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Particle Size Distributions of Bed Sediments along the Mississippi River, Grafton, Illinois to Head of Passes, Louisiana, November 2013

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Changes in Mississippi River bed material gradations between Cairo, IL, and Head of Passes, LA, have been previously determined in 1932 and 1989. In November 2013, bed material samples were collected from the thalweg and across the channel width along a reach extending from Grafton, IL, to Head of Passes, LA. In all, 754 samples were collected at 496 locations, and results were compared to the earlier sampling programs. Results show that since 1932 the Lower Mississippi River bed sediments have become more uniform, the reach-averaged D_{50} grain diameter has reduced by approximately 50%, and the river has relatively fined upstream and coarsened downstream with little change since 1989.

Background

In 1932 and again in 1989, the U.S. Army Corps of Engineers (USACE) sponsored efforts to collect and analyze data to investigate bed sediments from the Mississippi River channel thalweg between Cairo, IL, and the Head of Passes, LA, a distance of 1,070 miles in 1932. The reach from Cairo to Head of Passes is generally referred to as the Lower Mississippi River (LMR) and currently extends for a length of 955 miles.

The many engineering works that occurred on the Mississippi River between 1932 and 1989 were considered a significant reason for investigating changes in the river bed sediments for that period of time. The three predominant works were construction of dams on the Missouri River, shortening of the river by cutoffs and channel realignment, and construction of bank revetments and training works. Since 1989 there has been a continued effort to construct bank revetments and training works, but there have been no additional reservoirs or cutoffs. Comparatively, the magnitude of changes in the Mississippi River that have occurred between 1989 and 2013 are not as significant as the changes seen between 1932 and 1989; yet, recent data and studies indicate that the LMR continues to adjust in response to earlier and on-going construction works.

Recognizing that sediment size is a fundamental parameter governing sediment transport and sedimentation, changes in the size distributions of bed material have important management implications in navigation (dredging operations), wetland restoration (river diversions), and flood control (aggradation and degradation). The data provided by this study are intended to support future MRG&P research endeavors related to sediment transport processes and the geomorphic response of rivers to engineering works, thereby facilitating improved river management and restoration practices.

Techniques

Sampling of bed material was accomplished using the same sampler design and procedures used previously in 1932 and 1989. Thalweg sample locations were matched to previous locations using maps from the previous work to correlate with global positioning system (GPS) coordinates. Additional samples were taken across the channel width at select locations to aid in understanding the variability in material sizes laterally across the river bed. Samples were analyzed using standard sieve analysis methods for particles 0.063 mm and larger while finer materials were analyzed using laser diffraction techniques. Laser diffraction results were compared against those from pipet methods of previous sample materials.

MRG&P
Mississippi River Geomorphology & Potamology Program

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Results and Findings

The grain size distribution of material coarser than 0.063 mm for samples collected in November 2013 was divided into two groups: one group includes samples taken from the Upper Mississippi River (UMR) between Grafton and Cairo, IL; the other group includes samples taken from the LMR between Cairo, IL, and Head of Passes, LA. The data for the UMR provide new baseline information, but no historic data exist that can be used for comparisons. Sediments of the UMR are composed chiefly of medium-coarse sands and gravels. The reach-averaged D_{50} grain diameter for the UMR was calculated as 0.74± 0.70 mm whereas the mean diameter, as calculated by the moment method, was 1.96 ± 2.1 mm. No trend in grain size was identified from these parameters. Sediments of the LMR are composed chiefly of coarse to fine sands. The reach-averaged D_{50} grain diameter in the LMR decreases downstream from approximately 0.6 mm to 0.18 mm, typical of deltaic rivers.

The 2013 sediments were generally finer and more uniform than sediments collected in 1932 and 1989, though few changes occurred between 1989 and 2013. The reach-averaged LMR mean grain diameter was 0.71 ±1.1 mm compared to 1.67±3.57 mm and 0.75±1.61 mm for 1932 and 1989, respectively. In the same way, the reach-averaged D_{50} grain diameter was 0.40±0.22 mm for 2013, compared to 0.96±2.64 mm and 0.46±1.29 mm for 1932 and 1989, respectively. Similarly, the reach-averaged sorting coefficient was 1.93 for 2013 while those for 1932 and 1989 were 2.40 and 1.67, respectively.

In 2013, the original hypothesis projected that upstream reaches would produce coarser bed material than found in 1989 but probably not as coarse as in 1932. This theory was based on observations of extensive gravel bars between Cairo and Memphis and evidence of continued downward channel movement from hydrographic surveys and the revision of the LWRP in 2007. There are several locations where gravel deposits extend across the channel as evidenced by dredging operations in the channel thalweg. Results for 2013 gravel materials show a general decrease from 1989 results. However, between RM 700 to RM 475, the 2013 results showed a net increase in gravel percentages over 1989 levels. Downstream of RM 350 results were approximately the same. The results between RM 700 to RM 475 partly validated the theory postulated that the bed had coarsened within MVM. However, this was only true up to RM 700, and upstream of that the results did not follow expected trends.

To access the *Particle Size Distributions of Bed Sediments along the Mississippi River, Grafton, Illinois to Head of Passes, Louisiana, November 2013* report, click the link: http://acwc.sdp.sirsi.net/client/en_US/search/asset/1049446.

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Summary of Significant Findings

- The 2013 samples were significantly finer relative to 1932, but there was little change in bed composition since 1989.
- The 2013 samples were more uniform relative to 1932 and 1989.
- Since 1932, there were marked declines in percent gravel and very coarse sand upstream of RM 500. These were replaced by fine, medium and coarse sands.
- Since 1932, there were marked declines in clay, silt, and very fine fractions replaced by fine and medium sands below RM 500.
- The 2013 samples contained less gravel than the 1932 and 1989 samples except between RM 650 and RM 575 where there was more gravel.
- Use of laser diffraction produces slightly different results from sieve-pipet methods.

Points of Contact

Roger A. Gaines, Author, USACE MVM
Roger.A.Gaines@usace.army.mil

Anthony M. Priestas, Author, USACE ERDC-CHL
Anthony.M.Priestas@usace.army.mil

Freddie Pinkard, MRG&P, Sr. Program Manager, USACE MVK, Freddie.Pinkard@usace.army.mil

Ty V. Wamsley, MRG&P Technical Director, USACE MVD, Ty.V.Wamsley@usace.army.mil