Material cycles in Kojima Lake -From oxidation-reduction in the sediment to fish

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Kojima Lake is an artificially-made lake located at south part of Okayama Prefecture. The water quality has been deteriorated since 1959 when the lake was isolated by setting the closing levee at the mouth, which was constructed as part of land reclamation. Although the water quality has been gradually improved by several measures such as equipment of sewage treatment plants, fish production is still decreasing largely.
There are several numerical studies on material cycles of the lower pelagic ecosystem of the lake. Therefore, in the present study, we tried to expand the numerical study to the oxidation-reduction processes occurring in and around the bottom sediments at the sluice of the lake and also to the higher trophic level.
We conducted field observations at 5 stations both on water quality and sediment quality 4 times in 2014. Nutrient concentrations and dissolved metal concentrations were determined for water samples including sediment interstitial water. As for the sediment quality, water content, ignition loss, acid volatile sulfide concentration, and phosphorus content were also measured. Furthermore, water temperature, underwater fluorescence, turbidity, pH, and dissolved oxygen concentration were monitored at the central lake station.
A numerical model was constructed using a software, STELLA (isee systems, ver. 10.0.4), and the outputs were verified with the collected data and other published data. In the model, the lake area was divided into 2 sub areas because of the different of conditions in terms of sediment quality; the sediment is quite anoxic near the sluice due to seawater intrusion from out of the sluice which may derive sulfate reduction. Crusian carp, the dominant species in the fishery statistics, was incorporated in the model as 2 compartments, large fishing size group and small non-fishing size group. The calculation was made with a time step of 1/64 days and initial values obtained in the field observations and published data.
Seasonal variations of dissolved inorganic phosphorus (DIP), dissolved organic phosphorus (DOP) concentrations and others were well reproduced by the numerical model. Out of the total DIP loads to the water column in the central part, 60% was estimated as those supplied by the decomposition of organic matter in the water column. On the hand, 30% was from sediment decomposition in the sluice area. About 90% of total DIP loads was estimated to be consumed by phytoplankton. The primary production and decomposition of the produced organic matter are the main path in the system.
In the sensitivity analyses by increasing and decreasing of riverine phosphorus load, DIP load at 80% or less of the present level drastically decreased the small non-fishing size crusian carp biomass. It was understood that the nutrient load from the river is quite important to maintain the productivity of the ecosystem whereas the riverine load is only 15%.

Keywords: Brackish water, levee, oxidation-reduction, fish

