Impact of Sea-Level Change and Regional Subsidence on Coastal Evolution: Prospects for the Mississippi Delta

Blum, Mike [1] (1) Exxonmobil Upstream Research Company, Houston, TX.

The Mississippi River delta is the midst of an environmental transformation that is unprecedented in scale in United States history. >25% of deltaic wetlands have disappeared during the last 100 yrs, and the entire region, including New Orleans, is increasingly vulnerable to storm surge. Land-building diversions of Mississippi and Atchafalaya River water and sediment are envisioned to achieve sustainability of delta surface area. This presentation examines subsidence, sea-level rise, and sediment mass balance, and whether supplies of sediment are sufficient to achieve sustainability.

Holocene history of the delta region reflects filling of a glacial-period incised valley followed by construction of an extensive and complex delta plain. Long-term rates of deposition required to fill the valley and construct the delta plain over the past 12,000 yrs are ~230 million tons/year, with the remaining supply dispersed to the shelf. Prior to the 20th century, sediment was dispersed to the delta plain through crevasse and distributary channels, but continuous levees now render the delta plain transport-limited. Moreover, >40,000 dams now trap ~50% of the Mississippi's natural sediment load: 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 km2 of the delta plain now resides below sea level. Predictions of future submergence due to sea-level rise and subsidence face uncertainties that are not easily resolved. However, tide-gauge data shows the Gulf of Mexico tracks global sea-level rise, which is currently ~3 mm/yr, and expected to accelerate to ~4 mm/yr by 2100, whereas geologic and geodetic data converge on subsidence rates of 1-3 mm/yr in updip reaches to >6-8 mm/yr in downdip reaches. Without diversion of sediment to the delta plain, a conservative sea-level rise and subsidence scenario will therefore inundate the ~10,500 sq. km that is now <0.5 m in elevation by the year 2100, whereas a worst-case scenario will inundate >13,500 sq. km.

~18-24 billion tons of sediment will be required to sustain surface area to the year 2100, which is more than can be drawn from the Mississippi and Atchafalaya Rivers in their current supply-limited state. However, even if natural loads were restored, rates of sea-level rise are >3 times higher than at any time in the last 6000 yrs, the period over which the the delta plain was constructed, and significant drowning is inevitable.