Review of

Hydrologic modification and channel evolution degrades connectivity on the Atchafalaya River floodplain. Earth Surf. Process. Landforms. 2022;47:1790–1807.

Authors: Daniel E. Kroes, Charles R. Demas, Yvonne A. Allen, Richard H. Day, Steven W. Roberts, Jeff Valrico. 2022.

and

Sediment Trapping and Carbon Sequestration in Floodplains of the Lower Atchafalaya Basin, LA: Allochthonous Versus Autochthonous Carbon Sources. Journal of Geophysical Research: Bio geosciences

Authors: Cliff R. Hupp, Daniel E. Kroes, Gregory B. Noe, Edward R. Schenk, and Richard H. Day. 2019

By

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INTRODUCTION

These manuscripts will be reviewed individually although there are a couple of important links. Also, one contradicts the other. They have been put forward as supporting benefits of the East Grand Lake project recently proposed by CPRA. My analysis concludes that they do not support the proposed project.

REVIEW OF KROES ET AL. (2022)

Kroes et al. (2022) in their Abstract claim that:-

"Our results indicate that much of the floodplain no longer receives headwater discharge (upstream to down-stream, > 200 km2) or receives too little discharge to alleviate stagnancy and hypoxia in the forested wetland at lower stages. Large portions of the Basin (400 km2) have low water levels controlled by channel geomorphology and sea-level rise that inundate the forested floodplain for more than 50% of the calendar year. This extended duration of inundation contributes to hypoxia and likely reduces nutrient retention."

"The confinement of discharge to a large efficient channel (Atchafalaya River) compromises the ability of this system to respond to sea-level rise and subsidence."

However, there is no discussion of the geomorphological modifications in the Atchafalaya Basin due to both natural and man-made processes, or a full recognition of the changes in discharge regime being forced by the sediment infilling of the Basin (see van Heerden 2019a for example).

Additionally, no data is presented concerning hypoxia. This Kroes paper appears to be primarily focused on hydrology. In other words, this is purely an examination of the Basin hydrology in its current state and should not be used by CPRA or TNC to support conclusions as to either the causes or the effects of the hydrologic conditions of the Basin. Rather it is an observation of the flow in and out of the Basin without data or analysis on cause or effect.

SEDIMENTATION AND INFILLING OF THE BASIN

Ample evidence exists that the Atchafalaya Basin Floodway is rapidly infilling with sediment. See van Heerden 2019 for example. Against this background this review of Kroes etal (2022) is undertaken. Kroes et al. (2022) point out that the area of the Basin is some 5700 km^2 and that because of the flood-control guide levees, one along each side of the Basin, the Basin was basically cut into three distinct parts or segments. The Atchafalaya Basin, preconstruction of the Atchafalaya flood control levees (the so-called M R & T guide levees), was almost twice its present size (van Heerden 2019a). As depicted in Figure 1, the guide levees crossed open water and swamp. Basically, it would appear that two lines were drawn on a map, each being a guide levee, without any consideration of the environmental and ecological impacts. Thus, construction of the control structure at Old River and the flood control 'role' given the Basin has meant that the sediment load of the Atchafalaya River has now only half the area it used to have to be 'spread out,' thus with the same load as before means twice the potential sedimentation rate across the Basin (van Heerden 2019a). So, from 1955 onwards the US Army Corps of Engineers

(COE) very effectively altered the river basin's physics setting up a change in the physical environment with its attendant biological responses. The authors do acknowledge that no Atchafalaya River sediment is being deposited outside of the Floodway Guide levees, but do not acknowledge the consequence of this major Basin modification on the Floodway itself. The East Grand Lake project is within the Floodway part of the Basin.

