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Metal contaminations in water, flora and fauna of Subarnarekha River at Jamshedpur, Jharkhand

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Abstract- The rising levels of heavy metals concentrations in the Subarnarekha River are of great concern due to their highly bio accumulative nature, potential ecological effects, persistent behavior and higher toxicity. The heavy metals bio- magnifies in the food chain and imposes various toxic effects in aquatic environment and organisms. Heavy metal concentrations like Zn, Pb, Cr, Cd, Ni, Mn, Co and Cu in water, sediment and in different food webs were determined using Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) for sampling site that are found stressed with high contamination due to urbanization and anthropogenic activities. The bio-absorption capacity of the water hyacinth (*Eichhornia crassipes*) in minimizing various contaminants present in the industrial waste water is well studied. Fish reflect the higher degree of environmental contamination by heavy metals. Several studies and research work have been cited to establish and evaluate the relationship between heavy metal contents in water column, sediment fractions, and biota. The objectives of this work are to compare the level of heavy metals concentration in water column, flora and fauna in Subarnarekha River at Jamshedpur.

Key words: Anthropogenic activities, Heavy Metals, Bio-accumulation, *Labeo rohita*, Subarnarekha River, *Eichhornia crassipes*.

INTRODUCTION

Heavy Metal ions can be entered into food chains and accumulated in biota of aquatic ecosystem to a level that affects their physiological function. Heavy metals are high priority pollutants because of their relatively high toxic and persistent nature in the environment. There are mainly three reservoirs of heavy metals in the aquatic ecosystem: water, sediment and biota i.e., flora and fauna. Heavy Metal levels in each of these three reservoirs are dominated by a complex dynamic equilibrium governed by various physical, chemical and biological factors. Numerous researchers have reported the accumulation of considerable amounts of heavy metals by aquatic macrophytes in their tissues such as water hyacinth.[1-4] The rapid growth of Water hyacinth (*Eichhornia crassipes*) causes a great loss of water level as well as the danger for blocking the water stream of river Subarnarekha. Subarnarekha River plays major roles to the community especially in the fishing industry and a source of water supply for people residing within the vicinity of the Jamshedpur area. Indian monsoon has important role in Subarnarekha water supply; hence climate change is one of the reasons to destroy the water supply to the river. River contamination either directly or indirectly will affect human being as a top consumer. The heavy metals are required as micronutrients but it can be toxic when present

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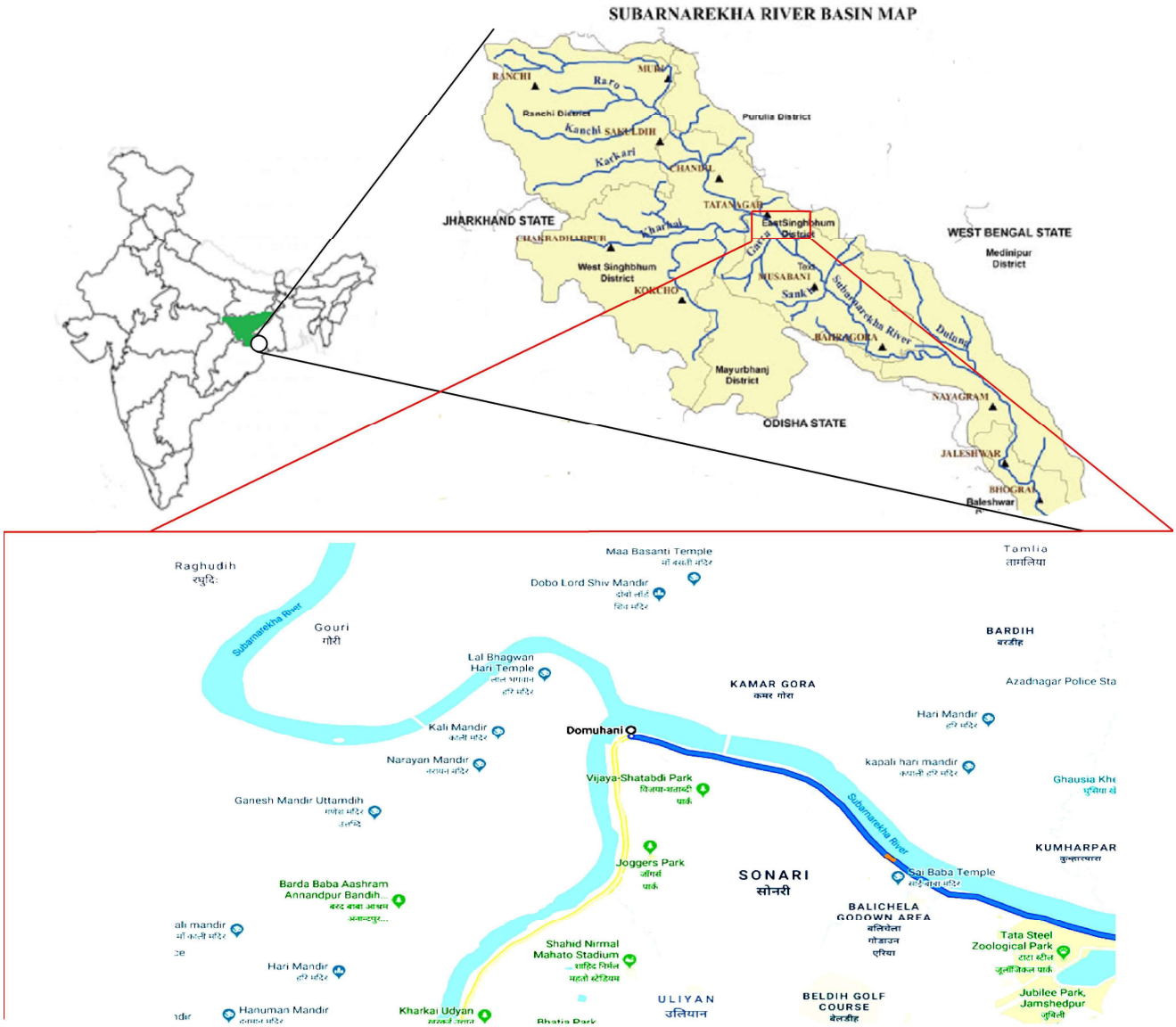
higher than the minimum level of requirements. The important anthropogenic sources of heavy metal contamination are mining, disposal of untreated and partially treated effluents containing toxic metals from different industries and indiscriminate use of heavy metal containing fertilizer and pesticides in agricultural fields.[5-7] Rivers in urban areas such as Subarnarekha River at Jamshedpur, have also been associated with water quality problems including heavy metal contamination due to the practice of discharging of untreated domestic and small-scale industrial effluent into the water bodies.[8-12] Hence this paper is showing the comparison of heavy metals in water, flora and fauna in Subarnarekha River (Dumohani) at Jamshedpur city.

