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Seasonal variation of heavy metals in water of Shitalakkhya river

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Abstract

The present investigation was carried out from April 2002 to January 2003 in respect of pre-monsoon, monsoon and post monsoon periods to evaluate the Seasonal variation of Heavy Metals in water of Shitalakkhya river. Seasonal variation of heavy metals such as Copper (Cu), Lead (Pb), Cadmium (Cd), Calcium (Ca),Magnesium(Mg), Zinc(Zn), Manganese(Mn) and Iron(Fe) concentrations in water and sediments. By employing air-acetylene and Nitrous Oxide flame in combination with single element hollow cathodes lamps and atomic absorption spectrophotometer (GBC-902). In water, metal concentrations (ug.ml^{-1}) were found to range from 0.00 to 0.003 for Cu, 0.0027 to 0.0056 for Pb, 0.0010 to 0.009 for Cd, 8.0 to 16.3 for Ca, 5.8 to 15.5 for Mg, 3.91 to 10.87 for Zn, 3.00 to 9.24 for Mn and 4.00 to 21.92 for Fe.

Introduction

Metals and their compounds have been used by man during much of his existence. Some metals like Fe, Cu, Zn, Pb, Cd, Mn, Ca, Mg etc. have such chemical and physical prosperities which make them attractive for scientific, agricultural, industrial and domestic use.

In aquatic environment especially rivers and oceans heavy metal pollution occurs due to anthropogenic activities. Heavy metals from agricultural land, urban activities and industrial effluents mix rapidly with river, estuaries or ocean water and hence deteriorate the water quality. Many studies have been conducted concerning the distribution of metals in fresh, estuarine and marine ecosystem Some scientists and biologists like George (1986), Kadri & Salen (1985), Pfeiffer *et al.* (1986), Tailor *et al.* (1990) Me Crea & Fishcher (1986) and Nolting *et al.* (1990), have studied on the concentrations of heavy metals in different riverine water throughout the world. In most of the work they observed significant concentrations which might be harmful to the biota.

It is difficult to assess the contamination of the vatic environment by heavy elements, as the natural level of these materials is not well-known. Despite this limitation, metal pollution has been clearly identified in many areas of the world.

Many heavy metals are normally present in the river. The natural concentrations of mercury lead, zinc cadmium, chromium, copper, iron, cobalt, nickel and molybdenum lie in an order of magnitude between about 10"5 and 10"8 gm/l. The trace elements have a great significance in the construction of animal and plant cells, although there is still little known about biochemical cycles, consequently their influx into the sea can lend to an increase in production. Heavy metals can be highly concentrated in organisms belonging to the food chain, thereby having a highly toxic influence on the ecosystem.Continuous discharge of untreated industrial wastes into the aquatic environment, endangers the safely of aquatic life and can reach the human body through the food chain.

The effect of heavy metal on aquatic system have been studied extensively as a result of widespread contamination by inorganic and organic metallic species from industrial process Unambiguous findings of the effects of trace metal pollution on the biota of aquatic system are rare, however, as confounding factors are often present. In attempting to quantify metal pollution, studies on the effects of metals pollution are often hampered by the presences of more than one metallic element and the variable toxicity of waste caused by changes of molecular form.

The river water is being used both for drinking as well as for irrigational work. With growing urbanization the rivers, the receive a. very higher quantum of city sewage and discharge of effluents from various factories etc. on way. Such discharge of effluents which are mostly untreated, have posed serious pollution problems, especially from heavy metals.

Materials and Methods

Description of the Investigated Area

The river Shitalakhya originated from Padma has been stable over last few decade and maintains a good navigation channel allover the year. The river covers a large industrial belt of Polash, Ghorasal, Kaliganj, Detnra, Adamjee and Narayanganj. River Sitalakhya about 50 km in length and 0.4 km average width, is also a tributary of river Dhaleswari and meets it only 11 km down stream of Buriganga confluence.

