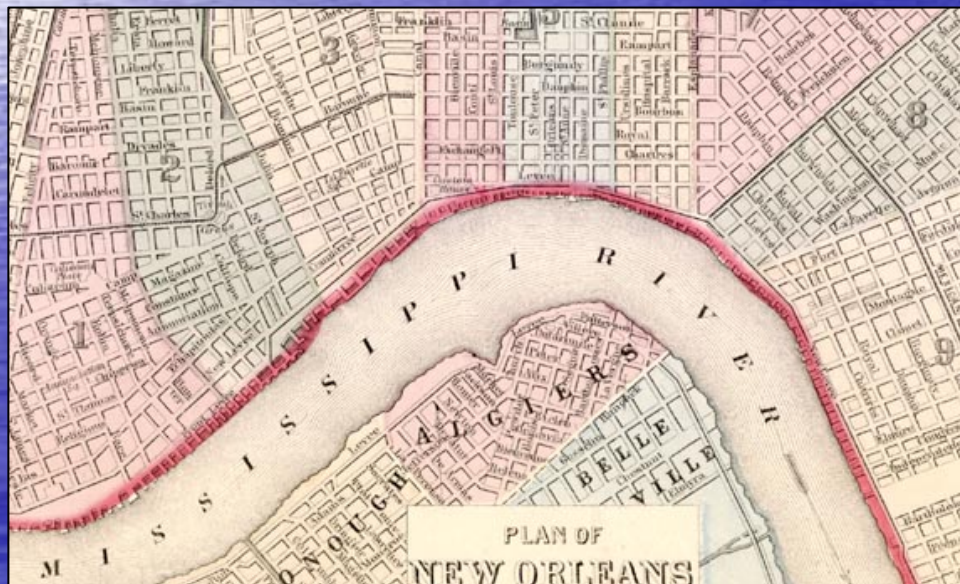
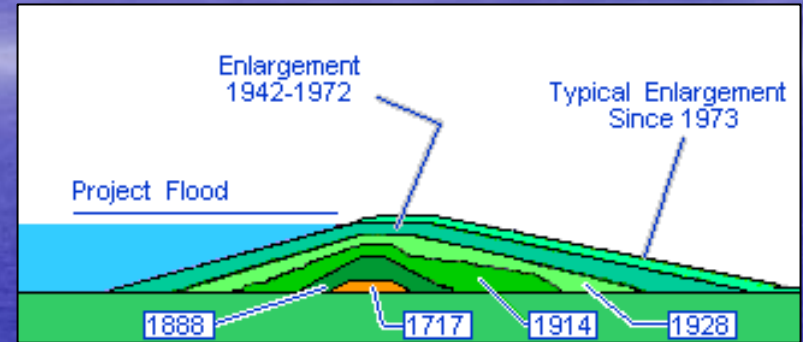


The bed of the Mississippi River is below sea level during the last 450 miles of its course, up to Greenville, Mississippi. This causes the upper portion of the river to fall over the lower part, creating turbulence and undercurrents which wreck havoc on outboard bends in the channel.

Raising levees



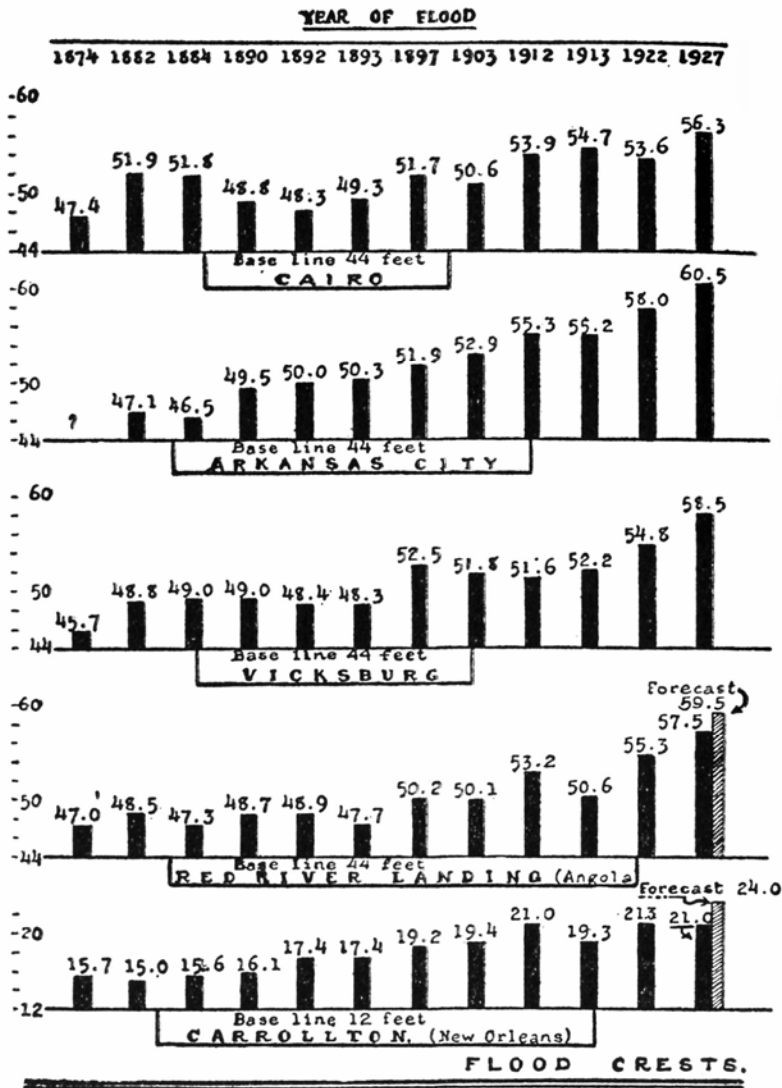
1845 map of New Orleans – note inset wharves



