Doctoral Dissertation Defense Announcement

SEDIMENT DYNAMICS AND ASSOCIATIONS WITH POLYCHLORINATED BIPHENYLS AND DIOXINS IN AN URBAN ESTUARY

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ABSTRACT

Polychlorinated biphenyls (PCBs) and dibenzo-p-dioxins and dibenzofurans (PCDD/Fs, or "dioxins") in the sediments of aquatic systems is a persistent global problem that poses serious health risks. This dissertation focuses on understanding the occurrence of PCBs and dioxins in the sediments of the Galveston Bay Estuary System (GBS) by first compiling flow, sediment, and PCB and dioxin data spanning two decades and then investigating the contaminant concentrations from a spatiotemporal perspective. Correlations revealed a significant impact of hurricanes and tropical storms on the sediment properties and sediment-associated PCBs and dioxins. Different spatial patterns were observed in the aftermath of the surge-based Hurricane Ike and the rain-based Hurricane Harvey. From statistical analyses, legacy sources, namely industrial sources and Superfund sites, were found to be significant contributors to PCBs and dioxins in the system. Novel distribution-based qualitative and quantitative methods of source apportionment were used to identify and quantify the sources of dioxins in the system sediment. The results indicated a global contribution from air and runoff sources across the estuarine system and over time with more localized impacts of the Superfund sites and industrial sources within the system. Statistically significant correlations were observed between source contributions from the proposed and conventional methods, demonstrating the utility of the sourcing approaches used in the study. Additionally, the proposed methods were rigorous in elucidating spatial and temporal changes in the sourcing of dioxin to the estuary, indicating their suitability for use for other contaminants and other estuarine systems. The Environmental Fluid Dynamics Code (EFDC) was used to investigate the water column and sediment dynamics within the system, including water column velocities, salinity, and suspended sediment, for both normal and rainfall conditions. The developed model helped identify locations of interest in the system with unique dynamics and possible effects on system parameters and contaminant distributions, especially during storm conditions. The Lagrangian Particle Tracking (LPT) and toxics modules were used to model fate and transport of contaminants in the system during different hydrologic conditions. The modeling results support findings from the retrospective data analyses and provide additional insights into sediment dynamics and behavior in the estuary.