The authors state that the Basin traps 12.5 billion kg of sediment annually. So, if the original area of the Basin was 5,700 sq km and the floodway is about half or 2800 sq km and given the 12.5 billion kg of sedimentation each year means on average of 4.4 million kgs deposited per square km which ~ 4.5 kg/m^2. A very high sedimentation rate! Very effectively the activities of man are filling in the Flood Way Basin, reducing its capacity, decreasing the efficiency and potential for the floodway to hold flood waters – a real public safety issue (van Heerden 2019 a, b).

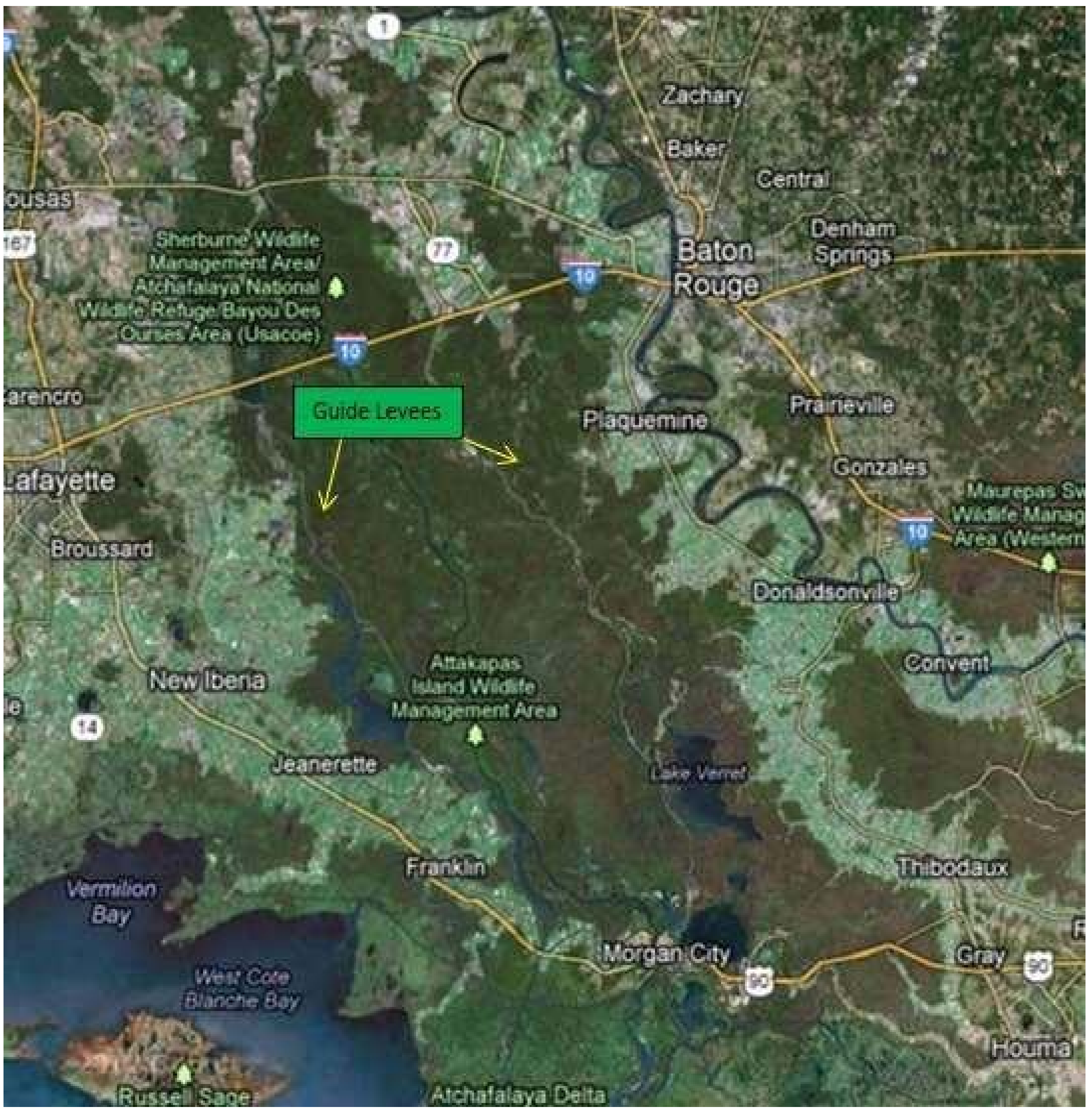

Figure 1. Atchafalaya Basin, south central Louisiana. Note the large area of swampland outside the M R & T guide levees.