METHODS

I. Study Area: -The researcher works on Metal contamination in water, flora and fauna at Rivers'-meet point of Kharkai and Subarnarekha (Dumohani) at Jamshedpur city. Jamshedpur is a big industrial city of Jharkhand in India situated on the banks of River Subarnarekha which flows through East Singhbhum district for their civilization and development. It is an important industrialized area of India known for ore mining, steel production, power generation, cement production etc. The river Subarnarekha is a rain fed river and originating near Nagri village in Ranchi district of Jharkhand, India.



II. Sampling and Analysis: -Water sample, sediment fraction, saplings of water hyacinth plant (Flora) and *Labeo rohita* (Fauna) were collected from Rivers' meet point of Kharkai and Subarnarekha (Dumohani) at Jamshedpur city. Water samples were collected in pre-conditioned acid-washed high-density polyethylene (HDPE) containers. The samples were filtered through pre-washed 0.45µm Millipore nitrocellulose filters. The initial portion of the filtration was discarded to clean the membrane, and the following ones destined for metal determination were acidified to pH < 2 using supra pure nitric acid and then stored refrigerated in pre-cleaned HDPE bottles until analysis.[13]

III. Physio-chemical Analysis: -The water samples were analyzed in the CSIR-NML Jamshedpur using standard methods.[14] The pH and Dissolved Oxygen of water samples were measured immediately after sampling at the field itself. Samples were subjected to filtration before chemical analysis. The determination of TDS was done by gravimetric process while the total hardness was carried out by EDTA complexometric titration method.[14] The Winkler's alkali iodide-azide method was followed for the estimation of DO and BOD.

IV.Analysis of Water hyacinth: -Leaves, stems and roots of *Eichhornia crassipes* were digested in 100ml of HNO_3 with 50ml of H_2O_2 dilution and then boiled at 100ºC. The prepared samples were run for Heavy Metals estimation in Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES)

V. Analysis of Fish: -Liver of *Labeo rohita* was cut by glass knife, extracted, crushed by hand and were digested in 100ml of HNO_3 with 50ml of H_2O_2 dilution and then boiled at 100ºC. The prepared samples were run for Heavy Metals estimation in Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES)

