Estimation of nutrient discharge with groundwater flow to the ocean in the Yellow river delta

Shin-ichi Onodera[1], Mitsuyo Saito [2], Makoto Taniguchi [3], Jianyao Chen[4], Kunihide Miyaoka[5], Tomotoshi Ishitobi[2], Guanqun Liu[6], Tiezhu Mu[6], Tomochika Tokunaga[7], and Yoshihiro Fukushima[2]

[1] Graduate School of Integrated Arts and Sciences, Hiroshima University, 7398521, Japan
[2] Research Institute for Humanity and Nature, Japan
[3] JSPS research fellow, Graduate student, School of Biosphere Sciences, Hiroshima University, Japan
[4] School of Geography Sciences and Planning, Zhongshan University, China
[5] Faculty of Education, Mie University, Japan
[6] College of Environmental Science and Engineering, Ocean University of China, China
[7] Graduate School of Frontier Sciences, University of Tokyo, Japan

Intorduction

As the human impact on water resource is expanding and becomes complex, we have to evaluate globally the control factors. Yellow River has kept the condition with a shortage of the river water since 1990's in the downstream area (Chen et al., 2003) by the increase of agricultural water use in the upstream area. The change in such a large river would act on the ocean environment as well as water resources, that is, on the global water and mass cycle. In addition, the Yellow river delta formed within the last 100 years has been used as agriculture land for last 20 years despite of extremely high salinity in the soil. Consequently, nitrate contamination of groundwater has been expanded there. To clarify the effect of such drastic changes on the ocean and groundwater, it is necessary to confirm the groundwater flow and nutrient transport in the delta area where the boundary of land and sea. However, the effect of human activity has not been considered in such large scale from upstream to downstream area.

The objective of this research is to confirm the effect of human activity on nutrient discharge with groundwater flow to the ocean in the Yellow river delta.

Method

In this research, we measured variations of groundwater level automatically and examined distribution of groundwater table in the area. In addition, we collected samples of river water, groundwater, soil water, and seawater. Then we estimated groundwater flux in various river runoffs, using a simple aquifer model. The major chemical component was analyzed in the laboratory.

Results and Discussion

The groundwater level distribution at the delta area indicated groundwater flow from river to ocean in both periods of wet and dry. The seasonal variations of water level were about 1m to 2m. Groundwater flux during the dry season was estimated to be about a half of that during wet season by the simple model. The relationship of groundwater flux and river runoff estimated by the model supported that groundwater discharge decreased but the nutrient flux to ocean maintained during the drought period in the river. On the other hand, it was suggested that river runoff increased in the magnitude of more than 2 orders during the wet period but groundwater flux increased only several times even in the maximum. These results indicate that groundwater discharge was dominant only during the completely draught period, but river discharge was dominant during the wet period and it is more than 100 times of groundwater. The nutrient component of river and groundwater was nitrogen rich and phosphorus and silica rich, respectively. The groundwater was also contaminated by nitrate under the agriculture land as well as river water, but the nitrate elimination occurred with groundwater flow. Therefore, it was estimated that nitrate discharge with groundwater was little. Consequently, nutrient discharge pattern was suggested that phosphorus and silica discharge were dominant during a drought period by groundwater, while nitrogen discharge was dominant during a flood period by river, respectively.

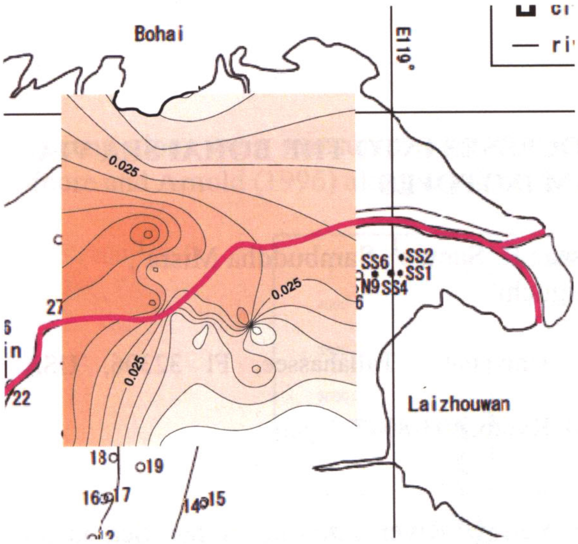

Fig.1 Inorganic nitrogen content in soil layer surface to the depth of 1m.

