PHOSPHORUS RELEASE FROM THE SEDIMENT IN THE RIPARIAN COMMUNITY AND ITS EFFECT ON THE PRIMARY PRODUCTIVITY OF THE ESTUARY ECOSYSTEM

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Abstract: In order to determine the factors to sustain the high primary productivity of an estuary community, we analyzed the dynamics of nitrogen and phosphorus in the estuary of the Chikugogawa River, South-Western Japan. The ratio of Total-P / Total-N of river water showed the maximum value of 0.25 (molar ratio) at the point from 10-20 km from the river mouth. Primary productivity of the riparian community of *Phragmites australis* showed also maximum at the same point. Phosphorus from the upstream of the river accumulates to the sediment near the river mouth and phosphorus is released from the sediment after mineralization under reduced condition of sediment. This process could be the main source of phosphorus to the estuary community, and this could sustain the high productivity of estuary aquatic macrophyte community. We discuss the function of riparian communities including sediments in nutrient dynamics of the estuary community as well as salt tolerance of *P. australis* and *Scirpus planiculmis*, the dominant species of the riparian community in the estuary.

Key Words: Chikugogawa River, phosphorus, productivity, salt marsh, salt tolerance

INTRODUCTION

Estuary is one of the most productive wetland ecosystems. Nutrient supply from the ocean and upstream basin compensate each other and the chemical stoichiometric balanced nutritional condition sustains the high primary productivity of the estuary ecosystems. Uplift of the sediment materials by tidal change also supplies nutrients to the aquatic and riparian communities and the consequent increase of primary production (Barbanti et al. 1992).

Phosphorus is one of the limiting elements in the limnological ecosystems and hence the P mineralization and mobilization could limit the primary productivity of the aquatic ecosystems. In the terrestrial ecosystems, mycorrhizal fungi of the vascular plants' roots mobilize P and then plants can absorb P via mycorrhizal fungi. Mobilization of P in the aquatic ecosystems proceeds under the acidic or anaerobic conditions, and then the anoxic horizon of the sediments could be the active site of the P mobilization.

Our research tried to test the function of P release from the estuary sediment and how it contributes to the primary productivity of the estuary ecosystems. This paper presents the preliminary study on the P and N dynamics in the estuary ecosystems with special reference to the stoichiometric P / N balance of the river water. In order to clarify the P and N dynamics in a river system, we investigated water quality of river water including N and P. from uppermost to the river mouth of a river basin at ca. 1.0 km intervals. From the data of the spatially successive water quality measurements, we extracted the change of river water chemistry along a river and evaluated the causal factor for water quality change. From the gradients of water quality, we discussed the nutrient dynamics of the estuary wetland ecosystems.

STUDY SITE

Chikugogawa River [raninging from 33°8'N to 33°5'N and from 130°21'E to 130°15'E maxim altitude 1140m above sea level] is located in the northern part of Kyushu island, Japan, and area of the basin is 2860 km2.The total length of the main stream is 143 km (Figure1).

We surveyed from the river mouth of the Chikugogawa River up to the origin of the Kusugawa River, a tributary of the Chikugogawa River.

Downstream from the flood gate at 24.5km from the river mouth is affected by sea water inundation. Tidal marsh riparian community dominated by *Phragmites australis* develops in the estuary of the river.

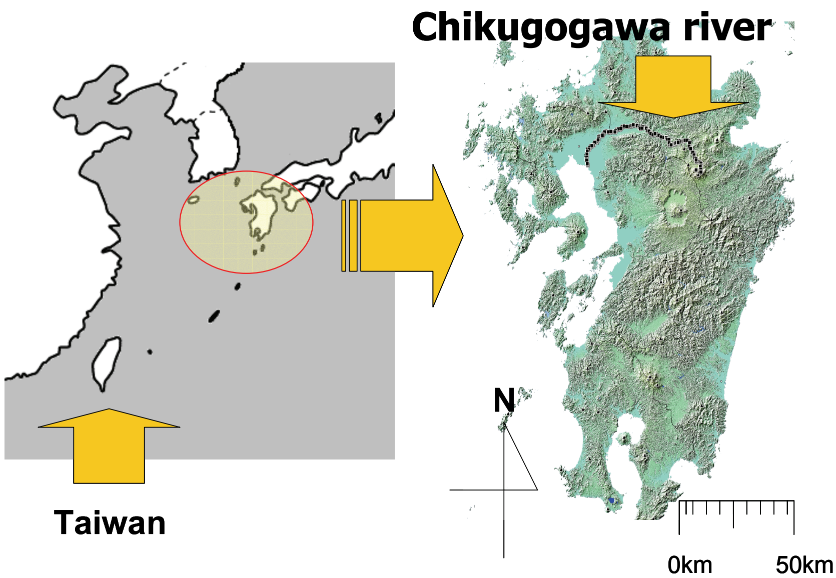

Figure 1. Map showing the study area of Chikugogawa river basin in the northern part of Kyushu Island, Japan.

