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WATER ENVIRONMENT AND POLLUTION OF HUONG RIVER IN HUE CITY, CENTRAL VIETNAM

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Abstract

Water quality parameters of Huong river in Hue city (Central Vietnam) were analyzed in 2005 and 2006. Main impacts to its water quality were defined to be drainage from Hue urban area and back flow of sea water. Upper stream of the river was clean in term of TOC (about 1 mg/l). But the river water in the reach, where drainage of the old city around the royal palace and the new city flows in, began to be contaminated (TOC varied in the range of 1.5 – 2.5 mg/L). Nutrients levels in the river, especially in its canals around Hue old city were rather high: TN and TP in the river and its canal varied in the range of 0.25 – 0.95 mg/L and 0.01 – 0.06 mg/L; 1.1 – 2.9 mg/L and 0.03 – 0.12 mg/L, respectively. That means eutrophication in the canals was more sever. With regard to these nutrients concentrations in water column, DRP level in the river (0.005 – 0.02 mg/L, average = 0.01 mg/L) was enough to support plankton growth and phosphorus was limiting factor for eutrophication in the river: the ratio of TN/TP varied in the range of 10 – 350 (media = 25 – 47). Levels of TOC, TN and TP in ground water samples collected near to the river were higher than that in the river.

Keywords: Huong river, water quality.

1. Introduction

Hue City was the capital of Nguyen Dynasty, the last dynasty of Vietnam that lasted from 1802 to 1945, and had been the political and cultural center in Central Vietnam. It is the noted sight-seeing resort that was registered as a World Culture Heritage in 1993. The sewer system is under construction. Water of Huong River, that runs through the center of the city, is said to be polluted by living sewage and wastes thrown away into it by people who make a living on the water (floating community) and on its banks. Especially, eutrophication caused by aquaculture at the mouth of the river and agriculture in its basin is worried about (Hop et al., 2005).

The authors started research of organic pollution and eutrophication of the river from aqua-chemistry aspect as the joint project of Hokkaido University and Hue University from February, 2005.

Huong river is formed from two branches (Ta Trach and Huu Trach), which originates from mountains in the west of the city, combining at Tuan confluence. The part of Huong river is 32 km long, its basin area is 2830 km² and the population of its basin is 540,000. The river divides Hue city into two parts on its flowing way: north part (old city) and south part (new city). Huong river which is clean in the upper part, is polluted by drainage of Hue city (its population was about 300,000 in 2005) as it runs through the city. Drainage of Hue city is discharged directly into the river or underground except a few of the drainage simply treated. Also, drainage of the people living on the water and sight-seeing boats is untreated. That affects the river water quality greatly. Especially drainage from the old city around the royal palace locating on the north part of the city polluted the river and its branches. A damp (Thao Long damp) has been being built at the mouth area of the river to prevent saline intrusion from the sea via Tam Giang – Cau Hai lagoon (with the length of 68 km, the area of 22,000 ha and the population of approximately 300,000).

In this study, we report the results of the research made in 2005 and 2006 on water environmental chemistry of the river, focusing on its eutrophication.

2. Method

We researched water quality in Huong river from the two upper branches to the river mouth directly bordering Tam Giang - Cau Hai lagoon and underground water quality of Hue city. The main research points are shown in figure 1 and figure 2. Water samples were kept frozen until we made analysis of total organic carbon (TOC) and nutrients. Inorganic components were analyzed by ICP optical emission spectrometry. Procedures for analysis of the parameters of water quality were carried out according to guidelines of Standard Methods for the Examination of Water and Wastewater (APHA, 1995).

Trilinear diagram and Principle Component Analysis (PCA) method was applied to data treatment and interpretation.

