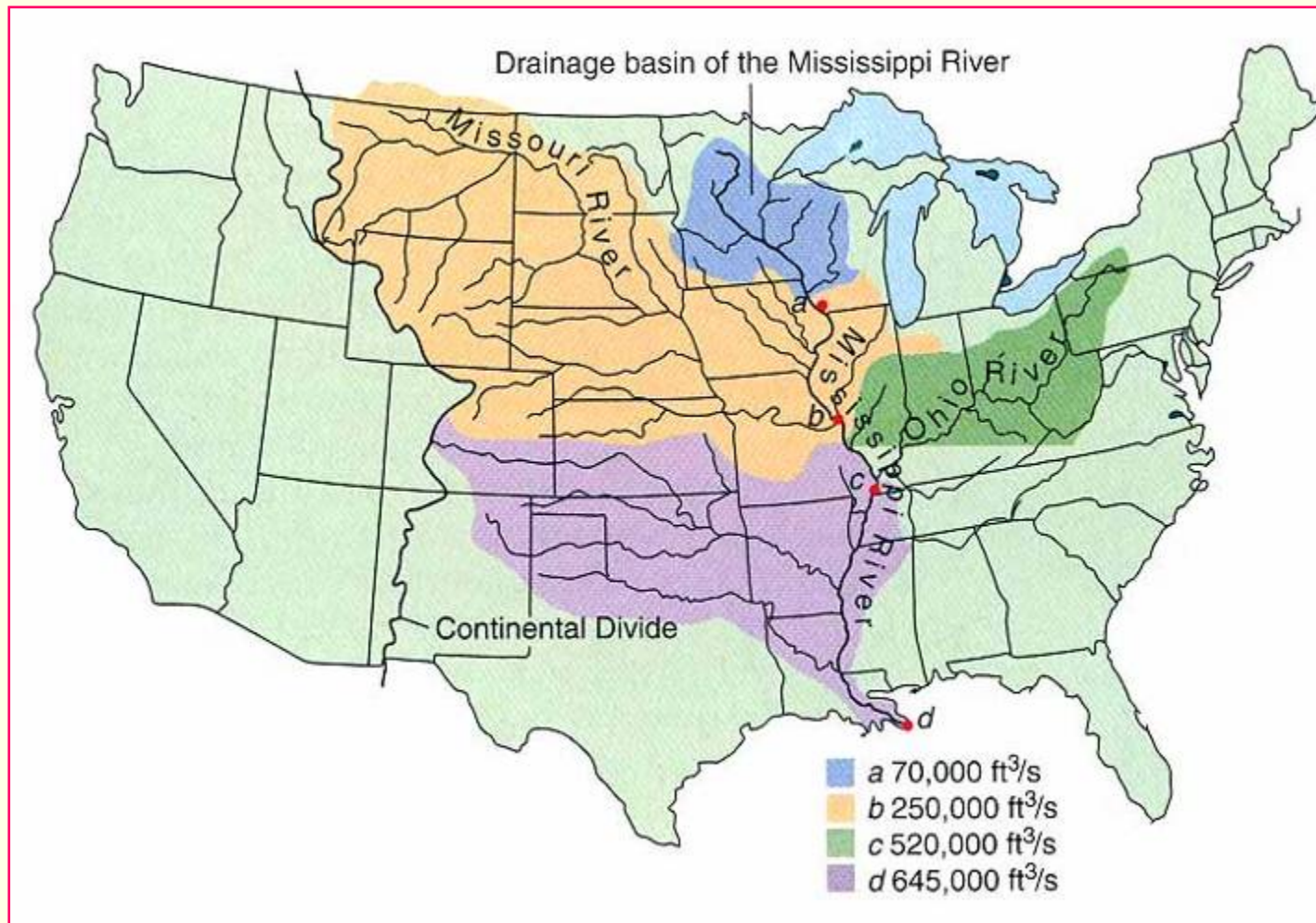
An aerial photograph of New Orleans, Louisiana, showing a dense urban landscape with numerous buildings, streets, and a complex highway interchange. In the foreground, the large, circular, metallic Superdome stadium is prominent. The text is overlaid on the image.