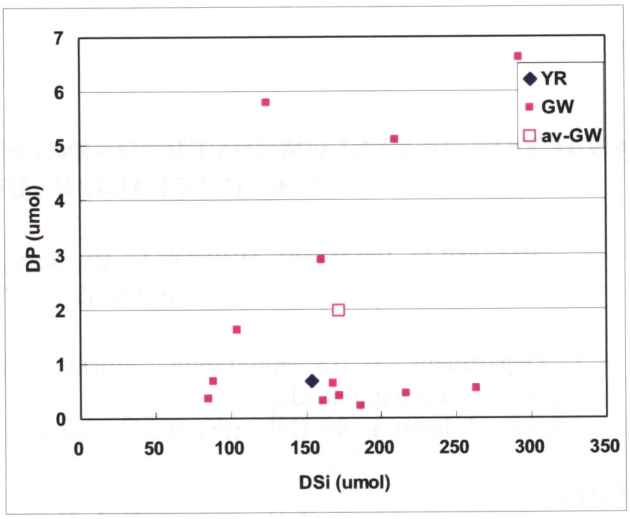

Fig.2 Dissolved Si and P of river water and groundwater in the Yellow River delta.

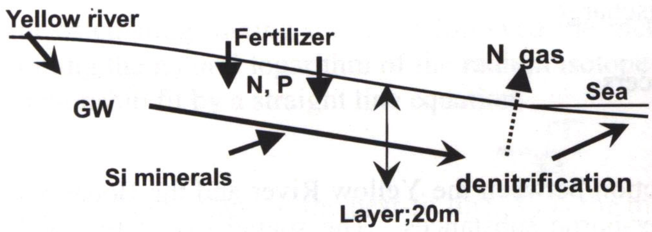

Fig.3 Solute transport model in Yellow River delta.

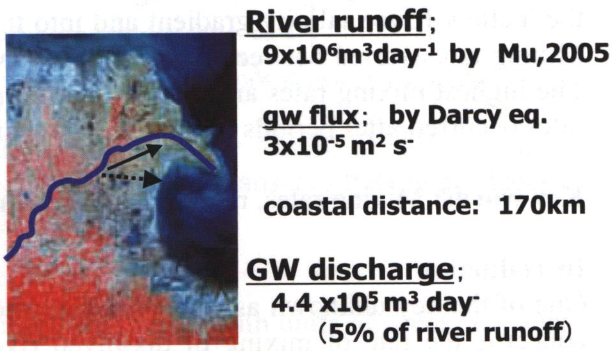

Fig.4 River runoff vs. groundwater discharge in the delta to the ocean.

		river	groundwater
Flow In 2005		100	5
DTN	conc.	100	50
	discharge	100	2.4
Si	conc.	100	1190
	discharge	100	60
DTP	conc.	100	1000
	discharge	100	50

Fig.5 Nutrient discharge by river and groundwater

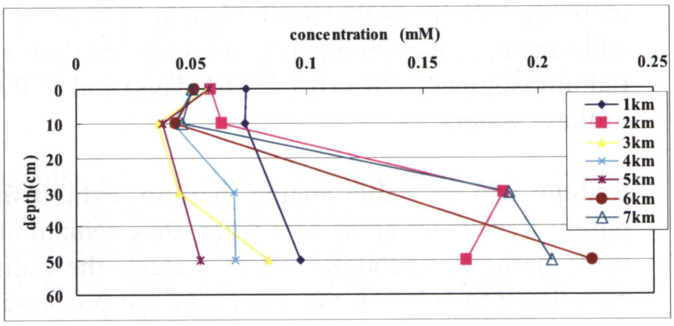

Fig.6 Dissolved nitrogen profile in pore water of seabed from the beach to 7km offshore.