CHARACTERIZATION OF WAVE AND CURRENT ENERGY LEVELS IN ESTUARINE WATERS FOR PARTICULATE DISPERSION STUDIES: CASE STUDY WINYAH BAY, SOUTH CAROLINA

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ABSTRACT

The Southeastern coast of the United States is characterized by shallow estuaries formed from sea level intrusion on low lying plains (Patchineelam et al., 1999). Estuaries are coastal environments subjected to marine, riverine and meteorological processes, such as sediment discharge from rivers, mixing of fresh and salt waters, tidal currents, and wind-generated waves (Lin et al., 2002; Kim and Voulgaris, 2008). All of these processes interact within the estuary and play important roles in sedimentation processes. Previous studies on sedimentation within an estuarine environment do not address the impact of wind generated waves and the combination of waves and currents on estuarine sedimentary processes. This study looks at the current, the wave and the combined wave and current induced bottom shear stress to better determine ability of each process to resuspend sediments throughout an estuary. Evaluation of the estuary's current, wave, and wave and current stress, its spatial distribution and its correlation with sediment remobilization processes can be used to benefit dredging operations for better disposal retention. Furthermore, the determined stress levels can be used as the baseline stress of the estuary and thus help coastal managers identify the effect of human activities, including boating and associated wake-induced energy, in the system.

This work presents a methodology for carrying out such an assessment for Winyah Bay, a 29 mile km long, partially mixed estuary located in South Carolina. In-situ data of waves are collected for a period of approximately forty days (March to April 2011), at two locations within the estuary. The two sites exhibit different wave heights in response to the different wind fetch. An unstructured version of the wave propagation numerical model, Simulating Waves Nearshore (SWAN), is developed for Winyah Bay and it is validated by the in-situ data.

The model is run under the typical wind conditions determined by a ten year meteorological analysis. The effect that the wind speed, wind direction and tidal stage have on the current, wave, and wave and current induced bed shear stress and sediment flux is determined. Additionally, the current, wave and the wave and current induced bottom shear stress and sediment flux that occurs monthly, seasonally and annually within the estuary was established. This climatology allows us to identify areas with high and low potential for sediment erosion and accretion.