Hurricane Preparedness for the City of New Orleans

John D Winter
Department of Geology
Whitman College

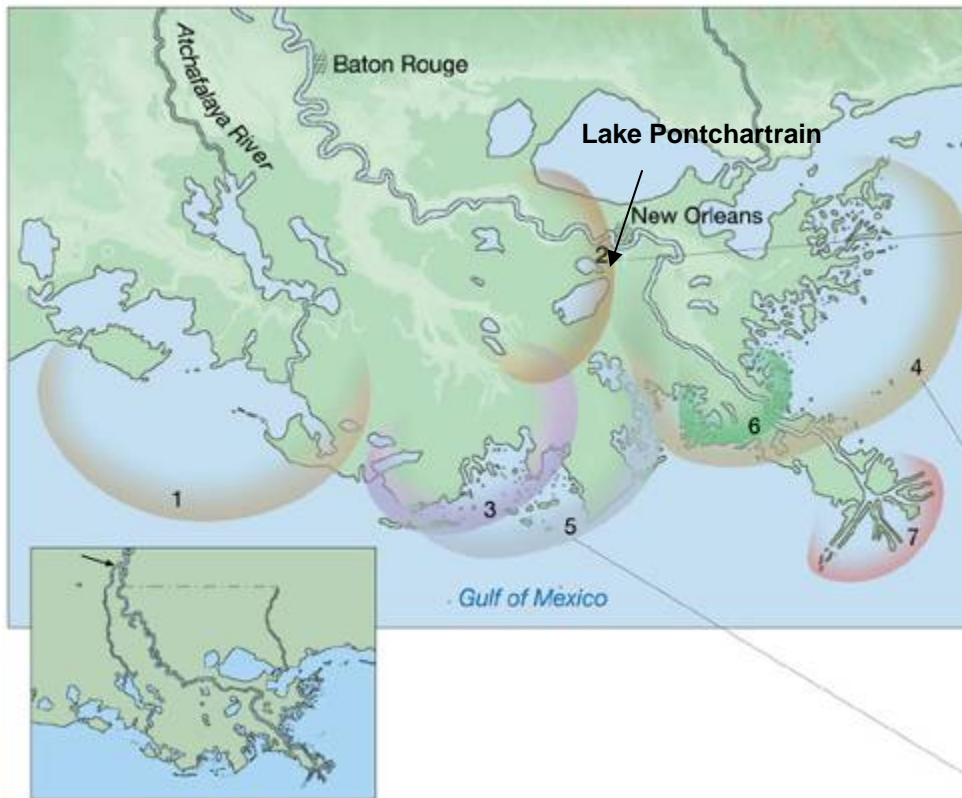




From Tarbuck and Lutgens, An Introduction to Physical Geology. Prentice Hall.

The Mississippi river carries 1 Million tons of sediment each day to the delta, which is now over 30,000 km² x 1.5 km thick

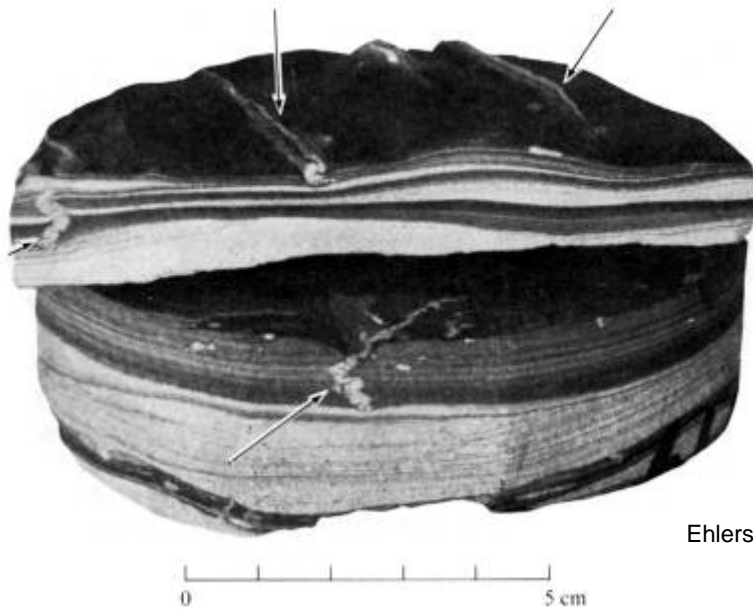
Delta Sedimentation



NASA Image

From Tarbuck and Lutgens, An Introduction to Physical Geology. Prentice Hall.

Delta Sedimentation



Ehlers and Blatt, Petrology.Freeman.

