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Overbank sedimentation from the historic A.D. 2011 flood along the Lower Mississippi River, USA

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EXPANDED METHODS

Field sampling occurred in August and September 2011. A primary role of Dr. Richard Kesel (Co-PI of NSF-RAPID project) was to ensure that field-sampling procedures and study sites were consistent with that previously conducted during the 1973 flood investigation (i.e., Kesel et al., 1974). Most of the sites visited are correlative with a 1973 site, but others are at new locations and, in turn, some of the 1973 sites were inaccessible.

At each of the 49 sites visited, sediments deposited by the 2011 flood were closely inspected and identified by: (i) their relatively pale color indicative of low organic matter; (ii) occurrence on top of sheltered, undisturbed concrete pads or a distinct layer of vegetation litter; or (iii) for sands, position above a thin, relatively fine-grained recessional drape (Magilligan et al., 1998; Schalk et al., 1998; Shen et al., 2015) (see Figs. DR1–DR5 in the GSA Data Repository). Three representative measurements of thickness (mm) were made at each site, and the average was used for subsequent analysis and plotting. Additionally, GPS coordinates and flood-inundation depths (m), if preserved as silt or seed lines (Koenig et al., 2016), were recorded at each site. Further, a few sites exhibited evidence of overbank flow direction, such as dune or ripple crests or orientation of grasses pushed over by the flow, and a compass was used to measure their orientation. At 39 sites, a flood deposit sample was collected for laboratory analysis of organic matter content and particle size of inorganic sediments.

Sediment samples were characterized by Munsell color (moist sample) and analyzed for organic matter content (%) and particle size (mm) in the USM Sedimentology Laboratory. Organic matter content (%) was measured by heating a known dry mass of sediment to 550°C in a Thermo muffle furnace for 4 hr and re-weighing the sediment sample. For particle-size analysis, H_2O_2 (30%) was applied to a separate dry sample to remove organic material until no further reaction occurred. The remaining sediment was dried in a convection oven, disaggregated with a pestle and mortar, and 50 g of sediment was analyzed using hydrometer and wet-sieve procedures according to Gee and Bauder (1986). Pre-treatment procedures included standard physical and chemical disaggregation by milk-shake mixing and 5% $(NaPO_3)_6$.

Gee, G.W., and Bauder, J.W., 1986, Particle-size analysis, *in* Klute, A., ed., Methods of soil analysis: Part 1: Physical and mineralogical methods, 3rd ed.: Madison, Wisconsin, Soil Science Society of America, p. 383–411.

Kesel, R.H., Dunne, K.C., McDonald, R.C., Allison, K.R., and Spicer, B.E., 1974, Lateral erosion and overbank deposition on the Mississippi River in Louisiana caused by 1973 flooding: Geology, v. 2, p. 461–464.

Koenig, T.A., Bruce, J.L., O'Connor, J.E., McGee, B.D., Holmes, Jr., R.R., Hollins, R., Forbes, B.T., Kohn, M.S., Schellekens, M.F., Martin, Z.W., and Peppler, M.C., 2016, Identifying and preserving high-water mark data: U.S. Geological Survey Techniques and Methods, book 3, chap. A24, 47 p.

Magilligan, F.J., Phillips, J.D., James, L.A., and Gomez, B., 1998, Geomorphic and sedimentological controls on the effectiveness of an extreme flood: Journal of Geology, v. 106, p. 87–96.

Schalk, G.K., Holmes, Jr., R.R., and Johnson, G.P., 1998, Physical and chemical data on sediments deposited in the Missouri and Mississippi River flood plains during the July through August 1993 flood: U.S. Geological Survey Circular 1120-L, 62 p.

Shen, Z., Törnqvist, T.E., Mauz, B., Chamberlain, E.L., Nijhuis, A.G., and Sandoval, L., 2015, Episodic overbank deposition as a dominant mechanism of floodplain and delta-plain aggradation: Geology, v. 43, p. 875–878.

Table DR1. Site-specific data of locations (WGS 84) and sedimentary characteristics for overbank flood deposits associated with the 2011 flood along the Lower Mississippi River near Fort Adams, MS, and St. Francisville, LA. Sediment thickness values for each site represent an average of three individual measurements sampled within a ~20 m radius. Sites without sediment data indicate that only thickness was measured and samples were not taken. A thickness value of 0.0 mm indicates no 2011 flood deposits were able to be discerned. Thickness values for 1973 flood from Figure 1 of Kesel et al. (1974).