For the present investigation five sampling Stations were selected

Nabinagor (S1) : Latitude is 23°34.166/N and Longitude 90°32.083' E.
Narayangonj (S2):Latitude is23°36.546/N and Longitude 90°30.434' E.
,Katchpur Bridge(S3): Latitude is 23^{0}42.024'Nand Longitude 90^{0}30.094' E
Kaligonj (S4) :Latitude is 23°56.279' N and Longitude 90°37.063' E
(Ranigonj (S5): Latitude is 24°04.034' N and Longitude 90°37.898' E

Sample collection and Preservation

Sub-surface river water samples were collected seasonally, during the period of April '02, August' 02. and January' 2003 which were considered as the representative of pre-monsoon, Monsoon and post monsoon respectively from shitalakhya river at different station as Nabinagar (S1), Narayangonj (S2), Katchpur bridge (S3), Kaligonj (S4) and Ranigonj (S5) by using a Ruttnersampleroffibre glass made. The water samples were kept in acid washed polyethylene bottles, acidified immediately after collection with the addition of 2 ml ultrapure HNO3 per liter of water (Morse *el. al,* 1993) and then carefully preserved in a refrigerator at 4°C before laboratory analysis.

Digestion of Samples

250 ml of well mixed acidified water samples were kept in pyrex beaker and evaporated the samples on water both (temperature above 100°C) placing watch glass on each beaker to about dryness. Then 5 ml concentrated $HN0_3$ was added in each beaker and digested on water bath. Digested samples were filtered by using filter paper (Quantitative What man 541) and

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were made the filtrate to 25 ml with demonized water in a 25 ml volumetric flask. Blank digestions were carried out for each sample.

Preparation of standard solution

The standard solution of elements Fe, Cu, Zn, Pb., Cd,Ca, Mg and Mn were prepared by pipetting the required amount of the solution from the stock solution, manufactured by Fisher Scientific Company, New Jersey, USA. The standard solution was prepared before every determination of the analyses of the present work.

Preparation of calibration curve

Calibration curves were prepared by plotting the absorbance against concentration of the standard solutions for each element. Metal concentration in the samples were measured with the help of these calibration curves. For the calibration curve, the standard solutions were prepared with the concentration covering the optimum liner absorbance range. In all absorbance measurements, (he reading was taken nflcr (he instrumental zero has been adjusted. By measuring the absorbance of the standard solutions for respective elements, a calibration curve was automatically constructed and displayed in the monitor. The calibration curve was checked occasionally by making measurements with the standard solutions, and if necessary a new calibration curve was checked occasionally by making measurements with the standard solutions, and if necessary a new calibration curve was prepared.

Atomic absorption spectrophotometric measurement

The digested samples were then analyzed by using air acetylene and nitrous oxide flame with combination, as well as single element hollow cathode lamps into nn atomic absorption spectrophotometer (GBC-902). The sample was injected by an automatic sampler and the absorbance and concentration data were automatically printed out and displayed.

Table 1. Flame condition for analysis of heavy metals in water is as follows

Element	Lamp wave Length (nm)	Silt width (nm)	Lamp current (M4)	Flame type
Cu	324.7	0.5	3	Air acetylene
Fe	248.3	0.2	7	Air acetylene
Pb	217.0	1.0	5	Air acetylene
Cd	228.8	0.5	3	Air acetylene
Zn	213.9	0.2	5	Air acetylene
Mn	279.5	0.2	5	Air acetylene
Ca	422.7	0.5	10	Nitrous oxide
Mg	285.2	0.5	2	Air acetylene

Results and Observations

The results of heavy metal concentrations in water samples are presented table-2:

Copper (Cu)

The concentrations of Cu in water Samples varied from 0.00 to 0.03//g.ml" among the five sampling Stations of the river Shitalakya. The minimum concentration were recorded at Stations Sj. Sand 85 during the periods of pre-monsoon and maximum concentrations were recorded at Stations S during the periods of pre-monsoon.

Lead (Pb)

The concentration of Pb in water Samples varied from 0.0027 to 0.0056/g.ml"1 among the five Sampling Stations of the river Shitalakhya. The minimum and maximum concentrations were recorded at Stations S.i and Sj during the post monsoon and monsoon periods respectively.