If Kroes et al. (2022) so chose they could have looked at historic aerial photographs, charts and maps, and compared these to satellite imagery and more recently LiDAR data and seen for themselves just how much sedimentation has occurred in the Basin since 1955. However, the authors state the floodplain surface has been subsiding at a net rate of 4 to 41 mm/yr (derived from floodplain, bank, and spoil bank elevation loss). They seemingly imply that because it is subsiding, the area needs sediment input. Kroes et al (2019) also state that preliminary measurements of deposition within the hydrologically isolated area indicate a deposition rate of 2 to 8 mm/yr of highly organic sediment (Hupp et al., 2019 – reviewed below). This scenario Kroes et al (2022) claim would result in a 2 to 39 mm/yr sediment deficit without considering sea level rise. They use this conclusion to state that large areas of the Basin will convert to standing water and that these would become non-regenerative for trees, and thus more sediment needs to be introduced. So on one hand East Grand Lake supporters say the project <u>would not</u> introduce sediment to interior swamp basins and yet now Kroes etal 2022 claim sediment is needed?

But there appears to be a major flaw in their assumptions of subsidence rates and they also, as seen below, appear to misquote Hupp et al (2019).

DISCUSSION OF KROES ET AL (2022) CONCLUSIONS

The 2023 CPRA State Coastal Master Plan (CPRA, 2023), after extensive data review and assimilation contains two coastwise maps of total subsidence rates, one for a lower scenario (Figure 2) and one for a higher scenario (Figure 3).

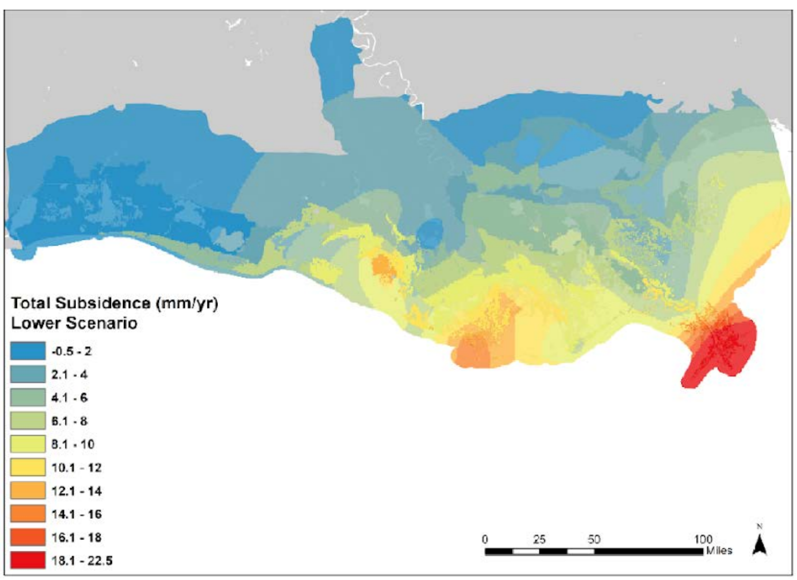

Figure 2. Coastwise map of total subsidence rates for the lower scenario.

