Topic 13: Floods – The Basics

photo: U.S. Coast Guard@wikipedia

3 videos! 9a,b,c

Weekly test #4 (Mon 10/28)
will include homework 2!
Questions on geowiki under tests tab

2005 Hurricane Katrina

2012 Superstorm Sandy

Why Floods?

✧Lecture 1: most frequent natural disaster – Floods
✧Floods have a significant human impact factor –
   both in enhancement and in cause
✧disparity between rich and 'poorer' communities?
   (deferred maintenance)

Prolonged Floods:
underappreciated
less newsworthy
no flood insurance
-> less insured losses
-> never make the "top 10"

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What Causes Floods?

- local thunderstorms/heavy rain -> flash floods -> fatalities
- extended rainfall -> prolonged regional floods -> damage
- snow melt -> regional floods

8/26/24 Flash Flood – HW4

10/26/18 S.D. Union Tribune

18 students swept away in Jordan flash flood

Flash floods unleashed by heavy rains swept away a group of middle school students and teachers visiting hot springs near the Dead Sea on Thursday, killing 18 and injuring 35 as the torrent carried some for several kilometers, a civil defense official said.

Thirteen people escaped without injuries, said Brig. Gen. Farid al-Sharaa, speaking after nightfall as large spotlights illuminated the flooded area. Some survived by clinging to rocks, he said.

A dramatic rescue operation involving helicopters and divers continued into the night. Israel's military said it dispatched a search and rescue team at the request of Jordan's government.

Understanding Flood Risks

NATURAL

➢torrential and/or prolonged rain
➢tropical cyclones -> rain + storm surges (Katrina, Galveston)

1900 hurricane,
U.S. deadliest nat. dis.

HUMAN FACTORS

➢ failing of human-built dams and levees
2005 Hurricane Katrina deadliest recent on mainland US
1889 Johnstown dam failure second-deadliest in US
➢ (excessive) sedimentation in dammed waterways
and reservoirs

1) Levees, seawalls and dams have limited live time
2) …. may be poorly built or sit on unstable ground

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Galveston, TX - 8 Sep 1900 Hurricane

deadliest U.S. natural disaster

- ❖ Galveston lies on barrier island
- ❖ port
- ❖ wealthiest TX town at time
- ❖ 38,000 residents

- ✧ caused by hurricane surge (winds, low pressure, high tide)
- ✧ waves 1 ft higher than highest elevation
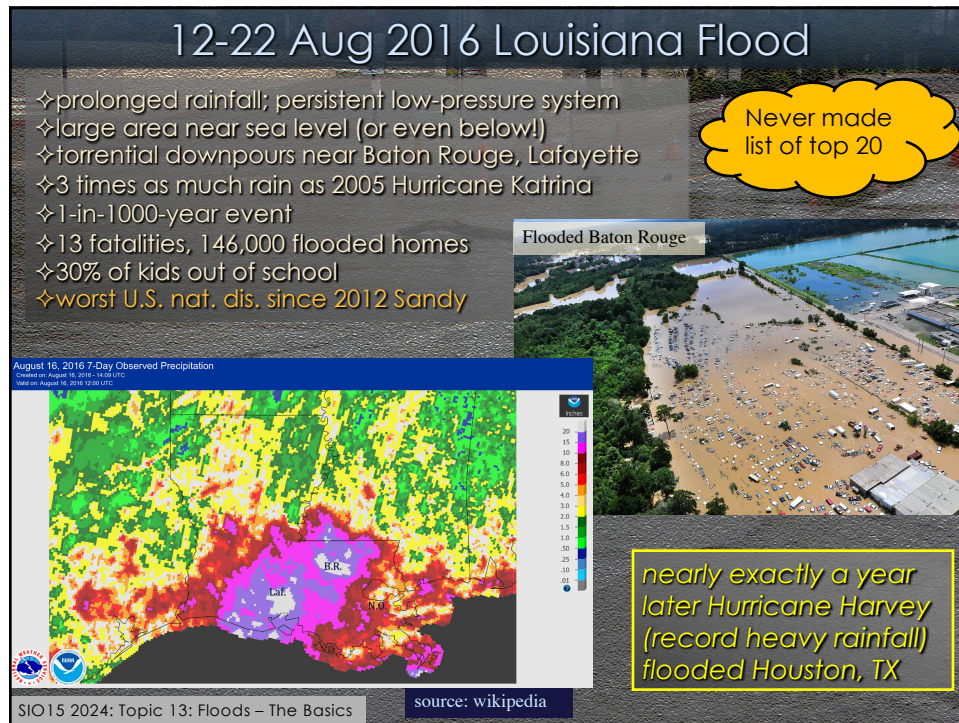- ✧ 6000 people perished

Johnstown, PA 1889

- ❖ worst dam burst in U.S. history
- ❖ storm
- ❖ 3rd deadliest U.S. flood
- ❖ 2200 people perished