1875 map of New Orleans –wharves gone

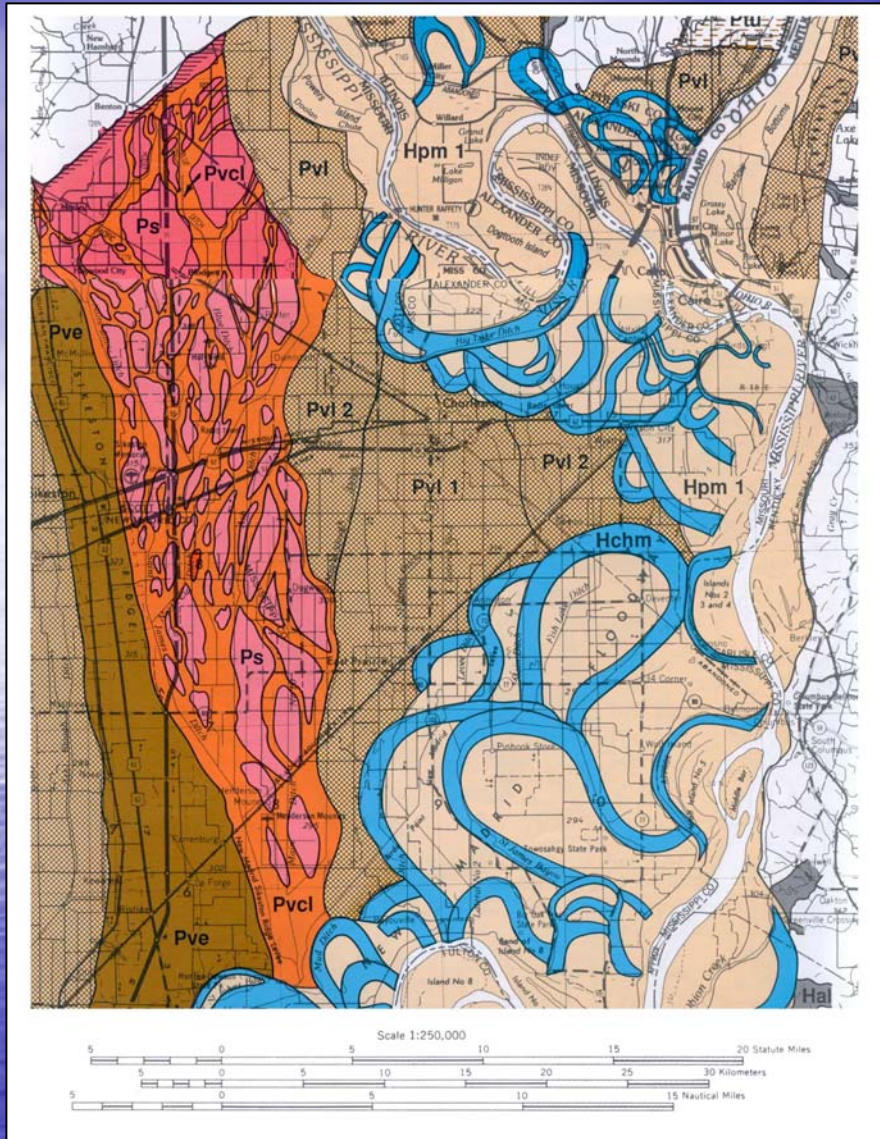
The first levee at New Orleans was constructed in 1717; then heightened significantly in 1888. Protective levee districts were formed in the 1890s.