Cadmium (Cd)

The concentrations Cd in water samples varied from 0.0010 to 0.009/g.ml"1 among the five sampling Stations of the river Shitalakhya. The minimum and maximum concentration were recorded at Station Sj during the periods of post monsoon and pre-monsoon respectively.

Calcium (Ca)

The concentrations of Ca in water samples varied from 8.0 to 16.3/g.ml"' among the five sampling Stations of the river Shitalakya The minimum and maximum concentrations were recorded at Stations S and 84 during the pre-monsoon and , monsoon periods respectively.

Magnesium (Mg)

The concentrations of Mg in water sample varied from 5.8 to 15.5/g.mr' among the five sampling Stations of the river Shitnlakhya. The minimum and maximum concentrations were recorded at stations S and 85 during the pre-monsoon and monsoon periods respectively.

Zinc (Zn)

The concentrations of Zn in water samples varied from 3.91 to 10.87/g.mr' among the five sampling Stations of the river Shitalakhya. The minimum and maximum concentrations were recorded at Station Sj and 8.1 during the Pre-monsoon and monsoon periods respectively.

Manganese (Mn)

The concentrations of Mn varied from 3.00 to 9.24/g.ml"1 among the five sampling Stations of the river Shitalakhya. The minimum and maximum concentrations were recorded at Stations Ss and Si during the Pre-monsoon and monsoon periods respectively.

Iron (Fe)

The concentrations of Fe in water samples varied from 4.00 to 21.92/g.ml"1 among the five sampling Stations of the river Shitalakhya. The maxfmum and minimum concentrations were recorded at stations S during the periods of pre-monsoon respectively.

Table 2. Seasonal Variation of heavy metal concentrations (^/g. ml"') in water sample at different stations of the river Shitalakya.

Station	Season	Metal Concentration (//g.ml"1)							
		Cu	Pb	Cd	Ca	Mg	Zn	Mn	Fe
S1	Pre-monsoon	0.03	0.0042	0.0010	12.8	5.8	4.07	9.01	21.02
	Monsoon	0.002	0.0046	0.0014	13.3	7.3	4.59	9.24	21.92
	Post monsoon	0.003	0.0037	0.0011	12.1	6.91	4.57	6.08	11.14
S2	Pre-monsoon	0.00	0.0045	0.0011	8.0	6.3	4.02	6.21	7.92
	Monsoon	0.002	0.0042	0.0013	12.5	9.2	4.67	6.97	8.18
	Post monsoon	0.002	0.0048	0.0012	11.2	8.6	4.07	2.41	12.83
S3	Pre-monsoon	0.002	0.0036	0.009	13.4	9.0	3.91	5.16	12.64
	Monsoon	0.005	0.0037	0.0016	13.5	11.3	4.50	5.46	12.34
	Post monsoon	0.001	0.0027	0.0010	12.4	8.3	4.30	3.10	11.06
S4	Pre-monsoon	0.00	0.0048	0.008	15.0	9.7	4.05	3.00	10.24
	Monsoon	0.001	0.0049	0.0013	16.3	9.8	10.87	6.85	4.45
	Post monsoon	0.001	0.0036	0.0012	14.5	7.2	5.60	4.60	15.23
S5	Pre-monsoon	0.00	0,0051	0.0012	16.1	11.2	0.05	0.00	0.00
	Monsoon	0.00 1	0.0056	0.0015	16.2	15.5	4.26	3.24	16.79
	Post monsoon	0.001	0.0046	0.0013	12.3	14.1	5.58	4.30	19.20

Table 3. Descending Series of heavy metal concentrations (// g-inl"') in water samples during Pre-monsoon, Monsoon and Post monsoon at different stations of the river Shitalakhya.

