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Original Research Paper

Survey of Trace Metal Contaminants in Sediments of Kabini River in the Nanjangud Industrial Area, Mysore District

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ABSTRACT

The Kabini river, a confluence of the Panamaram and Mananthavady rivers, originate from Wynad district of Kerala and flows into the Bay of Bengal. It is passing from the Nanjangud industrial area, which is known as a “toxic hot spot” due to the heavy loads of metals and organic compounds discharging from various industries, mostly settle down at bottom of the river. To determine metal content of the Kabini river sediments, five samples were collected along its main course. All the samples were analysed for six heavy metals (Cd^{+2}, Cr^{+3}, Cu^{+2}, Pb^{+2} and Ni^{+2}, Fe^{+3}) and ten physico-chemical characteristics (pH, EC, water holding capacity, Ca^{+2}, Mg^{+2}, Na^{+}, K^{+}, Cl^{-}, NH_4^{+}, % organic carbon). The highest levels of copper were detected in the industrial area point, while for chromium, it was in downstream site. The lowest amount of lead was determined in upstream locations, whereas nickel and iron were found in industrial area site. Total amounts of heavy metal contaminant, however, were below the maximum permissible limits.

INTRODUCTION

Environmental contamination by heavy metals is a critical issue. Unlike many organic contaminants, which lose their toxicity by biodegradation, metals can not be degraded and their toxic effects may remain for a long time (Clark 2001). Metals are added to aquatic systems by natural and man-made sources through several routes and are distributed between different compartments of aquatic ecosystems, such as water, sediment and biota. Metals, which are least soluble in water, get adsorbed and accumulate at the sediments acting as sink (Hakanson 1980). Likewise, at the bottom of Kabini river, the distribution of heavy metals is affected by minerological and chemical composition of suspended materials, anthropogenic influences and processes such as deposition, adsorption, enrichment in organism, etc. (Forstner & Muller 1975, Jain et al. 2004).

Sediments are useful in assessment of heavy metal contamination of waters (Forstner & Wittmann 1979). The ability of sediments to concentrate and retain trace elements, depends on several factors such as physical properties including the grain size and surface area of the sediments (Horowitz & Elrick 1987). Since, most metals associate with the surfaces in particles, they are preferentially transported, deposited and eventually buried with fine-grained, high surface area sediments (Gibbs 1973, Hornberger et al. 1999, Sposito et al. 1999). Different studies have widely confirmed contamination of sediments by heavy metals. Fytianos & Lourantou (2004) studied the speciation of trace elements in sediment samples of the Volvi and the Koronia lakes in North Greece and reported that the lakes are not yet polluted. Chandrasekhar et al. (2003) found heavy metal contamination in sediments and edible fish samples of the Kolleru Lake. It was found that cadmium and lead contents of sediments pose high risk to the Gomati river environment. The present study aims to the determination of heavy metal concentrations in sediments of the Kabini river passing around the Nanjangud industrial area.

MATERIALS AND METHODS

Sampling points: Five sampling points (Fig. 1) were selected for the study:

1. **N1:** One of the major sources of effluent discharge of the pulp and paper mill factory in upstream of the Kabini river.
2. **N2:** This point is located on right bank of the river dominated by heavy discharge of domestic sewage and solid waste.
3. **N3:** This sampling site is important because of ascertaining cumulative effects of pollution in the Kabini river.
4. N4, N5 are located in downstream part of the river receiving the aggregative loads of industrial effluents.

Sample collection: As clay and silt particles generally contain highest concentration of pollutants and are most readily transported in suspension, the natural water analysis for heavy metals is normally carried out in sediment (Fytianos & Lourantou 2004). For present study, freshly deposited sediments were collected from shallow water near edges of the banks of Kabini river in the month of June 2008. All the samples were air dried and stored at 4°C in refrigerator until further analysis. Ten physico-chemical characteristics including pH, electrical conductivity, water holding capacity, Ca^{+2}, Mg^{+2}, Na^{+}, K^{+}, Cl^{-}, NH_4^{+}, % organic carbon and heavy metals contents (Cd^{+2}, Cr^{+3}, Cu^{+2}, Pb^{+2}, Ni^{+2} and Fe^{+3}) were analysed by standard methods given by Trivedy & Goel (1986), APHA (1992).

RESULTS AND DISCUSSION

The results of physico-chemical analysis of sediments are shown in Table 1. pH of the river sediments vary from 7.80 to 8.08 indicating slightly alkaline nature. There was, however, no significant difference in electrical conductivity values between the sampling sites (0.35-0.48 mmho). The highest organic carbon content was observed at point N2 (2.601%). It may be due to direct discharge of large amounts of effluents from pulp and paper industry into the river. The chloride contents were generally high (71.0 to 532.5 ppm) and no significant difference was observed in chloride values. High concentrations of exchangeable cations were found in all the samples without any significant difference in the obtained values, except for N2. Ammonium nitrogen levels were high (466.66 to 500.69 ppm) in all the studied points.