Rising river bed and raising levees

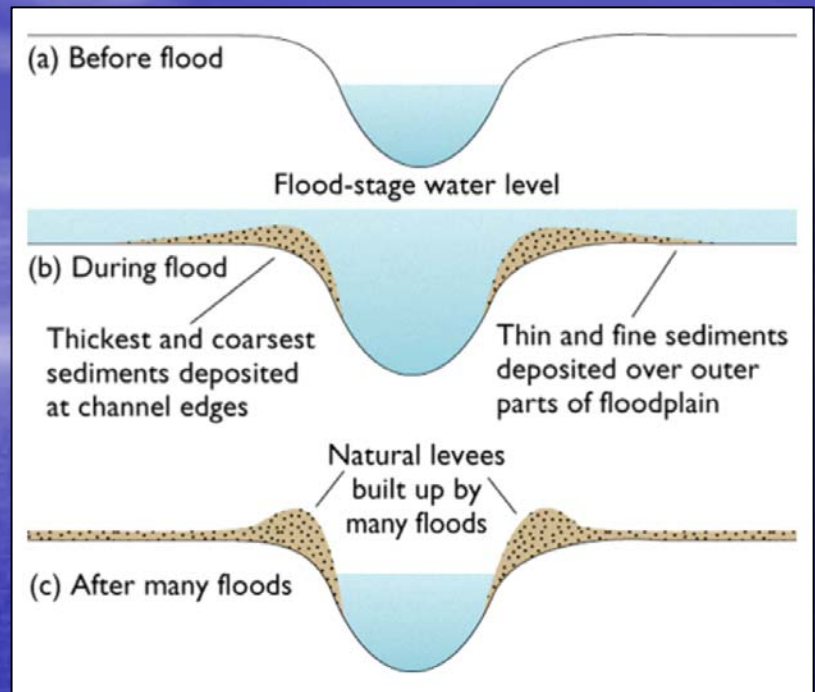


The flood height of the river at New Orleans increased from 15 to 21 feet between 1874 and 1912.

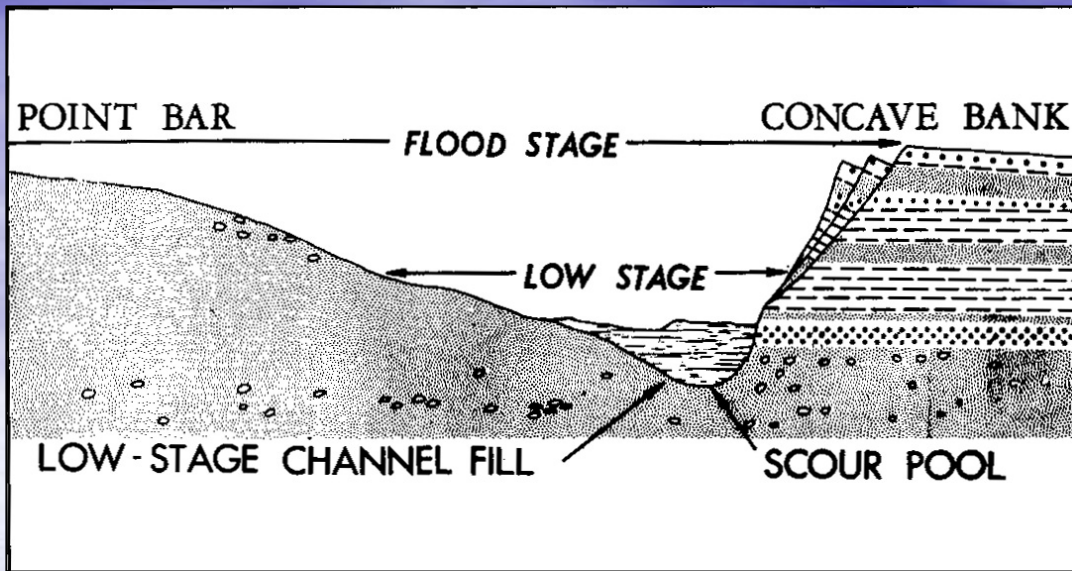
- The levee at Morganza, LA was 7.5 feet high in 1850
- By the mid 1920s, this same levee was 38 feet high, nearly the height of a 4-story building.



Map of Mississippi River Valley showing abandoned meanders. The active channel is shown in white along right side of map.



- A major shortcoming of the MRC's **"levees only policy"** was that it was 2-dimensional: ignoring channel curvature and natural channel migration



Asymmetric channels

- The Mississippi channel is sinuous; migrating towards the outside of downstream bends through bank undercutting. Levees had to set back from these bends.





The 1927 Flood

The 1927 flood was the largest ever recorded on the lower Mississippi Valley. 18 inches of rain fell on New Orleans in a 48 hr period in late March 1927, and six months of flooding was to ensue, inundating 27,000 square miles of bottom land; displacing 700,000 people, killing 1,000 more, and damaging or destroying 137,000 structures.



