Coastal Subsidence: Harbinger of Future Flooding? Insights from Geodesy and Geology

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While it is not currently possible to predict the coastal locations that will be flooded by major storms and hurricanes, the timing and location of nuisance flooding (tidal-induced local floods) can be predicted with some accuracy. Nuisance flooding can be considered a wake-up call, a clear indicator of future, more catastrophic events that our coastal areas will face. While sea-level rise is a global issue, the goal of this research is to heighten awareness of the problem of human-induced land motion and its relationship to nuisance flooding. The Atlantic Coast of North America is experiencing spatially variable, long-term vertical motion due to Glacial Isostatic Adjustment (GIA). Most of this margin is increasingly affected by nuisance flooding which causes inundation of many low-lying areas. High-quality records of late Holocene relative sea-level (RSL) rise are now available along the Atlantic Coast of North America, allowing separation of long-term GIA-induced displacement from modern vertical displacement measured by Global Positioning System (GPS). We compare geological records of late Holocene RSL to present-day vertical rates from GPS. For many coastal areas we found no significant difference between these independent data. Exceptions occur in areas of recent excessive groundwater extraction (Virginia and Carolinas) where the present-day subsidence rates are approximately double the long-term geologic rates. We show that vertical land motion induced by recent anthropogenic activity and GIA are contributing factors for increased nuisance flooding. Our analysis and results are based on a range of data sets that cover different time scales (e.g., GPS, tide gauges, extensometer, satellite gravimetry, hydrological models, Holocene RSL rise rates and GIA models). Our results have implications for flood susceptibility, forecasting and mitigation, including better management practices for extraction of groundwater from coastal aquifers. It is also important to recognize that areas currently experiencing nuisance flooding are "canaries in the coal mine" for many other coastal areas that are increasingly susceptible to both nuisance and catastrophic flooding as sea-level rise accelerates.