Sediment Transport in the Mississippi River

Mead Allison and Barb Kleiss,
Tulane University

Historical Context – Meade and Moody

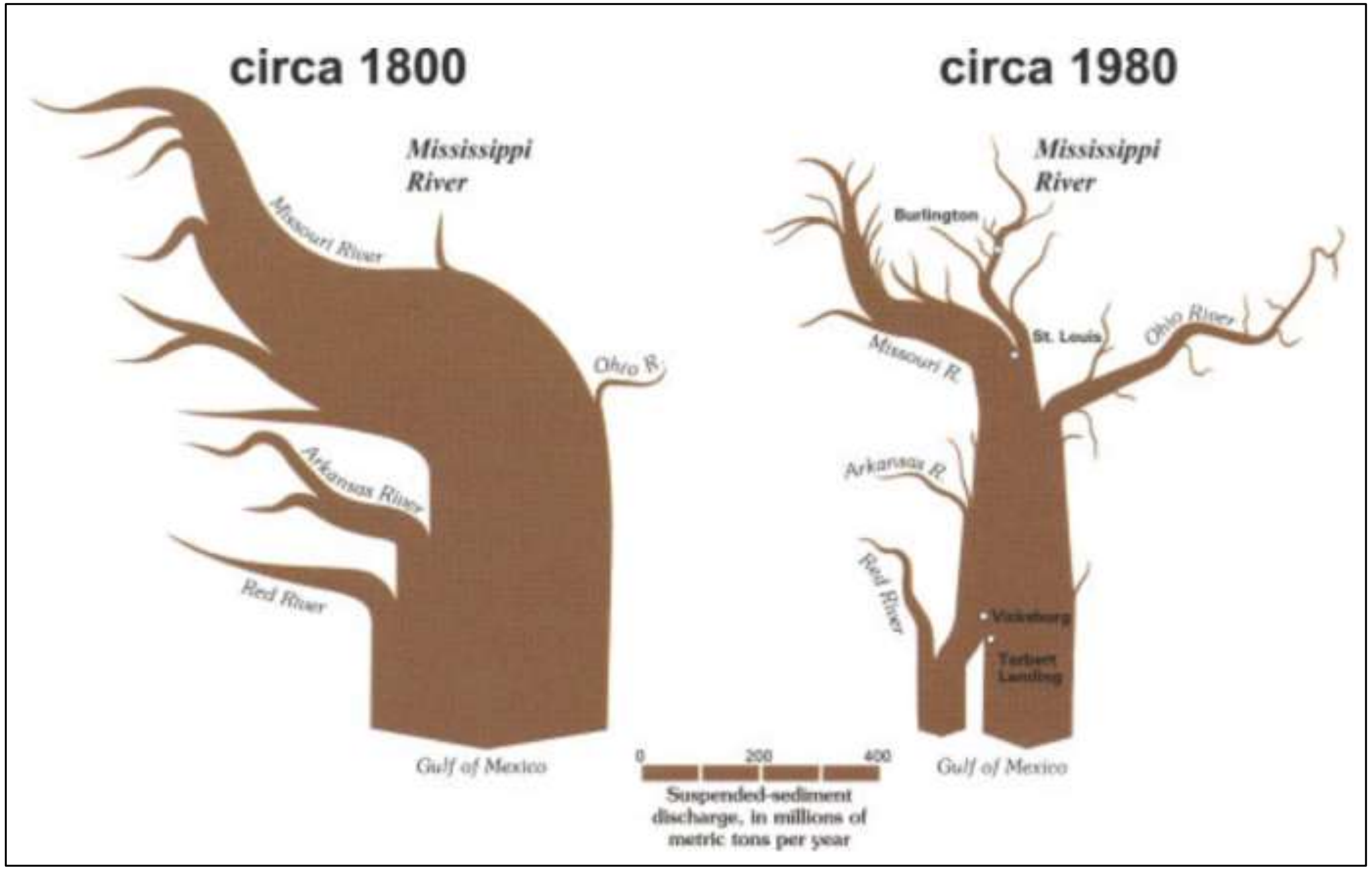


Figure 3. Flow diagrams of average annual suspended-sediment discharges in Missouri–Mississippi River basin. *Left, circa* 1800. *Right, circa* 1980. Diagrams were originally published by Meade (1995). Diagram for 1800 is an impressionistic estimate, based on our readings of the Journals of Lewis and Clark (Moody *et al*., 2003), results of Humphreys and Abbot (1876), observations reported by Mark Twain (1883) and on more recent analyses (Blevins, 2006) that concluded sediment concentrations in the Missouri River have decreased at least 70–80% from predevelopment conditions.

R. H. Meade and J. A. Moody. 2009. **Causes for the decline of suspended-sediment discharge in the Mississippi River system, 1940-2007** Hydrological Processes. https://dx.doi.org/10.1002/hyp.7477

Missouri River Reservoirs & Dams

The six reservoirs have a combined 73.4 million acre feet of storage. Lake Oahe is the largest reservoir in the US at 578 mi^2 and a maximum depth of 205 ft. And has the fourth greatest volume.

