D-1 Research on dynamics of environmental pollution through The Changjiang River and its effect on marine ecosystem in East China Sea

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1.Introduction

The Changjiang River is the third longest river in the world. The watershed of the Changjiang River covers twenty percent of China's land area, and about four hundred million people live in this watershed. This area produces about forty percent of agriculture and industrial products in China. To support this dynamical human activity, land uses are being changed dramatically in the watershed. For example, agricultural land is being converted to use for human settlements and industry, and forests are being cut and converted to agricultural land. These changes result in more pollutant loads from factories and towns flowing into the Changjiang River, as well as greater amounts of soil, fertilizer and agricultural chemicals from farms.

2. Research Objective

The objective of this study was to predict the pollutant load from the Changjiang River flowing into the East China Sea by analyzing the relationship of pollutant and discharge from past water quality and discharge data and to assess the impact on constat marine ecosystem.

3.Result

Field observation for estimation of pollution load from the Changjiang river was conducted at 9 sampling points between Nanjing and Shanghai in Nov. 9-12, 1998 and Oct. 28-30, 1999. Suspended solid ranged from 90 mg/l ~ 200 mg/l which indicated strong influence by the flow rate from the Changjiang rive. Si concentration showed rather constant value of ca. 110 ~ 120μM. 80 percentage of total phosphate was in the particulate form and disolved inorganic phosphate was ca. 0.7μM. NO_3-N concentration was ca. 40μM which was supplied from agricultural land, and NH_4-N concentration was ca. 40μM which was loaded mainly from sewerage in Shanghai. Sporadically water mass with extremely high concentrations of N (in the order of ~ 400μM)were observed and it was suggested that the pollution load from Shanghai city should be evaluated accurately. Despite of high nutrients concentrations in Changjiang estuary , photosynthetic rate was law and the contribution of bacterial production as metazooplankton food resources is three times larger than photosynthetic production as metazooplankton food resources. It was found that photosynthetic production is limited by light due to high turbidity and it becomes dominant metazooplankton food resources after released from light limitation due to sedimentation.

Based on field observations and flow rate data in 1998 and 1999, flux of pollution load from the Changjiang river was estimated and it was found that nutrients discharge from large cities, like Shanghai, contribute in large percentage to the total flux and the flux to the East China Sea was large during flood period. Total nutrient load to the East China Sea could be estimated by using nutrient concentration at Liuhe and water quality at sewerage diffuser from Shanghai city.

The borehole data showed that the Changjiang delta changed its progradation rate about 2,000 years, probably reflected by the increase in sediment discharge to the river-mouth area. One possible cause was an increase in sediment production, particularly suspended sediment, in the drainage area due to widespread human activities, such as intensive rice cultivation and deforestation. Another possible cause was a relative decrease in deposition in the middle reaches in relation to river-channel stability by human activities. Extensive flood plains and numerous natural lakes occur in the middle reaches between Yichang and Hukou. Even now, the middle reaches are frequently subject to heavy flooding during the rainy season, and more than 20 percent of the suspended sediment load that passes through Yichang station is trapped in this region. Human activities like levee construction in the middle reaches will probably influence the changes of sediment discharge, resulting in the increase of delta progradation. Sediment cores taken from the delta-front to pro-delta area showed special change of accumulation rates ranging from 1-2 mm/yr to several cm/y, measured by Cs-137, Pb-210 and C-14 methods. High accumulation rates were observed in regions with water depths of 15-28 m. Assemblages of identified dinoflagellate cysts in a sediment core indicated that causative organisms for paralytic shellfish poisoning, thought to be *Gymnodinium catenatum*, were found in the two intervals of 80-85 cm and 180-185 cm depth from the core top, which are estimated to be dated at about 1,000 years ago by C-14 dating. It is the oldest record for this species.

In 1998, the suspended particles in the Changjiang River water were collected and their total phosphorus was quantified. The concentration of the suspended particles in the

Changjiang River water is gradually declined from the upstream to the downstream. On the contrary, the concentrations of total phosphorus contained in them increase from the upstream to the downstream. It implies that suspended particles containing high concentration of phosphorus is continuously being supplied along the Changjiang River from the upstream to the downstream. The concentration of the phosphorus contained in the suspended particles in the Changjiang River water at the most downstream site is approximately 1.9 mg/g which is similar to that of the phosphorus contained in the sediments at the Changjiang estuary A drastic decrease in the concentrations of phosphorus contained in the suspended particles in the Changjiang River water is found around the Gezhouba dam, a sole dam on the Changjiang River. This might be due to the sedimentation of bulky suspended particles in the Changjiang River water by the Gezhouba dam

