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HEAVY METALS IN ICHCHAMATI RIVER ECOSYSTEM IN EAST KHASI HILLS, MEGHALAYA, INDIA

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Abstract: Ichchmati River is a major river of East Khasi Hills district in Meghalaya near Bangladesh Border. This river ecosystem has a great importance as a natural habitat among the various ecosystems of the region, whereas there are a little agricultural practices and no more industrial pollution. Location variation in nutrients concentration of the river was studied with special reference to physico-chemical parameters and heavy metals in the river water and sediment. Heavy Metals were found almost nil or in very low concentrations at selected site. The present study deals with the preliminary physico-chemical characteristics and Heavy Metals in the river water and river sediment, which exhibits the status of water quality and transfer of Heavy Metals from river water to sediment.
Keywords: Heavy Metals; Pollution status; Sediment; Transfer factor; Water Quality.
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INTRODUCTION

The impact of anthropogenic pollution from industrial, agricultural, sources, quarrying and tourists activity on water quality has concerned environmentalists and scientists for the past three decades. Ecological, geo-chemical and hydrological research has been carried out in various ecosystems to understand the factors controlling the chemistry of natural water (Baron and Bricker, 1990; Malik and Bharti, 2005a). In North-East region, a river Ichchamati, 80 Km. far away from Shillong city is the study site near Ichchamati village for the accounting of physico-chemical parameters and Heavy Metals in natural water and fluctuations at the different locations along with the river. Adequate understanding of the North-East regional rivers is extremely important for the development of a realistic program for utilizing the potential of water that exist in the form of surface water resource in the region. The dynamic balance in the aquatic ecosystem is upset by human activities, resulting in pollution which meter, is manifested dramatically as fish kill, offensive taste, odour, colour and unchecked aquatic weeds. The over production of higher tropic levels biomass and the subsequent decay of dead plants could lead to oxygen depletion, death of aquatic organisms and development of anaerobic zone where bacteria action produce foul odours and bad tastes (Forstner and Wittman, 1979). Water quality characteristic of aquatic environment arise from a multitude of physical, biological and chemical interactions (Dezuane, 1979). The water bodies, lakes, rivers, dams and estuaries are continuously subject to a dynamic state of change with respect to the geological age and geochemical characteristics. This is demonstrated by continuous circulation, transformation and accumulation of energy and matter through the medium of living thing and their activities (Adefemi, 2007). The present study deals with

the characteristics the water nutrient chemistry, influenced by anthropogenic activity and quarrying of the geologically sediment environments and to determine the nature and degree of anthropogenic impacts on qualitative and quantitative variations occurred in nutrients in relation to physico-chemical parameters and Heavy Metals of river water and sediment.

Study Area

Meghalaya is very well known for the record of rainfall, the state consists of the two places namely Cherrepunjee and Mawsinram for maximum rainfall throughout the year. So, the maximum water resources are depending chiefly on total precipitations of the region. The Meghalaya has been surrounded by the natural beauties with lovely trees and cool climate, which is not only a pleasant place to live in but relaxing for holiday also. This is not only a popular state but also valuable or important place for tourism. Shillong is the capital of Meghalaya state. Mowlong Cherra Cement Ltd and Lafarge Umaim Mining Ltd are the major industries of the region. The all seven states of North East India are quite famous as Seven Sisters. Basically, Ichchamati River originated from the hills of Assam-Meghalaya. Population of the region is completely depending upon the river water for drinking, bathing, and other activities. *Meteorologically*, region has a cool and pleasant climate. *Geologically,* North-east hills are enriched with various minerals and the hills near Bangladesh are rich in limestone. *Geographically*, the study area is situated in the globe on a Latitude 25° 09' 58.1" N and Longitude 91° 41' 26.5" E.

