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Duration of Coastal Flooding and its link to Tidal Properties.

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Abstract

The impact of coastal storm flooding and high-tide flooding depends not only on the peak water level, but on the length of time that a flood-relevant datum is exceeded. In this talk, we borrow a trigonometric concept used in architecture—the sagitta—to explore analytically how tidal and storm surge properties influence the duration of coastal flooding, and therefore impact. We find that 3 physical factors are important: the period or time-scale of the dominant long-wave (tide or surge), its amplitude, and the maximum water-level above a datum. All else equal, diurnal tide waves along the US Gulf Coast lead to longer flood periods than semidiurnal waves on the US East Coast. Similarly, for the same water level exceedance, locations with small amplitude tides will exceed a flood datum for a longer time-period than locations with big tides. Finally, the duration of a flood occurs varies non-linearly with the amount a datum is exceeded. A 1 cm exceedance may produce little flood time, whereas a 10 cm exceedance will produce a much longer flood. The non-linear relationship between exceedance and duration suggests that risk assessments based on extreme value analysis should include information on flood duration.

Through an analysis of >1000 tide gauge data sets in the USA, we show that the potential duration of flooding varies greatly within individual estuaries (e.g., San Francisco Bay, Chesapeake Bay, Saint Johns River) and on regional and basin scales. Storm surge exerts a minor control on flood duration, except in locations in which it is larger than the astronomical tides. Regions with small tides will experience fast increases in both the number and duration of high-tide flood events, particularly when tides are primarily diurnal and sea-level rise rates are large. The differences in tide properties lead to large differences in outcome. Some regions will cross into persistent flooding—defined here as being flooded 2% of the time, or 10,512 hours a year—many decades before other regions exhibit a problem.