SIMULATION MODEL OF A COASTAL ECOSYSTEM INFLUENCED BY EUTROPHICATION

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The integration of the complex processes occuring in physical systems is being carried out nowadays using simulation models (FASHAM *et al.*, 1990). Such an approach to describe the dynamics of a coastal ecosystem influenced by eutrophication, caused by sewage effluents, is attempted in the present work. The modelling effort is focused on the interactions between phytoplankton, heterotrophic bacteria and organic matter, with less emphasis on the phytoplankton-nutrient interrelationship. The physical system is located along the coastal area of the city of Mytilini. Physical, chemical and biological data have been collected from two stations, the first one characteristic of eutrophication, and the other one of oligotrophy. Sampling details and the analytical methodology have been given in previous work (KARADANELLI *et al.*, 1992). Two spatial compartments were defined in the model, the eutrophic receiving the sewage effluents and the oligotrophic located offshore. Interactions between the two compartments are permitted using a turbulent exchange coefficient. Physical forcing from temperature and solar radiation have also been considered. The flow diagram is presented in Figure 1.The state variables of the model are phytoplanktonic and bacterial carbon, ammonia, nitrate and dissolved organic carbon concentrations. Nitrogen was chosen for the description of the energy flow since it is recognized as the primary limiting nutrient for algal productivity in coastal waters (BLACKBURN & SORENSEN, 1988). The key processes to be modelled are photosynthesis, driven by the physical forces of solar radiation and temperature, phytoplanktonic exudation, bacterial growth and organic matter mineralization. The flow diagram inside the eutrophic compartment is presented in Fig.2. The model was run until steady-state using the Runge-Kutta fourth-order integration algorithm for the solution of the differential equations, with a time step of one day. The annual cycles of phytoplanktonic and bacterial biomass as well as the ammonia and dissolved organic carbon concentrations in the eutrophic compartment are presented in Fig. 3 and 4.

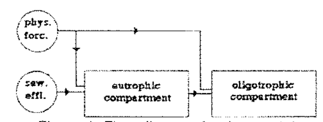

Figure 1. Flow diagram for the spatial compartments of the model.

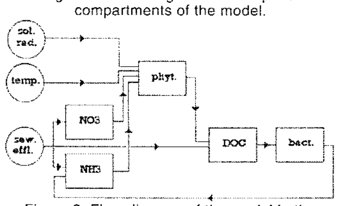

Figure 2. Flow diagram of the model in the eutrophic compartment.

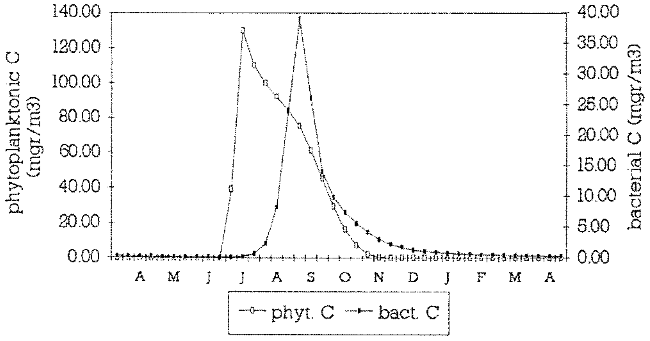

Figure 3. Annual cycles of phytoplanktonic and bacterial biomass in the eutrophic compartment.

A general pattern of low values in winter and very high in summer for phytoplanktonic and bacterial biomass was predicted by the model, in good agreement with the observed data. The bacterial peak in September can be attributed to the high concentration of dissolved organic matter, resulting from the degradation of phytoplanktonic products.

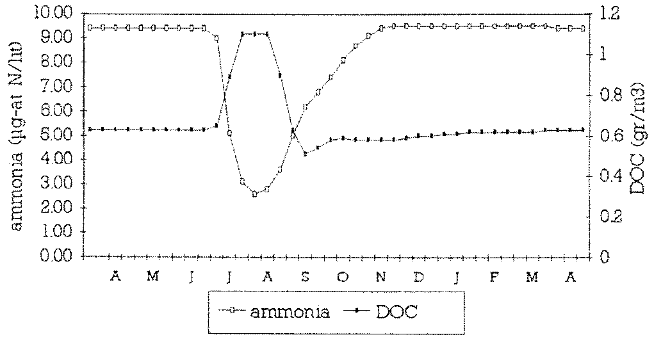

Figure 4. Annual cycles of ammonia and DOC concentrations in the eutrophic compartment.

High concentration of ammonia is predicted by the model, in accordance to the observed data, due to the input from the sewage outfalls. Almost the same patterns, for the annual cycles of the state variables, were observed for the oligotrophic compartment, but the values were much lower. An attempt was made to model the dynamics of a coastal ecosystem influenced by eutrophication. A better parameterization is being carried out using validation data, for further evaluation of the model and its use as a tool for a better understanding of microbial processes.

ACKNOWLEDGEMENTS

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