- ✧ booming coal-/steel town 60 mi from Pittsburgh
- ✧ lake for exclusive summer resort upstream
- ✧ egoistic politics by tycoons
- ✧ poor dam maintenance

12-22 Aug 2016 Louisiana Flood

✧prolonged rainfall; persistent low-pressure system
✧large area near sea level (or even below!)
✧torrential downpours near Baton Rouge, Lafayette
✧3 times as much rain as 2005 Hurricane Katrina
✧1-in-1000-year event
✧13 fatalities, 146,000 flooded homes
✧30% of kids out of school
✧worst U.S. nat. dis. since 2012 Sandy

Never made list of top 20

Flooded Baton Rouge

August 16, 2016 7-Day Observed Precipitation
Created on: August 16, 2016 - 14:09 UTC
Valid on: August 16, 2016 12:00 UTC

nearly exactly a year later Hurricane Harvey (record heavy rainfall) flooded Houston, TX

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source: wikipedia

Louisiana Floods

❖recurring floods
❖much land below sea level
❖flood risk increasing

Louisiana floods

From Wikipedia, the free encyclopedia

Louisiana floods may refer to several events throughout Louisiana history:

- Great Mississippi Flood of 1927 - The worst river flood in U.S. history caused damage in Louisiana along with other states
- Mississippi flood of 1973 - Affected areas around the Mississippi River in Louisiana and other states
- May 1995 Louisiana flood - Much of New Orleans flooded after heavy rainfall across South Louisiana
- 2005 levee failures in Greater New Orleans - After Hurricane Katrina many levees failed in New Orleans causing widespread catastrophic flooding in 80% of the city
- 2011 Mississippi River floods - Severe flooding across the Mississippi River Valley affected Louisiana
- 2015 Louisiana floods - The Red River reached record levels, resulting in flooding
- 2016 Louisiana floods - Prolonged rainfall across South Louisiana caused catastrophic flooding resulting in over 146,000 flooded homes and 13 deaths

wikipedia as of 10/25/24

… and then there is the Mississippi …

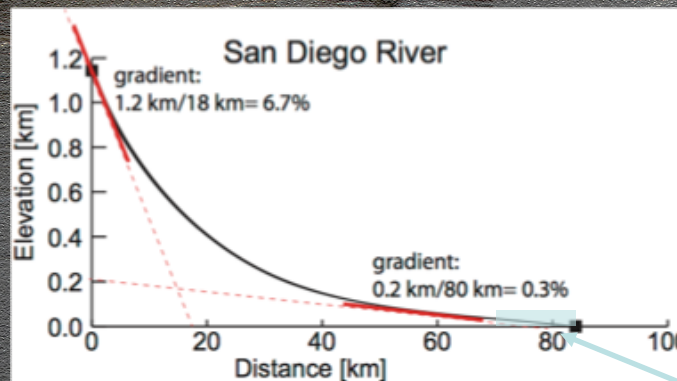SIO15 2024: Topic 13: Floods – The Basics

Stream Profile, Discharge of a River

short videos 9a,b!   Discharge: amount of water per time
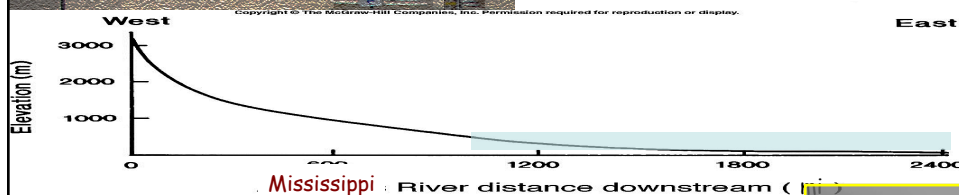
longitudinal vs. cross-section

San Diego River

gradient:
1.2 km/18 km= 6.7%

gradient:
0.2 km/80 km= 0.3%

base level

flood plain ?

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The Mississippi River: Its Natural Course

West   Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.   East

Elevation (m)

3000

2000

1000

0   1200   1800   2400

Mississippi   River distance downstream (mi)

FLOOD
PLAIN!

➢worlds 3rd-largest drainage basin
➢2,340 mi/3,710mi
➢with Missouri (3,710 mi) 4th-longest
  river system
➢one of world's largest river deltas

— Reference plane

Time 4:
A new, low-relief landscape
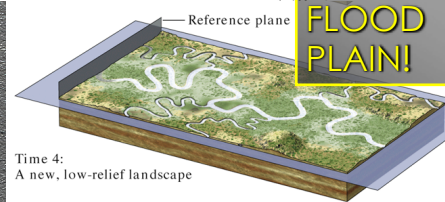
Meanders
short video
9c!

