System Simulation of Tidal Hydrodynamic Phenomenon in the Galveston Bay, Texas

Bernard B. Hsieh
Research Hydraulic Engineer
US Army Engineer R&D Center, Waterways Experiment Station
3909 Halls Ferry Road, Vicksburg, MS 39180

Dr. Bernard Hsieh received his Ph.D. degree in Civil Engineering from Clemson University, South Carolina and Master's degree in Estuaries and Hydraulics from the College of William & Mary, Virginia while his undergraduate work major was Physical Oceanography. He joined WES in 1988 after working four years as water resources engineer for the state of Maryland Department of Natural Resources.

Dr. Hsieh has over 25 years of professional experiences using the emerged techniques of numerical analysis, optimization methods, stochastic processes, and control algorithms to solve many complex engineering and scientific problems, particularly in hydraulic phenomena. His current projects include a 3-D numerical simulation for the C&D Canal channel deepening study, an optimal design of contaminant groundwater capture zone under parameter uncertainty, and an artificial neural networks approach for the hydrological forecasting system. Dr. Hsieh is member of ASCE 3D free surface hydrodynamic model verification task committee and groundwater model calibration task committee.

SYSTEM RESPONSE APPROACH OF TIDAL HYDRODYNAMIC PHENONEMON IN GALVESTON BAY, TEXAS

Dr. Bernard Hsieh
Coastal and Hydraulics Laboratory, US Army Engineers R&D Center, Waterways Experiment Station, Vicksburg, MS 39180

With the advancement of multidimensional modeling techniques and computer facilities, the computational horizon to demonstrate complicated theory and complex field applications for estuarine systems becomes much wider. However, for a fully 3D high resolution mesh numerical model, conducting a series of long-term production runs still requires another generation of super computers to eliminate time constraints. Therefore, an alternative model, capable of analyzing changes at individual points in an estuary system, as opposed to the global solutions generated by a numerical model, was developed.

A system response approach has been developed using input/output relationships via nonlinear frequency domain analysis of numerical model results to prescribe the dynamic behavior of tidal dynamic phenomena. Under this design, the system response functions from a verified numerical model for a particular location can be used to simulate the resulting output function, such as change in salinity, when input forcing functions, such as tidal variation and freshwater inflow, change. To incorporate the system model with numerical model input/output structure, a moving response functions with fixed inputs designed for the system model was developed. Solving a nonlinear system requires a nonlinear decomposition and time shifting procedures to correct the so called group time delay and amplitude distortion problems.

This approach was applied to address the salinity response due to freshwater inflow changes for 16 selected locations in Galveston Bay, Texas. The system model base was constructed by selecting node points from 3D numerical hydrodynamic ressults. The annual numerical simulation of both base geometry (12-m-deep channel) and project conditions (13.7-m-deep channel) for 1990 medium-flow conditions was used to construct the system response function. The results and system model development will be discussed and the future research incorporating neural network techniques to strength the nonlinearity solutions will be highlighted.