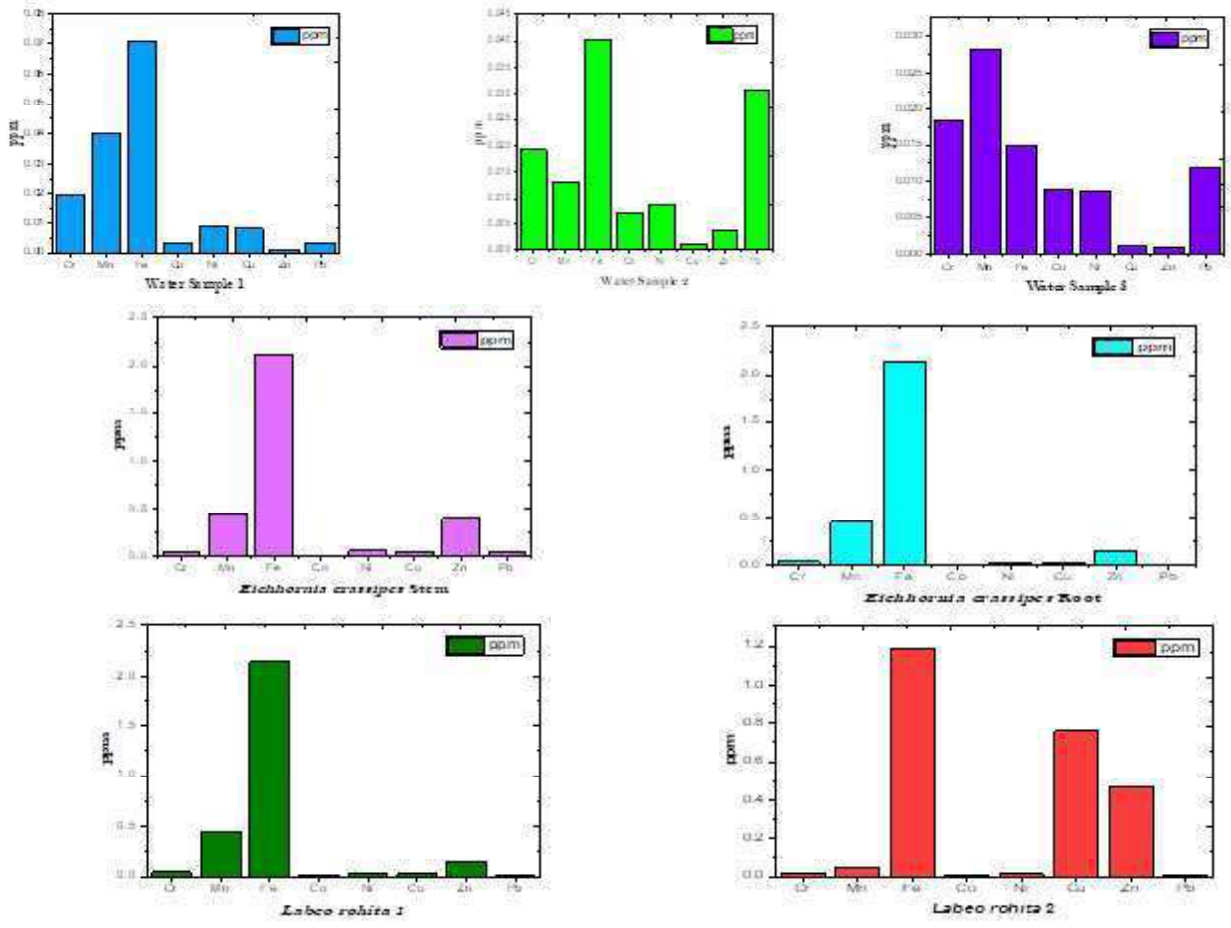
RESULTS & DISCUSSION

Table 1. Physiochemical Parameters of water sample of Subarnarekha River at Dumohani,

	Sample 1	Sample 2	Sample 3
pH	6.46	6.36	7.07
Turbidity	1.82ntu	1.74ntu	2.74ntu
Conductivity	321 µs/cm	336 µs/cm	331µs/cm
Alkalinity	4.2ml	4.2ml	4.4ml
Smell	Muddy smell	Muddy smell	Rotten smell
Colour	5CU	5CU	5CU
DO	7.0 mg/l	5.5 mg/l	4.5 mg/l
BOD	2.0 mg/l	3.5 mg/l	5.5 mg/l

Table 2. Heavy metals in water sample of Subarnarekha River at Dumohani,

	Water Sample 1	Water Sample 2	Water Sample 3	*Eichhornia crassipes* Stem	*Eichhornia crassipes* Root	*Labeo rohita* 1	*Labeo rohita* 2
Cr	0.0194	0.0192	0.0183	0.0349	0.0386	0.06	0.019
Mn	0.0400	0.0131	0.0282	0.4403	0.4490	0.021	0.0417
Fe	0.0706	0.0403	0.0149	2.1168	2.1420	1.14	1.19
Co	0.003	0.007	0.009	0.0027	0.0045	0.001	0.0058
Ni	0.0091	0.009	0.0087	0.0553	0.0258	0.03	0.0118
Cu	0.008	0.0011	0.0013	0.0533	0.0255	0.54	0.7588
Zn	0.0010	0.0037	0.0010	0.3895	0.1513	0.52	0.4652
Pb	0.0034	0.0308	0.0120	0.0355	0.009	0.01	0.0062