Mudstones typically contain 60% or more water and this is squeezed out as compressed by subsequent deposits

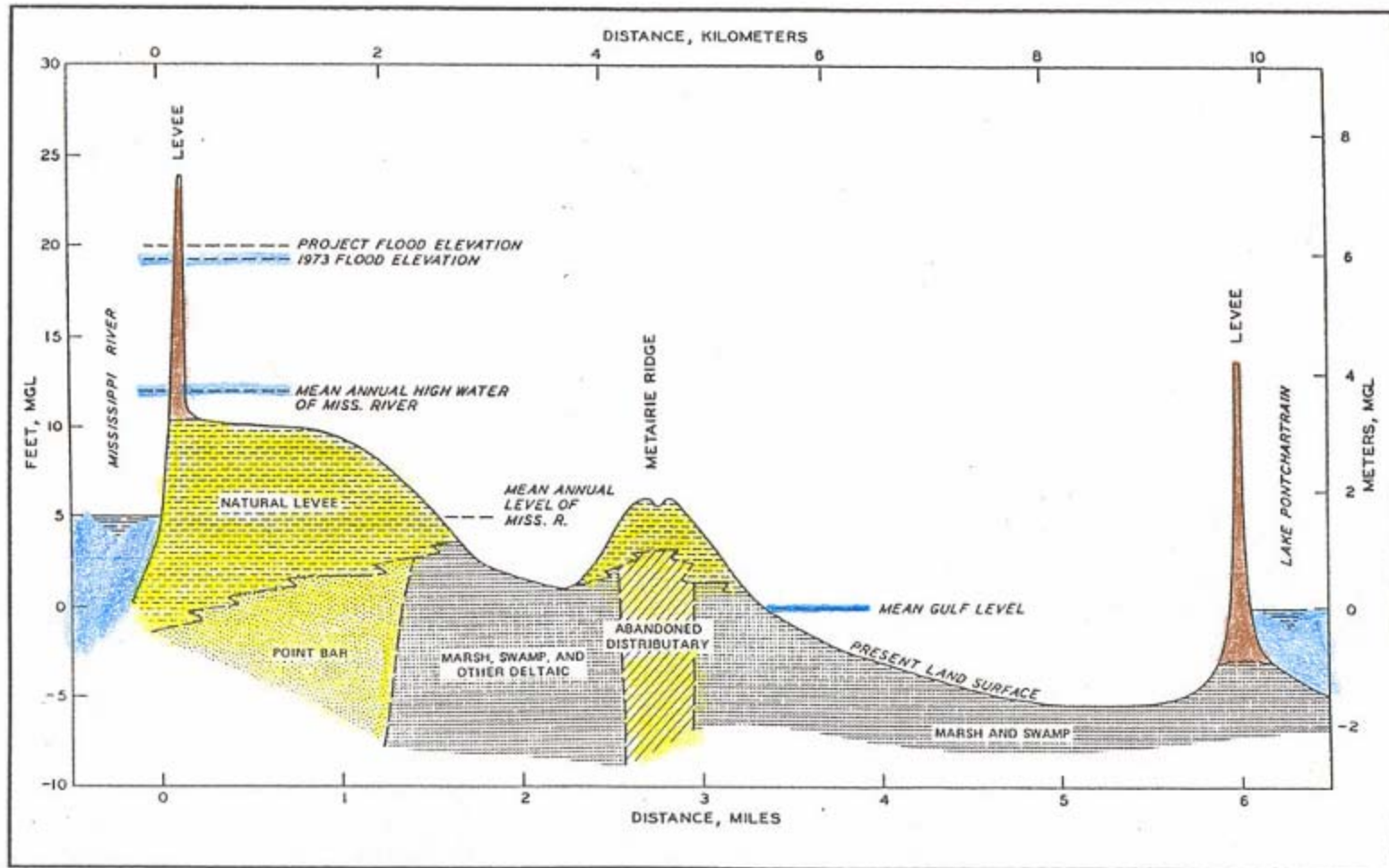
Sample from subsurface drill core

Deltas remain near, but above, sea level because continuous sedimentary deposits keep up with compaction and subsidence

Delta Sedimentation

New Orleans:

- Weight of buildings
- Series of levees which protects from floods, but also keeps out renewed sediment
- Sea level has also risen 15-20 cm. (global warming)
- Result: New Orleans subsides at a rate of $\sim\frac{1}{2}$ cm/yr: now in a bowl 1-3 meters below Lake Pontchartrain, the Mississippi river, and the Gulf of Mexico.
- 560 km of levees now surround the city
- New Orleans will sink another meter in the next century





