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Contextualized sedimentation rates for large floods along the lower Mississippi River: the importance of flood duration

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Flood sedimentary deposits vary due to upper basin and lower basin controls. In this study we focus on overbank sediment thickness, which over longer periods drives changes to riparian aquatic habitat and floodplain construction. The study setting is a ~25 km long segment of the lower Mississippi alluvial valley, between Natchez, MS and Red River Landing, LA. We report new field data for overbank sedimentation generated by compound flooding over 2018 and 2019 hydrologic years, and compare with sedimentation data from prior large flood events. Overbank conditions in 2018 and 2019 persisted for 286 days (at Natchez, MS). During the 2019 hydrologic year the Mississippi was overbank for a record duration of 216 days, resulting in a much greater duration of overbank sedimentation than the 2011 (53 days) and 1973 (90 days) flood events.

The thickness of overbank deposits are reported for 48 field sites across a range of depositional environments typical of large lowland meandering river floodplains. Flood deposits were sampled in October 2019 using conventional field sampling procedures, including sedimentation traps (artificial grass mats installed in October 2017) and recognition of recent sediment deposited atop buried organic layers. The thickness of each reported sample is an average of three measurements obtained at each field site.

The average thickness of flood deposit samples over 2018-2019 hydrologic years is 71 mm, with variability according to distance from channel and floodplain depositional environment. Maximum sedimentation was associated with crevasse (750 mm) and sand sheet (1,430 mm) deposition along the crest of natural levees. Sedimentation thickness decreases within ~250 m of the channel, but remains high at a distance of ~3.5 km (30 mm). Beyond the range of sand sheet deposition, overbank deposition is likely influenced by variability in floodplain hydrology and geomorphology across natural levee (181 mm), meander scroll (30 mm), old channel (77 mm), and backswamp (108 mm) environments. High backswamp sedimentation at the study site is likely influenced by historic hydraulic engineering for flood control, which has altered local sedimentation patterns.

The 2018-2019 sedimentation data are contextualized by comparison with field data from the record 2011 magnitude flood (peak Q of 65,978 m^3/s at Vicksburg, MS, USGS 0728900) and the historic 1973 flood (55,558 m^3/s). Average sediment thickness for the 2011 and 1973 overbank deposits was 42 mm (n=49) and 230 mm (n=31), respectively. The 2018-2019 daily sedimentation

rate (0.25 mm/day) is much less than 2011 (0.75 mm/day). Thus, the much thicker sedimentary deposits for the 2018-2019 events suggests the greater importance of flood duration – rather than flood magnitude – to overall floodplain processes and alluvial fill chronologies along lowland rivers. The much lower flood sedimentation rate for 2018-2019 in comparison with 1973 (2.49 mm/day) may reveal the persistent decline in Mississippi suspended sediment loads since the early 1950s. Study results are further contextualized by considering corresponding event-based discharge – suspended sediment dynamics, sediment province, as well as flood hydroclimatology.