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Studies on Heavy Metal Pollution of Karnaphuli River, Chittagong, Bangladesh

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Abstract: *The Karnaphuli, a major river of Bangladesh, is polluted in several ways particularly through industrial and sewage disposal. Increased anthropogenic activities have increased the potential pollution of the river, especially, the heavy metal pollutants which may be toxic to humans and aquatic fauna. Presence of heavy metals in the river water causes perilous impact on the aquatic organisms. Hence, regular monitoring of pollution levels in the river is indispensable. The present study dealt with the heavy metals distribution viz. Cadmium (Pb),Chromium (Cr), Lead (Pb) and Nickel (Ni) in water of Karnaphuli River during rainy and winter seasons. Four stations were selected for collection of water samples in different locations. Atomic Absorption Spectrometer (AAS) analysis of water sample of four discharge points reveals that the concentration of Lead (Pb) may be very low as AAS could not detect the amount present in the water samples, whereas, that of Nickel (Ni) and Cadmium (Cd) were comparatively high. Chromium (Cr) was detected relatively low throughout the study period. The concentration of heavy metals showed seasonal variation and it was higher in winter season than rainy season in most of the station.*

Keywords*: Pollution, Heavy metal, Karnaphuli River, Nickel, Cadmium, Lead, Chromium.*

I. Introduction

The Karnaphuli is the principal river of Chittagong district of Bangladesh. It originates in the Lushai Hills of Mizoram of India, flows through Rangamati and the port city of Chittagong and discharges into the Bay of Bengal at latitude 22°12´N and longitude 91°47´E near Patenga. People of Chittagong city depend on Karnaphuli for variety of aspects. Numerous industries are the major source of water pollution. The important industries in Bangladesh include tanneries, garments, ship breaking, pulp and paper, refineries, food, fertilizer, textile, pharmaceuticals, steel, chemical and other small-scale and agro-based industries. Most industries are located in greater Chittagong, Dhaka and Khulna. Within greater Dhaka, industries are mainly concentrated at Narayanganj, Demra, Tongi, Hazaribag Tejgaon, Joydevpur and Narshingdi. In Chittagong, industries are located mainly at Fauzdarhat, Kaptai, Nasirabad, Barabkunda, Bhatiary, Sholashahar, Patenga and Kalurghat. In Khulna, areas of industrial concentration include Boyra, Khalishpur, Rupsha and Shiromoni (Atiur et al.) [1]. Chittagong city, being highly industrially developed area the heavy metal pollution of the Karnaphuli River is also increasing sharply. Ahmed and Reazuddin [2] reported that the availability of the heavy metal in river water directly affects the fish physiology and by the consumption ultimately affects the human health. For the increasing level of pollution the availability of fish is decreasing rapidly, as a result the socio-economic condition of the fishing community is affected (Rashid et al.) [3]. In Chittagong region, wastewater from Nasirabad industrial area (mainly chemical, leather, textile and steel re-rolling industries) is discharged into surface drains that ultimately carry it to the Karnaphuli river. Industries (largely chemical, leather and textiles) at Kalurghat area drain that wastewater into drainage canals, which is ultimately discharged into the Karnaphuli river. This also endangers the drinking water supply in Chittagong by polluting water at the intake region of the Mohara water treatment plant (BKH,1995) [4]. Undoubtedly, heavy metal pollution of river is a problem associated with disposal of untreated sewage discharges, industrial pollutants, land washout, city run-off and urban wastages into rivers. In these circumstances, it is essential to evaluate the presence of heavy metal contamination in the Karnaphuli river water. Considering the importance of studying heavy metal pollution for understanding suitability of river water as fish habitat and human use the research is designed to determine the levels of some heavy metals (Pb, Ni, Cr and Cd) of four selected sites of the Karnaphuli river and to evaluate the water quality parameters of the River Karnaphuli as affected by industrial pollution.

II. Materials And Methods

2.1 Water samples collection:

Water samples were collected from four selected stations viz. Station 1 (Discharge opening of Regent Textile), Station 2 (Discharge opening of TK group), Station 3 (FIDC) and Station 4 (Noakhal) of the Karnaphuli River (Fig.1) at two different seasonal period; rainy season and in winter season during the years 2011- 2012.The characteristic rainy season samples were collected after sufficient rainfall. Surface water samples were collected manually. For heavy metal analysis the primary sampling point was in the surface water layer (0-5 cm from the surface) at main flow. Surface water was collected using acid-leached polythene bottles and chilled immediately to 3º to 4ºC.