Missouri River Contributions – Allison, 2017

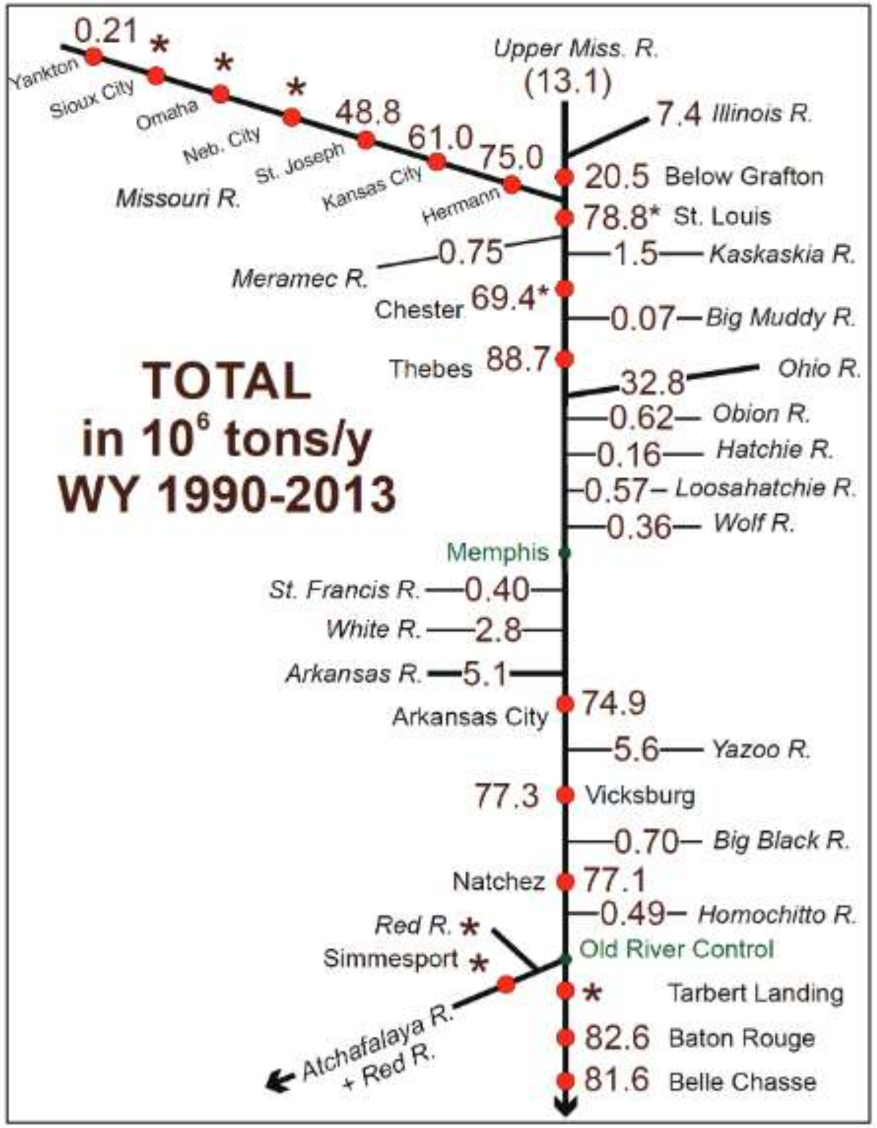
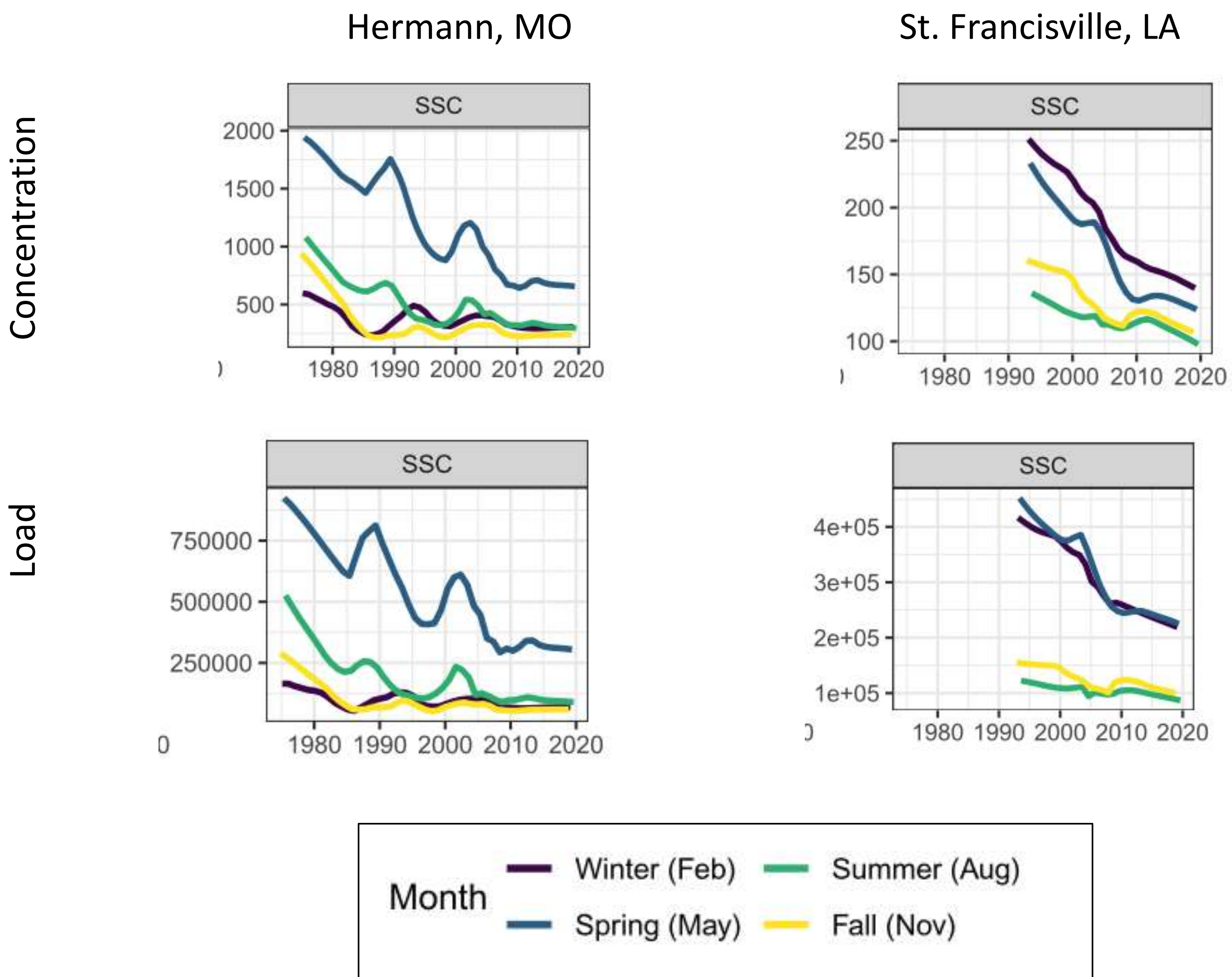


Figure 8. Annual average total suspended loads (computed in 106tons/yr) for Mississippi River stations and Missouri River stations (red circles) and tributary inputs in the reach from St. Louis, MO, to Louisiana integrated for the period of WY 1990–2013. Asterisks in the Missouri River refer to insufficient sediment data to calculate a load and in the Red River, Simmesport, LA, and Tarbert Landing, MS, stations refer to incomplete data analysis by the station operator(s). Asterisks at St. Louis, MO, and Chester, MO, refer to the interpretation that the data are over such a limited time frame (WY 2010–2014) that it impacts the load calculated.

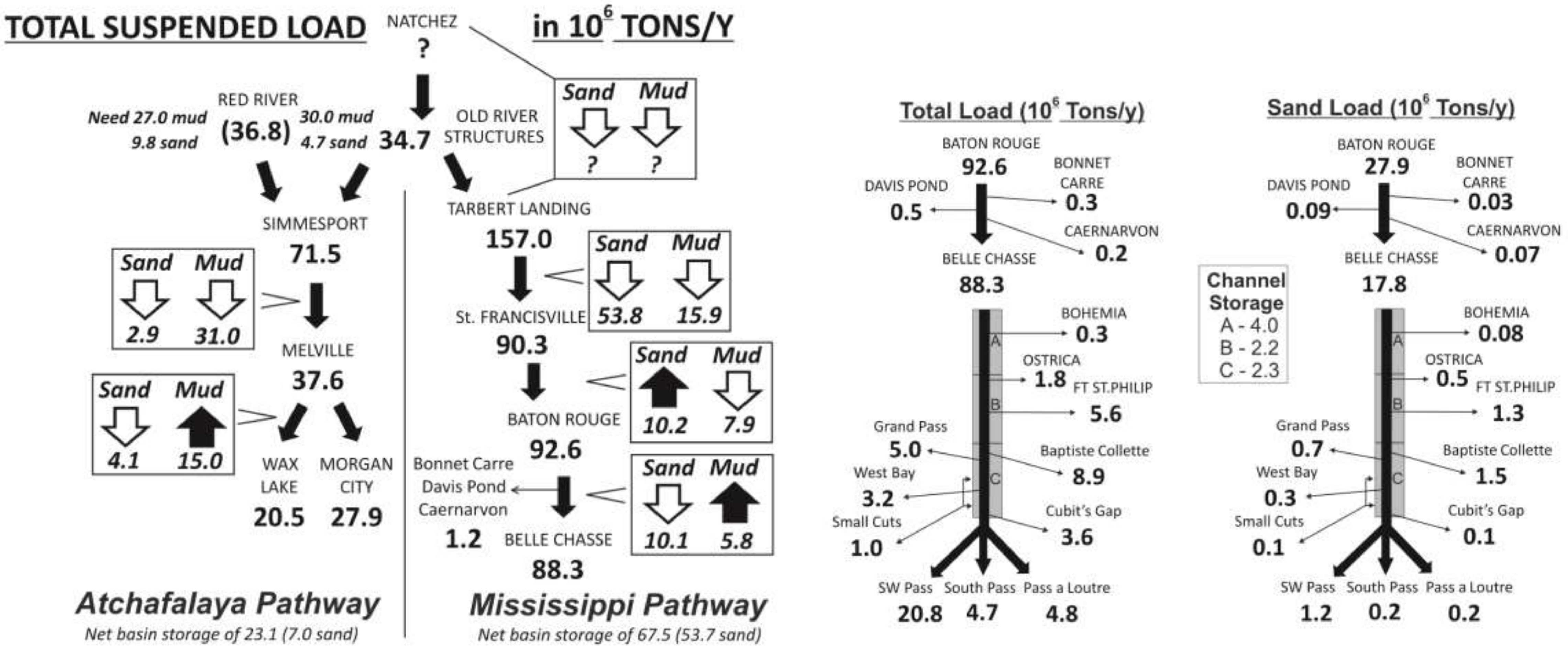
Allison, M., Biedenharn, D., Little, C., 2017. Suspended sediment loads and tributary inputs into the Mississippi River below St. Louis, MO, 1990–2013 : A comparison with the Keown et al. (1981) report.. doi:10.21079/11681/22782