The results of the analysis of heavy metals are shown in Table 2 and Fig. 2. Among heavy metals, the concentration of nickel varied from 0.151 to 0.428 ppm and the highest concentration was found at N4 (0.428 ppm). Chromium concentra-

Fig 1: Sampling sites along the Kabini river around Nanjangud industrial area, Mysore district.

Table 1: Physico-chemical characteristics of silt at sampling point in Kabini river of Nanjangud industrial area.

S. No.	Parameters	N1	N2	N3	N4	N5
1	pH	7.80	8.02	8.02	7.93	8.08
2	Electrical Conductivity (mmho)	0.48	0.41	0.35	0.39	0.39
3	Water holding capacity (%)	10	14	6	2	12
4	Calcium (ppm $CaCO_3$)	380.76	901.8	260.52	460.92	440.8
5	Magnesium (ppm $CaCO_3$)	230.85	546.75	157.95	279.45	267.3
6	Sodium (ppm)	11	15.5	7.5	8.5	12.5
7	Potassium (ppm)	2.5	14	7.5	1	8.5
8	Chloride (ppm)	106.5	532.5	71	177.5	71
9	Ammonium nitrogen (ppm)	466.66	486.11	500.69	466.66	500.69
10	Organic carbon (%)	1.071	2.601	1.071	1.224	1.377

Table 2: Heavy metal content in bed sediments.

Sl no.	Station	Ni^{+2} (ppm)	Cr^{+3} (ppm)	Pb^{+2} (ppm)	Cu^{+2} (ppm)	Cd^{+2} (ppm)	Fe^{+3} (ppm)
1	N1	0.272	0.603	0.184	0.537	Nd	18.307
2	N2	0.420	0.665	0.179	0.369	Nd	18.399
3	N3	0.151	0.419	0.189	0.77	Nd	17.362
4	N4	0.428	0.740	0.005	0.450	Nd	18.465
5	N5	0.291	0.658	0.21	0.178	Nd	18.438

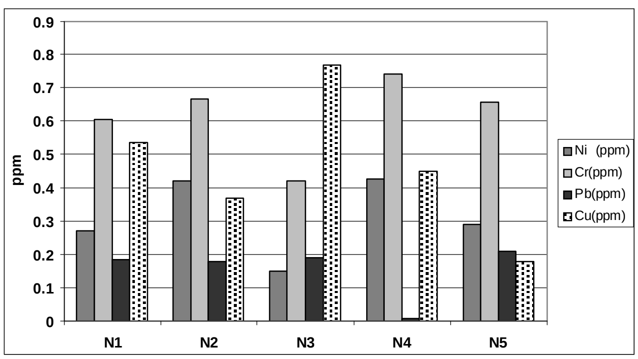

Fig. 2: Heavy metal content in bed sediments.

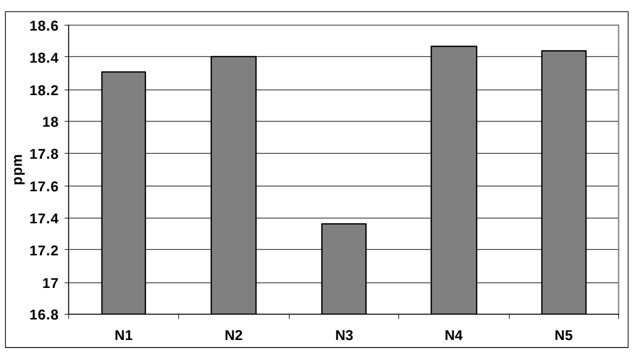

Fig. 3: Iron content in bed sediments.

tion ranged from 0.419 to 0.74 ppm with the highest concentration at N4 (0.74 ppm). Maximum value (0.21 ppm) and minimum value (0.005 ppm) of lead were found at N5 and N4 respectively. Copper had the highest concentration (0.77 ppm) at N3. Cadmium was not detected in the studied sediment samples. Iron was the most abundant metal in all the sediments with concentrations ranging from 17.362 to 18.465 ppm. (Fig. 3).

CONCLUSION

The variations in the total concentration of heavy metals may be due to difference in the source of heavy metals and prevailing physico-chemical conditions and complex reactions such as adsorption, precipitation and redox conditions.

Total amount of copper concentrations in downstream sediments was found to be higher than the other sampling sites, likely because of aggregation of the industrial loads. Higher amounts of chromium in N_3 might be occurring as a result of the direct discharge of industrial effluents in the river flow. In most of the cases, lead and nickel showed similar concentrations except in two sites (N_3 and N_4). Iron content showed high concentrations in all the samples, since this is one of the most common elements in the earth's crust.

Although the selected bed sediments of the Kabini river were affected by industrial effluents, total amounts of the heavy metals were found to be lower than the maximum permissible limits prescribed by Central Pollution Control Board. The results of the study suggest that heavy metal concentration of the Kabini river sediments need to be continuously evaluated, even though it is comparatively low, since it may increase in future through anthropogenic activities.

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