DRAINAGE BASIN:
• area which drains into a river, incl. ALL tributaries
• continental divides separate drainage basins

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The 1993 Mississippi Flood

the only regional flood making it into the top 20 costly U.S. natural disasters

top 10 until 2005!
(see slide in back of lecture 1)

1988

St. Louis, MO

1993

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The 1993 Mississippi Flood

✧unusually late flood (Aug)
✧wet year (July jet stream like winter -> moist Gulf air far north)
✧upper Mississippi flooded for 160 days

1988

St. Louis, MO

1993

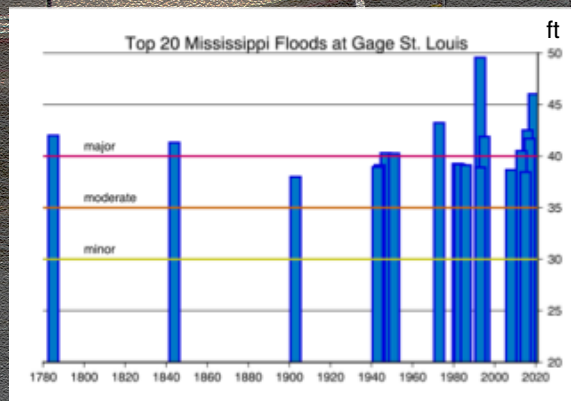SIO15 2024: Topic 13: Floods – The Basics

The 1993 Mississippi Flood

✧1083 of 1756 levees overtopped or breached;
MORE THAN HALF!

1988

St. Louis, MO

1993

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Floods and the Mississippi River

Top 20 Mississippi Floods at Gage St. Louis

River gage at St. Louis

top 5 historic crests:
1) 08/01/1993   49.58 ft
2) 06/09/2019   46.02 ft
3) 04/28/1973   43.23 ft
4) 01/01/2016   42.52 ft
5)   04/01/1785   42.00 ft

➢ more frequent
➢ higher

- since 1785, 6 of top 10 occurred 1993 or later
- biggest four within last 50 years

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Floods and the Mississippi River

elsewhere along the Mississippi

2002: Red River Landing 17.86 m (highest ever)

2008: Iowa, Bonnet Carre Spillway first in 11 years; Red River landing at 18.50 m)
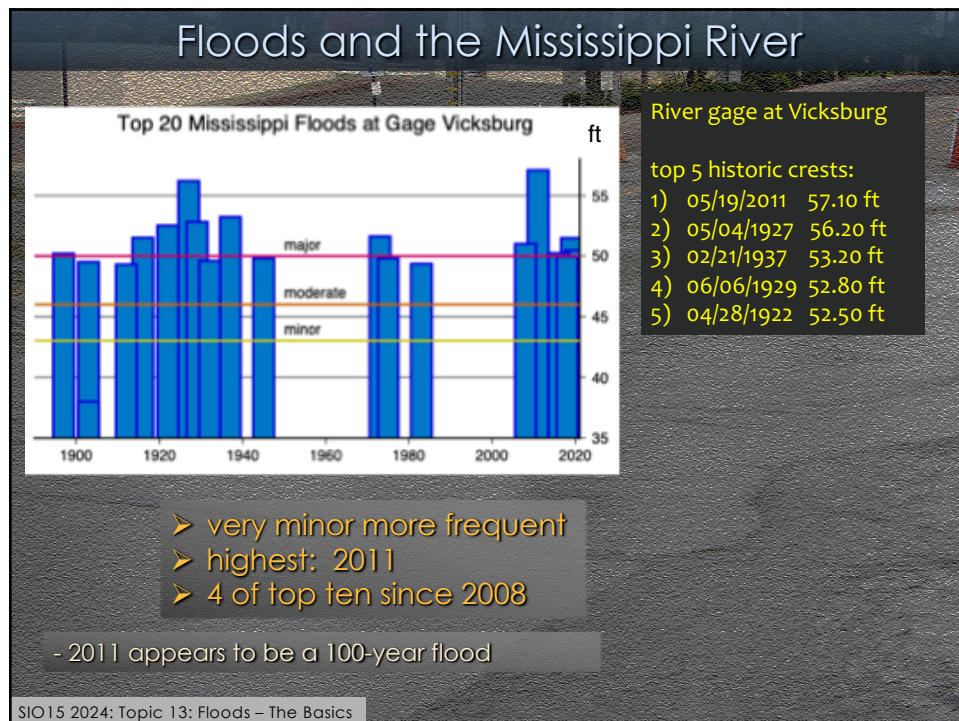
2011: Great MISSI Flood (rivaling 1927, 1993); Morganza Spillway opened to save New Orleans; 12,000 km^2 flooded

2014: upper MISSI

2017: middle MISSI ("historical")

2019: EPIC

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Floods and the Mississippi River

Top 20 Mississippi Floods at Gage Vicksburg

River gage at Vicksburg

top 5 historic crests:
1) 05/19/2011 57.10 ft
2) 05/04/1927 56.20 ft
3) 02/21/1937 53.20 ft
4) 06/06/1929 52.80 ft
5) 04/28/1922 52.50 ft