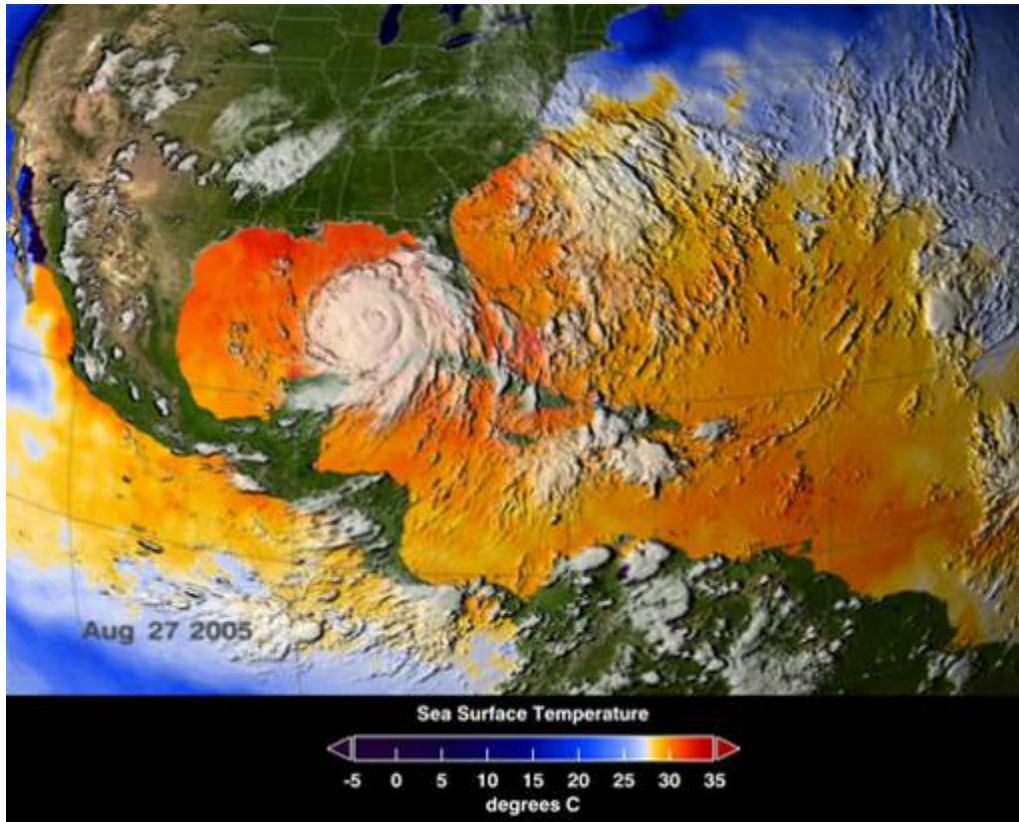
U.S. Hurricane Strikes by Decade

Number of hurricanes by [Saffir-Simpson Category](#) to strike the mainland U.S. each decade.

Decade	Saffir-Simpson Category ¹					All 1,2,3,4,5	Major 3,4,5
	1	2	3	4	5		
1851-1860	8	5	5	1	0	19	6
1861-1870	8	6	1	0	0	15	1
1871-1880	7	6	7	0	0	20	7
1881-1890	8	9	4	1	0	22	5
1891-1900	8	5	5	3	0	21	8
1901-1910	10	4	4	0	0	18	4
1911-1920	10	4	4	3	0	21	7
1921-1930	5	3	3	2	0	13	5
1931-1940	4	7	6	1	1	19	8
1941-1950	8	6	9	1	0	24	10
1951-1960	8	1	5	3	0	17	8
1961-1970	3	5	4	1	1	14	6
1971-1980	6	2	4	0	0	12	4
1981-1990	9	1	4	1	0	15	5
1991-2000	3	6	4	0	1	14	5
2001-2004	4	2	2	1	0	9	3
1851-2004	109	72	71	18	3	273	92
Average Per Decade	7.1	4.7	4.6	1.2	0.2	17.7	6.0

A Partial List of Previous Storms

- After a September 1947 hurricane flooded metropolitan New Orleans, hurricane protection levees were built along Lake Pontchartrain's south shore.
- September 1965: Hurricane Betsy made landfall 80 km east of New Orleans. 200 kilometers/hour winds and the storm surge neared 3 meters. After extensive flooding, the Orleans Levee Board raised existing levees to a height of 4 meters.
- August 1969: Hurricane Camille was said to be the worst storm ever to hit mainland United States. With winds > 320 km/hr and storm surges over 7 meters, it hit the Mississippi Gulf Coast near New Orleans.
- August 1992: Hurricane Andrew hit Florida at category 5 but was downgraded to 3-4 when hit Louisiana 160 km southwest of New Orleans. Sustained winds of 266 kilometers per hour and 5.5-meter storm surges that inundated coastal towns. \$25 billion in damages and more than 60 deaths.