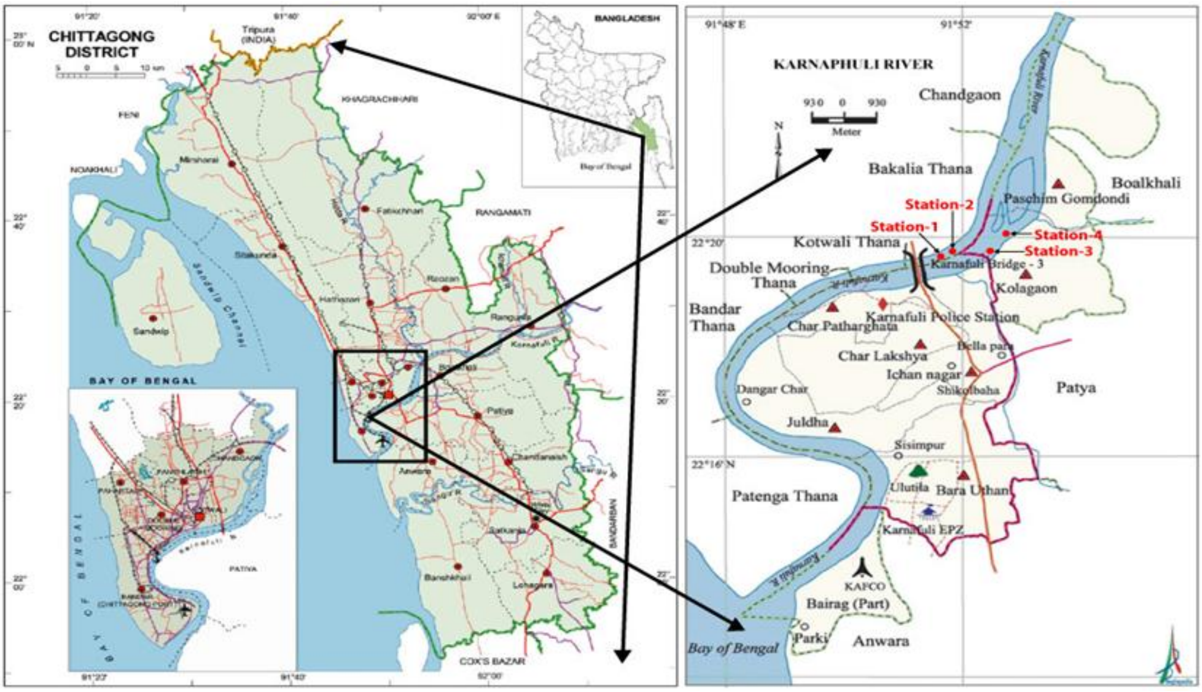

Fig. 1: Geographical location of sample collecting site.

2.2 Preliminary treatment of samples for heavy metal determination:

Preliminary treatments of samples were done by following international standard method given by APHA [5]. Water Sample was agitated to obtain homogeneous suspension of solids. 500 ml sample was measured and transferred to an evaporating dish; sample was acidified with 5 ml HNO_3 and evaporated on a steam bath to 15 to 20 ml. Then the solution was transferred, together with any solids remaining in the dish, to a 125 ml conical flask. 5 ml additional HNO_3, 10ml H_2SO_4 and few glass beads (to prevent bumping) were added into the solution and it was evaporated on a hot plate until dense fumes of SO_3 appear in the flask. A clear solution was observed and all the HNO_3 was removed. The solution was cooled to room temperature, carefully diluted to about 50 ml and filtered through a porcelain filter crucible & washed the residue with 2 small portion of water. Then the filtrate was transferred to a 100 ml volumetric flask and made up to the mark with distilled water. A aliquots of this solution were taken for the determination of metals.

2.3 Analytical Techniques:

The samples were analyzed by an atomic absorption spectrophotometer (Type: iCE 3300 AA system, Thermo Scientific, designed in UK) using an air acetylene flame. All the spectroscopic measurements of the standard metal solutions as well as the sample solutions were done at their respective wavelength of maximum absorptions λ_{max}.

III. Results And Discussion

To determine the level of heavy metal pollution, concentration of four metals were measured at different stations in two seasonal periods. Findings of this study along with the recommended standards of World Health Organization (WHO) have been summarized in Fig.2-4 and Table 2-3. Recorded heavy metal concentrations in the water of Karnaphuli river showed little seasonal variation. Most of the dissolved heavy metals were found to be in slightly higher concentrations during winter than that of the rainy season. This trend indicates that during low flow condition of river, the accumulation of the metal concentration increases. This finding is in well agreement with the findings of several authors [6-7]. Obasohan and Eguavoen[6] have stated in their research that dry seasons have an effect on the accumulation of heavy metals in water and its reared fish of Obga river in Nigeria. In a similar study, Ahmed et al.[7] investigated the distribution of heavy metals concentration in the Buriganga River and found that distribution of Cd, Cr, Cu, Ni, and Pb varied seasonally. Abdel-Satar [8] explained the trend to be due to the high evaporation rate of surface water followed by elevated temperature.

