A Tale of Two Cores: harmonized paleoflood hydrologic data works best for estimating flood frequency and magnitude

By Ray Lombardi and Dr. Lisa Davis, The University of Alabama Department of Geography

Introduction:

- Particle size offers valuable paleoflood magnitude information for low-lying floodplains.
- The interpretation of the number and size of paleofloods may by locally altered by variation in flood-deposition (Fig 1) and post-deposition disturbances across floodplains.

Fig 1: Flood deposit spatial variability on the Mississippi R. (Gomez et al., 1997).

We reconstructed paleoflood chronologies from two sites that have experienced the same floods over time to address the following research questions:

1. Can two sites on the same alluvial surface represent distinct paleoflood chronologies?
2. Do distinct paleoflood chronologies alter flood frequency models?

Study Area and Research Approach:

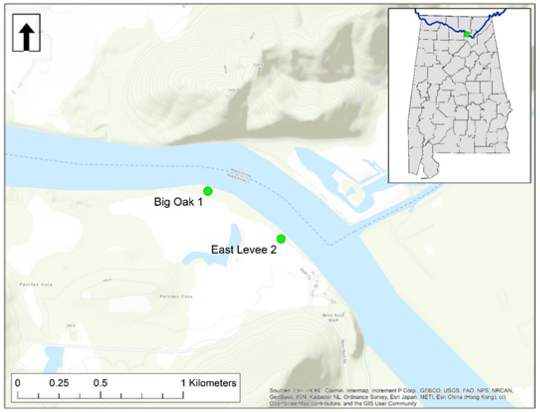

Fig 2: Sample locations for two sediment cores ~ 500 meters apart.

Fig 3: Workflow of methods

Flood Peaks

1. Change point analysis[10]
2. LOESS Smoothing[11]
3. Identify positive residual > 4

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Flood Record + Paleostage

4. Extract ages and d90 particle size of flood peaks **
5. Calculate min. flood depth based on d90
6. Cross correlate paleofloods between sites

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Paleoflood Magnitude

7. Create HEC-RAS geometry for each paleoflood based on depth
8. Iteratively run discharge until it generates flood stage equals d90 paleostage

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Flood Frequency Analysis

9. Independent FFA at each site using Bayesian MCMC estimate in RMC-BestFit
10. FFA of cross-correlated paleofloods only

Address Question 1

Address Question 2

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Can two sites on the same alluvial surface represent distinct paleoflood chronologies? **YES**

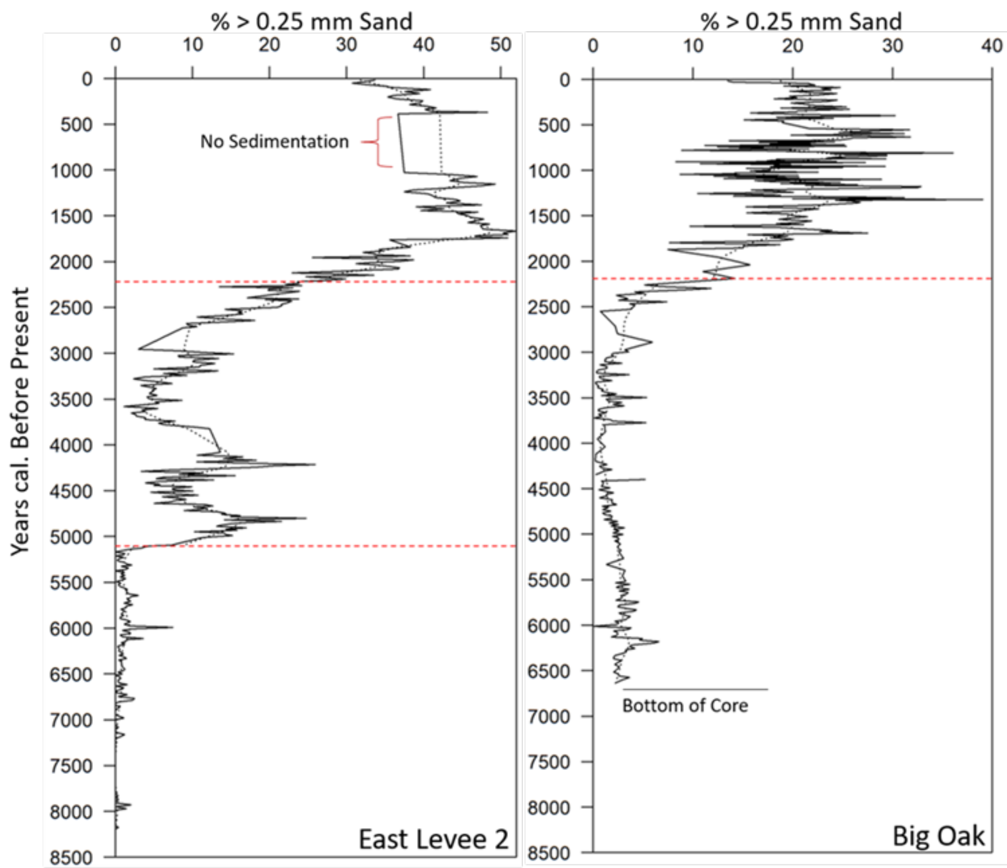

Fig 4: These graphs depict the volume of sediment that is 0.25 mm sand or large at each site over time (black lines). Peaks above the LOESS smoothing line (black dotted lines) are considered flood peaks. Red horizontal dotted lines denote significant change points in average sedimentation of medium to coarse sand.