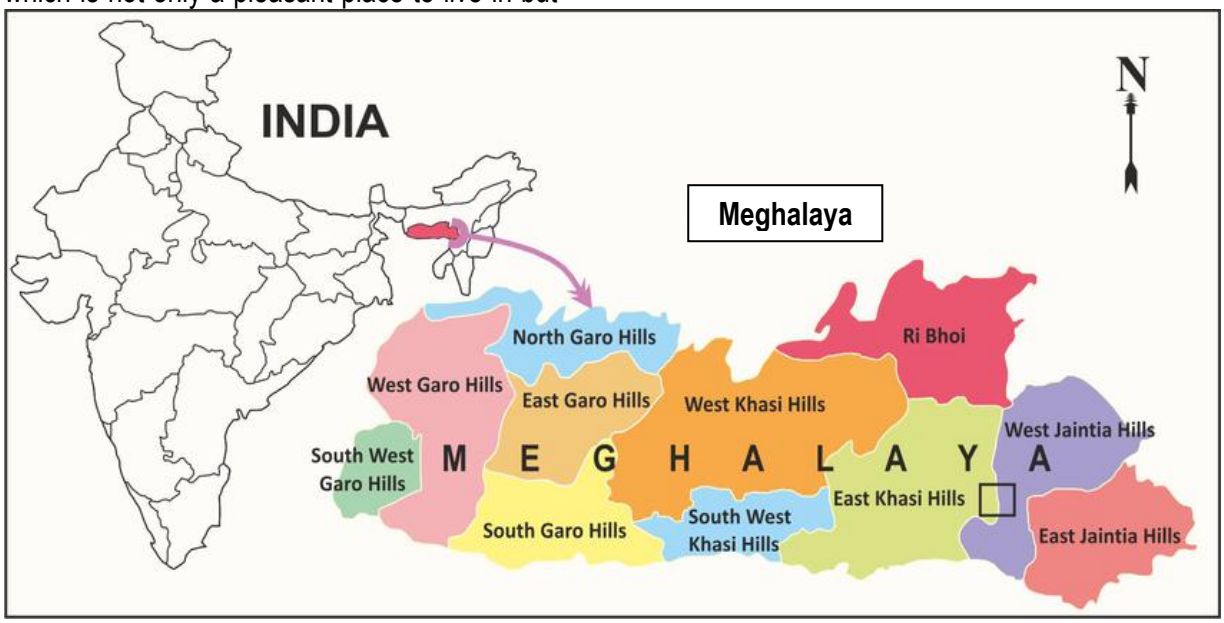

Figure 1: Map showing location of Meghalaya

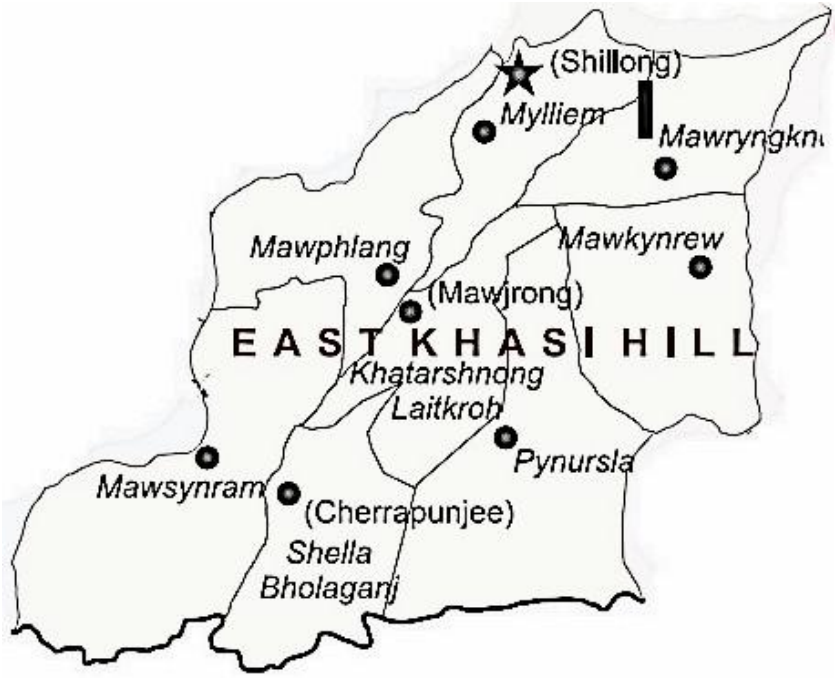

Figure 2: District Map of East Khasi Hills

EXPERIMENTAL

The samples for physico-chemical parameters and Heavy Metals were collected by using rinsed Borosil glassware, and analyzed with the help of the procedure described by APHA (1995) and Trivedi and Goel (1984). The water samples were collected from Ichchamati River near Ichchamati Village according to the analytical requirement in morning period 9:00 Hrs. to 10:00 Hrs. Colour, Odour, Turbidity, Velocity, Temperature and Dissolved oxygen were analyzed on sampling sites. Samples were collected from selected sites and immediately preserved in ice boxes, and transfer to the lab for further analysis. Water samples were digested and Heavy Metals were detected using Atomic absorption spectrophotometer. Transfer Factor (TF) was calculated according to Bharti (2007) to assess the status of Heavy Metals transfer from river water to river sediment of Ichchamati River.

RESULTS AND DISCUSSION

Ichchamati River is flowing through a piece of plain and hills chain near the Ichchamati village, enriched with minerals, which affect the water quality of river according to the locations. Nutrients concentration, Heavy Metals and related physico-chemical parameters from selected sites are depicted in tables. Ichchamati River has the spatio-temporal variations of water temperature, which plays a vital role in all physico-biochemical reactions and self-purification power of aquatic system (Badola and Singh, 1981). Higher value of temperature was found 16 °C in summer and minimum 12 °C in winter season. Turbidity is striking characteristic of the physical status of the water bodies. Although in Ichchamati river water is clear because there is no more pollution, siltation was the main source of turbidity in tributaries. Detritus and other non-organic material being added to water mass due to rainfall and anthropogenic activities (Camron, 1996). Maximum turbidity was recorded 27 NTU during monsoon season and minimum 21 NTU in summer season. The maximum depth of photic zone provides the better biological production for all aquatic organisms in a river (Malik and Bharti, 2005b). Total dissolved solids were found in the range of 90 mg/L in winter to 147 mg/L in monsoon season, due to the gradual increases in velocity of river which favored effective sedimentation (Subramanian, 1979). Chemical oxygen demand was found 6 mg/L during the study period. Chemical oxygen demand represents chemically oxidizable organic matter load in water, while biochemical oxygen demand is only biodegradable materials (Malik and Bharti, 2005c). In the present study the values