➢ very minor more frequent
➢ highest: 2011
➢ 4 of top ten since 2008

- 2011 appears to be a 100-year flood

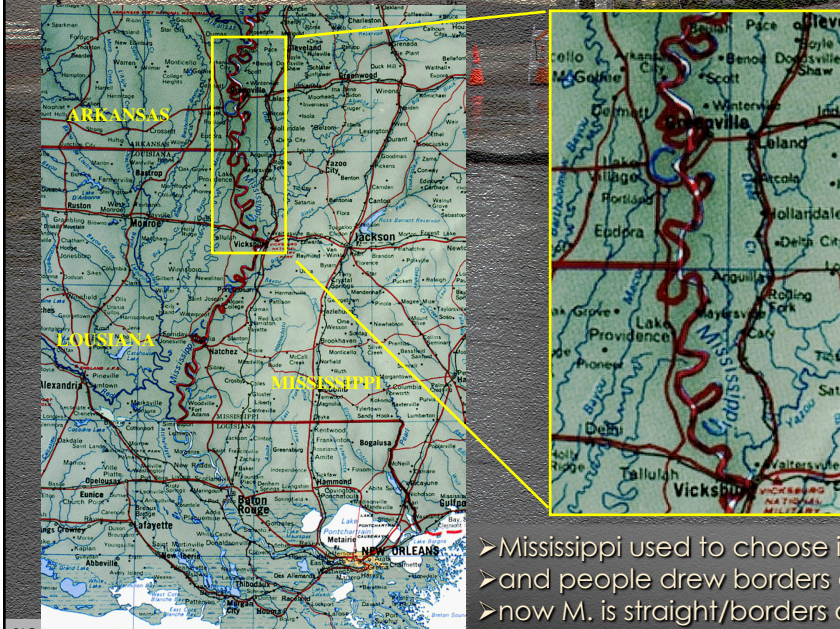SIO15 2024: Topic 13: Floods – The Basics

Floods and the Mississippi River

despite our knowledge and efforts,
floods are not getting less!

SIO15 2024: Topic 13: Floods – The Basics
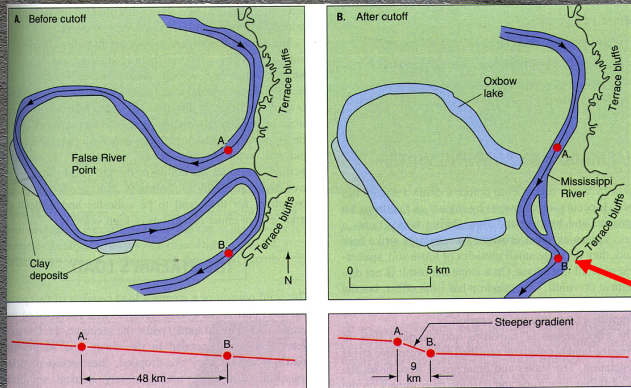
The Mississippi River and State Borders

ARKANSAS

LOUSIANA

MISSISSIPPI

NEW ORLEANS

Vicksburg

➢Mississippi used to choose its path
➢and people drew borders along it
➢now M. is straight/borders crooked

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Changing the MISS Discharge: Human vs River

➢ Mississippi used to choose its path
➢ now people choose it
➢ shorten but steepen longitudinal profile
➢ increase flow speed as well as erosion/load ← more discharge!
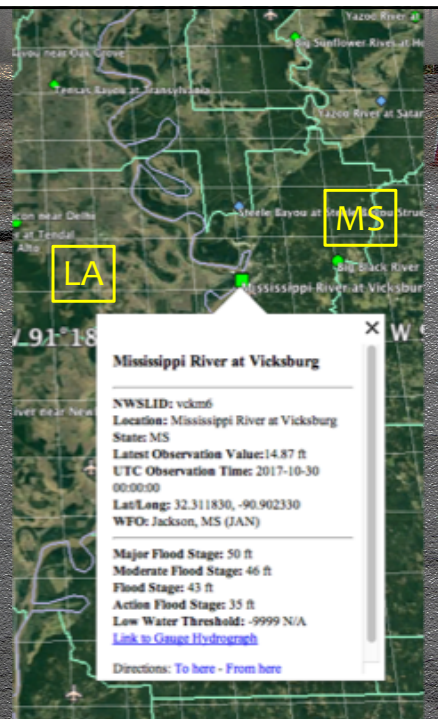➢ risk of flooding EVERYWHERE downstream

A. Before cutoff
False River Point
Clay deposits
Terrace bluffs
N
A.
B.
48 km

B. After cutoff
Oxbow lake
Mississippi River
Terrace bluffs
0   5 km
Steeper gradient
A. B.
9 km

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Mississippi River Gages

next slide:
River gage at Vickburg

MS
LA

Mississippi River at Vicksburg

NWSLID: vckm6
Location: Mississippi River at Vicksburg
State: MS
Latest Observation Value: 14.87 ft
UTC Observation Time: 2017-10-30 00:00:00
Lat/Long: 32.311830, -90.902330
WFO: Jackson, MS (JAN)