Historical Context – Kleiss et al.



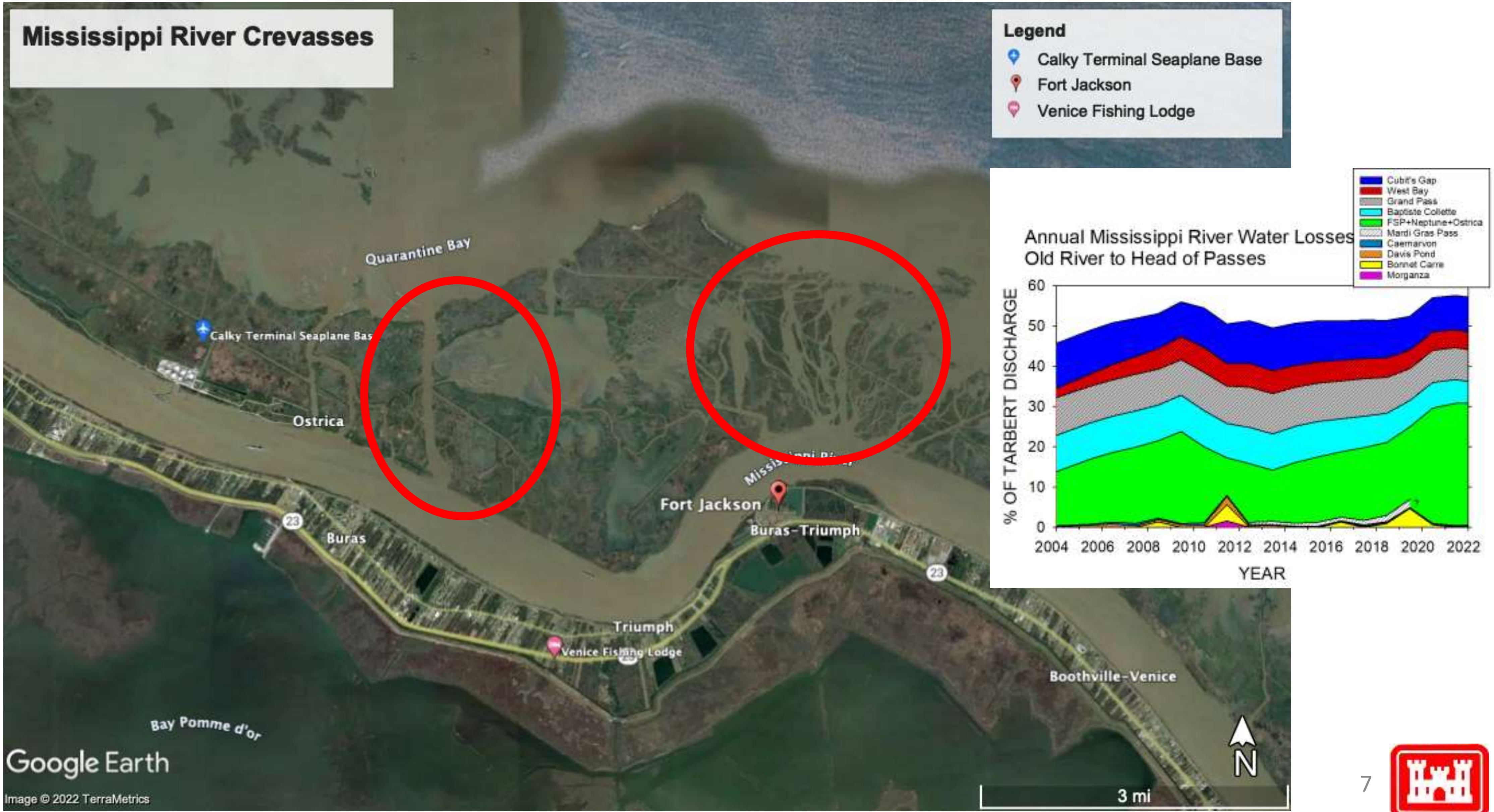
B. A. Kleiss, J. C. Murphy, C. M. Mayne, J. P. Allgeier, A. B. Edmondson, K. C. Ginsberg, et al. 2021. Incorporating Water Quality Analysis into Navigation Assessments as Demonstrated in the Mississippi River Basin. J. of Waterway, Port, Coastal, and Ocean Engineering 2021 Vol. 147 Issue 5 Pages 04021022. DOI: 10.1061/(asce)ww.1943-5460.000651

Context – Allison et al., 2012 SEDIMENT



M. A. Allison, C. R. Demas, B. A. Ebersole, B. A. Kleiss, C. D. Little, E. A. Meselhe, et al. 2012. **A water and sediment budget for the lower Mississippi–Atchafalaya River in flood years 2008–2010: Implications for sediment discharge to the oceans and coastal restoration in Louisiana.** Journal of Hydrology 2012 Vol. 432-433 Pages 84-97 DOI: 10.1016/j.jhydrol.2012.02.020 https://doi.org/10.1016/j.jhydrol.2012.02.020

Context – Current Conditions



Context – Suspended Sediment Leaving the Passes

Context – Suspended Sediment Leaving the Passes

Total Suspended Sediment Discharge
(10^3 tons/d)
USGS Belle Chasse
4/25-4/27/2022

