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Sustainability of massively anthropic deltas via dispersal of sediment to manage land building: results from two unique case studies, the Mississippi River (U.S.A.) and the Yellow River (China) deltas

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Owing to their extraordinary natural resources and ecosystem services, deltaic coastlines host hundreds of millions of people worldwide. Societal sustainability on these coastal landscapes is far from certain, however, due to anthropogenic influences including sediment-supply reduction, accelerated subsidence from sub-surface fluid extraction, and leveeing of rivers. The crucial resource in building stable deltaic coastlines is sediment, and the key control on sediment delivery, whether natural or engineered, is by way river channel diversions. Two case studies, based on previous and ongoing research efforts, are presented here to describe the effects of engineered diversions for the removal of river water and associated sediment: the Mississippi River (U.S.A) and the Yellow River (China). Comparatively speaking, these two systems are end-members: Mississippi River water discharge is five times greater than the Yellow River, and yet historically, the Yellow River sediment discharges five times more sediment than the Mississippi system. As such, diversions for the two systems have contrasting goals. During flood events, the Mississippi water stage threatens major metropolitan regions with levee overtopping; spillways are therefore utilized to reduce water flux through the main channel. For the Yellow River, extremely high sediment loads result in significant sedimentation within the main channel, and so there is a concerted effort to divert and shorten the main channel, in order to enhance the water surface slope and increase sediment transport capacity. Interestingly, the net effect of these two projects has been to deposit a significant amount of sediment into the respective receiving basins, which in turn has led to the development of subaerial land. In essence, this represents two compelling case studies documenting how managed (engineered) land building practices can be implemented for other large fluvial-deltaic systems. Observational data collected from field studies of both the Mississippi and Yellow rivers have been used to inform and validate numerical modeling efforts that seek to replicate the morphodynamics of the two diversions. The aim is to evaluate best practices for building deltaic landscape. Based on these research efforts, there are key similarities found for the delta systems: 1) coarse (sandy) sediment is the primary contributor to subaerial delta development, despite the abundance of mud for both rivers; 2) the influx of freshwater into estuarine regions of deltas has tremendous impact on vegetation development, and therefore the cohesion of the deltaic sediment deposit; and 3) it is feasible to produce efficient diversions that maximize sediment delivery and still provide for continued use of the riverine resource (for example, navigation of the channel by vessels). These findings are critical when considering future plans that seek sustainable management practices of other large, anthropic fluvial deltaic systems.