Major Flood Stage: 50 ft
Moderate Flood Stage: 46 ft
Flood Stage: 43 ft
Action Flood Stage: 35 ft
Low Water Threshold: -9999 N/A
Link to Gauge Hydrograph

Directions: To here - From here

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The 1927 Mississippi Flood
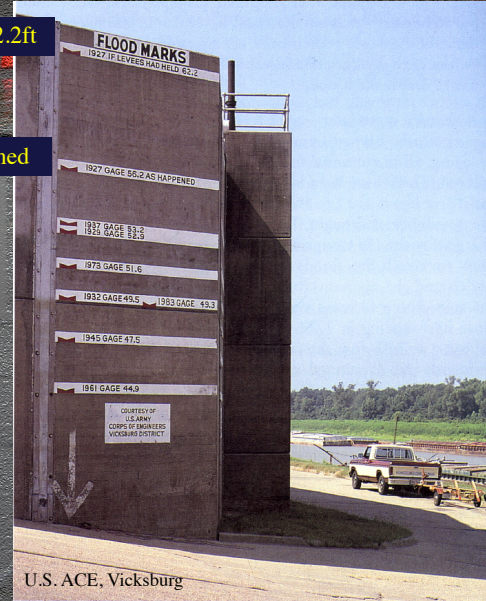
1927 if levees had held 62.2ft

1927 gage 56.2ft as happened

the short story
- flood breached levees in 225 places
- inundating 19,300 mi^2
  (1993: 12,500 mi^2)
- 183 fatalities

the long story:
- flood threatened New Orleans
- levee upstream dynamited
- sea 26,000 mi^2 in 7 states;
  18 ft deep; 80 mi across
- 246 deaths, maybe 500
- 650,000 homeless

U.S. ACE, Vicksburg
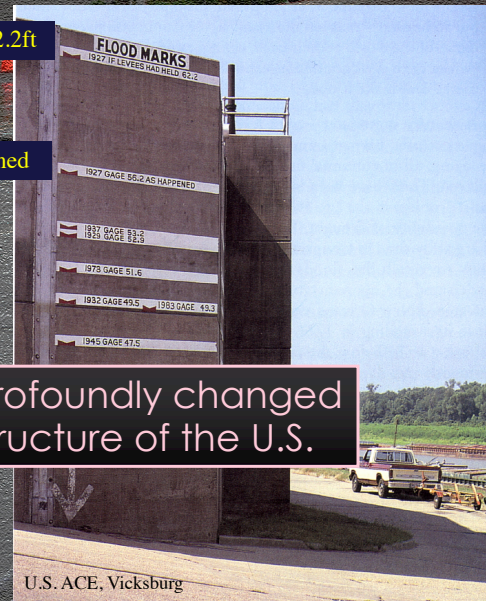
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The 1927 Mississippi Flood

1927 if levees had held 62.2ft

1927 gage 56.2ft as happened
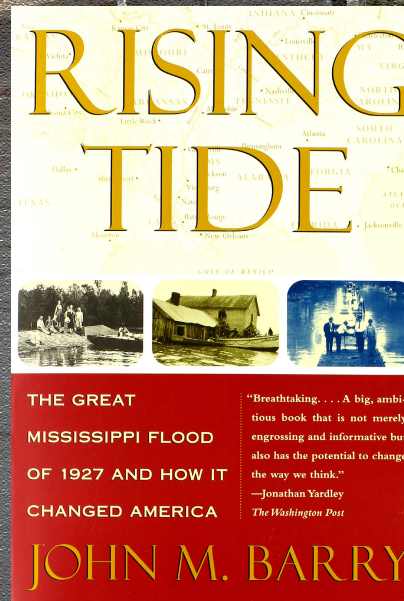
Great Migration:
6M people
to industrial North/Midwest
"Black Migration"

this event profoundly changed
the social structure of the U.S.

U.S. ACE, Vicksburg

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The 1927 Mississippi Flood

RISING TIDE

THE GREAT MISSISSIPPI FLOOD OF 1927 AND HOW IT CHANGED AMERICA

"Breathtaking. . . . A big, ambitious book that is not merely engrossing and informative but also has the potential to change the way we think."
—Jonathan Yardley
The Washington Post

JOHN M. BARRY

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Poll

Is dynamiting levees in the U.S. a thing of the past?

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The April – August 2011 Mississippi Flood