Site #	Latitude (°N)	Longitude (°W)	Depositional Sub-environment	d_{16} (mm)	d_{50} (mm)	d_{84} (mm)	Thickness – 2011 (mm)	Thickness – 1973 (mm)
001	31.08572766	91.54928075	Backswamp	0.01800	0.0310	0.063	3.0	5.0
002	31.09565139	91.56787895	Point bar (Ridge)	0.00010	0.0050	0.042	20.0	20.0
003	31.09730875	91.56986592	Point bar (Ridge)				1.0	
004	31.09748352	91.56976413	Point bar (Ridge)	0.00010	0.0050	0.034	12.5	50.0
005	31.13897449	91.59691932	Point bar (Ridge)	0.00010	0.0040	0.020	16.2	25.0
006	31.18364379	91.52627328	Abandoned channel (Levee backslope)	0.00010	0.0020	0.056	10.9	75.0
007	31.09056474	91.54816721	Backswamp	0.00500	0.0700	0.200	3.4	5.0
008	31.11659415	91.60194760	Point bar (Swale)	0.00010	0.0070	0.028	27.4	20.0
009	31.11547101	91.60810234	Point bar (Swale)	0.00005	0.0010	0.013	11.4	40.0
010	31.16326135	91.59098045	Point bar (Ridge)				0.5	
011	31.16343226	91.59034645	Point bar (Ridge)	0.00010	0.0050	0.028	1.0	
012	31.21653824	91.60009547	Point bar (Ridge)	0.00010	0.0090	0.035	15.0	
013	31.23567509	91.60646750	Point bar (Ridge)	0.00005	0.0040	0.020	14.0	130
014	31.25472045	91.60918926	Levee backslope	0.14800	0.2150	0.375	313	3000
015	31.16942005	91.58828468	Abandoned channel	0.01200	0.0330	0.207	6.2	270
016	31.11107796	91.53380484	Backswamp				0.0	10.0
017	31.11144398	91.53798815	Backswamp	0.00010	0.0050	0.036	9.0	10.0
018	31.17687836	91.57456610	Point bar (Swale)	0.00005	0.0040	0.028	5.2	30.0
019	31.16584163	91.55029046	Point bar (Swale)				0.5	8.0
020	31.22163643	91.58193408	Point bar (Ridge)	0.00010	0.0030	0.015	1.4	50.0
021	31.25888819	91.60779769	Levee crest	0.08500	0.1580	0.224	175	540
022	31.12260835	91.60890817	Point bar (Ridge)	0.00010	0.0030	0.017	11.0	40.0
023	31.11193172	91.61369811	Point bar (Ridge)	0.00040	0.0140	0.039	18.0	
024	31.11406333	91.61570498	Levee crest	0.05000	0.0650	0.106	64.8	1000
025	30.86601761	91.51035447	Levee crest	0.03600	0.0820	0.115	5.8	
026	30.86626667	91.51069701	Levee crest	0.02800	0.0670	0.115	78.0	
027	30.85425078	91.51288695	Levee crest	0.13600	0.1880	0.240	60.0	
028	30.85424022	91.51258557	Levee crest	0.13800	0.1910	0.244	620	
029	30.82412192	91.50901129	Levee backslope	0.01600	0.0360	0.086	1.4	40.0
030	30.79754602	91.52972068	Levee crest	0.03000	0.0670	0.108	22.4	90.0
031	30.77700623	91.55127743	Levee crest	0.09000	0.1590	0.221	0.0	

032	30.77831518	91.54803937	Levee crest	0.13700	0.2070	0.362	372	390
033	30.78683069	91.45528033	Backswamp	0.00010	0.0010	0.009	2.6	25.0
034	30.78450218	91.44959659	Backswamp				2.6	
035	30.76438254	91.47644199	Point bar (Ridge)	0.00010	0.0030	0.020	4.4	11.0
036	30.76063152	91.47636185	Point bar (Swale)				8.2	11.0
037	30.75807545	91.49535452	Point bar (Ridge)	0.00005	0.0004	0.007	8.8	
038	30.76050313	91.37126889	Levee backslope				1.0	
039	30.75976375	91.37221399	Levee crest	0.02000	0.0670	0.132	10.4	
046	31.08655601	91.58093135	Point bar (Swale)	0.00010	0.0020	0.014	12.0	100
047	31.08688217	91.58016038	Point bar (Ridge)	0.00005	0.0010	0.016	4.8	20.0
048	31.09099612	91.58228547	Point bar (Ridge)				5.4	20.0
049	30.73788441	91.56435226	Point bar (Ridge)	0.03200	0.0800	0.114	4.0	
050	30.73815152	91.56425633	Point bar (Ridge)	0.05100	0.0840	0.113	4.2	
051	30.76068833	91.58852931	Levee crest	0.10500	0.1700	0.225	15.4	
052	30.75770741	91.58373557	Point bar (Swale)	0.00010	0.0020	0.044	3.6	620
053	30.75853418	91.58492129	Point bar (Ridge)				3.0	
054	30.77420754	91.56182314	Levee crest	0.09300	0.1650	0.225	89.0	460
055	30.87476209	91.49834137	Backswamp				0.0	10.0

