are many nutrient budget studies in deep estuaries regarding the fate of total nitrogen and total phosphorus inputs. For example, Nixon et al. (1996) found that the net transport of nutrients through estuaries to the continental shelf is inversely correlated with residence time of water in the relatively deep water systems. Whereas shallow water regions, with depths less than 2-3 meters, differ markedly from deep estuarine systems. In a shallow system, the light can penetrate through the water column and reach the bottom, which affects both the pelagic and benthic ecology. Activities of benthic microalgae influence sediment biogeochemistry processes, through uptake and release of nutrients in different seasons. This study aims at describing the unique aspects of nutrient budget in a typical shallow water region, Lynnhaven River, Virginia. In order to examine the role played by the benthic microalgae when nutrients pass through the Lynnhaven River, two numerical models, UnTRIM (hydrodynamic model) and CE-QUAL-ICM (eutrophication model), were utilized. The nutrient budgets were analyzed from the well-calibrated models results, which include the newly constructed sediment flux sub-model with benthic microalgae effect. Based on the results of annual nutrient budgets, it was shown that the major external source for nitrogen and phosphorus was from nonpoint source loadings (91% of the total nitrogen and 95% of the total phosphorus). There were three comparable sinks: (1) export to the Bay (32% for nitrogen and 26% for phosphorus), (2) burial in the deep sediment (31% for nitrogen and 74% for phosphorus), and (3) denitrification in the case of nitrogen (37%). One of the major pathways for nitrogen and phosphorus was the internal recycling. The regenerated dissolved nutrients that were recycled in the water column were more than two times larger than the current total nutrient external loadings. Sensitivity tests showed that, due to their retention capacity, benthic microalgae's presence in the Lynnhaven could decrease the overall export to the Bay, enhance the internal recycling, and increase the denitrification rate in the sediment.

Growth potential and productivity of phytoplankton community inhabiting in eatuarine ecosystem, Western Japan

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Annual growth potential and productivity of estuarine phytoplankton community was investigated in Shinkawa-Kasugagawa estuary, western Japan, from January 2005 to December 2006. Annual variation of physico-chemical parameters was also monitored in the study site. Growth rate of natural phytoplankton community was estimated from increase of Chl *a* concentration during incubation of natural seawater for ca. 6 hours.

Water temperature, salinity and nutrient concentration at high tide varied as follows; 5.4-34.4℃, 7.2-29.4 psu, 7.52-144 μM (DIN), 1.04-6.24 μM (PO_4) and 10.1-123 μM ($Si(OH)_4$), respectively. Growth activity of the phytoplankton community was low under high light intensity and low temperature condition in spring, indicating photoinhibition. Afterwards, the growth rate was increased (1-4 div./day) with rising of water temperature, and extremely high growth rate, close to 7 div./day, were observed at 30℃ in summer. Unialgal culture strain of *Cheatceros* sp., dominated in summer at the study site, showed extremely high growth rate (over 10 div. /day) under 700 μmol m^{-2} s^{-1} (14:10 LD) at 30℃.

These result suggest that the primary productivity of natural phytoplankton community in the estuary was low in spring, but had extremely high productivity in summer. Primary production rate was calculated using the increase of Chl *a* concentration and C/Chl *a* weight ratio (33.7 for the benthic diatom) to 0.32 gC m^{-2} day^{-1}.

Modelling diffuse nitrogen and phosphorus pollution in a medium-sized watershed: a comparison between a grid-based GIS method and the physically-based AnnAGNPS model

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The aim of this study was to compare and assess two models to calculate diffuse nitrogen and phosphorus emissions on a selected watershed. The empirical grid-based GIS method and the physically-based AnnAGNPS model were evaluated for comparative purpose. The methodologies were applied for the Jiulong River