In this study Pb was found below detection level in all stations during both seasons. This might be due to low solubility of Pb containing compound in water. Venugopal et al. [9] also found non detectable level of Pb in their study. Ni and Cr were found to be within the detection level but below the permissible limit of WHO standard of drinking water (1993, 2004 and 2011,[10-12]). Cd was the only metal which was found above the permissible limit of WHO drinking water standard, 2011 [12].

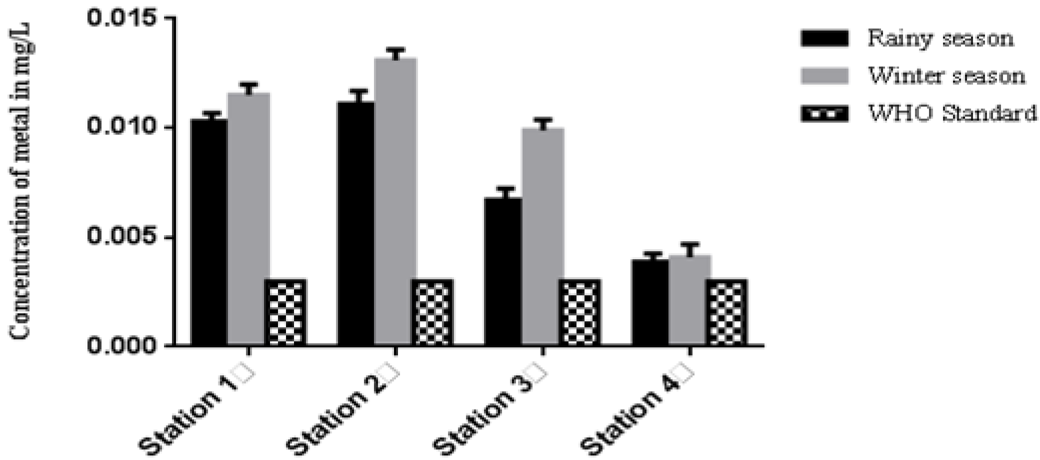

Fig.2: Showing seasonal and station wise mean concentration of Cadmium (Cd) with WHO standard. Detection Limit of Instruments: For Cd 0.0028 mg/L . WHO standard: 0.003 mg/L

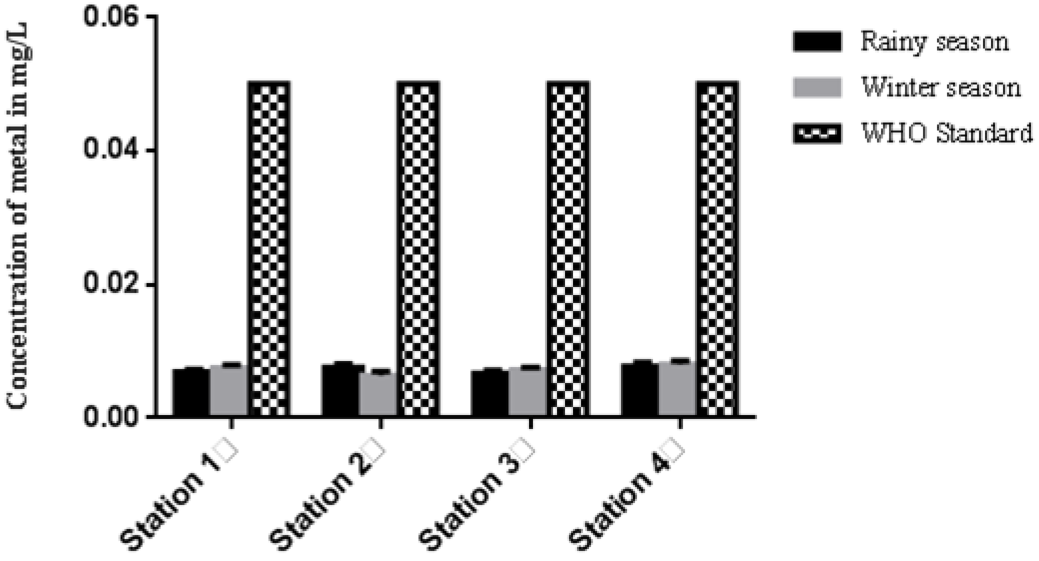

Fig. 3: Showing seasonal and station wise mean concentration of Chromium (Cr) with WHO standard. Detection Limit of Instruments: For Cr 0.0054 mg/L. WHO standard: 0.05 mg/L.