- comparable in size to 1927 and 1993
- 20 fatalities (300++ from other storms)
- $2 – 4 billion damage
- levee dynamited to save Cairo, IL (court-approved, 2-mi hole)
- agricultural land flooded in MO, KY
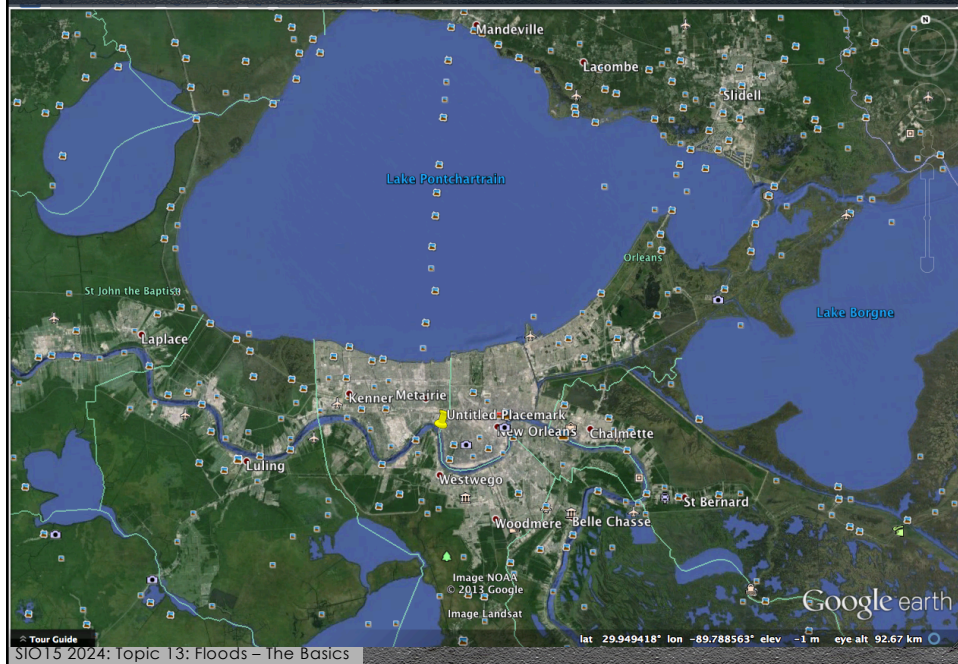- 200 homes in MO
- 9 Atchafalaya spillways opened

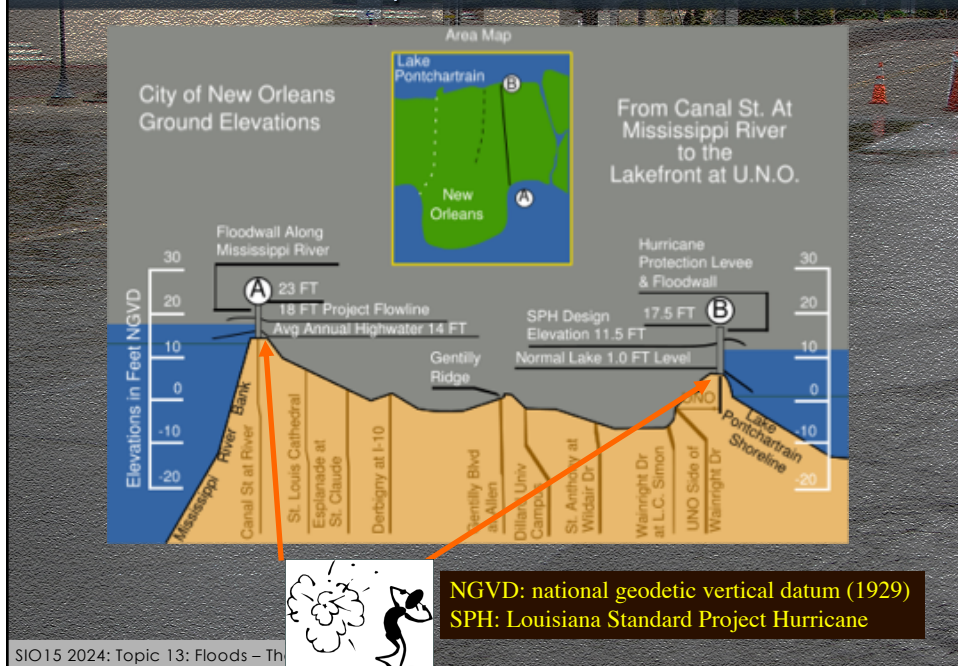SIO15 2024: Topic 13: Floods – The Basics

2005 Hurricane Katrina

- 2nd costliest nat disaster in U.S.
- 4th deadliest U.S. nat disaster
- some 1800 people perished

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2005 Katrina: The Impact of Levees – New Orleans

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2005 Katrina: The Impact of Levees – New Orleans

NGVD: national geodetic vertical datum (1929)
SPH: Louisiana Standard Project Hurricane

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2005 Hurricane Katrina

(AP Photo/Vincent Laforet, Pool)

Levee Breach
Floodwaters pour through a levee along Inner Harbor Navigaional Canal.

⬥first ever mandatory evacuation for New Orleans
⬥levees failed at 53 places, incl 3 key locations
⬥industrial canal served as funnel

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2005 Hurricane Katrina

photo: U.S. Coast Guard@wikipedia

⬥levees did not overtop
  ⬥culprit: shifting soil beneath
  ⬥-> levees failed below design specs
  ⬥some levees moved as much as 12 m

"the worst civil engineering disaster in American history"

⬥Dec 2007: first street car back
⬥Dec 2008: first RED street car back
⬥Jul 2009: post-Katrina repairs on
   Canal St. Line -> busses
"Mardi Gras was never cancelled"
⬥2010: areas not flooded: fully repopulated
⬥2016: ?? did everybody move back?