MATERIALS AND METHODS

In this study, we investigated river water chemistry at 157 sampling points in Chikugogawa River (Figure 1). These 157 sampling points ranged from the river mouth up to 139km upstream. There is a flood gate at 24.5km from the river mouth and sea water inundation appeared up to the gate.

Electric conductivity (EC), pH, major cations (Na+, K+, Mg2+, Ca2+), anions (Cl–, Br–, SO42–, F–, NO3–), total-N (TN), total-P (TP), total organic carbon (TOC) were analyzed. EC and pH were measured in situ with conductivity meter (ES-51, Horiba), respectively.

TN was determined by UV spectroscopic measurement after acid digestion. TP was determined by the molybdenum blue method after alkaline digestion. TOC was measured with a TOC analyzer (TOC-V, Shimazu).A 157 water samples was filtered with a glass fiber filter (Whatman GF/C) and then used for analysis of ionic concentrations.

RESULTS AND DISCUSSION

Phosphorus and Nitrogen

The ratio of Total-P / Total-N of river water showed the maximum value of 0.25(molar ratio) at around 10-20 km from the river mouth (Figure2). Because phosphorus from the upstream of the river accumulates to the sediment near the river mouth and phosphorus is released from the sediment after mineralization under reduced condition of sediment. This process could be the main source of phosphorus to the estuary community, and this could sustain the high productivity of estuary aquatic macrophyte community.

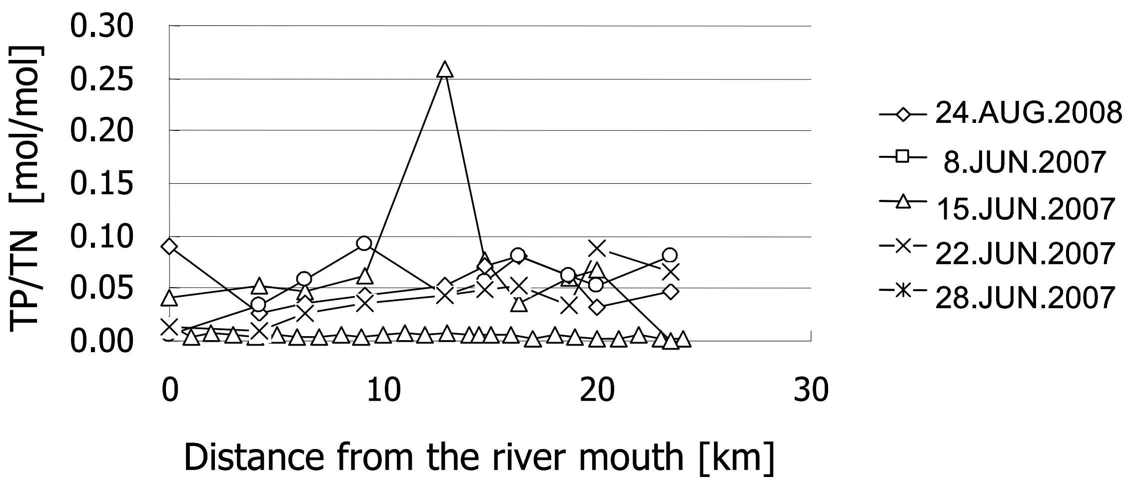

Figure 2. The ratio of Total-P/Total-N of river water from river mouth to flood

The ratio of Total-P/Total-N of river water showed relatively higher value at around 90-110 km from the river mouth (Figure3). This could be due to the contamination of non-treated sewage in the urbanized area discharged water from including agricultural land and livestock farming.

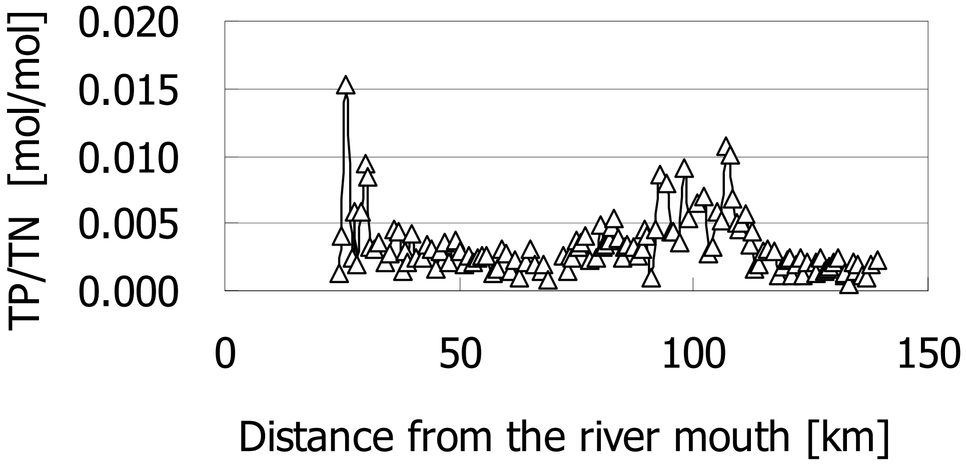

Figure 3. The ratio of Total-P/Total-N of river water at middle and upper basin.