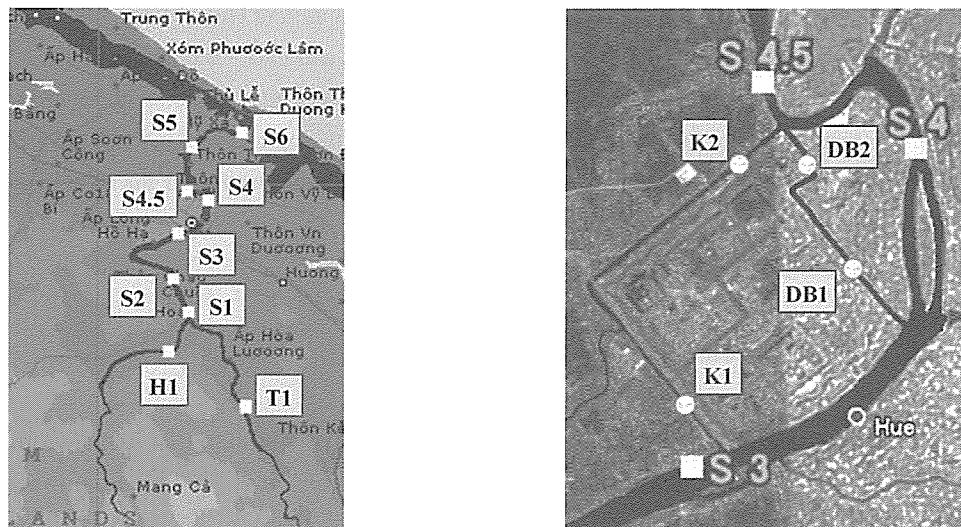


Figure 1. Sampling points at Huong river:

T1: at Ta Trach branch; H1: at Huu Trach branch; S1 – S6: at the main part of the river

Figure 2. Sampling points at Hue old city:

K1 and K2: at Ke Van canal; DB1 and DB2: at Dong Ba canal

3. Results and discussion

3.1. Hydraulic condition of Huong River

Monthly mean flux at point S2 is shown in Figure 3 (IUCN, 2004). In dry season (from January to August) the flux is low. Flux becomes much in rainy season (from September to December). At October, 2006, when we researched, flux were about $250 \text{ m}^3/\text{s}$, which was in the early rising period.

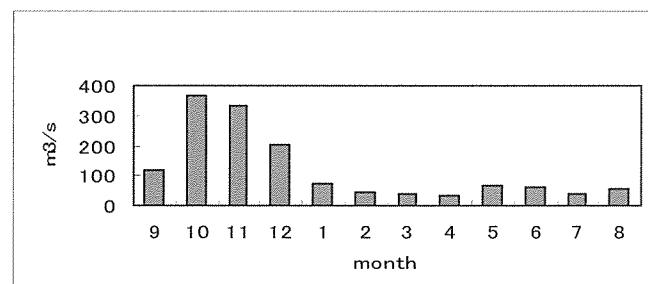


Figure 3. Monthly mean flux at point S2

3.2. Water environment of Huong river

Figure 4 is a trilinear diagram of inorganic ions. This shows that Huong river flow is affected by sea water, especially its downstream in dry season is greatly affected. Changes of concentration of TOC and DOC (dissolved organic carbon) along the river are shown in Figure 5. Upper stream of the river was clean in term of TOC (about 1 mg/l). But water from point S4, where drainage of the old city around the royal palace and the new city flows in, began to be contaminated (TOC in the range of 1.5 – 2.5 mg/L). Downstream water quality recovered owing to dilution by sea water. Huong river water had much suspended organic carbon at the time of research in October 2006. Concentration of nutrients (TN and TP) became high from points S4 – S45 (Figure 6), caused by wastewaters from the city activities discharged directly into the river.

