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Short Communication

Assessment of Toxic Metals in Subarnarekha River Basin in and around Jharkhand Area

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ABSTRACT

The present investigation is aimed at assessing the concentration of heavy metal ions along the Subarnarekha river in Jharkhand .Eight samples were collected along the stretches of Subarnarekha basin during the period (Water Year) June-2012 to May-2013 on the first working day of every month. The purpose of this study was to estimate eight heavy metals (Cu, Zn, Cd, Pb,Fe,As,Ni and Cr) in the surface water of the Subarnarekha river, one of the most important rivers in Jharkhand and Northern Odisha, India. In the selected research area, the Subarnarekha River is receiving the domestic, industrial, and municipal waste waters/effluents all along its course. All in all, the ascendancy of the analyzed heavy metals in the surface water of Subarnarekha followed the sequence: Cu>Fe>Pb>Zn>Cd>As>Ni>Cr>Hg. Our findings highlighted the deterioration of water quality in the rivers due to industrialization, mining and human activities.

Keywords: Heavy metals (Cu, Zn, Cd, Pb, Fe, As,Hg, Ni and Cr).

INTRODUCTION

The study is carried out in Subarnarekha river which flows through the East Singhbhum district, which is one of the India's important industrialized areas known for ore mining, steel production, power generation, cement production and other related activities. The Subarnarekha river is the eighth river in India by its flow (12.37 billion m^3 $year^{-1}$) and length. The River Subarnarekha is a rainfed river originating near Nagri village ($23^0 18^1 02^{11}$ N, $85^0 11^1 04^{11}$ E) in the Ranch district ,runs through several major cities and towns such as Ranch, Muri, Jamshedpur, Ghatshila, Adityapur etc covering a distance about 400 km.It finally join the Bay of Bengal at Kirtania Port($21^0 33^1 18^{11}$ N, $87^0 23^1 32^{11}$ E) in Odisha .Before falling in the Bay Of Bengal the River flows through Ranchi, Saraikela and East Singhbhum district of Jharkhand, West Midnapur districts of West Bengal and Balasore district of Odisha.Of its total length 269 km are in Jharkhand,64 km in West Bengal and 62 km in Odisha.The Subarnarekha basin covers an area 19,300 km^2.This area is nearly the 0.6% of the total national river basin area and yields 0.4% of the country's total surface water resources. Its important tributaries include Kanchi, Karkari, Kharkhai and Sankh rivers.. As water is one of

the most basic necessities of the habitants, its safeness must be studied before use. The present study aims at detecting the presence of trace and toxic heavy metals. Heavy metals are metallic elements which have a high atomic weight and have much high density at least 5 times that of water. They are stable elements i.e. they cannot be metabolized by the body and bio-accumulative i.e. passed up the food chain to humans. They are highly toxic and can cause damaging effects even at very low concentrations. Increasing urbanization and industrialization have increased the levels of trace metals, especially heavy metals, in water ways.

There are over 50 elements that can be classified as heavy metals, but only 17 that are considered to be both very toxic and relatively accessible. Mercury, lead, arsenic, cadmium, selenium, copper, zinc, nickel, and chromium should be given particular attention in terms of water pollution. Heavy metal toxicity has severe effect on our mental health, nervous system, kidneys, lungs and other organ functions. Surface water bodies get polluted due to urban sewage discharge [1,2,3]Present study is focused on quantitative analysis of heavy metals of Subarnarekha river.

MATERIALS AND METHODS

Water samples were collected every month, from June 2012 to May 2013 from eight different stations as mentioned below, in clean and dry polythene bottles.The water samples were collected and preserved for testing of various parameters at 10^{o} C throughout the period of chemical analysis. The heavy metals were preserved by adding 5 mL of 1N HNO3 in one liter of sample to maintain the pH below 4.0.The samples were then filtered through Whatman filter paper No. 40 and the filtrate was directly used for analysis in the Atomic Absorption Spectrophotometer[4]. At the time of sampling the samples are acidified as per standard, international method reference given by APHA [5].

Sample Code	Name of the station	River/Tributary	State	District	Latitude	Longitude
S_1	Muri	Subarnarekha	Jharkhand	Ranchi	$22^0 48' 56''$	$86^0 12' 47''$
S_2	Adityapur	Kharkai	Jharkhand	Purb Sighbhum	$22^0 47' 29''$	$86^0 10' 06''$
S_3	Kulpatanga	Kharkai	Jharkhand	Dumka	86^0 06' 10"	22^0 49'04"
S_4	Jamshedpur	Subarnarekha	Jharkhand	Purb Sighbhum	22^0 47'00"	86^0 12'00"
S_5	Baridhi Nalla	Subarnarekha	Jharkhand	Paschim Singhbhum	86^0 14'33"	22^0 49'05"
S_6	Ghatshila	Subarnarekha	Jharkhand	Purb Sighbhum	22^0 34'49"	86^0 20'08"
S_7	Ghatshila Road Bridge	Subarnarekha	Jharkhand	do	22^0 35'15"	86^0 27'12"
S_8	Jamsholaghat	Subarnarekha	Jharkhand		22^0 13'08"	86^0 43'00"

RESULTS AND DISCUSSION

The analysis of water quality of Subarnarekha river was carried out for heavy metals viz: Cu, Fe, As, Zn, As, Cd, Hg and Pb. The maximum, minimum and average values of all the parameters except Hg are given in table 1,2 and 3.

