Doctoral Dissertation Defense Announcement

LONGITUDINAL CHARACTERIZATION AND MODELING OF HYDRODYNAMICS AND WATER QUALITY IMPACTS POST HURRICANES AND SEVERE STORMS

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Tuesday, July 31st 2018
2:00 PM – 4:00 PM
Engineering Dean's Conference Room (E421H)

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ABSTRACT

Tropical cyclones, also known as hurricanes, can have devastating effects on coastal regions, particularly those that have become increasingly urbanized and industrialized. While much progress has been made in terms of understanding hurricane impacts on urban landscapes and infrastructure, the same is not true for impacts on natural water systems and environmental infrastructure. This dissertation focuses on this knowledge gap and develops the longitudinal data, framework and models for understanding water quality and the environmental impacts of hurricanes and severe storms using Houston as a testbed. This research encompasses data collection in Houston waterways post Hurricane Harvey in addition to historical water quality data compilation and analysis. Data on leaks and spills and potential sources of environmental pollution are compiled to develop a database that is used in water quality and geospatial inundation model development. A hurricane-specific water quality model, EFDC-SS, was developed to compare different hurricanes and storms with a focus on land inundation, spill destination in both land and water and their associated risks, and to understand the relationships between hydrographs and pollutographs following such events. Analyzing longitudinal water quality data in the Houston area revealed that the difference between pH measured before and after severe storms was significant ($P\text{-value}<0.05$) for rain-based events but not for surge-based events. While the dissolved concentrations of trace metals in fresh and saline water were below standards and almost non-detectable, total metals concentrations were slightly higher than their historical counterparts before Harvey. A significant and strong correlation was found among changes in metal concentrations in sediment samples before and after severe hydrologic events and corresponding changes in percentage of different grain types. The modeling results illustrated the effect of the location of a chemical release and the time at which the release occurs relative to storm surge on spill transport. The fate and transport of spills during a normal flow regime was found to be significantly different from spills during severe storms. In addition, modeling results showed the need for consideration of local runoff flows from rainfall events that typically accompany hurricanes and may coincide with storm surge.