Head of Passes

SW Pass Entrance	South Pass Entrance	Pass a Loutre Entrance
90.9	20.6	15.0

SW Pass Exit	South Pass Exit	Pass a Loutre Entrance
18.2	0.7	0.8

Sand Suspended Sediment Discharge
(10^3 tons/d)
USGS Belle Chasse
4/25-4/27/2022

Head of Passes

SW Pass Entrance	South Pass Entrance	Pass a Loutre Entrance
5.4	3.5	2.0

SW Pass Exit	South Pass Exit	Pass a Loutre Entrance
1.5	0.2	0.02

Relevance

MPRnews SECTIONS MEMBERS MORE

ON AIR 0:00
The Splendid Table with Francis Lam

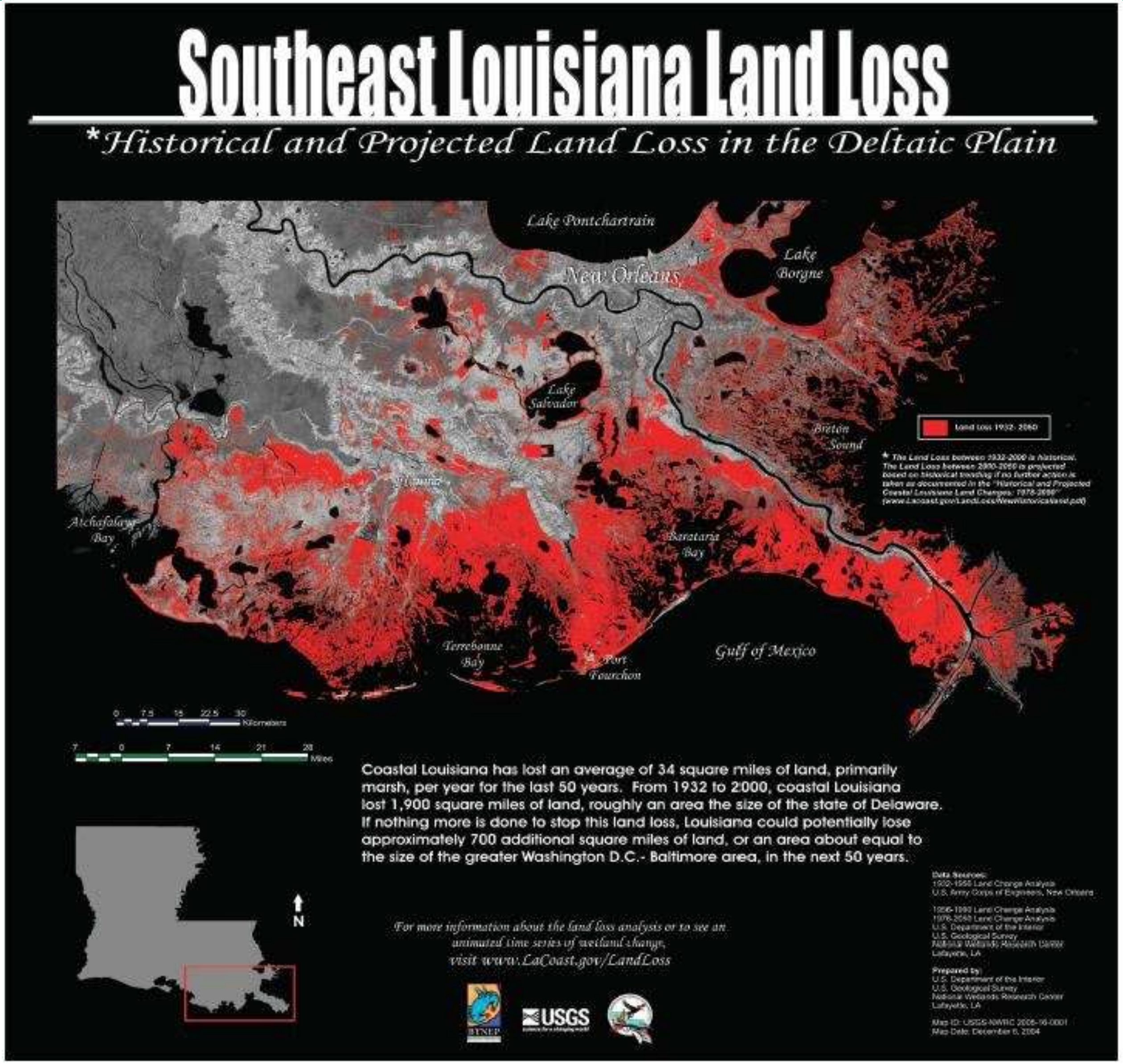
Water

Tiny particles, costly problem: Too much sediment in Upper Mississippi River

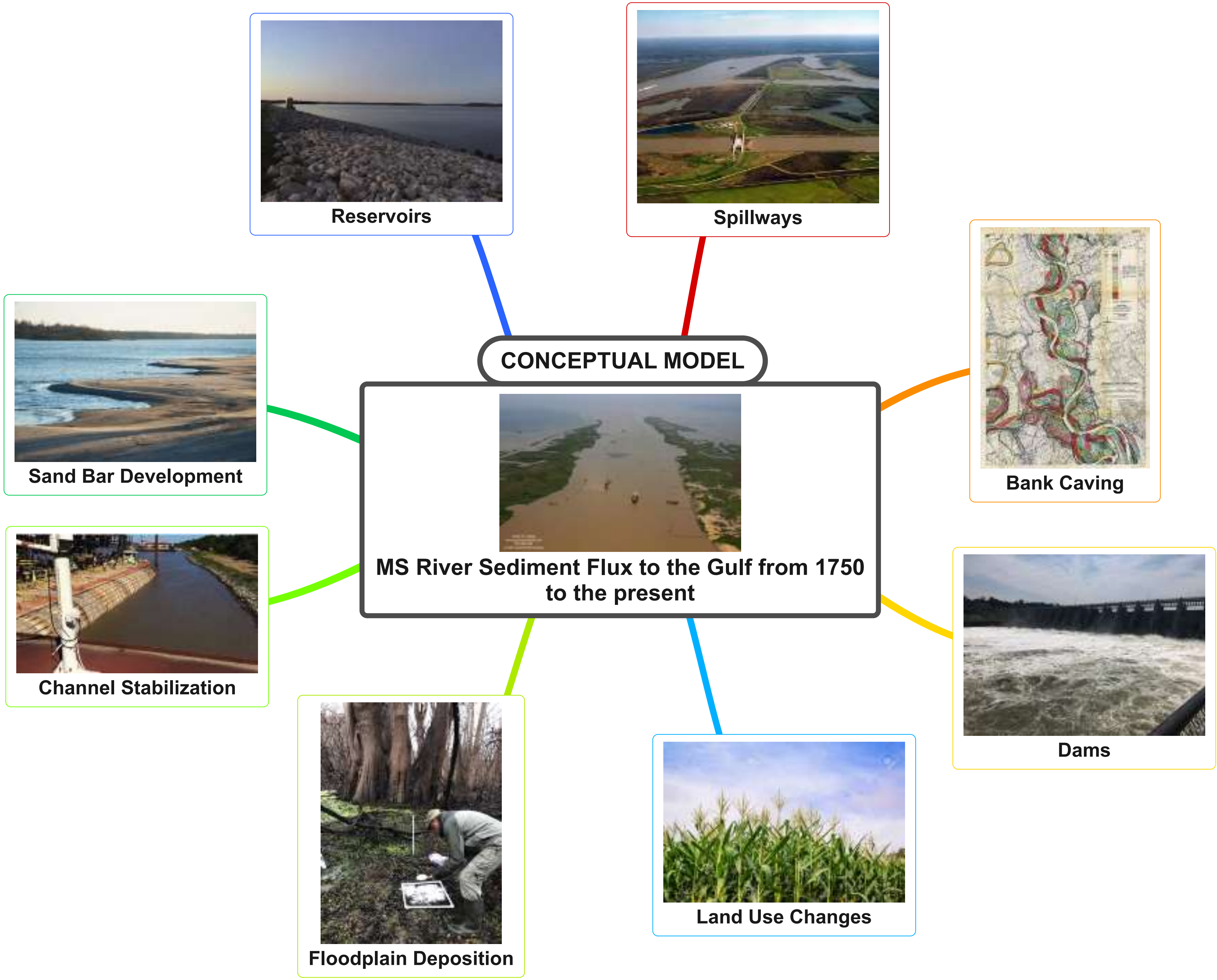
Kirsti Marohn Brainerd, Minn. August 20, 2020 10:04 AM

https://www.mprnews.org/story/2020/08/20/tiny-particles-costly-problem-too-much-sediment-in-upper-mississippi-river

