The Mississippi River Geomorphology & Potamology Program: Improving Understanding of Rivers by Combining Data Collection, Modeling, and Geomorphic Analysis

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Introduction

The primary purpose of the Mississippi River Geomorphology and Potamology (MRG&P) Program is to develop the understanding, tools, and techniques required for achieving the U.S. Army Corps of Engineers (USACE) mission of efficient management and operation of the Mississippi River to provide navigation and flood risk management in an environmentally responsible manner. The program will advance the Mississippi River Commission (MRC) 200-year working vision for the Mississippi River watershed through science investigation and technology development. The MRC recognizes that science and technology are critical to improving our understanding of the evolving geomorphology and potamology of the Mississippi River, accomplishing the USACE mission, and achieving their vision. The MRG&P Program strives to bring the best science to bear in answering today's questions as well as to develop the understanding and enabling capabilities that will allow USACE and MRC to advance, operate, and maintain the Mississippi River and Tributaries (MR&T) Project over the next 100 years. The MRG&P Program addresses the critical need of USACE to have access to the most up-to-date and technically competent scientific data and analysis for providing navigation and flood risk management in an environmentally responsible manner.

The MRG&P Program is a regional effort of USACE Mississippi Valley Division, with participation from the St. Louis, Memphis, Vicksburg, and New Orleans Districts, and conducted with technical contributions from the Engineer Research and Development Center. The program study area extends from the confluence of the Missouri River (specifically the sediment gage at Grafton, Illinois) to the Gulf of Mexico. The middle Mississippi River is defined as the area from the Upper Mississippi River's confluence with the Missouri River and extends 190 miles to its confluence with the Ohio River near Cairo, Illinois. From the confluence of the Ohio River to the Gulf of Mexico, the lower river is approximately 1000 miles. The lower Mississippi River valley is a relatively flat plain which has about 35,000 square miles of alluvial lands bordering the river. This valley begins just below Cape Girardeau and extends to the Gulf

of Mexico. The valley varies in width from 30 to 125 miles and includes parts of seven states; Missouri, Illinois, Tennessee, Kentucky, Arkansas, Mississippi, and Louisiana.

Following the 2011 flood, the Mississippi Valley Division and its Districts conducted a damage assessment which identified areas (levees, channels, structures, etc.) which were damaged and/or revealed weaknesses that need to be addressed before future floods occur. It also became apparent that the river channel itself changed and adjusted prior to and during the flood. At many locations, stages were different than historical discharges would suggest, and sediment transport and deposition occurred in patterns different than expected, leading to the need for updated river geomorphology. The 2011 flood again made it evident that on-going scientific studies are necessary to ensure that the USACE has access to the most up-to-date and technically competent scientific data and analysis, both during emergency operations and in the day-to-day decisions concerning the management and operation of the river for providing navigation and flood risk management in an environmentally responsible manner. The sporadic sampling programs of the past have left major data gaps and data collections errors undiscovered for decades, thus highlighting the need for a continuous science program. The MRG&P Program is required to support this need.

By integrating data collection, modeling, and analysis, the MRG&P program is improving the overall understanding of changing ecology, hydraulics, hydrology, channel geometry, and other issues related to rivers. MRG&P is a long-term program aimed at developing and maintaining our understanding of the river and continually developing the technology required to apply that knowledge for the practical management of the river. The Mississippi River is a complex, dynamic natural system that requires systematic study of the natural and engineered systems. As new science questions arise, study elements may be modified to respond to evolving needs.

Research Areas

Recent research projects are categorized in the following scientific areas, although several projects cross-over between multiple areas.

Data Collection

Work units in this area obtain important data, develop new measurement techniques, or improve the consistency or accuracy of existing data collection methods. Work units could also focus on identifying sources of errors and quantifying uncertainty in existing data collection practices. Recent project examples include bed-load, discharge, water surface slope, water quality, fish, macroinvertebrate, and sediment measurement data.