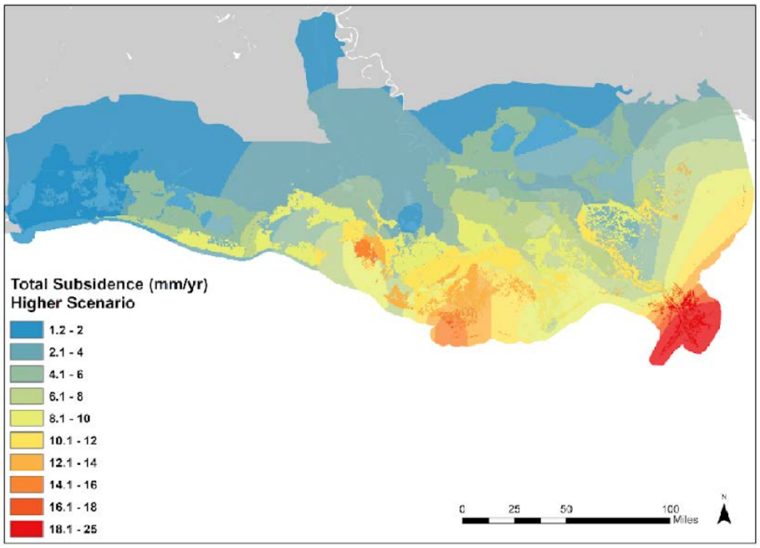

Figure 3. Coastwise map of total subsidence rates for the higher scenario.

CPRA (2023) used far more comprehensive data to determine subsidence rates than Kroes et al., and their data shows that no matter the subsidence scenario used, the total subsidence in the upper Basin is 1.2 to 2.0 mm/yr and the Lower Basin 2.1 to 4.0 mm/yr, much lower than the 4 to 41 mm/yr rate stated by Kroes et al. (2022). Thus, the official state of Louisiana (CPRA) data suggests that there would be net sediment accretion in the Basin (given the Kroes et al (2019) estimated deposition rates). As will be pointed out below utilizing the Hupp et al (2019) data for net sedimentation, there would be infilling rather than opening up of forested areas. This is in line with firsthand Basin observations and LiDar data, which reflects infilling rather than opening up of large deepwater areas over time. See van Heerden 2019 amongst others, also ask any fisherman, commercial or recreational! Kroes et al can not argue that their subsidence rates are so great that extra sediment input is needed in the face of contrary data from other sources.

The authors quote Faulkner et al. (2009) as evidence that, based on the subsidence rate Kroes et al (2022) used, areas would open up and result in non-regeneration of trees in the Basin. However, Faulkner et al (2009) state very clearly that "better data on flooding during the growing season are needed to more accurately identify and refine the location and spatial extent of the regeneration condition classes." (https://link.springer.com/article/10.1672/08-211.1).

MISSISSIPPI RIVER SOURCED NUTRIENT LOADING AND HYPOXIA DATA MISSING.

No data is presented by Kroes et al. (2022) concerning hypoxia. For instance, where it is occurring, when and why and most importantly what is the source of the nutrient loading that eventually precipitates Hypoxic conditions? As Kroes et al present no data, the reader is therefore referred to van Heerden (2019b). The source of the nutrients that precipitate hypoxic events in the basin is the fact that the Mississippi River's nutrient load is 4 to 5 times higher than it was in the mid 1970's principally due to farm runoff and heavy industrial fertilizer use.

In any study of the Basin it is extremely important to understand the nutrient input to the system; thus one needs to know just what is coming in from the Mississippi River and just as importantly how contaminated the river water is with chemical additives commonly and misleadingly referenced as "nutrients!'

Lastly, this short review covered a lot of material. But it is important to point out:-

- This paper's data re subsidence rates is inconsistent with CPRA/state planning data;
- CPRA/state planning data would suggest a subsidence rate that does not exceed sedimentation into the Basin;
- conclusions re tree non-regeneration is unsupported.

REVIEW OF HUPP ET AL (2019).

INTRODUCTION

In their abstract Hupp et al (2019) very clearly state:-

"The present study indicates the Atchafalaya River, fifth largest river in the United States in terms of discharge, traps 30 mm/year of sediment on average within its floodplain, which is the highest average non episodic rate of fluvial deposition on the U.S. Coastal Plain."

