A Eutrophication Model for Enclosed Coastal Sea

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A lot of simulations of water quality in a wide bay such as Tokyo Bay or Osaka Bay have been practiced, for example, for the prediction of the effect of bottom sediment improvement works as a countermeasure against eutrophication. In these simulations, a steady state in summer is assumed. However, water quality changes seasonally as well as spatially.

There are several models which compute seasonal change of water quality using a box model in a wide bay. However, they do not take into account dissolved oxygen (DO).

DO is one of the most important water quality indexes for marine organisms. In particular, in the lower layer of the bay head, significant seasonal change of DO occurs.

The aim of the model in this paper is the prediction of seasonal water quality change in a wide bay for the assessment of power plant siting, for example, the influence of warmed cooling water discharged from power plants on eutrophication. This model is rather simple and useful for the long term prediction of water quality change.

The model consists of flow and water quality submodels. In the flow submodel, the tidal residual current and the river inflow are calculated with a grid-type numerical scheme because these currents are considered to exist throughout the year.

In the water quality submodel, a box model is used avoiding a large quantity of computation. The flow rate between the boxes is calculated by the flow submodel. The change in river inflow is also considered.

The water quality submodel is a phosphorus cycle model. The state variables for eutrophication are temperature, salinity, chlorophyll-a, zooplankton, orthphosphorus, organic phosphorus, and dissolved oxygen.

In this model, organic phosphorus consists of detritus and dissolved organic phosphorus,and it is distinguished from the phosphorus content of algae and zoo-plankton. This modelling make it possible to understand the mechanistic structure of the production and consumption of organic matter and DO.

The model was applied to Tokyo Bay which has been extensively utilized by various industries, fishery and administrations. The concentration of population and industries along the coastal zone of Tokyo Bay has caused serious water pollution problems. Simulation area was divided into six boxes horizontally and two layers vertically. As the result of the model application, the seasonal change of temperature, the increase of chlorophyll-a in spring and summer and the decrease in winter, the increase of orthphosphorus in the lower layer in summer owing to the release from sediment, the decrease of DO in the lower layer in summer were simulated well.