Figure DR1. Overbank sediments deposited by the 2011 flood along the Lower Mississippi River at Site #004 near Fort Adams, Mississippi. Average thickness of the pale-colored, desiccated and cracked meander scroll ridge deposits was 12.5 mm.

Figure DR2. Overbank sediments deposited by the 2011 flood along the Lower Mississippi River at Site #002 near Ft. Adams, Mississippi. Average thickness of the relatively pale meander scroll ridge deposits was 20.0 mm.

Figure DR3. Overbank sediments deposited by the 2011 flood along the Lower Mississippi River at Site #024 near Artonish, Mississippi. Average thickness of the sandy natural levee deposits above the darker organic layer was 64.8 mm.

Figure DR4. Overbank sediments deposited by the 2011 flood along the Lower Mississippi River at Site #054 near St. Francisville, Louisiana. Average thickness of the sandy natural levee deposits above the uppermost darker organic layer was 89.0 mm.

Figure DR5. Overbank sediments deposited by the 2011 flood along the Lower Mississippi River at Site #051 near St. Francisville, Louisiana. Average thickness of the sandy natural levee deposits above the darker organic layer was 15.4 mm.

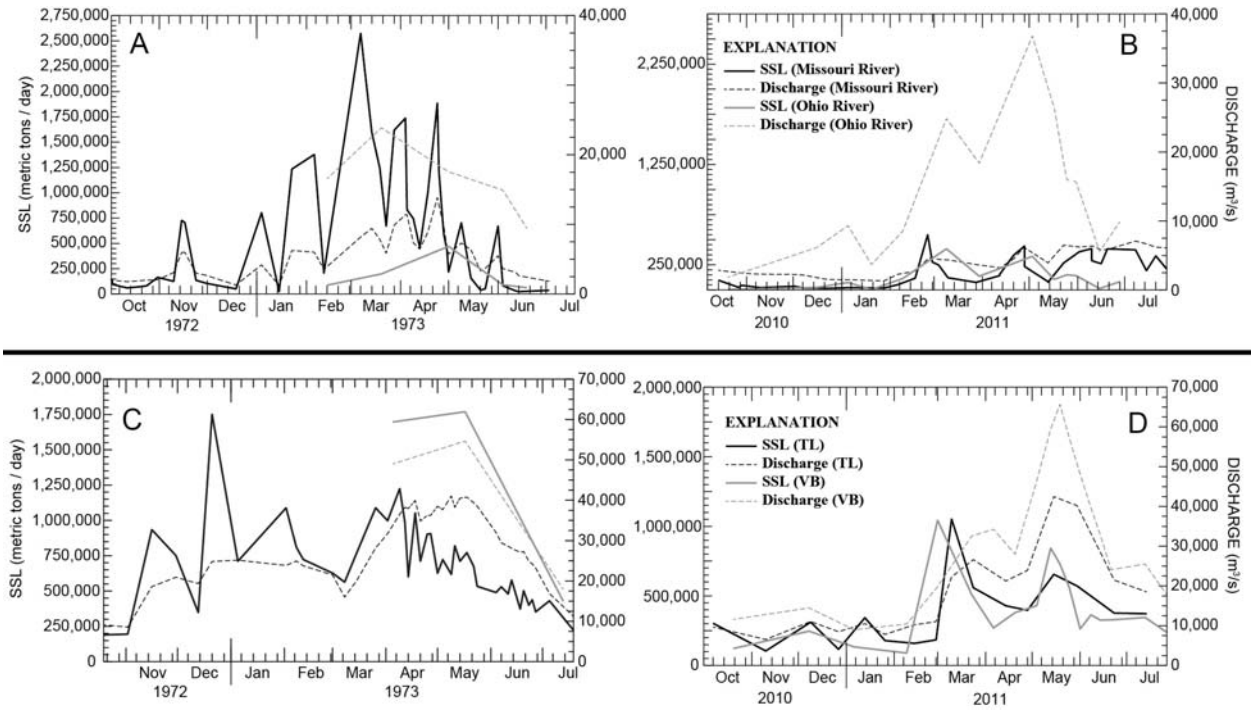

