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A Geomorphic Analysis of Floodplain Lakes along the Embanked Lower Mississippi River for Managing Hydrologic Connectivity

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Floodplain lakes are vital to the environmental integrity of lowland rivers. Embankment by levees (dikes) for flood control greatly reduces the size of lowland floodplains and is detrimental to the quality and functioning of floodplain water bodies, presenting a challenge to government agencies charged with environmental management. The embanked floodplain of the Lower Mississippi River is an enormous surface which includes a variety of lake types formed by geomorphic and anthropogenic processes. While much is known about the channel and hydrologic regime, very little is known about the physical structure and functioning of the embanked floodplain of the lower Mississippi. Importantly, management agencies do not have an inventory of the basic characteristics (e.g., type, frequency, location, size, shape) of water bodies within the lower Mississippi embanked floodplain.

An analysis of lakes along the Lower Mississippi River embanked floodplain is performed by utilizing the National Hydrographic Dataset (NHD) from the U.S. Geological Survey, a LiDAR digital elevation model (DEM), as well as streamflow data from the USGS. The vector NHD data includes every official mapped water body (blue line polygons) on USGS topographic maps at scales of 1:100,000 and 1:24,000. Collectively, we identify thousands of discreet water bodies within the embanked floodplain. Utilizing planimetric properties the water bodies were classified into the following lake types: cutoffs (neck and chute), sloughs, crevasse (scour), local drainage (topographic), and borrow pits. The data is then statistically analyzed to examine significant differences in the spatial variability in lake types along the entire lower Mississippi embanked floodplain in association with geomorphic divisions and hydrologic regime.

The total embanked floodplain area of the LMR is 7,303 km2,. The total area of floodplain lakes within the embanked floodplain is 382 km2, or 5.2% of the embanked floodplain surface area. Considerable variability in embanked floodplain area along the lower Mississippi, however, results in spatial variability in the frequency of specific lake types. Meander cutoff lakes represent the largest proportion of lake area, at 49%, with approximately half of this area comprised of artificial cutoff lakes. The next largest class of lakes are borrow pit lakes (at 16%), which are anthropogenic water bodies created for the process of levee (dike) construction and maintenance, but which represent valuable environmental habitat. Meander cutoff lakes are especially dominant in the upper reaches of the Lower Mississippi and diminish moving downstream, where the area of embanked floodplain also decreases. Interestingly, anthropogenic lakes (borrow pits) become increasingly prevalent further downstream and dominate over natural formed lakes.

The location of lake types along the Lower Mississippi does not correspond with recent historic geomorphic and hydrologic activity. The highest frequency of meander cutoff and crevasse lakes are not located within floodplain sections which historically had the highest rates of lateral migration (m/yr) and flooding (duration). Although overbank hydrologic connectivity varies along the river, it does not vary necessarily where it would be most advantageous to the connectivity of specific types of lakes. The research results provide government agencies with a spatial inventory and methodological approach to improve the management of floodplain water bodies for sustaining valuable aquatic habitat, whether by artificially restricting or enhancing hydrologic connectivity.

Key words: floodplain lakes, fluvial geomorphology, hydrologic connectivity, anthropogenic impacts, Lower Mississippi River