<u>Thirty mm per year and the subsidence rate (as established by CPRA data) is less than 4.0 max mm/yr – net infilling!</u>

Review of this report is further evidence that the Atchafalaya Basin Floodway is infilling with suspended sediment originating from the Mississippi River especially during floods.

HUPP ET AL RESEARCH

"High sediment loads from large watersheds combined with low-gradient fluvial processes that are characterized by prolonged inundation over broad floodplains facilitate the deposition and storage of substantial amounts of sediment and its constituent material such as carbon, nitrogen, and phosphorus. Much, to nearly the entire, watershed sediment load may be trapped prior to entering major estuaries (Ensign et al., 2014; Hupp et al., 2009, 2015; Kroes et al.,2007; Phillips, 1992)."

“The general study area in the lower part of the AB (Figure 4) is characterized by a network of numerous meandering natural bayous, constructed channels, extensive floodplain, and filling lakes where active lacustrine deltaic progression is obvious and dominant.”

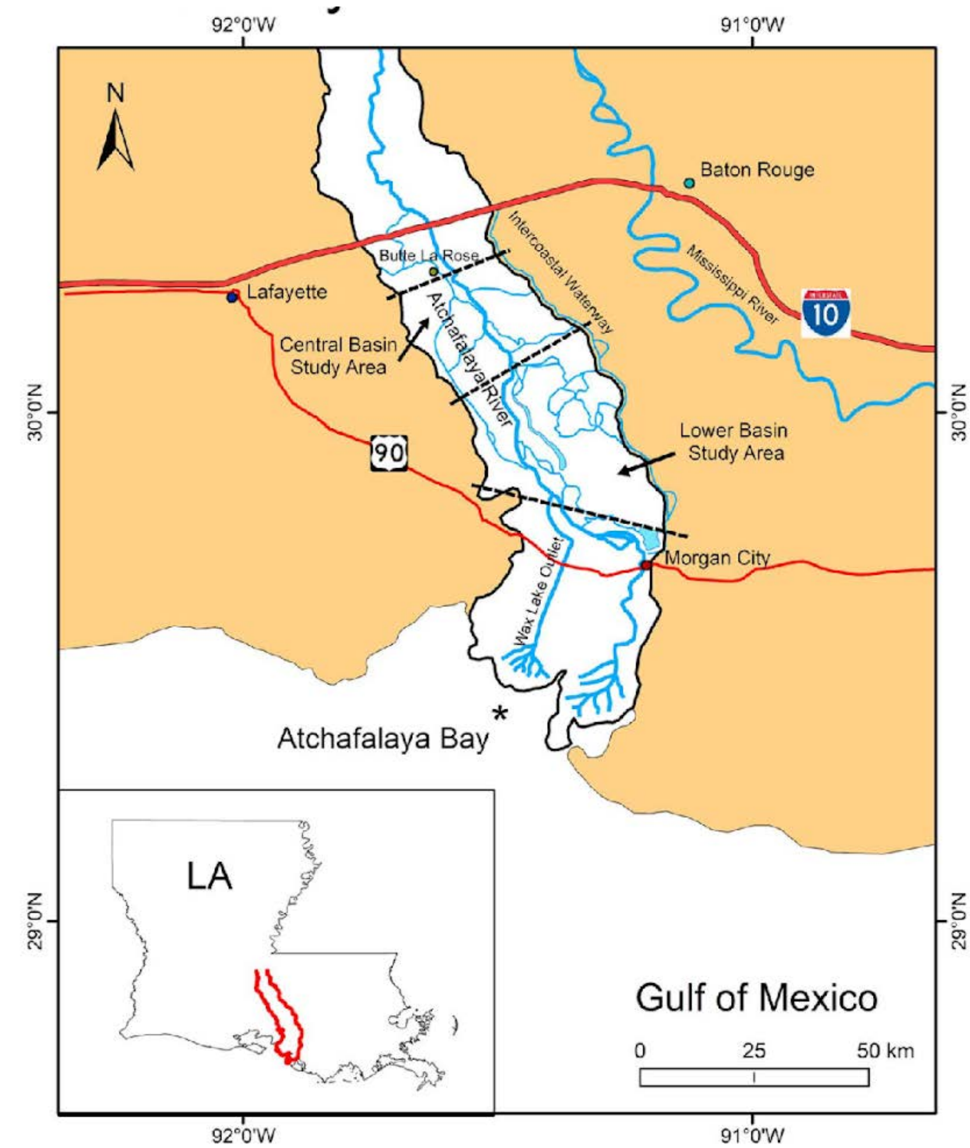

Figure 4. Map of study area with State of Louisiana inset. Both the earlier central basin study area and the present lower basin study area are shown, delineated by dashed lines. Main stream gage at Butte La Rose within the basin and sampling