Table 1

Parameters	Categories								
	S_1 (Muri)			S_2 (Adityapur)			S_3(Kulpatanga)		
	Min	*Max*	*Mean*	*Min*	*Max*	*Mean*	*Min*	*Max*	*Mean*
Iron (Fe)	0.466	0.916	0.661	0.344	0.882	0.560	0.284	0.692	0.487
Arsenic(As)	0.026	0.142	0.068	0.018	0.063	0.033	0.082	0.161	0.086
Cadmium (Cd)	0.08	0.14	0.10	0.08	0.14	0.11	0.07	0.16	0.11
Chromium (Cr)	0.011	0.082	0.032	0.008	0.031	0.018	0.009	0.031	0.018
Copper (Cu)	0.071	9.68	4.65	0.52	6.90	3.23	0.32	8.00	3.54
Nickel(Ni)	0.006	0.014	0.008	0.006	0.014	0.008	0.006	0.012	0.008
Lead (Pb)	0.06	4.63	1.67	0.06	4.77	1.47	0.02	4.69	1.65
Zinc (Zn)	0.21	0.64	0.38	0.12	0.39	0.28	0.13	0.29	0.22

Table 2

Parameters	S_4(Jamshedpur)			S_5(Baridhi Nallah)			S_6(Ghatshila)		
	Min	*Max*	*Mean*	*Min*	*Max*	*Mean*	*Min*	*Max*	*Mean*
Iron (Fe)	0.596	1.341	0.848	0.814	1.250	0.970	0.682	1.104	0.853
Arsenic(As)	0.016	0.156	0.086	0.021	0.121	0.047	0.018	0.063	0.032
Cadmium (Cd)	0.08	0.14	0.11	0.08	0.14	0.13	0.08	0.16	0.12
Chromium (Cr)	0.008	0.021	0.014	0.009	0.031	0.016	0.008	0.016	0.012
Copper (Cu)	0.83	11.68	5.02	0.51	8.90	3.91	8.54	30.31	18.19
Nickel(Ni)	0.006	0.018	0.009	0.007	0.100	0.016	0.012	0.026	0.019
Lead (Pb)	0.03	4.44	1.67	0.01	5.14	1.79	0.03	4.39	1.86
Zinc (Zn)	0.16	0.31	0.25	0.14	0.59	0.26	0.19	0.37	0.28

Table 3

Parameters	S_7(Ghatshila Rd Bdge)			S_8(Jamsholaghat)		
	Min	*Max*	*Mean*	*Min*	*Max*	*Mean*
Iron (Fe)	1.314	3.524	2.358	0.658	0.846	0.736
Arsenic (As)	0.016	0.064	0.040	0.014	0.061	0.032
Cadmium (Cd)	0.06	0.14	0.11	0.06	0.15	0.10
Chromium (Cr)	0.008	0.016	0.012	0.007	0.024	0.013
Copper (Cu)	9.25	31.00	19.39	0.63	13.24	4.75
Nickel(Ni)	0.024	0.101	0.063	0.014	0.041	0.031
Lead (Pb)	0.01	4.40	1.86	0.01	4.12	1.52
Zinc (Zn)	0.14	0.39	0.26	0.14	0.34	0.24

These parameters are discussed below. The variation of the concentrations of each of the parameter along the river basin at each sampling stations is graphically shown parameter wise in figures 1 to 8.

Iron (Fe): Iron may be present in varying amounts i.e from 0.5 ppb to 100ppb in surface water. Iron was found in the range of 0.34 ppb to 3.52 ppb which is well within the permissible limits as prescribed by ICMR[6], WHO[7] and BIS[8] standards. Iron ingestion is not generally unhealthy and is absolutely necessary in small amounts. Deficiency of iron in human body causes anemia.