Relevance



Southeast Louisiana Land Loss
*Historical and Projected Land Loss in the Deltaic Plain
Lake Pontchartrain
New Orleans
Lake Borgne
Lake Salvador
Breton Sound
Atchafalaya Bay
Barataria Bay
Terrebonne Bay
Port Fourchon
Gulf of Mexico
Kilometers
Miles
N
Coastal Louisiana has lost an average of 34 square miles of land, primarily marsh, per year for the last 50 years. From 1932 to 2000, coastal Louisiana lost 1,900 square miles of land, roughly an area the size of the state of Delaware. If nothing more is done to stop this land loss, Louisiana could potentially lose approximately 700 additional square miles of land, or an area about equal to the size of the greater Washington D.C.- Baltimore area, in the next 50 years.
For more information about the land loss analysis or to see an animated time series of wetland change, visit www.LaCoast.gov/LandLoss
Prepared by:
U.S. Department of the Interior
U.S. Geological Survey
Lafayette, LA
USGS


CONCEPTUAL MODEL
MS River Sediment Flux to the Gulf from 1750 to the present
Reservoirs
Spillways
Bank Caving
Dams
Land Use Changes
Floodplain Deposition
Channel Stabilization
Sand Bar Development

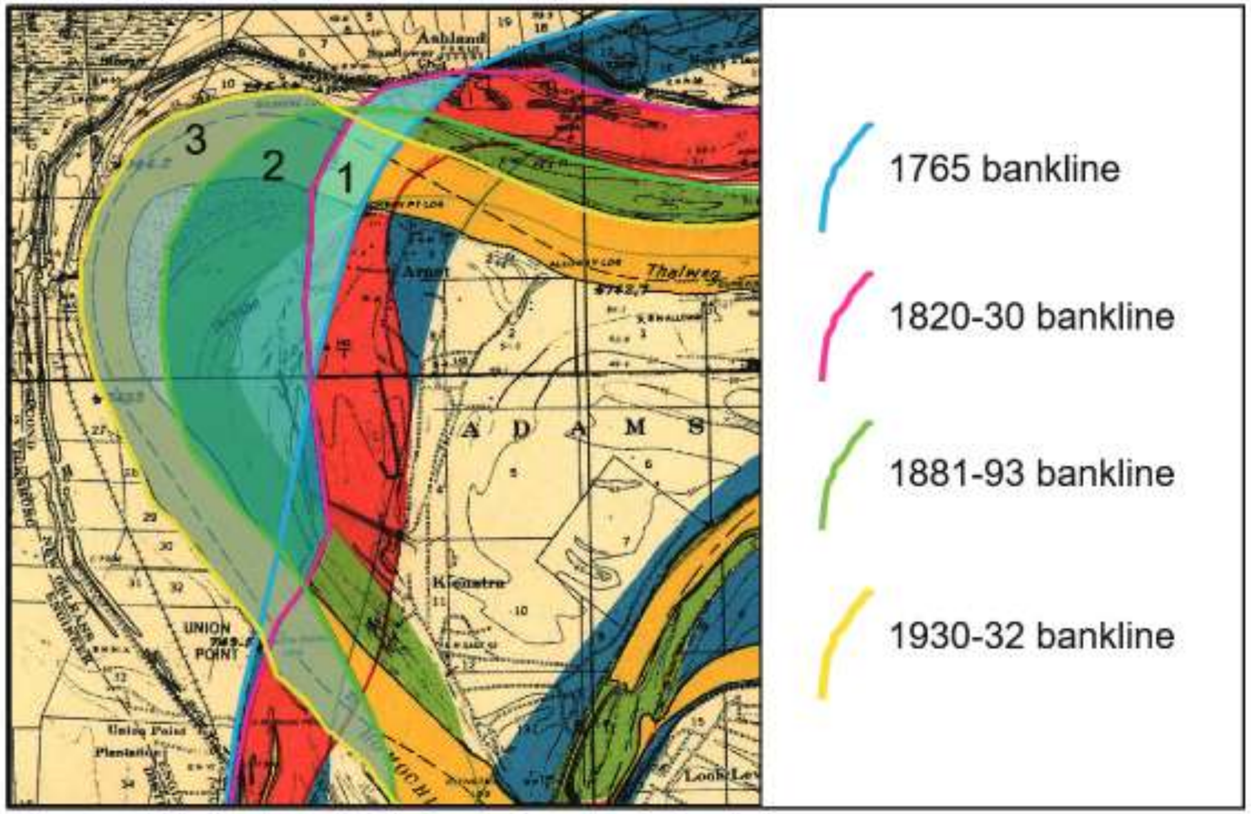
Channel Stabilization

361 miles of revetment in New Orleans District alone

https://www.waterwaysjournal.net/2020/02/14/corps-revetment-team-looks-to-the-future/