areas (asterisk) of Gordon and Goñi (2003) near Wax Lake and Atchafalaya River mouths are shown. A natural levee from deltaic process crosses the lower basin along U.S Highway 90; this levee is breached naturally by the river near Morgan City and cut during the construction of the Wax Lake outlet. (Hupp et al, 2019).

RESULTS AND DISCUSSION

“Mean sediment deposition rates by site regardless of regime ranged over 3 orders of magnitude from 7 to 153 mm/year, with an average of 30 mm/year over the entire lower AB. Mean deposition by hydrogeomorphic regime ranged from 9 (SE = 2) to 79 (SE = 24) mm/year with the greatest rates occurring in the Channel (79 mm/year; SE = 24) and Isolated East (28 mm/year, SE = 7) regimes and lowest rates in the West regime (9 mm/year, SE = 2)."

"Sediment accumulation rates (kg·m2·yr) generally decreased from the highly connected Channel regime to the Interior East regime with limited river connectivity." This is as one would expect.

"The total annual amount of sediment trapped by the five hydrogeomorphic regimes in the lower AB is nearly 5,755 Mg. The Channel regime is by far the smallest area, but with the highest deposition rate yields 854 Mg/year of sediment accumulation. Conversely, the Isolated East regime, with a relatively low deposition rate, yields 1727 Mg/year owing to the large areal extent of this regime."