NASA/SVS Image

Hurricane Katrina, Aug 28, 2005
Category 5 (4 by time hit shore).
Winds 230 km/h (140-mph).
3-4 meter (9-12 foot) storm surges.
Eye grazed New Orleans and hit Bay St
Louis, 20 miles east.

NASA Image



Timeline

Thursday, August 25

7 pm: Katrina comes ashore in south Florida as Category 1 hurricane with 80 mph winds, causes nine deaths.

Friday, August 26 (Whitman Residence Halls Open)

7 pm: **The National Hurricane Center warns that Katrina is expected to reach dangerous Category 4 intensity before making landfall in Mississippi or Louisiana.**

Mississippi and Louisiana governors declare states of emergency.

Saturday, August 27 (Whitman Convocation)

5 am: Katrina is upgraded to a Category 3 (a major hurricane).

Residents of Louisiana's low-lying areas are told they must evacuate; residents in other low-lying areas are urgently advised to do so.

President Bush declares a state of emergency in Louisiana. Highways leading out of New Orleans are filled with bumper-to-bumper traffic. Several major interstates are converted to one-way routes away from the city. Many refuse to leave or can't.

11 pm: **The National Hurricane Center issues a hurricane warning from Louisiana to the Florida border: hurricane conditions are expected within the warning area within the next 24 hours.**

Timeline

Sunday, August 28 (Book Discussions, Upperclass Shindig)

7 am: Hurricane Katrina intensifies to Category 5, the worst and highest category on the Saffir-Simpson scale.

10 am: **New Orleans Mayor orders mandatory evacuations as the storm moves directly toward the city.**

Bush declares a state of emergency in Mississippi and orders federal assistance. The National Hurricane Center says the Gulf Coast could expect storm surges of up to 8 meters as the storm, with top sustained winds of 250 kilometers/hr.

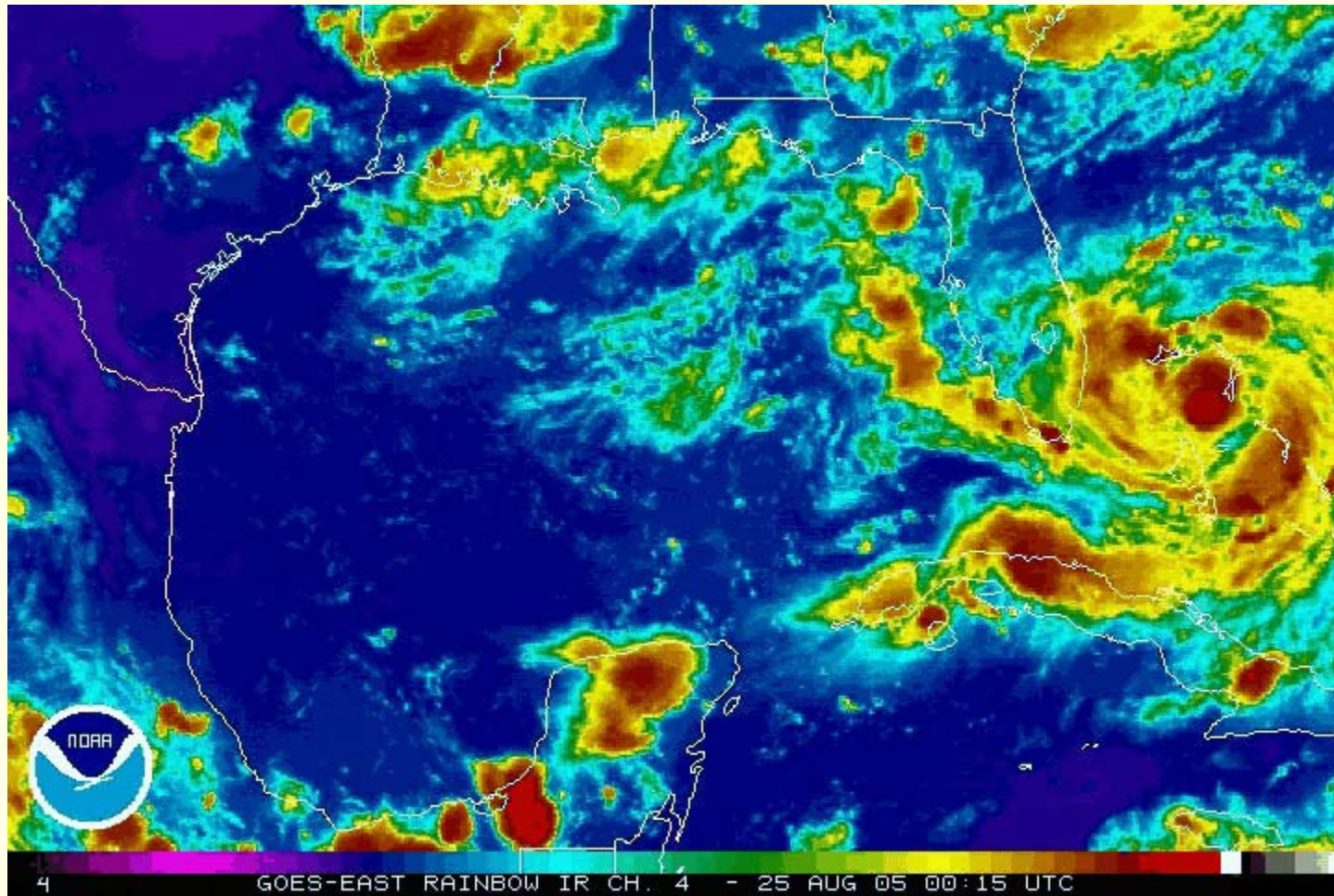
Monday, August 29 (Academic Advising)