The concentration of SO_4^{2-} showed the maximum value at the upper most basin of the river (Figure 4). This is due to the supply of sulfate from the volcanic sediments or ground water at the origin of the river.

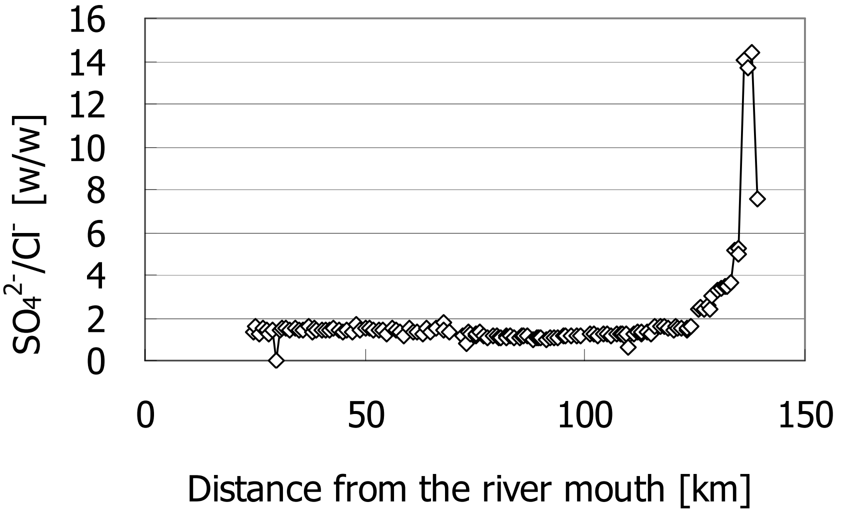

Figure 4. The concentration of SO_4^{2-} showed upper most stream of the river.

The ratio of SO_4^{2-}/Cl^- showed higher value at the upper most stream of the river (Figure 5). This implies the higher contamination of sulfate originated from volcanic activity. No contamination of upper most stream of the rive sulfate from other origin, e.g. pyritic sulfate, was discernible within the basin of the river.

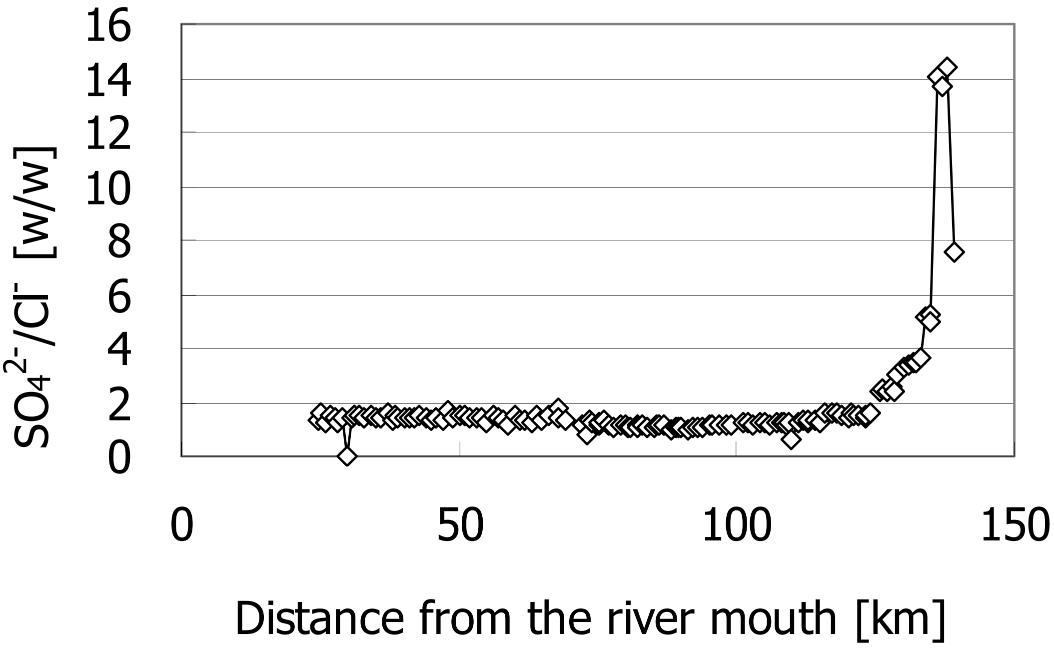

Figure 5. The ratio of SO_4^{2-}/Cl^- showed upper most stream of the river.

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