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2005 Hurricane Katrina – Lower 9th Ward
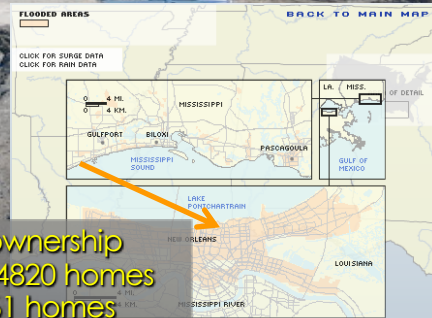
Friday Oklahoma National Guard Maj. Tim King checks a flooded neighborhood in New Orleans' Ninth Ward. (AP Photo/Charlie Riedel)

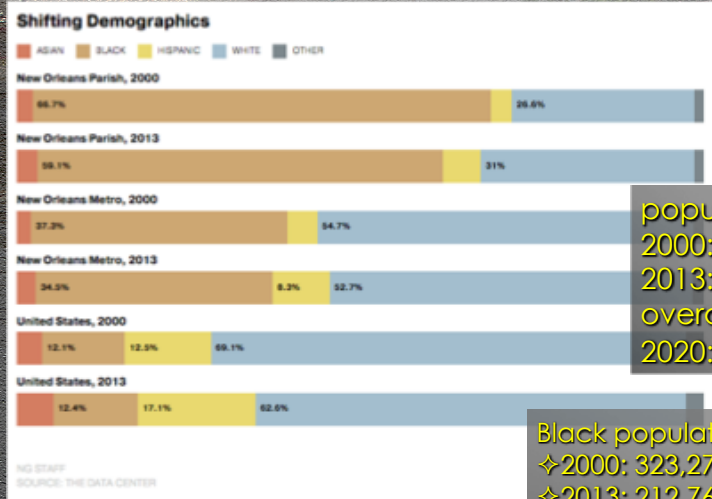SIO15 2024: Topic 13: Floods – The Basics

2005 Hurricane Katrina

this event brought profound changes to New Orleans

✧9th Ward: highest % of Black home-ownership
✧2000: 14,008 people; 3,467 families; 4820 homes
✧2010: 2,842 people; 683 families; 1061 homes

New Orleans Demographics

Shifting Demographics

ASIAN BLACK HISPANIC WHITE OTHER

New Orleans Parish, 2000

New Orleans Parish, 2013

New Orleans Metro, 2000

New Orleans Metro, 2013

United States, 2000

United States, 2013

population:
2000: 485,000
2013: 360,000
overall: ¼ lost
2020: 384,000

Black population:
✧ 2000: 323,278
✧ 2013: 212,760
✧ more than 100,000 (1/3) did not return!
✧ 2020: 206,000

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FEMA – Disaster Relief

SD UNION TRIBUNE 10/10/19

Wealthy counties get more FEMA buyouts

Local and state governments decide where to use funds

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Teach to Here

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The Mississippi River Delta

➢Mississippi changes course every 100s – 1000s years
➢currently wants to go into Atchafalaya!!

Delta deposits	Deposit age (years)
A	4,400 – 5,300
B	3,600 – 4,600
C	2,700 – 3,900
D	2,200 – 2,800
E	700 – 900
F	500 – 1,200
G	0 – 500

Source: S. Marshak "Earth: Portrait of a Planet"
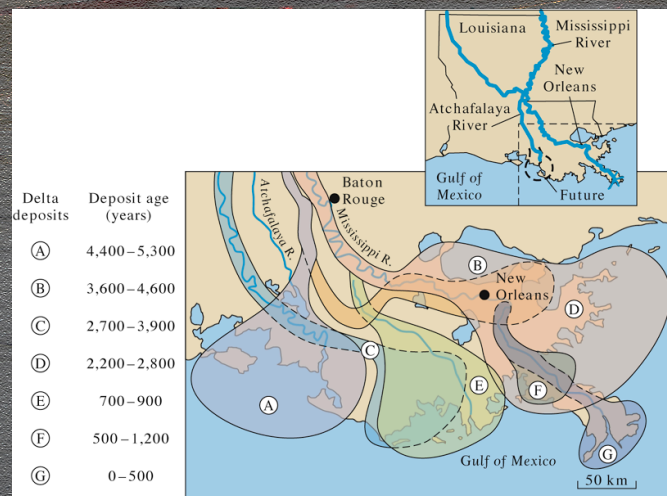
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Atchafalaya: Humans vs River, since 1831

Some history
- 1831 dig channel to by-pass "irritating" meander
- Old River remained active
- 1839 removed 30-mi log jam
  -> MISS wants to drain into Atchafalaya
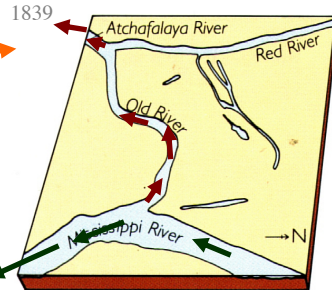- 1963: control structures (30%A/70% MISS)
- barely survives floods

New Orleans (Mardi Gras) ← Baton Rouge (transport)

Washington Post
"…Who will win as this slow-motion confrontation between human and nature goes on? …If we had to bet, We would bet on the river…."

