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BACKGROUND: Estuaries are important coastal features, worldwide. Uses of these coastal systems present potentially conflicting demands, often requiring management based on extensive monitoring. One cost-effective alternative to extensive monitoring is modeling. Some monitoring is still required to calibrate the models, define forcing functions and boundary conditions and skill assess the model's usefulness, but the resulting savings over the cost of a complete monitoring program should be significant.

Louisiana's bar-built estuaries are broad and shallow with mean depths of only a meter or two. Tidal currents and local wind have significant impacts on these estuaries. Management decisions concerning these environments concern the dominant physical processes, sediment erosion, transport and deposition, eutrophication, and recruitment to the estuarine nursery grounds, among others. Arguably the most accurately modeled, at this time, are the physical processes. Previously, a depth-integrated two-dimensional numerical hydrodynamic model was developed to study circulation, transport and flushing characteristics in two significantly different estuaries Terrebonne/Timbalier Basin (a sediment-starved, low-runoff environment) and Barataria Basin (an estuary with an extensive network of small creeks and channels in the upper basin). The hydrodynamic model has been carefully calibrated, skill-assessed, and applied.

OBJECTIVES: This study extends the previous modeling efforts. First, the depth-integrated two-dimensional hydrodynamic model is used to identify the impact of local wind forcing on dispersion and flushing characteristics in Barataria Basin. The second objective is to incorporate baroclinic pressure gradient due to variable salinity and/or temperature distributions into the hydrodynamic model. The third objective is to study the role of waves and currents on suspended sediments by actually measuring currents and suspended sediments in the field.

DESCRIPTION: There are three components covered in this report; an application of a previously developed two-dimensional depth-integrated hydrodynamic model, an enhancement of the depth-integrated hydrodynamic model, and a field program to measure currents and suspended sediments. Specifically, this report covers the following subjects; 1) a comparative model study of Barataria Basin, Louisiana, to delineate the role of wind forcing on flushing and dispersion characteristics, 2) an enhancement of the two-dimensional depth-integrated hydrodynamic model to include baroclinic pressure gradient; 3) the preliminary results of the first field deployment in Terrebonne Bay to measure currents and suspended sediments. The purpose of the field deployment is to document the role of waves and currents on sediment resuspension and eventually allow development and calibration of a suspended sediment module to be coupled to the hydrodynamic model. An accurate advection scheme is employed for advective transport of temperature and salinity. The hydrodynamic model that includes baroclinic pressure gradient has been successfully applied to Breton Sound. From the isolated measurements conducted so far, it is clear that wave-induced sediment resuspension is an important and poorly understood process within the shallow coastal bays of Louisiana.

SIGNIFICANT CONCLUSIONS: Usefulness of a depth-integrated two-dimensional hydrodynamic model is demonstrated by examining the local wind impact on dispersion and flushing characteristics of Barataria Basin. Wind enhances flushing as well as dispersion characteristics of the estuaries. The impact of wind forcing becomes more prominent where the tidal energy is higher and the local geomorphology is complex.

STUDY RESULTS: Using a depth-integrated two-dimensional hydrodynamic model forced by observed tides and winds, significant role of local wind forcing on flushing and dispersion characteristics of Barataria Basin is clearly demonstrated for the typical summer condition investigated. Flushing times for various subbasins were shorter by 20-40% under wind forced condition compared to without wind. Diffusivity values without wind forcing fall slightly below Okubo's range. Wind forcing enhances diffusivity values. In particular, wind forcing in combination with coastal and island trapping gives rise to the highest diffusivity values. The hydrodynamic model that includes baroclinic pressure gradient has been successfully applied to Breton Sound.

STUDY PRODUCTS: Park, D., M. Inoue, and W. J. Wiseman, Jr., 1999: A vertically-integrated model of Barataria bay, Louisiana: Transport, diffusion, and flushing characteristics under summer condition. American Geophysical Union Spring Meeting. Boston, MA.

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Inoue, M., W. J. Wiseman, Jr., D. Park, D. Justic, and G. Stone, 2001: Dispersion in Broad, Shallow Estuaries: A Model Study. OCS Study MMS 2001-054 U. S. Dept. of the Interior Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, La. 72 pp.

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