Inorganic pollutants in the Padma River, Bangladesh
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Abstract The water and bed-sediment pollution status of the Padma River was determined by analysis of representative samples for selected metals and ions. Water and bed-sediment samples were collected at a T-dam, Rajshahi, Bangladesh, for 7 months. Water and silt-metal content analysis was performed using atomic absorption spectrophotometry or other analytical methods. The data showed the variation of the metal ion-levels in water as follows: Ca 17.11–48.37 ppm, Na 17.51–20.09 ppm, K 1.00–3.60 ppm, Cr 2.80–7.00 ppm, and SO₄ 4.17–5.48 ppm; in bed sediment, the levels were Cr 35–1050 ppm and Pb 12–48 ppm. The occurrence of Na, K and Ca was in the normal range (US EPA permissible limit), but the levels of Cr in water were much higher than the permissible limit. The SO₄ ion content was well below the pollution level. The concentration of Pb in the bed sediment was within the permissible limit for the standard International Atomic Energy Agency (IAEA) Soil-5a, but the concentration of Cr in the bed sediment was significantly higher than the permissible limit for the standard IAEA Soil-5a. Thus the Padma river water was polluted with Cr. The occurrence of some ions showed a monthly variation.

Key words River water · Bed sediment · Trace metal · Heavy metals · River pollution

Introduction

The River Ganges originates in the Himalayan mountain range, Kumaun, India. Before it empties into the Bay of Bengal, the Ganges becomes the Padma River in Bangladesh. In southern Bangladesh, the water of the Padma River is distributed through distributaries. The River Padma is one of the major water sources for industry, agriculture, and innumerable households in Bangladesh. Long-term studies indicate that in both India and Bangladesh population growth, urbanization, agricultural practice and industrialization, coupled with the lack of efficient or adequate sewage treatment and waste disposal systems, have contributed to the contamination of the Ganges and the Padma (Ahmed 1990). This contaminated water is widely used in India and Bangladesh for rituals and drinking purposes, fishing, washing of clothes and utensils, and bathing of both humans and bovine animals. As the river comes from industrialized northern India, the Padma River pollution may result in an alarming situation unless proper planning and management are launched by the Indian and Bangladesh governments. In order to control natural and anthropogenic sources of pollution and prevent them from rising to levels detrimental to human beings, programs to monitor levels of pollutants in the river water and sediments are necessary. Procedures of this type are important in the environmental management of any industrialized or developing country (Goh and Chou 1997). Although partial analysis of water and sediments from the Ganges has been reported earlier (Joshi and others 1995; Sarin and others 1979; Subramanian 1979; Sarin and Krishnaswami 1984; Subramanian and others 1987), no significant work has been done so far on the pollution status of this river. In fact, there is a general lack of information on water and sediment chemistry of Asian rivers, especially the Ganges and the Padma (Subramanian and others 1985). Thus, data regarding the pollution status of the Padma River should be obtained for public interest. Therefore, this study was initiated as an attempt to obtain information about the presence and concentration range of some inorganic pollutants in the Padma river water and bed sediment. In this study, we determined the concentrations of chromium (Cr), sodium (Na), potassium (K), calcium (Ca), lead (Pb) and sulphate (SO₄) ions in river
water and the concentrations of chromium and lead in the bed sediment. Data obtained in this study should be useful in understanding the metal geochemistry of the Padma River.

**Methodology**

**Water and bed-sediment sample collection**
River water and bed-sediment samples were collected from November 1989 to May 1990. The samples were collected from a T-dam (a T-shaped dam to divert the river water and protect the city from flood water) constructed on the bank of the Padma River in the west of Rajshahi City (Fig. 1). The T-dam was chosen in an attempt to obtain a wide range of metal concentrations. The samples were collected on a weekly basis during the first 3 months and fortnightly during the subsequent 4 months. The water samples were collected in 2-l plastic containers. Bed sediments were collected by simple scooping with a plastic spade and transferred to 1-l plastic containers. Sealed water and sediment containers were brought to the laboratory and kept at <1 °C until prepared for analysis. The water pH was measured immediately after arrival in the laboratory.

**Qualitative analysis of samples**
Immediately following the sample collection, the presence or absence of some pollutants such as Cr, Pb, cadmium (Cd) and nickel (Ni) was determined. In water and bed sediment, Cr was detected by the diphenyl carbazide method (Feigl 1958). Lead in water and bed sediment was detected by the benzidine spot-test method (Feigl 1958). Nickel and Cd were tested by dimethyl glyoxime and di-p-nitrophenyl carbazide spot tests (Feigl 1958) respectively.

**Chromium determination in water and bed sediment**
The chromium presence was determined using the diphenyl-carbazide method (Feigl 1958). The absorbance was measured at 540 nm with a Bausch and Lomb Spectronic-20 spectrophotometer. Attempts were also made to determine Cr concentration in the water and bed sediment using an atomic absorption spectrophotometer (AAS). Unfortunately, the oxy-acetylene flame temperature of our AAS was not high enough for Cr determination.

**Lead determination**
The concentration of Pb in river water and bed sediments was determined with an AAS (Model ANA 180; Tokyo Photo-electric Co., Ltd.). A 5-g sample of the oven-dried bed sediment was digested with 20–40 ml (1:1) nitric acid for 2 h and filtered. After filtration (Whatman no. 1 filters) lead was determined by atomic absorption spectrophotometry (284.20 nm).

**Other determinations**
The collected water samples were filtered with Whatman no. 1 filters and the Na, K and Ca concentrations were measured using an AAS. Determination of the average monthly variation of some essential elements such as Na, K and Ca in the Padma River indicated the fertility of the river. The SO₄ ion in water was determined by turbidimetric method (Vogel 1978). The turbidity was measured with a Bausch and Lomb Spectronic-20 spectrophotometer. A blank solution was used to set 100% transmittance on the Spectronic-20. The transmittances of the samples were measured at 500 nm.

**Statistical analyses**
In this study, only the chromium concentration of river water and bed sediment was found to exceed the permissible limits. Significant differences between the sampled chromium concentrations and the permissible limits were determined using t-test (p ≤ 0.05).

**Results and discussion**
The Cr concentration (mean ± SEM) in river water samples was 5.05 ± 1.15 ppm for the period recorded (Table 1). The lowest Cr concentration observed was 2.80 ppm and the highest was 7.00 ppm (Table 1). Data indicate that the mean Cr concentration in river sediments was 329.36 ± 268.14 ppm (Table 2). The results also demonstrated a monthly variation of the Cr concentrations in both the sediment and river water (Fig. 2). This may have been due to an exchange of Cr between sediment and river water. The mean Cr concentration