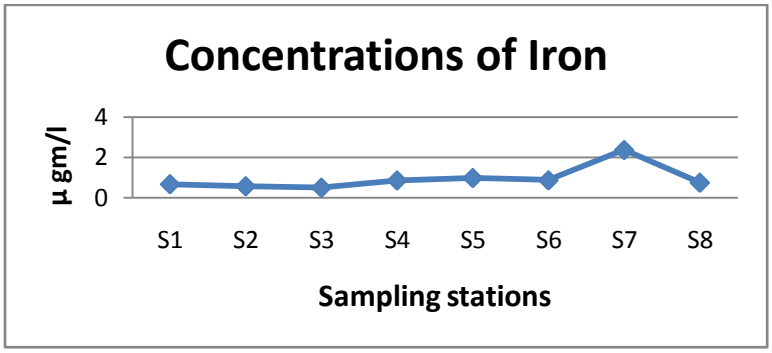

Figure-1

Arsenic (As): The usual arsenic level in drinking water is about 0.002 ppm [9,10]. However, in the present study arsenic was found well within the the acceptable limit of BIS. The range is 0.014 ppb at Jamsholaghat to 0.156ppb at Jamshedpur. All types of arsenic exposure can cause kidney and liver damage, and in the most severe exposure there is erythrocyte hemolysis. During chronic intoxication "garlic breath", skin sensitivity, dermatitis, and keratitis occurs very frequently. The acute effect of arsenic poisoning by oral intake are intense abdominal pairs, nausea, vomiting, diarrhoea resulting from gastro-intestinal tract damage and all terminating in coma and death [11].

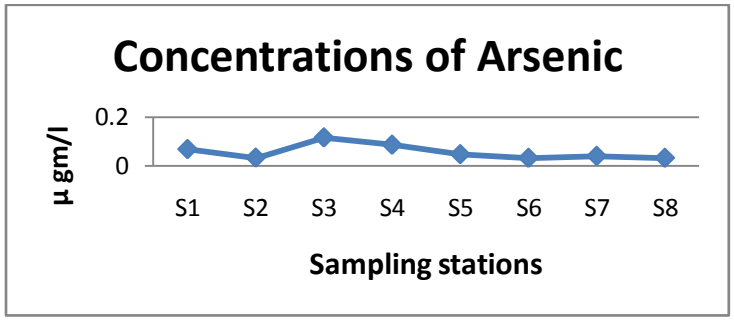

Figure-2

Cadmium (Cd): Cadmium is highly toxic because of the absence of homeostatic control of this metal in the human body. When excessive amount of cadmium is ingested, it replaces zinc at key sites and induces metabolic disorder. Cadmium was found within acceptable limits in water of Subarnarekhariver. The range is 0.06ppb at Ghatshila to 0.16ppb at Kulpatanga and Ghatshila.

Lead (Pb): Lead contamination in Subarnarekha water is considerable.In the month of June it was at its peak at almost all stations highest being at Baridhi Nallah.During the monsoon period the concentration of lead was at its lowest. The range was 0.01 ppb to 5.14 ppb. In most individuals there is a "lead balance", that is one excretes as much as they take in. However an increase in the rate of intake will result in accumulation or a "positive lead balance". Since lead is chemically very similar to calcium, it is handled by the body as if it were calcium. Thus the first place to which it is transported is to the plasma and the membrane sites in soft tissues. It is then distributed to the other sites where calcium plays an important

role, most notably in the teeth of developing children and in bone at all ages. Acute toxicity of Pb in invertebrates are reported at concentration of 0.1-10 mg L^{-1} [12,13].