4 am: Katrina is downgraded to a strong Category 4 storm.

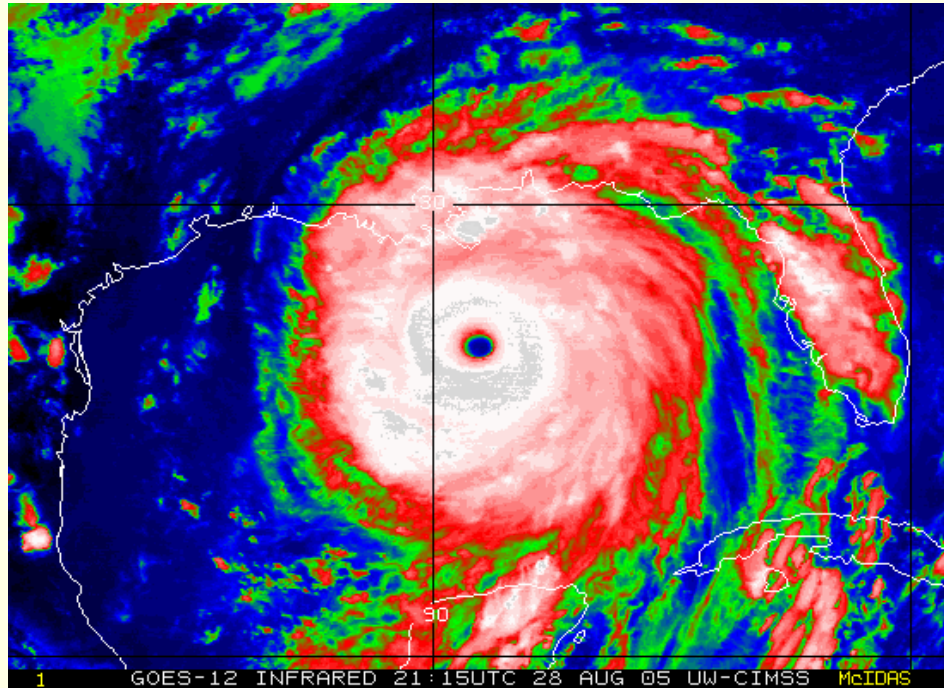
7 am: Katrina makes landfall on the Louisiana coast and ravages parts of Louisiana, Mississippi and Alabama.

Two major flood-control levees are breached in parts of New Orleans. Flooded neighborhoods are under as much as 20 feet of water.

10 pm: Katrina is downgraded to a tropical storm. Remnants head north toward the Ohio River Valley.