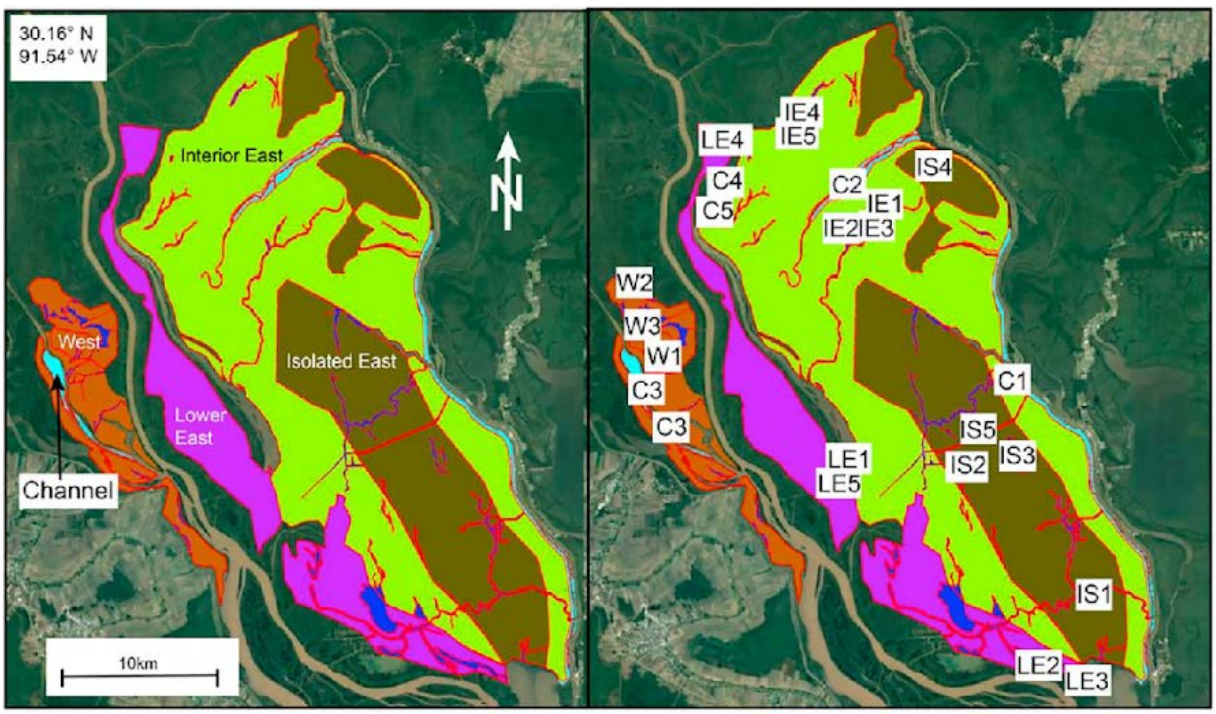

Figure 5. Aerial view of the lower, present study area, on left showing the hydrologic regimes used to partition the analyses into a gradient of connection to the Atchafalaya River. From Channel, through Lower East, West, Interior East to Isolated East regimes, the connection to the river diminishes. Site locations are shown on right figure. (Hupp et al, 2019)

"The lower Atchafalaya Basin, part of the largest contiguously forested floodplain wetland in the United States, experiences sustained sediment depositions rates (average 30 mm/year), which may be the highest average annual river deposition rate (not including single-event maxima) on the Gulf and Atlantic Coastal Plains (Aust et al., 2012; Hupp, 2000); single-event rates of sedimentation can be episodically higher. Aust et al. (2012) in review of bottomland sedimentation rates provides a high estimate of 53 mm/year (Kesel et al.,1974), also in

Louisiana. Hupp et al. (2008) reported a high of 42 mm/year and a sustained rate of 11 mm/yr in the central Atchafalaya Basin."

CONCLUSION BASED ON REVIEW OF KROES et al (2022) and HUPP et al (2019)

1. The lower Atchafalaya Basin, part of the largest contiguously forested floodplain wetland in the United States, experiences sustained sediment depositions rates (average 30 mm/year), which may be the highest average annual river deposition rate (not including single-event maxima) on the Gulf and Atlantic Coastal Plains.
2. Given the Kroes et al (2019) data for net sedimentation, and the CPRA (2023) data for subsidence, there would be infilling of the Atchafalaya Basin rather than opening up of forested areas. The trend of the past will continue through the present without the need for additional channels to introduce sediment into still water or backswamp locations.
3. There are certain groups that are pushing for the East Grand Lake project to be built based on a 'lack of sedimentation in the Basin.' This is obviously not true. Increasing discharges into interior waterbodies and swamps will result in very significant changes with some areas being converted to bottomland hardwoods. Also, increasing discharge into these areas will just enhance Eutrophication and Hypoxia events (van Heerden 2019b).

REFERENCES

CPRA 2023. State Master Plan.

van Heerden, I. L. 2019a. EXPERT REPORT ON BEHALF OF ATCHAFALAYA BASINKEEPER ET AL, MVN-2016-01163-CM. Agulhas Ventures, Inc., Reedville VA, 22539. 4th March 2019.

van Heerden, I. L. 2019b. TURBIDITY, NITROGEN, AND DISSOLVED OXYGEN ABNORMALITIES IN THE ATCHAFALAYA BASIN 2016-2019 – A WORKING PAPER. Agulhas Ventures, Inc., Reedville VA, 22539.