Figure DR6. Measured discharge and suspended-sediment loads (SSL) for the Missouri River at Hermann, MO (USGS 06934500) and the Ohio River at Dam 53 near Grand Chain, IL (USGS 03612500) (A and B), and the LMR at Vicksburg, MS (VB) (USGS 07289000) and Tarbert Landing, MS (TL) (USGS 07295100) (C and D) associated with the 1973 and 2011 floods (USGS, 2016). SSL values for USGS 06934500 are averaged for multiple measurements made during each day of data collection.

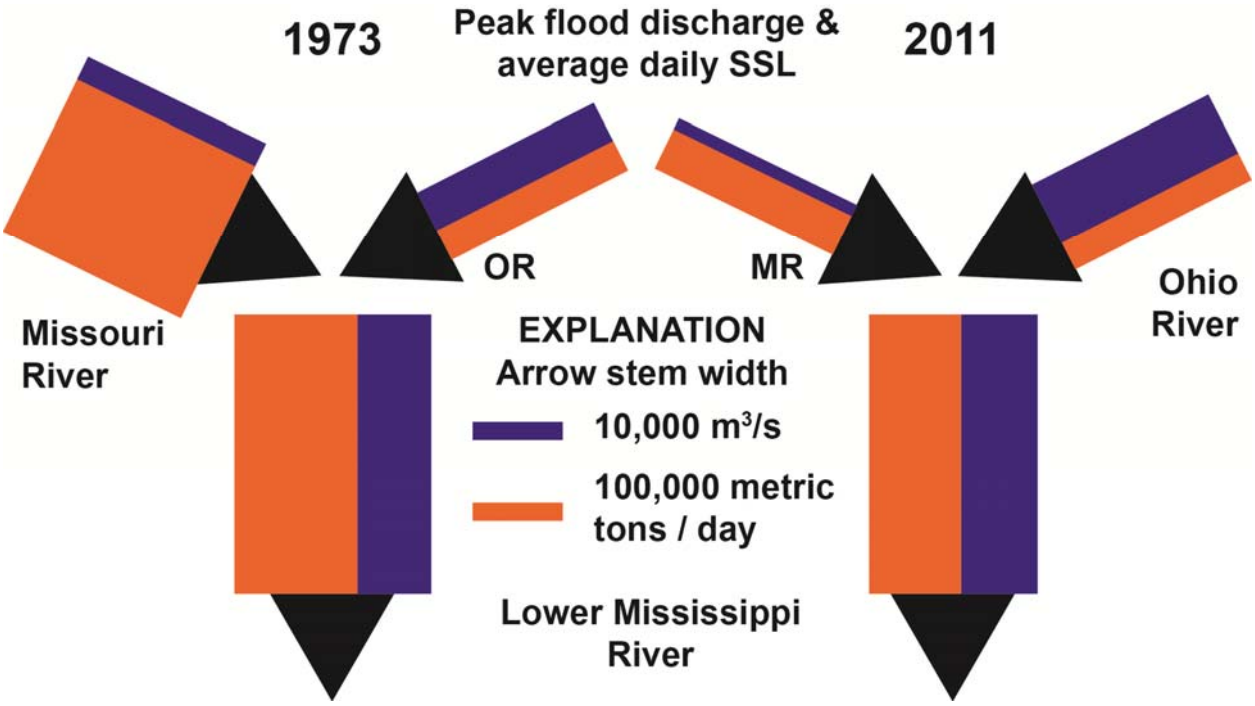

Figure DR7. Diagrammatic representations of peak discharges (m^3/s) (blue arrow stems) and average daily suspended sediment loads (SSL) (metric tons / day) (orange arrow stems) of the Missouri (USGS 06934500), Ohio (USGS 03612500), and Lower Mississippi Rivers (LMR) (USGS 07295100) during the 1973 and 2011 floods along the LMR (USGS, 2016). Arrow stem color width is directly proportional to the peak discharge and average SSL transported during the contributing or flood hydrographs. Contributing hydrographs for the Missouri River (MR) are February 12th to May 21st, 1973, and February 17th – May 13th, 2011. Contributing hydrographs for the Ohio River (OR) are February 14th – June 19th, 1973, and February 9th – June 28th, 2011. Flood hydrographs for the LMR are March 8th – July 5th, 1973, and February 28th – July 14th, 2011.