Thursday, August 25 – Monday, August 29





Before Katrina

The storm surge raised the water level in Lake Pontchartrain by over 1.5 meters

The water saturated the levee material which failed at several points

<http://www.flickr.com/photos/jomatt/38669580/in/photostream/>



© Dallas Morning News

After Katrina



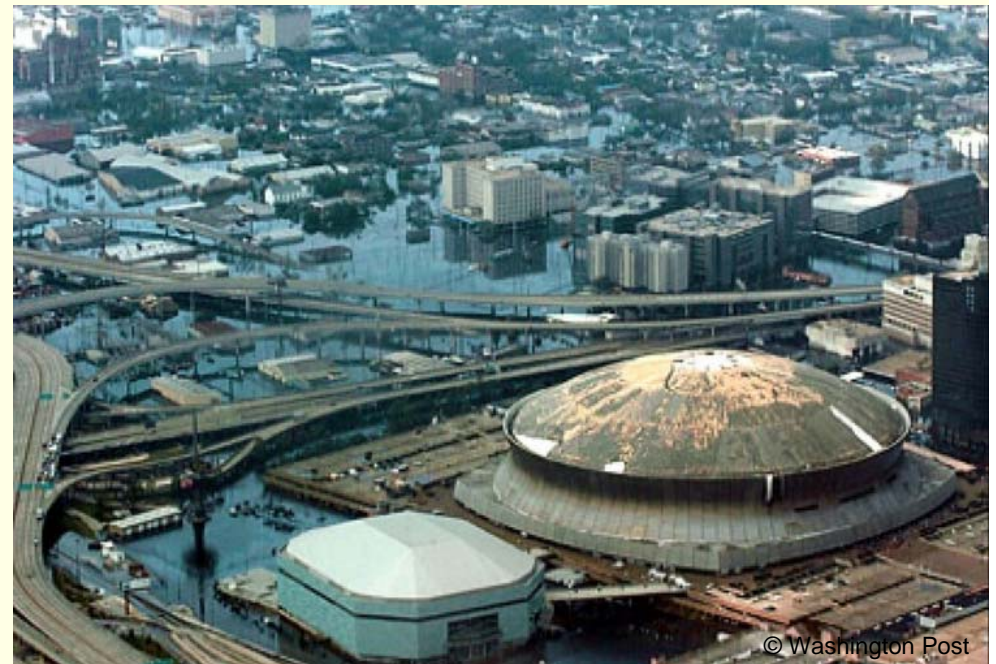
URL <http://www.hunt101.com/img/319526.JPG>