Bank Caving – Murray and Biedenharn, 2022

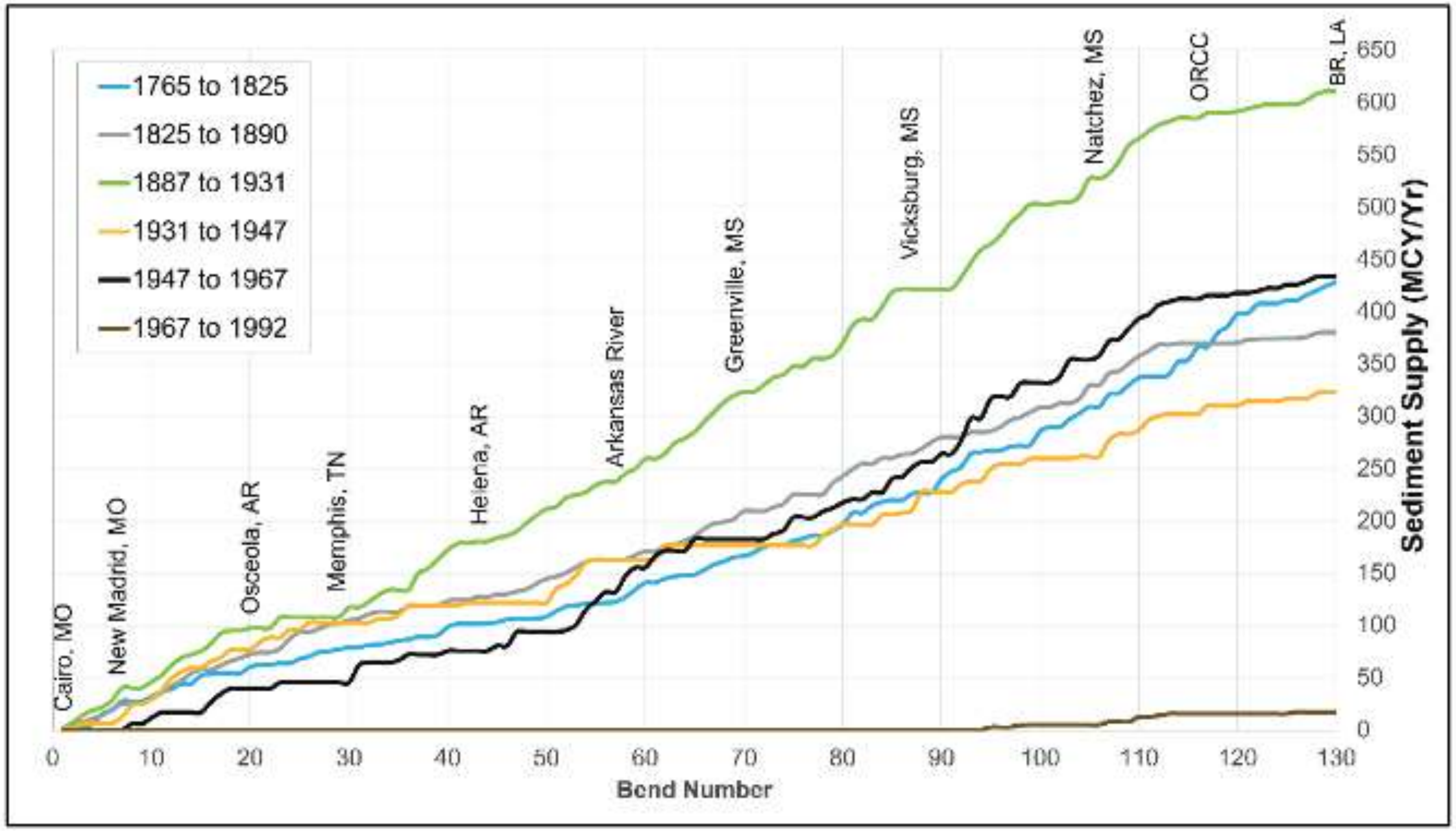
Figure 2. Bank line digitization for each river bend through time (shown in colors) at Jackson Point Bend in Mississippi. Polygons are drawn between corresponding banklines to calculate the area eroded through time (in square feet per year). Polygon 1 is for the 1765 to 1820–30 bankline comparison while polygons 2 and 3 are for banklines 1820–30 to 1881–93 and 1881–93 to 1930–32, respectivley.



Murray, A., Biedenharn, D., 2022. Sediment supply from bank caving on the Lower Mississippi River, 1765 to present.. doi:10.21079/11681/45281

Bank Caving – Murray et al.

Figure 6. Cumulative plot using the median bank height by reach for the six time periods.



Approximately 96% reduction in the amount of total sediment supplied by bank erosion

Murray, A., Biedenharn, D., 2022. Sediment supply from bank caving on the Lower Mississippi River, 1765 to present.. doi:10.21079/11681/45281

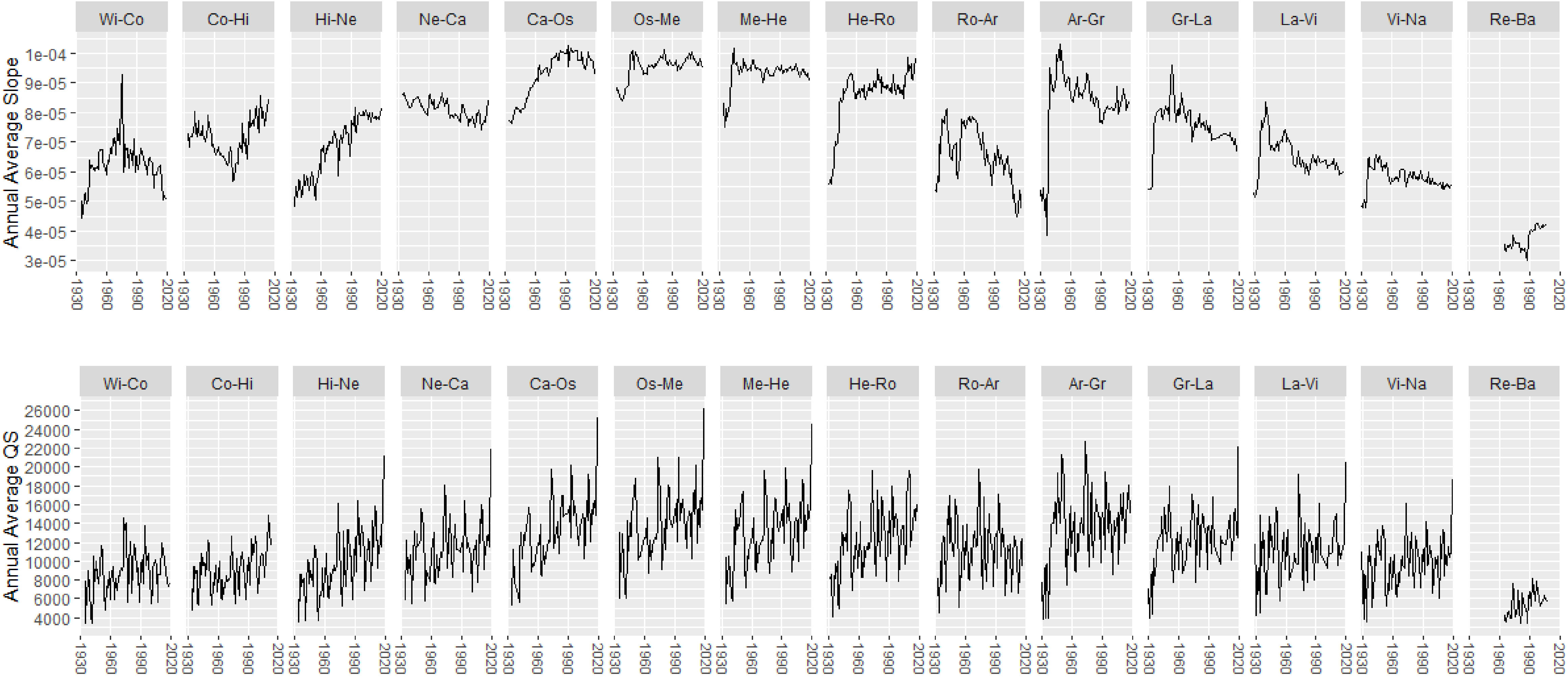
Spillways

Diverts river water through Lake Pontchartrain in order to keep flow past New Orleans less than 1.25 million cfs

Diverts 30% of the latitudinal discharge (Mississippi + Red River) through the Atchafalaya River