Sample 1: - Water sample from Subarnarekha before meeting Kharkai.
Sample 2: - Water sample from Rivers' meet Point (Subarnarekha-Kharkai).
Sample 3: - *Eichhornia crassipes* stem & root- sampling was done in river meet (Subarnarekha-Kharkai)
Labeo rohita 1: - Sampling was done in Rivers' meet Point (Subarnarekha-Kharkai).
Labeo rohita 2: - Sampling was done in Rivers' meet Point (Subarnarekha-Kharkai).

1. Physico-chemical analysis of water sample from different sites of Subarnarekha River showed that pH, turbidity, conductivity, alkalinity and smell was with ranges from 6.36-7.07, 1.74-2.74ntu, 321-336µs/cm, 4.2-4.4ml and muddy-rotten smell respectively. The results of water sample revealed significant variation between all samples.
2. A decrease in pH will decrease owning to competition for binding sites from hydrogen ions. The ionic form of metals is more toxic, because it can form toxic compounds with other ions. Electron transfer reactions that are connected with oxygen can lead to the formation of toxic oxy radicals, which leads to decrease in dissolved oxygen in aquatic environment. A toxicity mechanism now known to be of considerable importance in both flora and fauna. Superoxide anion (O^{2-}) and the hydroxyl radical (OH^{-}) can cause serious damage to the cells of aquatic organism.
3. Contamination factor (CF) of the samples was maximum in *Eichhornia* root sample among all samples except Zn and Pb. The minimum CF was observed for almost all metals in Sample 3 where *Eichhornia* plant has been found. The trend of CF for all studied metals were Fe>Mn>Zn>Cr >Ni>Cu>Pb>Co among all the samples (Table 2). Similar results were reported in the study.[4]
4. Heavy Metals accumulation showing following trend in *Eichhornia crassipes* stem as well as in root-Fe>Mn>Zn>Ni>Cu>Cr>Pb>Co.
5. Higher accumulation occurs in *Eichhornia crassipes* root almost all the heavy metals.
6. Heavy Metals accumulation showing following trend in *Labeo rohita*-1 & *Labeo rohita*-2 is Fe>Cu>Zn>Mn>Cr>Ni> Pb>Co.
7. There is a significant increase in metal biomagnification occur in *Labeo rohita*-2 compare to *Labeo rohita*-1.

DISCUSSION

The abiotic and biotic factors affect the uptake and accumulation of heavy metals in fish. Metal accumulation rates by fish are directly affected by Water acidity (pH). When the fall in pH of water, solubility of metal increases and the small particle of metals become more mobile. This is the reason why metals are more toxic in soft water. Water current coming from draining mining areas are generally very acidic and contain high concentration of dissolved metals with little aquatic biota. However, the trends of heavy metals concentration in different sample studied by the researcher are more or less same in the present study. As metals are non-biodegradable cause localized and dispersed metal pollution which leads environmental damage. Metals cannot be broken down into less toxic components in the environment as some organic pesticides.[15] Accumulation of Copper (Cu) in aquatic organisms is also higher at lower pH. Cadmium and lead levels in liver and kidney of *Salvelinus alpinus*, indicates higher uptake rates of both metals in summer when water temperature was high. Similar result has been found in the case of *Labeo rohita* in the present study.

The maximum temperature tolerance of tropical plant is about 34°C for only 4 weeks before it dies.[16] The Water hyacinth (*Eichhornia crassipes*) is a freshwater plant but it does have tolerance to a certain degree of salinity with a limit of withstanding 0.2 percent of salt in water.[16] During pre-monsoon season *Eichhornia crassipes* is at blooming condition and uptake more water which leads a great loss to the other aquatic biota in Subarnarekha River at Jamshedpur.

CONCLUSION

The results of the Samples analysis have shown that fish *Labeo rohita* and macrophytes water hyacinths *(Eichhornia crassipes*) can be used as bio-indicator as it contains variable levels of the heavy metals analyzed with high enrichment of Fe, Mn, Zn, Ni, Cu, Cr, Pb and Co observed. In order to reduce excessive discharge of metals into the Subarnarekha River there should be reduction in mining activities and disposal of waste water. Proper

management required for pollution free river. Heavy metals accumulation in aquatic organism results threats to the human health when they are consumed. Thus, further study should be done to determine the heavy metals concentration in edible part of aquatic organisms in Subarnarekha River at Jamshedpur.

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