Prediction of Climate Change Impacts on Primary Production and Nutrient Behavior in the Seto Inland Sea

*Hironori Higashi[1], Akiko Yokoyama[1], Satoshi Nakada[1], Hiroshi Yoshinari[1], Hiroshi Koshikawa[1]

1. National Institute for Environmental Studies

Considerable uncertainties remain in predicting climate change impacts on water environment and ecosystem in semi-enclosed sea. Although many previous studies investigated sea temperature warming and its impacts, there are few predictions including future changes in freshwater and nutrient discharges from watersheds, which governed water quality and biological production in the sea. We developed an integrated hydroenvironmnt assessment model to simulate hydrological discharge from river basins and subsequent hydrodynamic-biogeochemical processes in coastal ocean. We have been performing numerical predictions of climate change impacts on water environment and ecosystem in the Seto Inland Sea, which is the largest semi-enclosed sea in Japan, using the model with 1 km spatial resolution under the Representative Concentration Pathway (RCP) scenarios for possible future climate conditions.
The present study describes climate change impacts on primary production and nutrient behavior in the sea in accordance with the numerical predictions under the present (the end of 20th century) and the RCP8.5 future (the end of 21th century) climate conditions. Forcing meteorological data was extracted from “Regional Climate Change Projection Data” (Ministry of Environment) produced by the Non-Hydrostatic Regional Climate Model with 20 km spatial resolution (Meteorological Research Institute). Future condition of nutrient emissions from the river basins were assumed to be the same as the present.
Our simulations revealed that monthly climatology of the future sea surface temperature increased by 3.2–4.2 degrees C from that of the present. The sea temperature warming was particularly significant from summer to autumn in the center of the Seto Inland Sea. In these seasons, the sea temperature warming reduced primary production seriously because of high temperature stress for phytoplanktons, therefore nutrient concentration increased in the sea surface layer. After that, when the sea temperature dropped, the abundant nutrient enhanced the primary production. The trend of higher primary production in the future than in the present continued until spring, supported by sea temperature warming. As a result, nutrient concentration from winter to spring in the future was lower that in the present. The future change in the seasonal primary production also affected dissolved oxygen in bottom water; hypoxia in the warm season became weaker but its occurrence term became longer in Osaka Bay.
The simulations indicated that climatological changes in annual nutrient loads in the future were not significant although there were some seasonal and yearly variations. Additionally, since the primary production during warm season was remarkably restricted by the sea temperature warming, we believed that impacts of the nutrient loads on the primary production was relatively small in the RCP8.5 scenario. Assessment of the impacts under the other RCP scenarios was an issue to be addressed.

Keywords: climate change, primary production, nutrient, the Seto Inland Sea