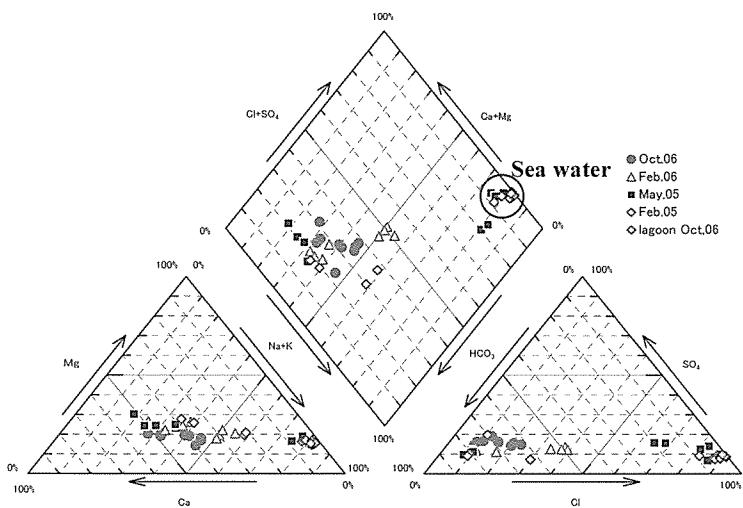


Figure 4. Trilinear diagram of inorganic components in Huong river

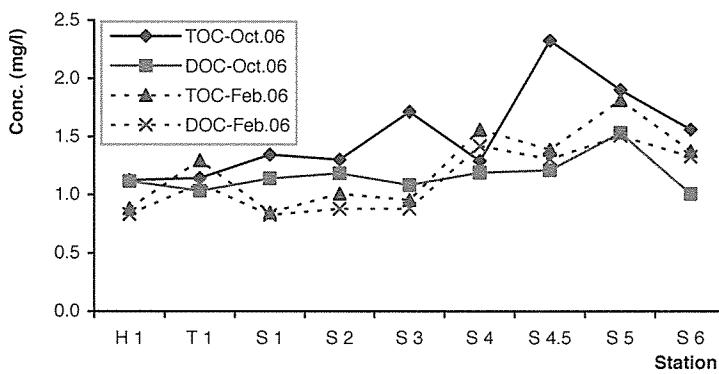


Figure 5. Changes of TOC and DOC in Huong river in 2006

Concentration of nutrients was low at Points S5 and S6 of the lowest stream, because the river water was diluted by back flow of sea water. Difference of the nutrients concentration between the upstream and downstream of the river was considerable in February and May of dry season because of drainage of the city. Speciation of the nutrients in small canal Ke Van (KV1 and KV2) and Dong Ba (DB1 and DB2) around the palace, and ground waters are shown in Table 1. This results indicated that the nutrients levels

in the canals were much higher than that in the river. That means eutrophication in the canals was more severe than that in the river. At average, DRP (dissolved reactive phosphorus) concentration in the river was in the range of 0.005 – 0.02 (average = 0.01 mg/L) and so that, this level was enough to support plankton growth (WHO, 2002). Obviously, eutrophication in the river, especially in its canals has been a concern about deterioration of their water quality. Because the ratio TN/TP in the river was rather high: 20 – 350 (media = 25) in October 2006, 10 – 70 (media = 43) in February 2006 and 12 – 94 (media = 47) in May 2005, phosphorus was limiting factor for the eutrophication in the river (WHO, 2002). This situation was also correct to the canals (the ratio TN/TP in the canals varied in the range of 13 – 357). Obviously, it is necessary to manage drainage from the city and the floating community on the river as soon as possible.

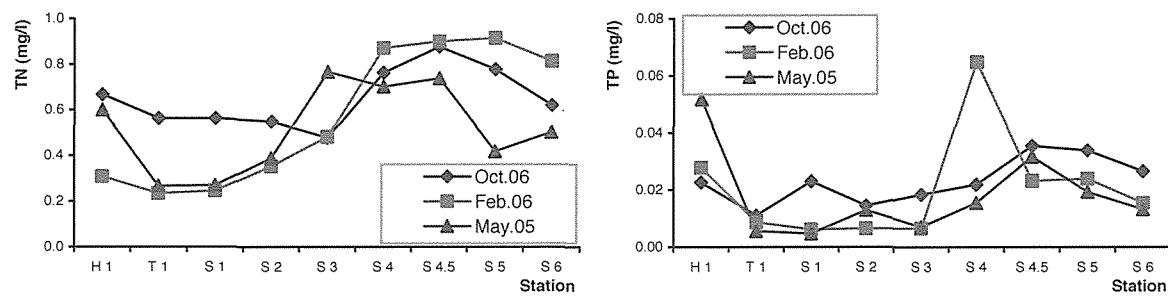


Figure 6. Changes of nutrients (TN,TP) in Huong river in 2005 and 2006

Table 1. Speciation of nutrients, TOC and DOC in small canals and ground water in Hue urban area

Time	Station	pH	NH ₄ ⁺ -N (mg/l)	NO ₃ ⁻ -N (mg/l)	DIN (mg/l)	DON (mg/l)	TN (mg/l)	DN (mg/l)	DP (mg/l)	DRP (mg/l)	TP (mg/l)	TOC (mg/l)	DOC (mg/l)	TN/TP
Oct.06	K1	6.9	0.75	0.13	0.90	0.36	2.87	1.26	0.016	0.004	0.12			15.6
	K2	6.7	0.36	0.06	0.43	0.30	1.23	0.73	0.030	0.012	0.097			12.7
May.05	DB1	6.5	0.50	0.25	0.79	0.24	1.25	1.03	0.016	0	0.050			25.0
	DB2	6.5	0.44	0.22	0.70	0.37	1.10	1.07	0.012	0	0.034			32.4
Oct.06	GW1*	7.2	0.01	2.48	2.55	0.13	2.71	2.68	0.52	0.52	0.54	4.0	3.0	5.0
	GW2*	6.3	0.09	0.39	0.49	0	0.64	0.49	0.016	0.016	0.059	2.1	1.3	10.8
	GW3*	7.2	3.33	3.12	6.73	0	6.99	6.73	0.12	0.11	0.16	2.4	2.0	43.7
	GW4*	7.2	0.37	5.00	5.42	0.29	5.71	5.71	0.52	0.52	0.56	2.7	2.2	10.2

* Ground water near sampling point S3.

