

## **Inevitable Drowning of the Mississippi Delta Region Due to Insufficient Sediment Supply and Global Sea-Level Rise**

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The Mississippi River delta region is the midst of an environmental transformation, the scale of which is unprecedented in United States recorded history. ~25% of deltaic wetlands have disappeared during the last 100 yrs, with loss rates of ~100 km<sup>2</sup>/yr, and the entire region, including New Orleans, is increasingly vulnerable to hurricane storm surge. Land-building and land-sustaining diversions of Mississippi River water and sediment load are envisioned to achieve sustainability of the delta region. However, restoration plans have not been evaluated within the broader context of subsidence, sea-level rise, and sediment mass balance, and whether supplies are sufficient to achieve stated goals.

Holocene history of the delta region is reasonably well known, and reflects filling of a glacial-period incised valley followed by construction of an extensive Holocene delta plain. We estimate the long-term mean rates of deposition required to fill the valley and construct the delta plain over the past 12,000 yrs to be on the order of 230 million tons/year, with the remaining supply having been dispersed to the inner shelf. Prior to the 20th century, sediment was dispersed from main stem channels to the delta plain during floods, through crevasse and distributary channels, but continuous levees now render the delta plain transport-limited. Moreover, more than 40,000 dams in the Mississippi drainage now trap ~50% of the natural sediment load, such that total modern loads are now significantly less than the time-averaged rates for the sediment storage component alone over the entire post-glacial period. Hence the modern delta plain is severely supply-limited.

An estimated 7000 km<sup>2</sup> of the delta plain now resides below sea level. Using conservative estimates of subsidence and sea-level rise, we predict submergence of an additional 10,500-13,500 km<sup>2</sup> by the year 2100 without diversion of sediment to the delta plain through the levee system. ~18-24 billion tons of sediment will be required to sustain surface area to the year 2100, let alone build new land that has already been submerged, which is 4-6 times more than can be drawn from the Mississippi River in its current supply-limited state. However, even if natural sediment loads were restored, rates of sea-level rise are now >3 times higher than at any time in the last 6000 yrs, the period over which the delta plain was constructed, and significant drowning of the delta region would be inevitable.