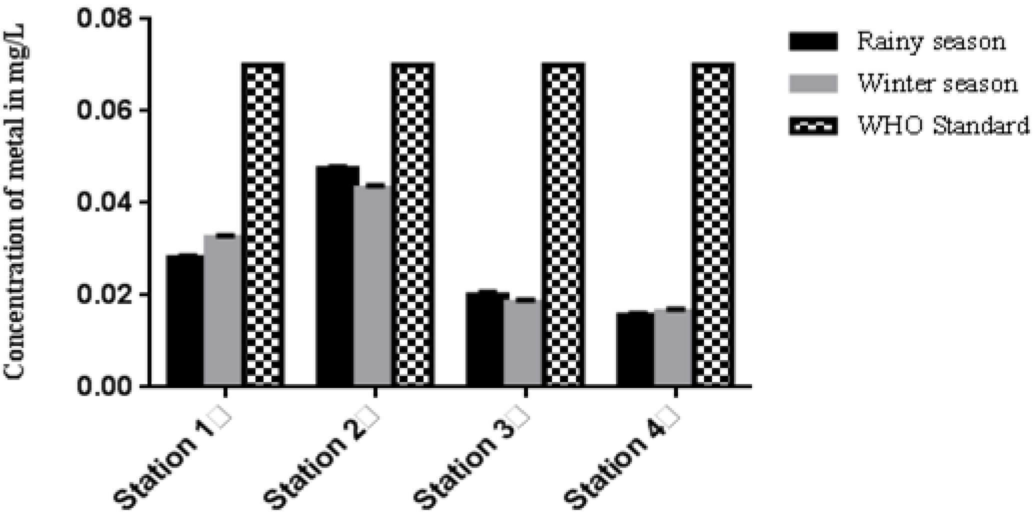

Fig .4: Showing seasonal and station wise mean concentration of Nickel (Ni) with WHO standard. Detection Limit of Instruments: For Ni 0.008 mg/L. WHO standard: 0.07 mg/L.

Table 1: Concentration of Lead (Pb) during rainy and winter season by at different station

	Station 1	Station 2	Station 3	Station 4	Mean	WHO standard
Rainy Season	BDL	BDL	BDL	BDL	BDL	0.01 mg/L
Winter season	BDL	BDL	BDL	BDL	BDL	

BDL = Below Detection Limit . Detection Limit of Instruments: For Pb 0.013 mg/L.

Table 2: Comparing overall mean concentration of metals in all stations with WHO standards.

Metal	Mean concentration in rainy season (in mg/L)	Mean concentration in winter season (in mg/L)	WHO standard (mg/L)	Comments
Cadmium (Cd)	0.008	0.0097	0.003	Above standard
Lead (Pb)	BDL	BDL	0.01	BDL
Nickel (Ni)	0.0278	0.0276	0.07	Below standard
Chromium (Cr)	0.0072	0.0073	0.05	Below standard

BDL= Below Detection Limit

Cadmium is toxic at a very low concentration and has no known functions in biochemical processes. Sources of cadmium include wastes from cadmium-based batteries, incinerators and runoff from agricultural soils where phosphate fertilizers are used since cadmium is a common impurity in phosphate fertilizers (Hutton and Symon) [13]. However, this result infers that low concentrations of the most of the metals in the river water may be due to physical and chemical phenomenon such as mobility, adsorption or co-precipitation of metals or existence of some respiratory mechanisms by aquatic fauna to eliminate accumulated metal ions from the river. Although the concentrations of all the studied metals except Cd were found in this study within the allowable limit of different guidelines; however, bioaccumulation of these trace elements in aquatic consumers for a long period can result in a substantial amount of heavy metal in them which can make a perilous impact on human health.

IV. Conclusion

Result of present analysis reveals that among four metals (Pd. Cr, Ni and Cd) only Cd exceeded the recommended values and confers little sign of presence of metal pollution which might still not be reached as an the alarming level; however, if this trend of contamination continues it may make an impact on the quality of water of the Karnaphuli river and in the long run can cause a serious threat for aquatic organisms. Therefore to prevent future adverse impact on the river a restriction must be imposed on the discharge of trace metals and sewages through different sources.

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