Numerical Constraints of Current Rates of Surface Elevation Change Due to Compaction of Holocene Sediments in the Louisiana Delta Plain

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Abstract

Quantitative estimates of the relative contributions of geologic and anthropogenic processes to subsidence of coastal Louisiana are largely unknown. Such information is critical for ongoing regional wetland restoration. We estimate the contribution of shallow (<200 m) natural compaction to the present subsidence rates in the delta plain using a stochastic approach. This approach constrains the range of compaction rates that can be expected both regionally and locally. It enables the identification of locations where observed subsidence rates are unlikely to be the result of Holocene compaction alone for further investigation.

Our approach uses Monte Carlo simulations to capture the anticipated range of present compaction rates for an array of sediment thickness and accumulation times. The simulations solve one dimensional multi-lithology compaction models based on Darcy flow and Terzaghi (1943) effective stress principles using a finite difference technique. We then convert present Holocene thickness data in coastal Louisiana to probable ranges of present rates of surface displacement due to compaction.

Ninety percent of our calculated rates of land surface elevation change due to compaction of Holocene sediments in the Mississippi delta region are $\leq$4 mm/yr, provided average depositional rates have not exceeded 40 mm/yr. Knowledge of present stratigraphic thickness and accumulation time allows the probable maximum and minimum rates of surface elevation change due to compaction to be predicted. Observed subsidence rates greater than the 90th percentile values likely reflect processes in addition to compaction of Holocene sediments.

Reference

Terzaghi, K., 1943, Theoretical Soil Mechanics, John Wiley and Sons, New York