Station	Descending sense of metal concentrations.		
	Pre- monsoon	Monsoon	Post monsoon
S1	Fe>Ca>Mn>Mg>Zn>QP-Pb>Cd	FoCa>Mn>Mg>Zn>Pb>Cii>Cd	Ca>Fe>Mg>Mn>Zn>Ph>C» >Cd
S2	Ca>Fe>Mg>Mn>Zn>Pb>Cd>Cu	Ca>Mg>Fc>Mn>Zn>Pb>Cu>Cd	Fe>Ca>Mg>Zn>Mn>Pb>Cvi>Cd
S3	Ca>Fe>Mg>Mn>Zn>Cd>Pb>Cu	Ca>Fe>Mg>Mn>Zn>Cn>Pb>Cd	Ca>Fe>Mg>Zn>Mn>Pb>Cu >Cd
S4	Ca>Fe>Mg>Zn>Mn>Cd>Pb>Cu	Ca>Zn>Mg^Mn>Fe>Pb>Cd >C«	Fe>Ca>M>Zn>.Mn>Pb>Cd >Cn
S5	Mg>Z,n>Pb>Cd>Cii>Mn>Fc	Fe>Cn>Mg>Zn>Mn>Pb>Cd>Cu	re>Mf>>Ca>Zn>Mn>ni>Cd>Cu

Discussions

Many studies have been conducted in various countries aimed at evaluating normal and elevated levels of heavy metals in different media. The introduction of sophisticated and increasingly sensitive analytical has made it possible to measure trace elements in extremely low concentration trace metals like Cu, Pb, Cd, Ca, Mg, Zn, Mn, and Fe were analyzed seasonally in water samples collected from the river Shitalakhya.

The concentrations of Cu in water Samples varied from 0.00 to 0.03 jj g.ml"! among the five sampling Stations of the river Shitalakya . The minimum concentrations were recorded at Stations S2,S4,and S5 during the periods of pre-n?onsoon and maximum concentrations were recorded at Stations Si during the periods of pre-monsoon.

Singh and Mehaver (1997), studied on organicaity associated Cu in Ganga and observed variations in the extractable and organically associated form of Cu and stated that those variations were might be due to the supper imposed effects of various factors such as adsorption or adsorption participate matter input by domestic wastes disposal in the river water . The present study is well agreement with the aforesaid authors.

Rungrojwanich *et al.* (2003), reported that the amount of Cu in the water of streams and rivers in rainy season was higher than in dry season, which is well agreement with reported that Cu enters in water body through industrial effluents containing CuSO4 used in metal plating and finishing operations. Lower concentrations in dissolved condition observed by Abdullah & Royle (1974), George (1986) and othen. In the present investigation, total Cu was observed and it showed higher concentrations tluin those of the above authors. The reason of those higher concentration may be due to direct dumping of copper compound by the industries.

The concentration of Pb in water Samples varied from 0.^027 to 0.0056/g. ml" 'among the five Sampling Stations of the river Shitalakhya. The minimum and maximum concentrations were recorded at Stations Si and S5 during the post monsoon and monsoon periods respectively., Which might be due to the discharge of untreated industrial wastes, oils, municipal wastes, etc.

Dissolved Pb was studied by Abdullah (1974), reported that the cause of its input to the river water due to industrial, municipal or surface discharge, which is well agreement with the present investigations.

George (1986), Pfeiffer *et al.* (1986) studied Pb concentrations in particulate and suspended materials and reported higher values. Finding of the present investigation agrees with the aforesaid authors.

Rungrojwanich *et al.* (2003) Reported that the amount of Pb in the water of streams and rivers in rainy season was higher than in dry season which is similar with Present findings.

Recommended values of Pb from National Research Council, Canada for estuarine water (Code No SLEW-2) is 0.027± 0.005 ng.ml"1 The concentrations of Pb found in the present investigation is higher than the recommended values of National Research Council, Canada, which might be harmful for the water quality as well as for the aquatic environment.

The concentrations Cd in water samples varied from 0.0010 to 0.009/g-ml"' among the five sampling Stations of the river Shitalakhya. The minimum and maximum concentration were recorded at Station 83 during the periods of post monsoon and pre-monsoon respectively, which was much higher the finding of Tailor *et al*. (1990) in Mississippi.

Pfeiffer (1986) detected the concentration level of Cd from a Brazilian river and stated that, its incident was due to the influences of the industrial disposal. This agrees with the present findings.

