貧酸素海域の生態系評価を目的とした内湾複合生態系モデル“ZAPPAI(雑俳)”の開発と適用

－干潟創生、浚渫・覆砂、流入負荷削減施策に対する東京湾生態系の自律的応答と赤潮に対する耐性－

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Abstract

In order to evaluate/predict the autonomous ecosystem response in a hypoxic estuary to the environmental measures (tidal flat creation, dredging, sand capping and load reduction etc.) and environmental impact (red tide) while considering the effect of a benthic-pelagic and a tidal flat-hypoxic area coupling, a new multiple coastal ecosystem model, "ZAPPAI", was developed. ZAPPAI can investigate the Oxygen-Carbon-Nitrogen-Phosphorus coupled cycle driven by physical and biochemical processes, and these modeled processes describe the ecosystem network of pelagic-benthic or central bay-tidal flat areas mechanically. Because of the drastic vertical change of biological metabolism in the benthic system, and of the high effectiveness of benthic biological metabolism for the total oxygen consumption in hypoxic estuaries, ZAPPAI describes the early diagenetic processes accurately by securing the micro scale benthic spatial resolution in the vertical direction. ZAPPAI was applied to Tokyo Bay, one of the most hypoxic and eutrophic estuaries in Japan. Temporal trend and spatial distribution of model variables both in the central bay and tidal flat pelagic/benthic system were in good agreement with the observed data. The calculated oxygen and nutrient fluxes at the water-sediment interface also reproduced the field measurements well. Simulation by using ZAPPAI described (1) both the tidal flat restoration and the load reduction in Tokyo Bay improve hypoxia, although 50% load reduction leads to the decrease of high trophic production, while the tidal flat restoration increases that, (2) former Tokyo Bay with early tidal flats can use more nutrients on higher trophic production and escape from hypoxia compared to present Tokyo Bay without early tidal flats, and (3) former Tokyo Bay with early tidal flats was resistant to red tide impact and could prevent the environmental deterioration spiral compared to present Tokyo Bay without early tidal flats.