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Can we train a large alluvial river? Lessons learned from the Mississippi River engineering

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Alluvial rivers are shaped by interactions of flow, sediment transport, and bed deformation. Under natural conditions, frequent avulsion of alluvial rivers is common in the low-lying coastal areas as a result of channel aggradation of sediment. Following an avulsion, new channel degradation and aggradation begin until an equilibrium situation is reached. These effects are generally aroused when a river approaches its receiving basin where flow is decelerated due to channel deepening and spreading of the offshore plume. As a result, sediment tends to deposit on riverbed during low-moderate flow events, while the bed is eroded during high-flow events because water surface is drawn down near the river mouth to match that of the offshore plume and generates accelerated flow. However, in the past century, the natural fluvial processes of many alluvial rivers have been altered by human interventions, such as levee and dike constructions, channel cutoffs, dredging, and water diversions. This has been especially true in the lower reach of large alluvial rivers where navigation and flood control play ultimate roles for regional and national industrial and economic development, such as the Lowermost Mississippi River. In this study, we used hydrographic survey data collected in 1992, 2004 and 2013 to analyse long-term changes in riverbed elevation, erosion and deposition of the last 500-km research of the Mississippi River. Additionally, we used satellite images acquired during 1985 and 2015 to assess changes in channel morphology and channel bar development. Our primary goal was to identify the patterns and mechanisms of riverbed deformation in this large, highly engineered alluvial river as a consequence of human interventions. We focused on three critical questions: 1) How has the riverbed changed in its first 100-km reach downstream the Mississippi-Atchafalaya avulsion node over time? 2) Where has the river experienced continuous bed aggradation and erosion? and 3) How much river sediment has been trapped in the river channel and how much has been delivered to the Gulf of Mexico in the past two decades? Our preliminary findings show that nearly 70% of the riverine sand are trapped within the Lowermost Mississippi River, and that, despite the tremendous annual dredging effort, continuous riverbed aggradation occurred below the Mississippi-Atchafalaya diversion, presenting favourable backwater conditions for river avulsion. Flow deceleration and backwater effects have controlled riverbed deformation in different reaches of the last 500 kilometres of the Mississippi River. This presentation will discuss the combined effects of the Mississippi River engineering and natural factors on these changes, as well as will identify implications for other alluvial rivers entering the oceans as global sea level continues to rise.