In the present investigation, the seasonal variation in the concentration Cd in water samples is minimum. Another observation was made by Khan and Rahman (1994) on trace metal pollution in the Kamafully river and found minimum seasonal variation. Ouseph (1992) studied on the dissolved and participate trace metal in the Cochin estuary nml observed little seasonal variation in the concentration of Cd. So, the present investigation is almost similar with the aforesaid author's.

The concentrations of Ca in water samples varied from 8.0 to 16.3 j.ig.mr' among the five sampling Stations of the river Shitalakya The minimum and maximum concentrations were recorded at Stations S? and 84 during the pre-monsoon and monsoon periods respectively. Ashlers *et al.* (1991) was observed the Manuherikia river, New Zealand, the concentration of Ca varied from 12.1-20.6 //g. ml"1 which does not agree with the present findings.

The concentrations of Mg in water sample varied from 5.8 to 15.5 ug.ml"' among the five sampling Stations of the river Shitalakhya. The minimum and maximum concentrations were recorded at stations Si and 85 during the pre-monsoon and monsoon periods respectively. Kirn and Hunter (2000) was observed the Taieri an waipori river, the concentration of Mg varied from 4.2-9.3/g. ml"', which was slightly lower than the present findings.

Kirn Hunter et al. (1999), reported that geochemical model which attributes Mg ion compositions to rain in put. The dominant sources of major ions were the weathering of limestone's and feldspars, which was well agreement with the above statements.

The concentrations of Zn in water samples varied from 3.91 to 10.87 iig.ml"1 among the five sampling stations of the river Shitalakhya. The maximum concentrations were recorded at Station 84 during the monsoon and minimum concentrations were recorded at station 82 during the Pre- monsoon periods,

which is much lower than the finding of Singh and Mahaver (1997) at river Ganga.

Zn comes to the water from industrial water pollution (APHA, 1980). George (1986), Pfeiffer (1986) studied the oncentrations of Zn from suspended and particulate materials and reported higher concentrations. They also reported that this metal came to the water body from industrial, surface and municipal run-off. Present finding agrees with the above statements.

In the present investigation, the seasonal variations of Zn concentrations is minimum Khan & Mehedi (1994) studied pollution status of the Foujderhat coastal zone, Chittagong and observed minimum seasonal variation. Another observation was made by Khan & Rahman (1994) on trace metal pollution in the Karnafully river and found minimum seasonal variation. So, the present findings is almost similar with Khan & Mehedi (1994) and Khan & Rahman (1994).

Rungrojwanich *et al*. (2003) reported the concentration of Zn in river basin in Thailand in rainy season was higher than in dry season, which is agree wilh the Present findings.

The concentrations of Mn varied from 3.00 to 9.24 Mg.ml"1 among the five sampling stations of the river Shitalakhya. The maximum concentration were recorded at station Si during the periods of monsoon and the minimum concentrations were recorded at station 85 during the periods of pre-monsoon, which was slightly higher than the findings of Tailor *et al*. (1990) in Mississippi river.

The concentrations of Fe in water samples varied from 4.00 to 21.92 ng.ini"1 among the five sampling Stations at the river Shitalakhya. The minimum and maximum concentrations were recorded at stations 84 during the pre-monsoon periods respectively, which is much higher than the findings of Kim and Hunter (1997) at the river Tokaka-Cobb in New Zealand.

Observed the brackish water pond in west Bengal, The concentrations of Fe in water was 3095.7 To 4617.4 mg. ml'", which was more higher than the present findings.

Ouseph (1992) and, Khan & Rahman (1994) found little seasonal variation in the Fe concentrations in the Cochin estuary and Karnafully river respectively. In the present investigation, seasonal variations of Fe concentrations are minimum and the present work substantiates the above Fe concentrations of coastal area of India, which is almost similar with the present finding. Much lower concentration also observed by Abdullah & Royle (1974), Me Crea *et al*. (1984), Styanarayana *et al.* (1985) and others. Their studies were limited to dissolved iron concentrations, but in the present investigation total iron concentrations were detected and it showed higher concentration.

Conclusion

The present investigation, the concentrations of Pb, Cd, Mn and Fe exceeded the Environmental Quality standard value for river water (DOE, 1991) which indicates the water is slightly contaminated by Pb, Cd, Mn and Fe.

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