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Land subsidence, sea level rise, and enhanced tidal intrusion: unveiling the land loss and nuisance flooding potential in the Barataria Basin, Louisiana

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Abstract

This study investigates land loss and coastal inundation in Louisiana's Barataria Basin, a region highly susceptible to anthropogenic pressures and natural factors like land subsidence, sea-level rise, and tidal dynamics. Using high-resolution Digital Elevation Models (DEM) and water level data from the Coastal Reference Monitoring System (CRMS) stations, we analyzed changes in land area and water levels between 2007 and 2022. The attenuation coefficient magnitude of tidal intrusion, which quantifies tidal amplitude reduction as a function of landward distance from the coastline, exhibited a persistent decrease from 2007 to 2022 for O1 and K1 (the dominant tidal constituents), with an accumulated decrease of nearly 20%, signaling enhanced hydrological connectivity across the region. We also projected land area for historic years and predicted it for future years up to 2075, based on a range of displacement rates to account for uncertainties in vertical land motion. Our analyses predict that, in the absence of human intervention, the significance of tidal variations in influencing land loss will escalate; by 2045, the land area estimated based on Mean Higher High Water (MHHW) will constitute approximately 65% of the land area estimated using Mean Sea Level (MSL). Our findings underline the importance of considering the compound effects of subsidence, sea-level rise, and tidal dynamics in future land loss mapping and flood risk assessments.