PCA method applied to water quality of Huong river:

PCA method was applied to the river water quality data of February and October 2006. The data of February 2005 was not included, because in that time, the river affected much by back flow of sea water. Figure 7 and figure 8 shows factor loadings and factor scores of the main components. The first main component was affected by sea water via Tam Giang – Cau Hai lagoon water. The second main component affected by urbanization. As contribution rate of the first main component was 98.8%, water quality of Huong River was greatly defined by backflow of sea water.

When backflow of sea water is interrupted, polluted water at the downstream of the river will not be

diluted, and so that further sewage management is necessary. As Huong river is an important river of a sightseeing city, and as it is a main water supply for the citizens, it is necessary to establish an action plan to manage sewage (with a mind to backflow of sea water) in order to mitigate the river water pollution and keep it clean.

Ground water quality:

Organic pollution in the ground water samples collected (TOC = 2.1 – 4.0 mg/L) was higher than that in the river. Nutrients (TN and TP) in the ground samples was higher than that in the river, especially, ammonia concentration in the sample GW3 was rather high in the time of this study (Table 1). Owing to almost people in Hue city use tap water as water supply, there was no concern about health risk to the people of the city, although pollution in the ground water was higher than that in the river.

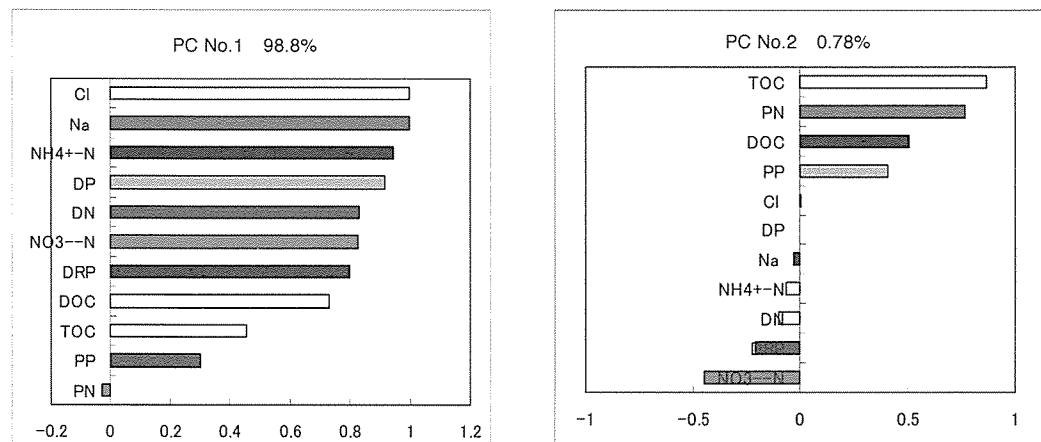


Figure 7. Factor loadings of Huong River in 2006

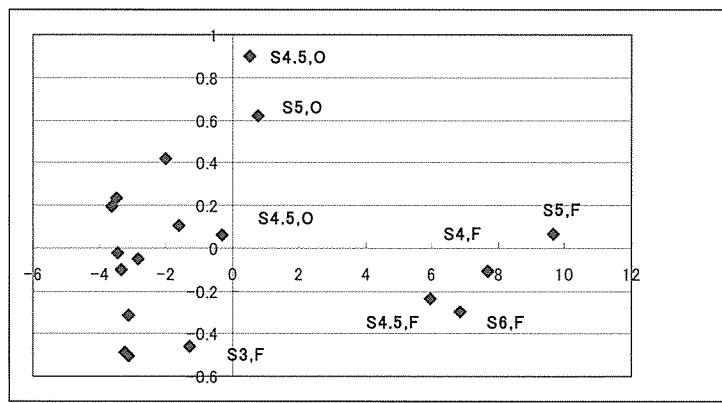


Figure 8. Factor scores of Huong river in 2006

Conclusion

Huong river water quality was affected by both drainage from Hue city and back flow of sea water. Eutrophication in the river, especially in its canals has been a concern about deterioration of its water quality. Follow-up actions should be urgently done to manage drainage from Hue urban area.

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