Trends in tidal range around the U.S. and potential implications for flooding occurrence

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Many locations in the U.S. have experienced large trends in their tidal range since the 19th century, often in response to altered coastal and estuarine morphology. Such tidal changes may enhance the vulnerability of an area towards flooding. In this contribution, >1000 estimates of tidal range from around the contiguous United States are digitized from the published tide tables of 1899 and compared to the tide table of 2020. Our approach enables much greater spatial coverage than previous studies. Tidal range has more than doubled in many regions due to anthropogenic development, including Miami, the Saint Johns River, and the Connecticut River. Important changes are noted in other tidal rivers, including the Sacramento, Savannah, and James Rivers. On average, gauges located inland experienced the largest changes in tidal range, followed by estuary stations; coastal stations showed the least variability. Amplified tidal range increases the prevalence of minor (nuisance) flooding. As shown by case studies of San Francisco, Wilmington (North Carolina) and Miami (Florida), the prevalence of minor (nuisance) flooding events has greatly increased due to tidal evolution. In locations without historical time-series, we infer the changed flooding using a statistical model that estimates changes to tidal constituents based on the observed change in tidal range and known constituent ratios. Results show that tidal change may be a previously underappreciated factor in the increasing prevalence of nuisance flooding in cities like Miami and Jacksonville, Florida, where long time series of data back to the 19th century are not available. Understanding the reasons for tidal change may provide planners and engineers with new tools to adapt to climate change effects like sea-level rise.