Serving Data and Tools

Work units in this area will make important data or tools available to others. This could include improving the service of existing data, developing a method for serving new data, creation of a new tool for analyzing the data, or adding capabilities to existing software. Activities seek to leverage advances in data integration that are rapidly developing in the information technology world as well as invest in modeling advancements and management of numerical models. The MRG&P Program seeks to facilitate compiling complete and accurate data, both measured and modeled, and streamline how it and other data is applied for project execution. Work units will advance numerical modeling capabilities specifically required for management and operation of

the MR&T. These activities will leverage and collaborate with work being conducted in USACE research and development programs as well as advancements being made by others, including other Federal agencies such as NOAA and academia. Numerical models developed and applied for the river all have a specific purpose and, depending on the problem to be solved, different models are the appropriate tool to be applied. Processes will also be supported to keep models active and up to date to the extent possible.

Geomorphology

The dominant morphological processes that shape the Mississippi River channel can operate over a very large range of spatial and temporal scales. There are many factors, both natural and man-induced, that can contribute to these processes. The effects of large flood events, changing sediment loads and characteristics, channel maintenance activities, dredging practices, diversions (natural and man-made), and relative sea level rise are just a few such factors. Accurate assessment of river morphology over these large scales requires evaluation of long-term trends in geometry adjustment, flow distribution, and sediment loading based on observed data. Morphologic changes have important implications related to flood risk management, navigation and maintaining a productive ecosystem. Work units include hydraulic, geomorphic, and sedimentation studies on the Mississippi River to determine trends and river processes for better long-term management of the Lower Mississippi River.

Ecohydrology

Ecohydrology is an interdisciplinary field studying the interactions between water and ecosystems. The MRC 200 year vision calls for a system that addresses the needs of environmental sustainability and allows for people to enjoy the fauna, flora, and forests surrounding the river while hunting, fishing, and recreating. Work units will collect data and evaluate system-wide relationships between hydro-geomorphic processes and biodiversity of fish and other aquatic organisms; identify environmental variables that can be used to predict biotic response of riverine and floodplain dependent species; and recommend conservation and restoration measures to mitigate adverse impacts of river regulation and protect important aquatic resources. MRG&P efforts will complement regular, ongoing District data collection and conservation efforts.

Endangered Species

Section 7(a)(1) of the Endangered Species Act requires federal agencies to use their authority as appropriate to carry out programs for the conservation of endangered and threatened species. Essential data collection and study on threatened species is required to implement conservation measures to maintain and improve habitat values within the Lower Mississippi River for recovery of species inhabiting the river channel. In addition, the non-jeopardy biological opinion (bi-op) negotiated with the US Fish and Wildlife Service in 2013 requires monitoring of the three species considered in the bi-op: pallid sturgeon, fat packet book mussel and the interior least tern. The secondary channels are very important to their survival, so monitoring them is also a priority. Work units include scientific system-wide field studies and monitoring to support the preparation of conservation plans. MRG&P efforts will complement regular, ongoing District data collection and conservation efforts.

Coastal Interaction

The interaction of riverine and coastal processes is complex with significant implications for navigation and risk of flood stages overtopping the Mississippi River levees. Antecedent river conditions have a tremendous effect on storm surge elevations in the river. Measurements have shown surges extend well beyond Baton Rouge. In addition, proposed diversions for sustaining coastal wetlands will influence the Mississippi River channel as well as the levees near the location where diversions are sited. Work units will investigate these interactions and develop tools to address Mississippi River issues influenced by coastal processes.

Watershed Change

Hydrologic processes can be sensitive to changes in land use, temperature (which can affect the form of precipitation), precipitation intensity and volume, the timing and volume of runoff, and conditions that cause or enhance drought. USACE policy and guidance requires consideration of climate change to reduce vulnerabilities and enhance the resilience of our water-resource infrastructure and ensure reliable services in changing conditions. Observed watershed change and variability have affected MR&T operations. Work units conduct scientific investigations and develop the tools required to adequately consider watershed change in the operation and maintenance of the MR&T system.

Communication of Data and Findings

The program effectively uses technology transfer mechanisms to share with the general public, academia and within the Corps of Engineers itself both the wealth of historical information on the middle and lower Mississippi River and the new information developed by the program. An MVD river science report, technical note, and fact sheet series has been established to highlight and summarize important research findings; these are made available in the national library system. Information and publications will also be available on the MVD Mississippi River Science and Technology website (https://www.mvd.usace.army.mil/mrgp.aspx).