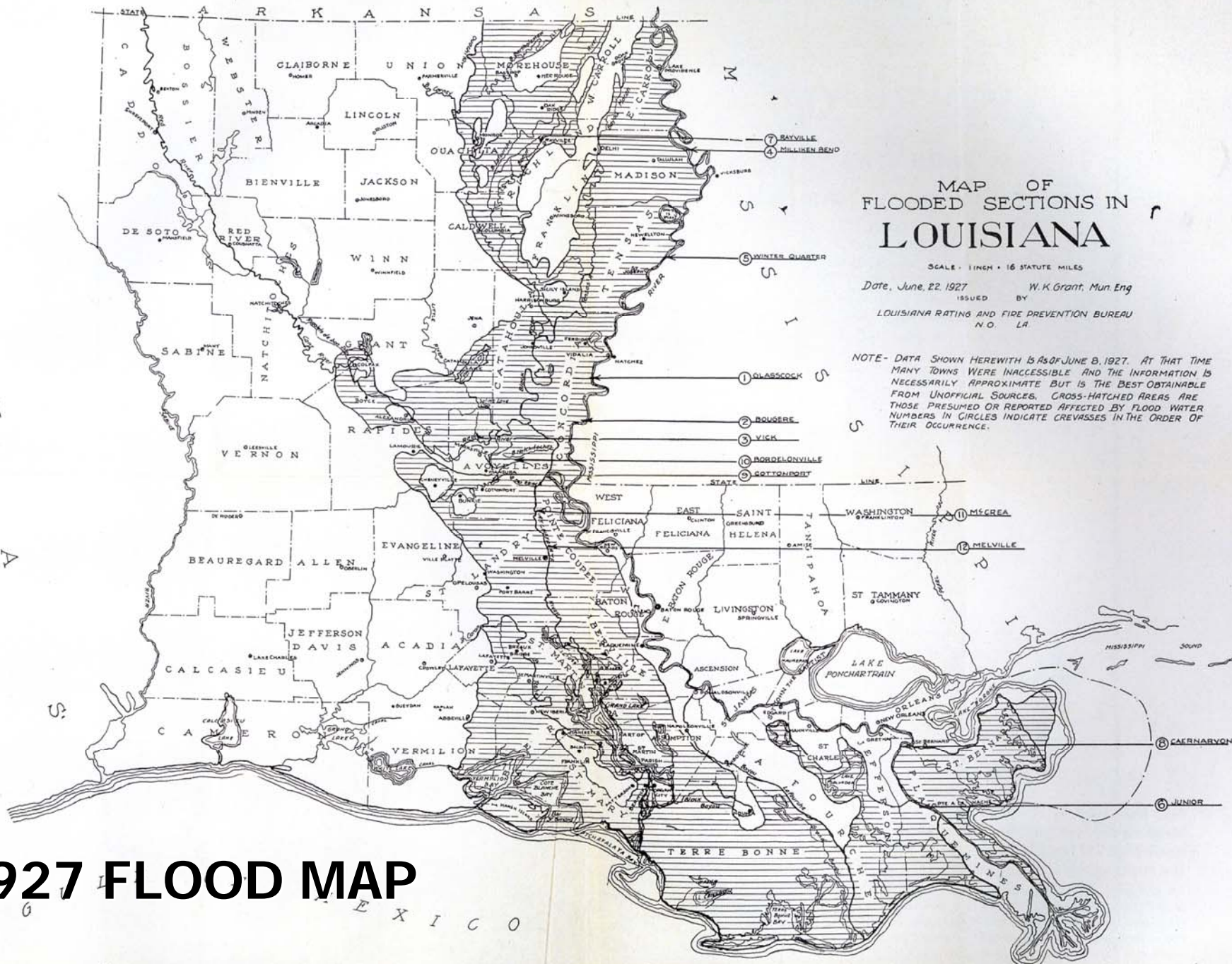
There was an enormous public outcry for the government to do something more substantive about flood control.

DYNAMITE

The political leadership of New Orleans dynamited the Mississippi levee downstream of New Orleans, to save the city from being flooded. It was not necessary, but prompted by fear.



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MAP OF FLOODED SECTIONS IN LOUISIANA

SCALE: 1 INCH = 16 STATUTE MILES

Date, June 22, 1927 W. K. Grant, Mun. Eng
ISSUED BY

LOUISIANA RATING AND FIRE PREVENTION BUREAU
N. O. LA.

NOTE- DATA SHOWN HERewith IS AS OF JUNE 8, 1927. AT THAT TIME MANY TOWNS WERE INACCESSIBLE AND THE INFORMATION IS NECESSARILY APPROXIMATE BUT IS THE BEST OBTAINABLE FROM UNOFFICIAL SOURCES. CROSS-HATCHED AREAS ARE THOSE PRESUMED OR REPORTED AFFECTED BY FLOOD WATER NUMBERS IN CIRCLES INDICATE CREVASSES IN THE ORDER OF THEIR OCCURRENCE.

1927 FLOOD MAP

G F X I C O