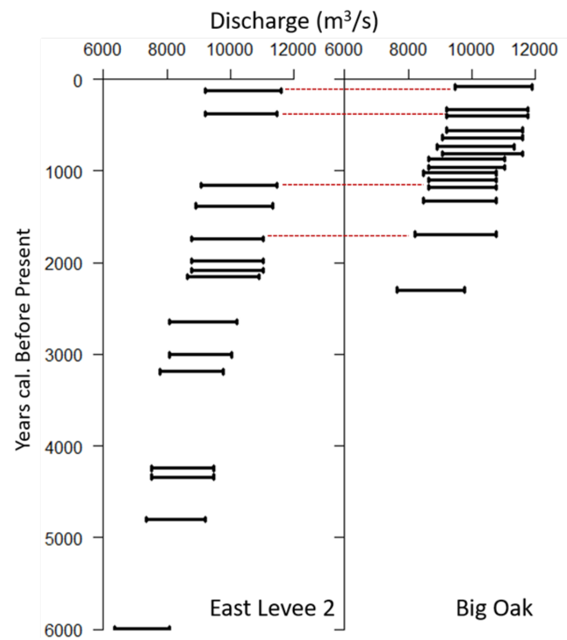

Fig 5: Paleoflood times series for each site. Black bars represent paleofloods, and red dotted lines indicate which floods overlapped between sites.

Key Findings:

- The timing of preserved paleofloods varied between sites but the overall trend in magnitude was consistent.
- EL2 preserved mostly older and smaller magnitude floods and appeared to be missing flood deposits for a high magnitude flood period.

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Do distinct paleoflood chronologies alter flood frequency models? **YES**

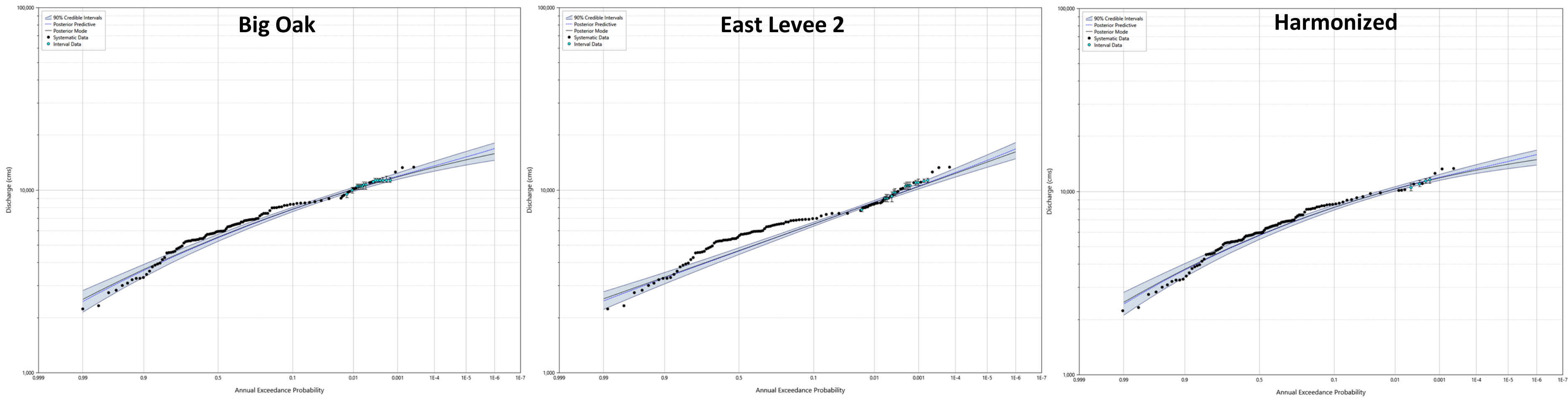

Fig 6: Flood frequency curves from Big Oak, East Levee 2 and the harmonized record.

Metrics	Big Oak	East Levee 2	Harmonized
AIC	2298	2486	2125
BIC	2307	2495	2133
RSME	418	676	354

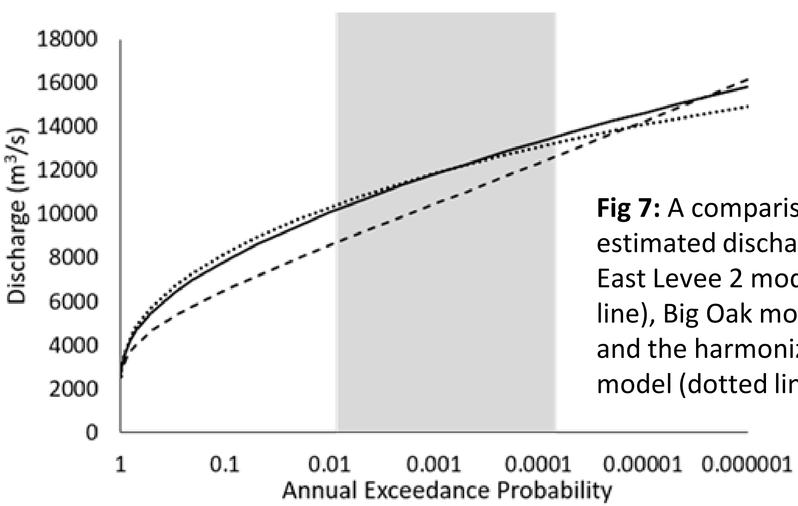

Fig 7: A comparison of estimated discharge between East Levee 2 model (dashed line), Big Oak model (solid line), and the harmonized paleoflood model (dotted line).

Key Findings:

- More moderate events and a gap in deposits during the extreme flood period resulted in flattened curves for EL2 and caused smaller flood estimates for important AEPs.
- The harmonized flood frequency curve had the best fit of data.
- Our findings suggest multiple sites are necessary to produce the most “complete” paleoflood records, even at small scales, to ensure the most robust flood frequency models.