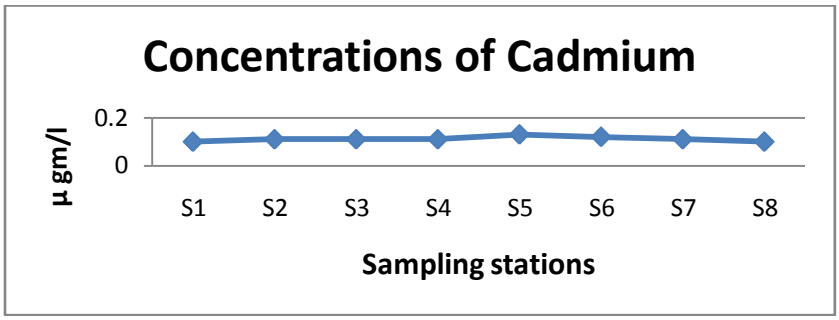

Figure-3

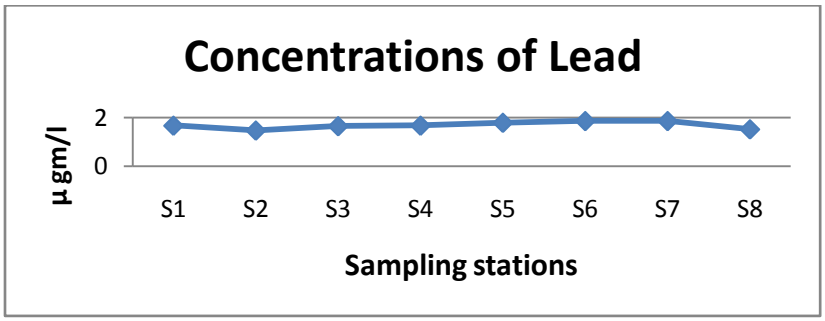

Figure-4

Copper (Cu): Copper is one of the earliest known metals. ISI [8] has prescribed the limit of copper is 0.05 ppb. In the present study the copper was found within acceptable limits at most of the places.High values were observed at Ghatshila and its down stream Ghatshila Road Bridge.This may be due to the Copper mining activities in the adjoining Jaduguda Copper mining area.The range of copper contamination of Subarnarekha river during the study period was found to be 0.32 ppb to 31.00 ppb Copper is an essential components of key metalloenzyme that maintains the vascular and nervous system.

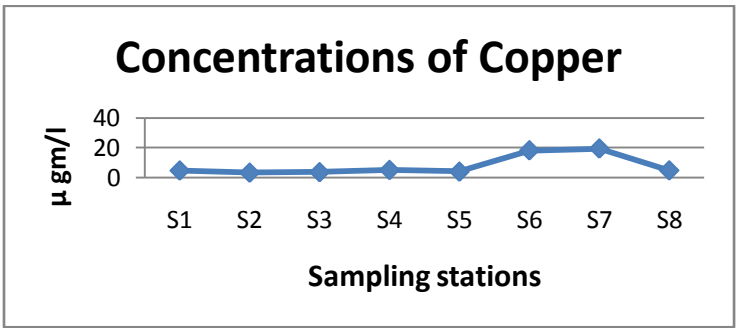

Figure-5

The other metals Cr,Ni,Zn are shown in figs. 6-8. The conc. of Hg is below detectable level.

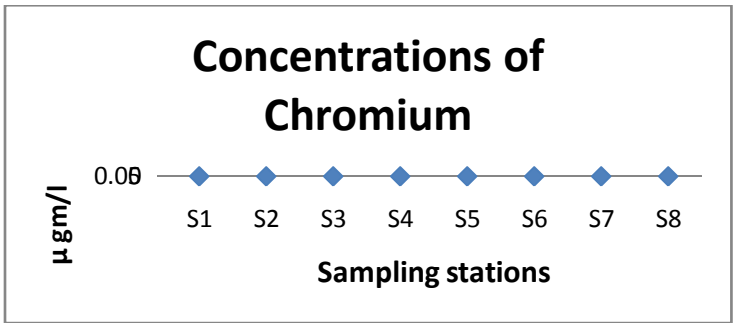

Figure-6

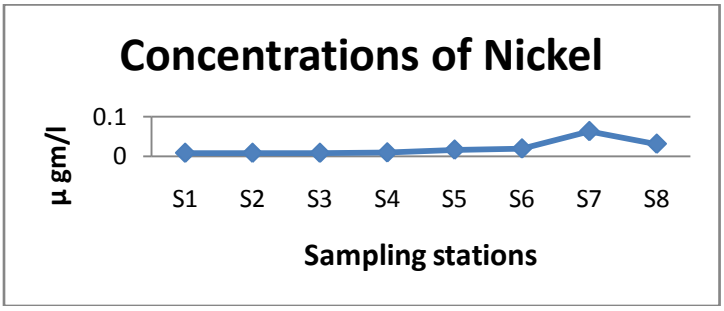

Figure-7

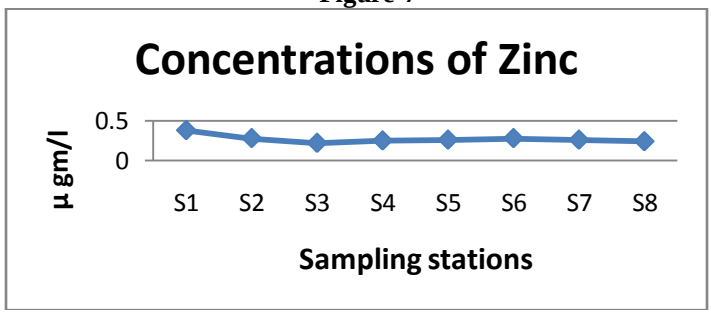

Figure-8

APPLICATIONS

These results are useful to know the Quality of water in study region and how far Polluted.

CONCLUSIONS

In the present study iron was found in the range of 0.34 ppb to 3.52 ppb which is well within the permissible limits as prescribed by WHO and BIS standards. Concentration of Cu was within acceptable limits though relatively higher values at Ghatshila and Ghatshila Road Bridge. Concentration of Hg was below detectable limits. Concentrations of other metals like As, Cd, Ni, Zn, Pb and Cr were within permissible limits of WHO and BIS. Since the effect of copper contamination is more good than bad for health the water of Subarnarekha river is suitable for drinking and irrigation purposes in heavy metal concentration point of view.

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