© MSNBC



US NAVY



© Washington Post

NEW IMAGES

Flooding in New Orleans



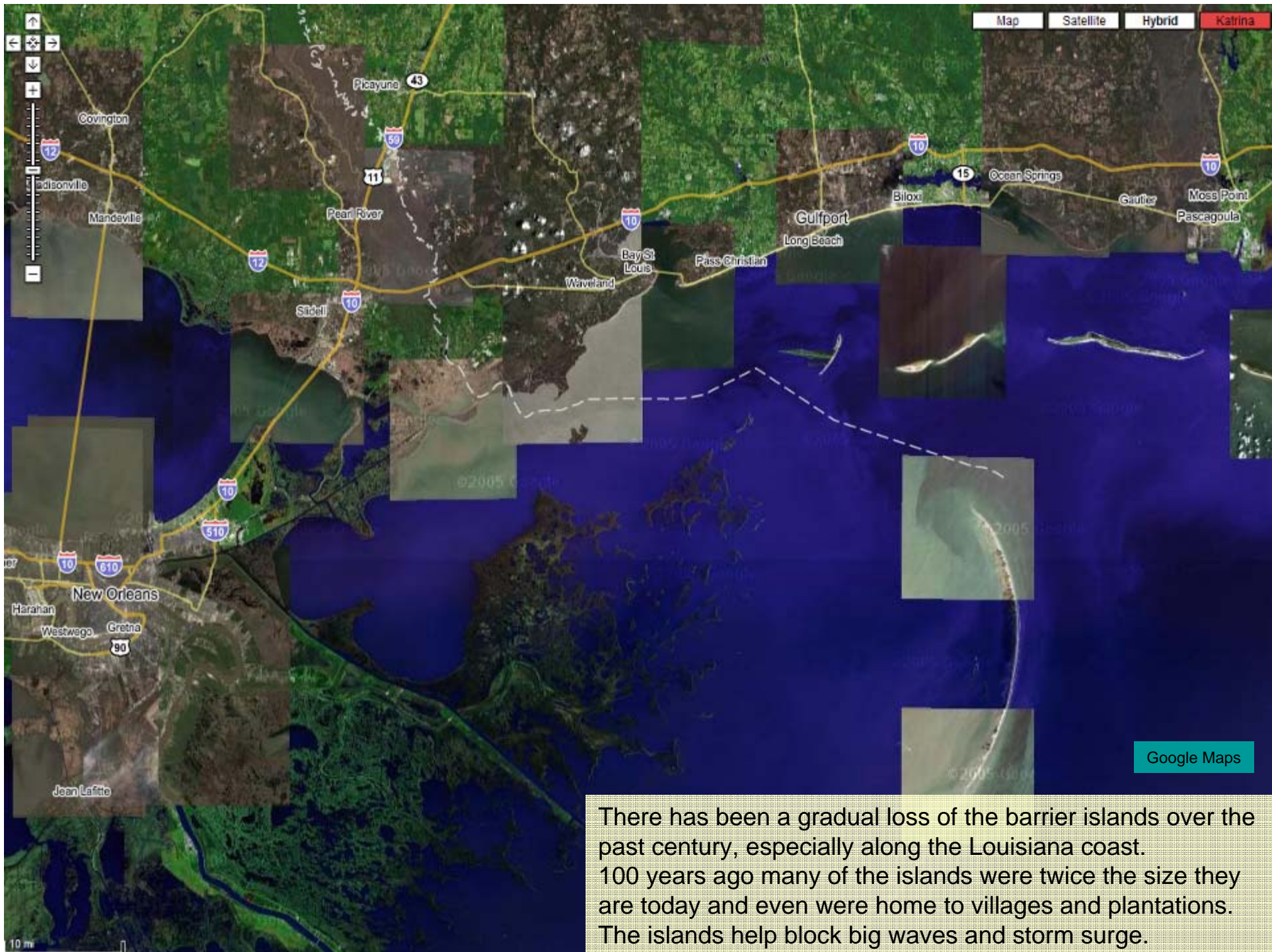
August 30, 2005

After Katrina



August 27, 2005

Before Katrina



There has been a gradual loss of the barrier islands over the past century, especially along the Louisiana coast. 100 years ago many of the islands were twice the size they are today and even were home to villages and plantations. The islands help block big waves and storm surge.

Biloxi, Gulfport, Bay St. Louis



Wednesday rescue in Bay St Louis, two days after storm.



Casino barge in Biloxi. ripped from moorings and floated half a mile across U.S. Highway 90, finally beaching itself on top of a Holiday Inn



Wreckage in Biloxi.



Car washed into neighbor's pool by storm surge, Biloxi.

Biloxi, Gulfport, Bay St. Louis



Debris blocks a road in Pascagoula on Monday.



Storm surge, on the road to Biloxi during the storm, Monday.



Storm surge halts Red Cross aid on Monday, Biloxi.



Trees ripped up in Gulfport.

Exacerbating problems

- Over 400 municipal sewage treatment plants in the flooded area. Lifting and conveying the sewage requires 83 electrically operated pumping and lift stations.
- 3 large attended stations and all automatic stations transfer total collected sewage to 2 treatment plants. The combined treatment capacity is 132 million gallons per day. Both plants discharge treated wastewater (pumped up) into the Mississippi River.
- Louisiana ranks fourth in the nation for releases of toxic chemicals into rivers and streams, and it leads the nation in releases of chemicals that persist in the environment and build up in the human body.
- Industrial waste plus many cans of paints, solvents, fertilizers and pesticides stewing in flooded garages and basements. If the chemicals haven't already leaked into floodwaters, household containers will soon rust in the warm, brackish floodwaters inundating New Orleans.
- Some neighborhoods could be so contaminated that they would be unfit for re-building houses.

- Since late 1960s Federal, state, and local officials worked on major hurricane and flood relief efforts.
- In 1995 Congress authorized the Southeast Louisiana Urban Flood Control Project (SELA).
- Next 10 years: Army Corps of Engineers spent \$430 million on shoring up levees and building pumping stations, with \$50 million in local aid.

- System designed for a storm of Category 3, assuming a larger storm has a very low probability of occurring.
- At least \$250 million in crucial projects remains, even as hurricane activity in the Atlantic Basin increased dramatically and levees surrounding New Orleans continued to subside.
- After 2003, the flow of federal dollars toward SELA dropped to a trickle.
- Times-Picayune: “The Corps never tried to hide the fact that the spending pressures of the war in Iraq, as well as homeland security -- coming at the same time as federal tax cuts -- was the reason for the strain.”
- In early 2004, as the cost of the conflict in Iraq soared, President Bush proposed spending less than 20 percent of what the Corps said was needed for Lake Pontchartrain.

Some Major Issues

- New Orleans is below sea level and will continue to sink.
- What is the “maximum acceptable risk” for which to design and build levees?
- Spending for levee improvement.
- Emergency preparedness.

Evacuation

Preparedness

"It is difficult to understand the lack of preparedness and the ineffective initial response to a disaster that had been predicted for years and for which specific dire warnings had been given for days," said Sen. Susan Collins, the Maine Republican who chairs the Senate homeland security committee.

- Does it make sense to rebuild New Orleans?