Missi: "I wanna go there!"

Humans: "You go there!"

1830 — Atchafalaya River, Log Jam, Red River, Mississippi River, Channel, S, N

1839 — Atchafalaya River, Red River, Old River, Mississippi River, N
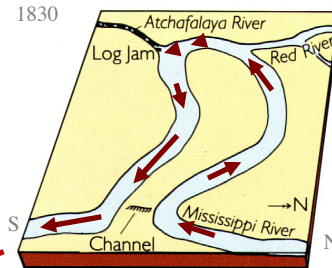
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Poll

Does a river delta ever change its shape?

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Update - Six Ways a Levee can Fail

- overtopping
- wave attack
- slumping
- piping

- shifting/weak soil beneath
- dynamiting

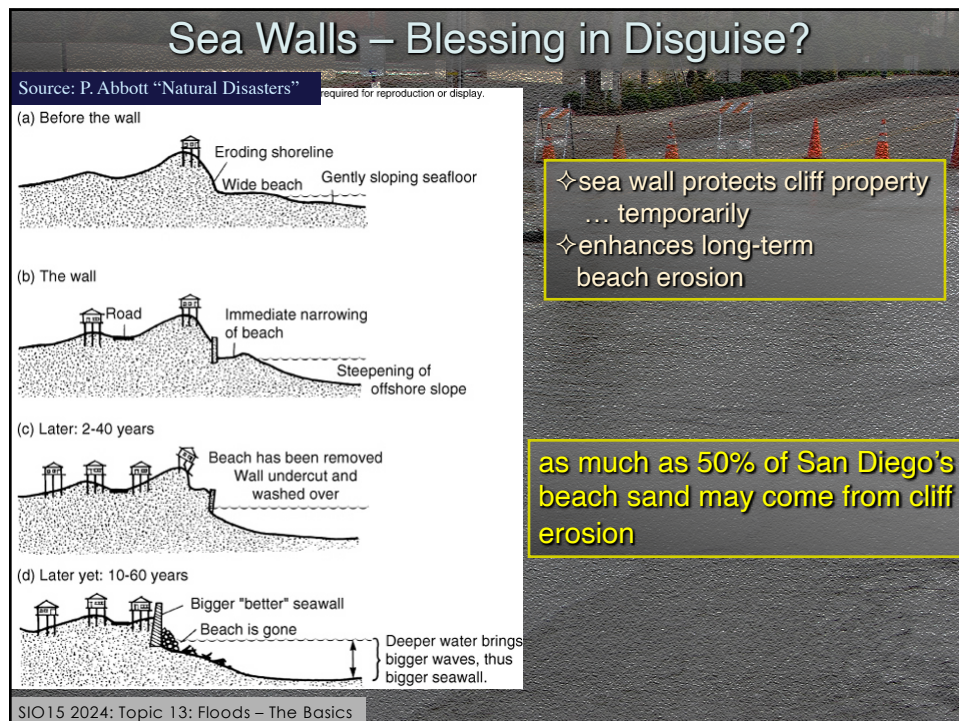SIO15 2024: Topic 13: Floods – The Basics

2005 Hurricane Katrina

severe coastal erosion and damage to wetlands

October 15, 2004   September 16, 2005

photo: MODIS/NASA@wikipedia

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Mississippi Delta Wetlands

➢ canals change MISS course
➢ wetlands cut off from MISS sediments!
➢ wetlands/bayous disappear/drown
➢ accelerated subsidence

$18 Billion to restore wetlands

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Sea Walls – Blessing in Disguise?

Source: P. Abbott "Natural Disasters"

(a) Before the wall
- Eroding shoreline
- Wide beach
- Gently sloping seafloor

(b) The wall
- Road
- Immediate narrowing of beach
- Steepening of offshore slope

(c) Later: 2-40 years
- Beach has been removed
- Wall undercut and washed over

(d) Later yet: 10-60 years
- Bigger "better" seawall
- Beach is gone
- Deeper water brings bigger waves, thus bigger seawall.

◇ sea wall protects cliff property … temporarily
◇ enhances long-term beach erosion

as much as 50% of San Diego's beach sand may come from cliff erosion

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Levees: PROs/CONs – Understanding Flood Risks

PROs:
prevent local/immediate flood damage

1) Levees, seawalls and dams have limited live time
2) …. may be poorly built or sit on unstable ground

CONs:
◇ building/maintenance costs > value of protected structure ?
◇ false sense of security -> increase development
◇ people live their against "common sense"
   -> tax money for disaster relief/rebuilding?