The Importance of Physical Processes in Land Use Planning (55)

Jack Blanton
Skidaway Institute of Oceanography
Savannah, GA

Willard S. Moore
University of South Carolina
Department of Geological Sciences
Columbia, SC

Samantha Joye
University of Georgia
Marine Science Department
Athens, GA

Francisco Andrade
University of Lisbon
Faculty of Sciences
Cascais, Portuga

M. Adelaide Ferreira
Instituto do Mar
Laboratório Marítimo da Guia
Cascais, Portugal

Pedro Leitão
University of Georgia
Marine Science Department
Athens, GA

Julie Amft
Skidaway Institute of Oceanography
Savannah, GA

One of the focus areas of the Land Use-Coastal Ecosystem Study (LU-CES) was to understand the physical processes, in particular the residence time (or flushing) occurring in creek-riverine systems. The residence time of water controls many aspects of water quality. Longer residence times allow more time for the water to accumulate nutrients, metals, carbon, and pollutants, and to become depleted in oxygen. We developed techniques based on a physical model and on radium isotopes. Aerial images of the Okatee River in South Carolina were obtained during the flood phase of the tide. Flooded water area was identified in each image using a maximum likelihood classifier. The water level, measured with a sub-surface pressure gage in the study area, was used as the vertical reference level for the corresponding flooded area. The final result was a digital elevation model of the intertidal areas of the tidal creek. A hypsometric curve,

defined from this data set, yielded water area as a function of water level for the entire tidal creek and several subsections. The equation of continuity was used to define a relationship between the rate of change of water surface area to the temporal changes in water volume flux. The consistent relationship between the tidal fluxes derived from the equation and the velocity data in the river illustrated the linkage between volume flux of material into tidal creeks and the topography of the intertidal area. The physical model, which was based on these data, determined the fraction of the tidal prism that returned to the estuary on the next high tide. This return flow factor (b) of the Okatee River was found to be 0.81; that is 81% of the water that left the estuary on a falling tide returned on the next rising tide. For the upper Okatee this yielded a flushing time of 2 days. We also used a mass balance model of ^{228}Ra and salinity to estimate b. This model gave an average b=0.79, virtually the same as the physical model. A third model, based on the decay of ^{224}Ra relative to long-lived ^{228}Ra, was used to determine the apparent age of water in the estuary. These ages ranged from 1.6-5 days with an average of 3.4 days. These three independent estimates agreed remarkably well. We used these residence times to develop a mass balance model for the radium isotopes in the Okatee estuary. This model showed that the major input for each isotope was submarine groundwater discharge (SGD). Knowing the water age and the radium isotope composition of groundwater entering the Okatee allowed us to estimate an average SGD flux of 1 m^3/s, similar to the average river flux. The SGD flux was a factor of 3-4 greater during the summer relative to the winter. This SGD supplied a considerable quantity of nutrients and carbon into the Okatee system. The major findings of this portion of LU-CES were the coherence of the residence time estimates and the importance of groundwater input to the estuarine nutrient budgets.