The Advocate: Travis Spralding

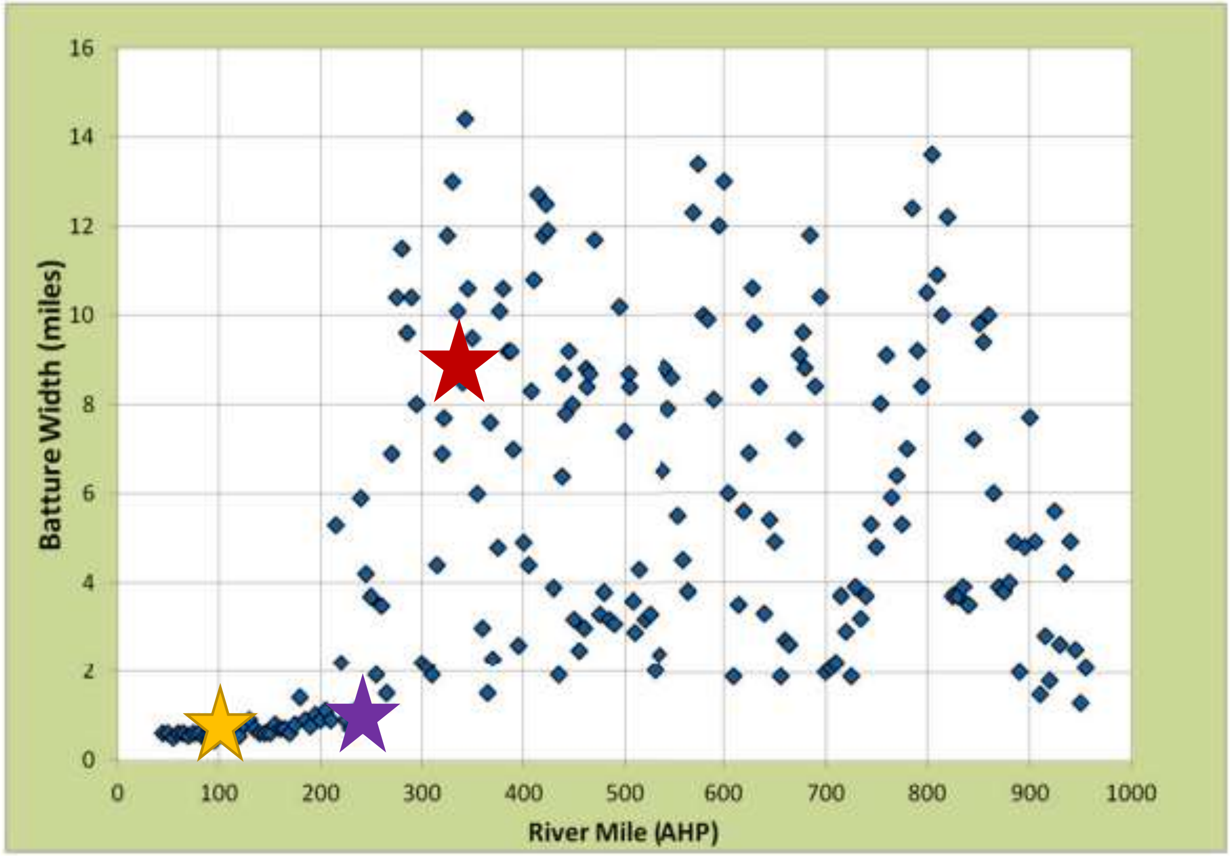
Stream Power Changes - Jones and Biedenharn



Jones and Biedenharn, 2021

Floodplain Deposition

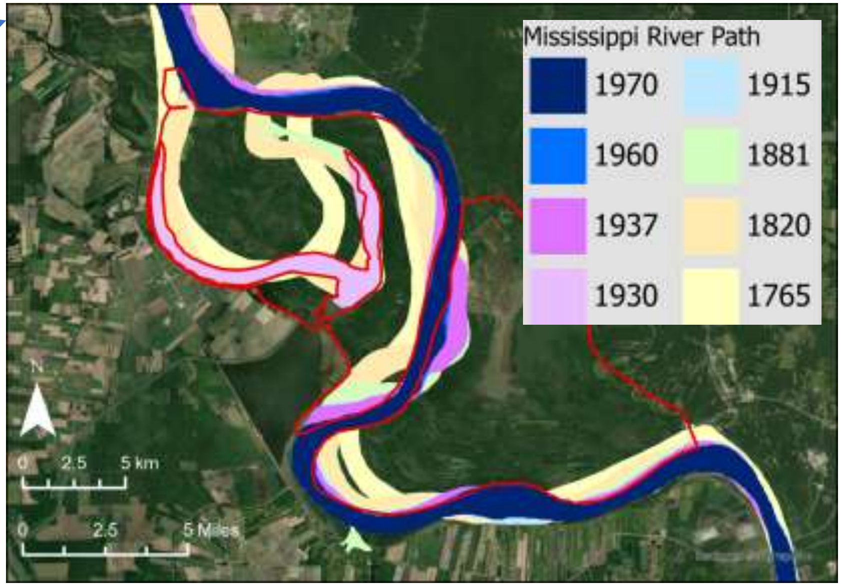
- 300 MT decrease in suspended sediment load (Meade and Moody, 2009).
- 73% decrease in floodplain area below Cairo, IL (Oswalt, 2013).
- Floodplains provide:
  - Flood relief
  - Ecosystem benefits
  - A sink or source of a river's suspended sediment load and associated contaminants.



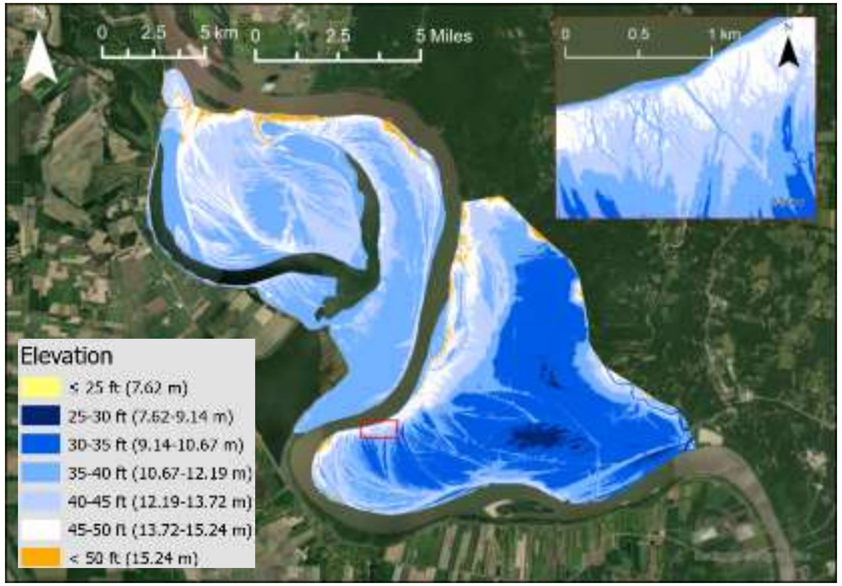
- New Orleans, LA
- Baton Rouge, LA
- Old River Control Complex

Modified from Biedenharn et al., 2018.

Study Area



Modified from Clifford and Harmar, 2006.

