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Assessment of factors contributing to the growth and loss of wetlands in Louisiana, USA

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Geologically, the wetlands present today in southern Louisiana are the result of recent processes initiated after the last world glaciation and subsequent significant sea level rise about 8,000 years before present. Two processes have been contributing to wetland growth: (1) deposition of sediments from the Mississippi river creating six switching and partially overlapping deltaic lobes emanating from the main discharge channels; and (2) regional rebound, though minor, due to regional glacial isostatic compensation. Concurrently, three natural forms of subsidence have been leading to wetland loss: (1) downward flexure of the lithosphere in isostatic adjustment to the accumulation of up to 20,000 m of post-Triassic sediments deposited on the northern margin of the Gulf of Mexico sedimentary basin; (2) basinward sliding of this sediment accumulation and associated normal faulting of the sediments; and (3) compaction of this accumulation by simultaneous compression of sediments and expulsion of fluids. By the beginning of the 1900s, the total area of the Louisiana wetlands was close to 20,000 km^2, indicating a prevalence of the constructive factors for an average build-up of 250 km^2 per century.

By the 1930s, there was quantitative evidence of reversal in wetland expansion, by which time new basinwide factors of anthropogenic origin had appeared: (1) starting in earnest after the 1927 flood, engineering modifications to the Mississippi river to control flooding and improve navigation have been reducing the amount of sediments reaching the coast and channelling their discharge to the continental platform away from the wetlands; and (2) worldwide, there has been an accelerated sea level rise roughly dating back to the beginning of the Industrial Revolution. Other local and temporary influences of less significance have been: (1) production of sulfur, oil, gas, and groundwater, which in general tends to collapse to various degrees the overlying sediments; (2) construction of navigational channels primarily to facilitate the drilling of oil and gas wells; (3) digging of open trenches for the laying of oil and gas production pipelines; and (4) changes in water chemistry by pollutants contributing to soils biodegradation. In the eight decades since the start of the surveying of the areal extension of the wetlands, the land loss has been 4,900 km^2, for an annual average of 61 km^2.

By using Monte Carlo simulation, we compared actual total subsidence rates as measured by a state-wide geodetical survey against the combined effect of all regional forms of subsidence in coastal Louisiana. In doing so, we clarified the magnitude and relative importance of those processes. Presently, there is no technology to ameliorate, let alone bring to a halt, the natural causes of subsidence. Among the anthropogenic causes, our study indicates that subsidence associated with oil and gas production has an average contribution of 5% relative to the natural causes of subsidence, with this minor contribution being reduced even further with better production practices. Sulfur mining stopped in 2000, and canal construction has been brought to an essential minimum after contributing, according to our analyses, to about 20% of the wetland areal losses, leaving sediment supply and sea level rise as the factors of main concern for the future. Controlled diversion of Mississippi river sediments into adjacent wetlands may help offset subsidence in local areas. Most studies on coastal change predict accelerated sea level rise for the remainder of the century. If those predictions turn true, eustasy by itself will make the wetlands disappear by 2100.