In the river mouth, hjgh concentration of particulate organic carbon (POC) was observed, and C/N ratio indicated that main source of POC was terrestrial organic material. At the coastal station B2 (122°30'East longitudes), where the concentration of suspended solids (SS) and POC decreased, percentage of POC to SS was much increased, and C/N ratio approached to that of planktonic material. Rapid increase of chlorophyll a concentration and phytoplankton abundance was also observed at station B2. From river mouth to station B2, conservative dilution of nitrate and silicate was observed, and both release and dilution of phosphate was observed. Phytoplankton abundance was the highest at station C1 (123°East longitudes). At station C1, nutrient decreased more than expected from dilution curve, indicating biological uptake. Increase in particulate Cd, Pb, and Zn as well as particulate C, N, and P was observed at station C1, and it suggested uptake and bioconcentration of heavy metal in this area. The depth of 1% PAR at station C1 (more than 15m) was much deeper than river mouth (less than 1 m), and light limitation for phytoplankton was released at station C1. Based on the dominant phytoplankton species, three phytoplankton assemlages were recognized in the studied area. From river estuary area to station B2, some pennate diatoms, which were probably originated in the fresh water, and blackish water species of cryptophytes were often observed in the samples. A coastal species of diatom, *Cheatocheros tenuissimus*, was recognized as one of the dominant species in station C1, and pelagic picophytoplankton such as *Synechococcus* were representative species in station C3. High concentration of nutrient supplied from the Changjiang River was diluted conservatively at the river month. At the offshore (123°East longitudes), where light limitation is released, increase of phytoplankton and biological uptake of nutrient and heavy metal were observed. Dominant phytoplankton species changed in response to the change in environment from freshwater, blackish water, to pelagic water.

Temporal and spatial variability of water mass was surveyed by the repeated observation with the STD and the time series observation with the mooring array. The origin of particulate matter, such as suspended particle, sinking particle and surface sediment, was determined by using the chemical composition, such as C/N ratio and stable isotope of organic carbon and nitrogen . Stable isotope ^{13}C value of the suspended particle strongly affected by the particle originated with the Changjiang River indicated -28.2‰ and tended to be higher toward offshore area due to the influence of the particles generated by the marine organism. Around the front area formed between the Changjiang River Diluted Water and its adjacent offshore water, where turbidity dramatically decreased, especially in the upper layer, and the sinking particles were produced by the marine organism. The fact that stable isotope ^{13}C value of the surface sediment was higher than that of the suspended matter near bottom suggested the influence of high stable isotope ^{13}C value of the sinking particle. The bottom turbid layer was observed near bottom in the front area and offshore area, where it suggested that the suspended matter was transported offshore by the advection .

In 1998 the second biggest flood occurred in the Changjiang catchment and max. freshwater inflow into the East China Sea was estimated to be ca. 86,000m^3/s. Flooded water had reached to the coast of Kyushu island and Japan Sea. Three-dimensional numerical model was applied to the East China Sea from May 1996-April 1999. Air temperature, relative humidity, solar radiation, cloud cover and wind velocity on the water surface were obtained from the results of GCM model (ECMWF). Precipitation on the water surface was given by Satelite date TRMM. Distributions of temperature/ salinity/ suspended matter in the East China Sea were validated with measured values with excellent agreement. Simulated results indicated clearly that freshwater from the Changjiang river had reached to Kyushu island in Japan.

Water quality data and discharge data in whole Changjiang River monitoring stations in 1987 and 1988 were collected and database were established. Those data including SS, COD, NO2-N, NO3-N, NH4-N, discharge, water temperature etc. in different sections along the main course of the Changjiang River from Upstream to the estuary. In order to get the pollutant load flowing into the East China Sea, water quality and discharge data below the Wuhan city were selected to establish the relationship with the discharge data. Because of lacking the TP, TN data, joint field surveys of water quality were conducted in the autumn of 1998 and 1999 along the main course of the Changjiang River from Chongqing to Shanghai, a distance of about 2300km. Relationship of the pollutant load with the discharge, such as $L=aQ^b$, has been established. The result obtained showed that the relationship of SS, COD, DIN load with the discharge had good correlation from the 1987and 1988 data. On the other hand the relationship of SS and TP, TN and DIN were found from the data source of the field survey in 1998 and 1999. Thus mainly pollutant load of SS, COD, TN, TP with discharge were achieved through the analysis of these data. It suggested that the long–term prediction of the pollutant load from the Changjiang River flowing into the East China Sea becomes possible.