Category and Session number: Interdisciplinary Working Groups- IWG4

Preferred Mode of Presentation: Oral

Nutrient Dynamics in Singapore Coastal Waters

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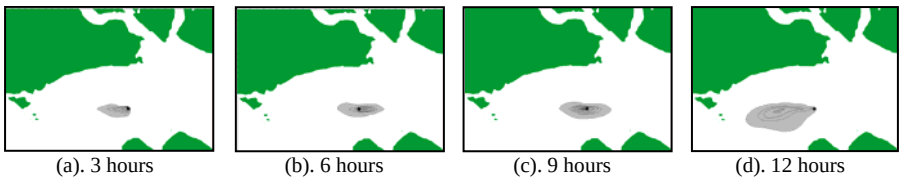
An eutrophication model (NEUTRO) is developed by combining the proficient WASP kinetics (USEPA) with the advanced 3-D advection-diffusion module to account more accurately for the spatial and temporal nutrient dynamics, and to predict the water quality trends in Singapore coastal waters. NEUTRO considers thirteen state variables, which describe interaction between the nitrogen, phosphorus and silica cycles, along with the phytoplankton, zooplankton, dissolved oxygen, bacteria and suspended matter kinetics. The externally pre-computed 3-D tidal hydrodynamics is utilized by NEUTRO for the water quality simulation. A statistical analysis is performed to find the average baseline concentration from field measurements and to identify the outliers in the data set. Iterative runs of NEUTRO are completed to fine-tune kinetic coefficients by fitting computational results onto the measured baseline values. The model is calibrated to reproduce the observed dynamics of nutrients. The water quality model is used for a short-term and long-term forecast studies. Analysis of the results shows that the dynamics of nutrients, plankton and oxygen is consistent with observations. The observed and computed oscillations, evident in the state variables, are due to a combination of the daily photosynthetic process and tidal forcing. The NEUTRO model is used to predict impact of coastal development and technogenic spills on the marine environment. The model results are intensively used for environmental impact assessment by local scientists and managers. Figure 1 shows the model application for a continuously released conservative effluent placed near the bottom at the location specified by a star. The sequence of plots gives an idea of the effluent dynamics and spreading due to tidal currents.



(a). 3 hours (b). 6 hours (c). 9 hours (d). 12 hours

Figure 1. Dynamics of plume at the sea surface at different instances after the spill. The near-bottom source is located at the point marked by "★"

Keywords: Singapore Strait; forecast; eutrophication, 3-D dynamics, numerical model, kinetics, water quality simulation, baseline concentration, environmental impact assessment.