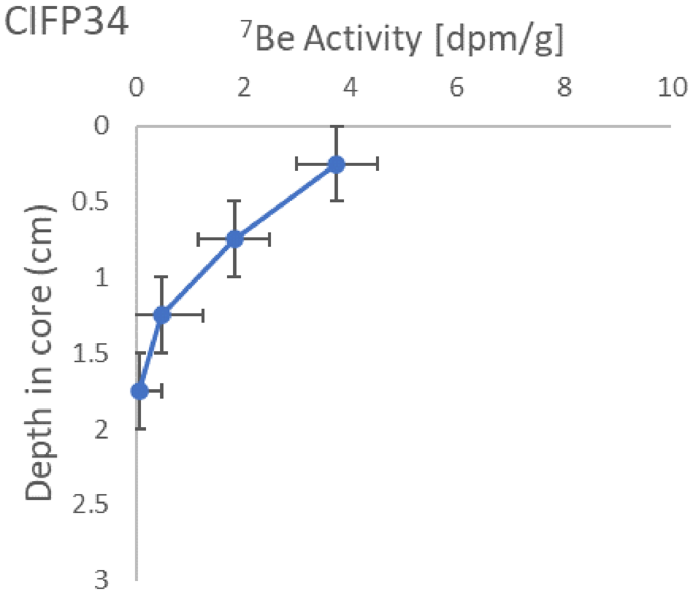


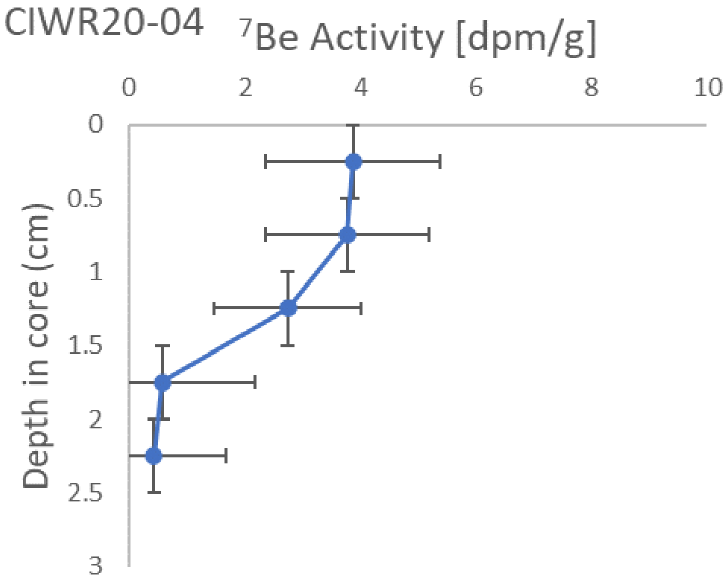
Louisiana Atlas, 2009.

Field Methods

Feldspar Plots:





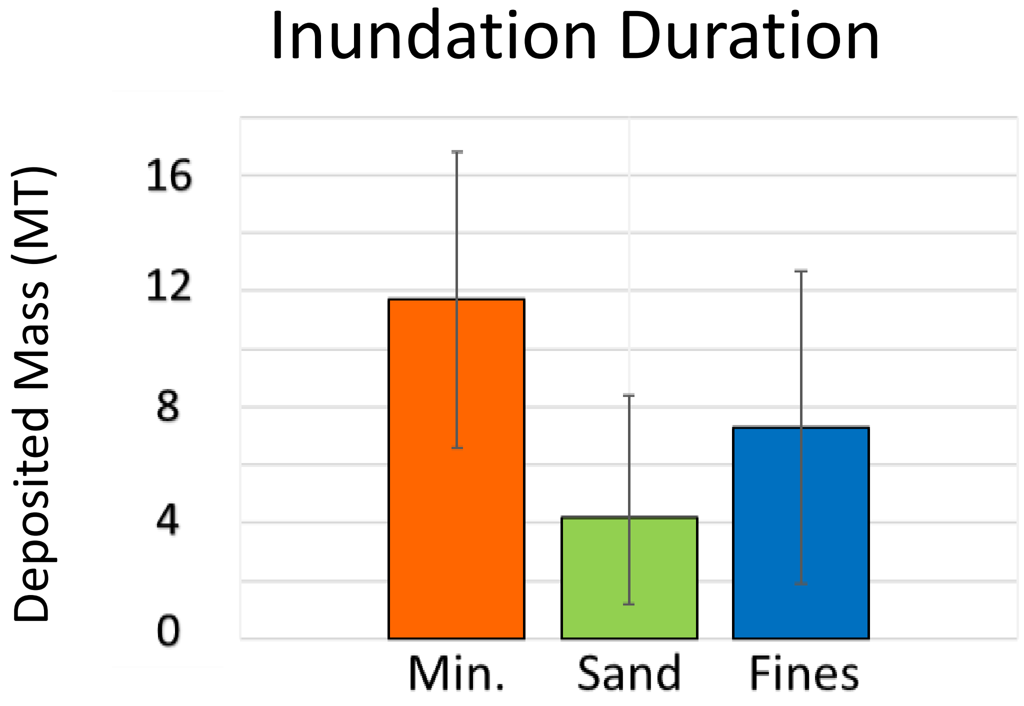


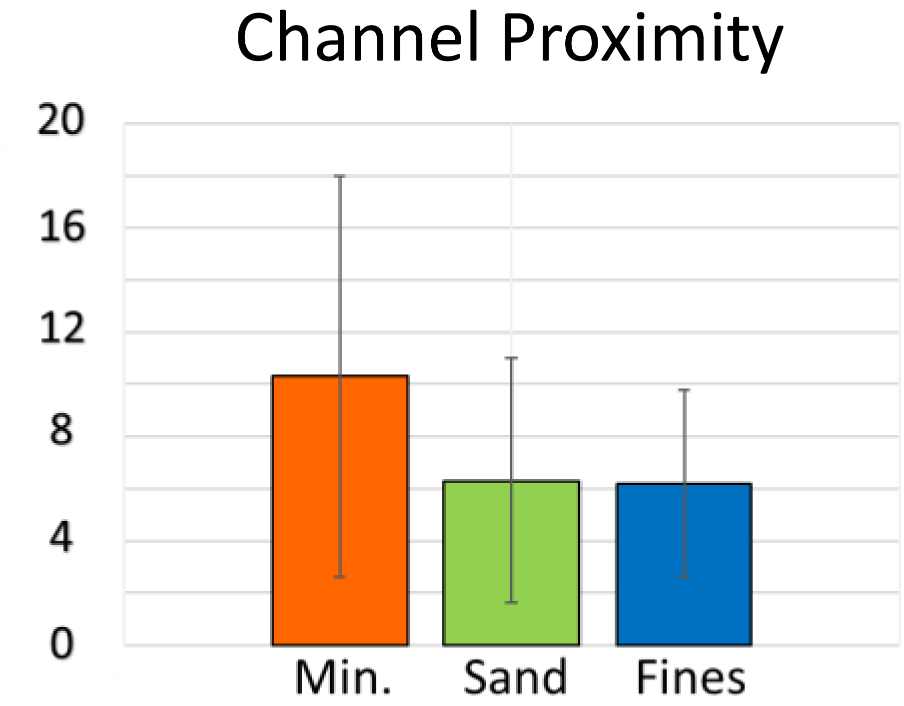
^{7}Be:

- Atmospherically produced cosmogenic nuclide.
- 53 day half life.
- Adsorbs onto fine particles during riverine transport.

Deposit Masses

WY 2021





- Mineral Sediment Deposit Mass: 10.3-11.7 MT
  - Sand: 4.2-6.3 MT
  - Fines: 6.7-7.3 MT

- 2 Superdomes of Sediment

Concluding Thoughts

LMR Broad Scale Regime Trends

Acknowledgments

US Army Corps of Engineers

USGS
science for a changing world