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Overbank Sedimentation from the 2011 Flood along the Lower Mississippi River: Characterization and Comparison of Two Extreme Events

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The geomorphic effectiveness of extreme events has long been a fundamental topic within Earth sciences. The 2011 flood along the lower Mississippi River (3.2 x 10-6 km2) was an extreme event and presented an ideal opportunity to consider controls on the magnitude and pattern of floodplain sedimentation. The study reach was located between Natchez, Mississippi and St. Francisville, Louisiana, the lowermost reaches of the alluvial valley, and the same location utilized in a well documented sedimentation study from a comparable flood event in 1973. Thus, the 2011 field study provided a rare opportunity to directly compare floodplain sedimentation from two extreme events on Earth's third largest fluvial system.
Although flood stage along the Lower Mississippi River is influenced by an extensive levee system the field setting is distinctive because it is not embanked by main-line levees. The field site was flooded for nearly two months, from early May to late June 2011. The flood crest exceeded long standing (> 100 yr) stage heights, including the infamous 1927, 1937, and 1973 events. The maximum discharge at Vicksburg, Mississippi, upstream of the study sites, was 65,695 m3/s, one of the larger discharge events along the Lower Mississippi River.
Field work was conducted soon after flood waters receded and before bioturbation disrupted the integrity of the flood deposits. We sampled flood deposits at fifty-five locations within a range of floodplain depositional environments to quantify and qualify the sedimentary, hydrologic, and hydraulic characteristics of the flood, and to make explicit comparison with the 1973 study. The average thickness of flood deposits ranged from < 1 mm to 650 mm, but was highly variable. Although natural levees had the thickest flood deposits several reaches along natural levees had no measureable deposits, despite being inundated by $\sim$4 m of flood water. In such cases the angle of the upstream channel relative to the downstream cutbank is suggested as a possible control on the pattern of sedimentation. Despite the magnitude and duration of the 2011 flood, the overall thickness of flood deposits was not very high and the geologic legacy of the event is likely to be unimpressive. Most sediment samples was < 10 mm in thickness, which could be due to the timing of the flood event superimposed upon an overall declining trend in suspended sediment load. The peak discharge was associated with a suspended sediment load of 727,400 tonnes/day. This is notably lower than the maximum suspended sediment load of 1,046,000 tonnes/day, which likely caused sediment exhaustion because of occurring about two months prior to inundation. The thickness of the 2011 flood deposits were about an order of magnitude less than the 1973 flood deposits (11 to 530 mm). Since the early 1900s the sediment budget of the Lower Mississippi has been fundamentally altered. Suspended sediment loads have declined by more than fifty percent, and could contribute to the overall low amount of sedimentation.