Abstract

[Project Information]

Project Title :	Development of Assessment Method for Nutrient Management in Specific Sea Areas
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[Abstract]

This study aims to develop a suite of techniques: a feasibility assessment method to be used prior to planning, numerical models for planning, efficient water quality monitoring methods, and methods to assess biological productivity, to support local governments for nutrient management in coastal waters. This study was conducted using the seasonal nutrient management operation of the Hiro sewage treatment plant in Kure city from October 2023 to March 2024 as a case study.

Sub-theme 1 addressed three key challenges: water quality and ecosystem monitoring.

(1)A two-step approach using Principal Component Analysis-End-Member Mixing Analysis (PCA-EMMA) was developed as a tool to determine the applicability and effectiveness of the method for nutrient management.

(2)A low-cost, easily fabricated surface water sampling device and an onboard water tank were installed on a survey ship, allowing continuous measurements and sampling during towing. An algorithm based on unmanned aerial vehicle (UAV) imagery was also developed to estimate chlorophyll-a concentrations and colored dissolved organic matter concentrations. The use of UAVs enables more frequent measurements than ship-based surveys because of the UAV's accessibility. Furthermore, a novel passive monitoring method for ammonia nitrogen has been developed.

(3)A quantitative DNA metabarcoding method incorporating internal standards was developed to monitor zooplankton biomass and secondary production, enabling the direct conversion of DNA quantity to biomass for six dominant copepod species. By estimating primary and secondary production using microscopic examination and DNA metabarcoding, the structure of the lower trophic-level productivity in Hiro Bay was clarified.

Sub-theme 2 addresses the development of a generic numerical model to assess the effects of nutrient management on coastal environments and ecosystems that can be used by local governments. The model consists of a distributed river basin model and a nesting coastal model that can predict hydrodynamic current and water quality with high resolution. To improve the model's performance and applicability, phytoplankton culture experiments were conducted to investigate the growth characteristics of the representative species.

We performed numerical experiments using the model to evaluate the effect of the seasonal operation of the sewage treatment plant on the enrichment of nutrient concentration and primary production in Hiro Bay. The results indicated that the effects of sewage treatment varied seasonally, although the differences were not significant. The simulations also revealed that the dominant factor governing the effects was the fast seawater exchange in Hiro Bay, which was less affected by changes in weather and water temperature.