observed during monsoon months may be attributed maximum biological activities and high temperature, stimulate the growth of microorganisms (William *et al.,* 1993). The pH of natural water was controlled in a great extent by the interaction of hydroxyl ions arising from the hydrolysis of bicarbonate (Sharma, 1986). The pH of Ichchamati River was recorded alkaline (7.4-7.8). Total hardness is mainly due to percentage of calcium and magnesium salts of bicarbonates, carbonates, sulphates and chlorides, while the value of alkalinity occured due to presence of bicarbonates. The concentration of hardness was analyzed 26-74 mg/L during the study. Alkalinity was also found 32-63 mg/L with a small fluctuation. A positive relationship between hardness and alkalinity was recorded in river Ganga at Rishikesh (Chopra and Patric, 1994). Maximum chloride concentration was recorded maximum (15 mg/L) in summer and minimum in monsoon (6 mg/L). Chloride and hardness showed a positive relationship to one another (Chopra and Patric, 1994). Chloride was found in the form of chloride ion, and one of the major inorganic anion present in natural water (Malik and Bharti, 2009).

Calcium and magnesium the dominant cations, and these represent the main weathering products, but significant hydro-chemical differences between the two sampling sites associated with the bedrock geology exist (Jenkins *et al.,* 1995) Calcium is one of the essential nutrients, which plays an important role in biological system. Maximum calcium concentration was recorded (28 mg/L) in monsoon and minimum in winter (22 mg/L). Positive relationship between, calcium and temperature was also reported by Khanna and Singh (2000) in river Suswa, Dehradun. Magnesium is also an essential element but it is toxic at higher concentration. The concentration of magnesium in Ichchamati River was found maximum (4 mg/L) and minimum (2 mg/L) and it was very low in comparison to Hill-streams of Uttarakhand (Bharti, 2004). During the summer season nutrients concentration in rivers and hill-streams became more. Miller *et al.* (1997) described the nutrients availability in selected environmental settings of the Potomac River and Cameron (1996) showed the similar type of fluctuation in Fraser river of British Columbia. Bond (1979) described similar nutrients concentration pattern in a stream draining a mountain ecosystem in Utah.

Dissolved oxygen was found 8.7 to 9.2 mg/L during the study period. While bio-chemical oxygen demand was found 1 mg/L in every season. Heavy Metals were found almost nil or in very low concentrations except iron. Heavy Metals like Cadmium, copper, lead and zinc were not found in high concentration at both sites during any season. Cadmium, copper and lead were absolutely absent in all seasons, while Zinc concentrations were also found below detection limit in maximum samples. The concentration of iron was maximum observed 0.8 mg/L during summer season. Zinc concentration was found 0.03 mg/L in monsoon season. Malik *et al*., (2009) described the role of Heavy Metals in the surface water of north India. The results of Bharti *et al*., (2010) were also indicated the relation of Heavy Metals and phytoplankton in a north Indian water body. Transfer factors from river water to sediment for all metals were found quite irregular. Transfer factor for cadmium was found 0, while it was found constant for copper in all seasons. It was found 2500, 3225.8 and 11764.7 in winter, summer and monsoon seasons respectively for Iron. Similarly, transfer factor was calculated 2500, 1666.7 and 10000 in winter, summer and monsoon seasons respectively for manganese. For Lead, transfer factor was calculated from 2950 to 11800. For zinc, transfer factor was calculated from 2633.3 to 15800. All results of transfer factors are depicted in Table 5. Physico-chemical parameters of river sediments are also depicted in Table 4.

Table 1. Physical characteristics of Ichchamati River water

S.No.	Parameters	Unit	Ichchamati River water		
			Winter	Summer	Monsoon

1.	Temperature	°C	12	16	15
2.	Colour	-	Clear	Clear	Clear
3.	Odour	-	Nil	Nil	Nil
4.	Turbidity	NTU	23	21	27
5.	TDS	mg/L	90	100	147

Table 2. Chemical characteristics of Ichchamati River water

S.No.	Parameters	Unit	Ichchamati river water			
			Winter	Summer	Monsoon	Mean
1.	pH	-	7.8	7.7	7.4	7.6
2.	Alkalinity	mg/L	58	76	91	75.0
3.	Total Hardness	mg/L	71	86	97	84.7
4.	Calcium	mg/L	22	29	38	29.7
5.	Magnesium	mg/L	4	3	2	3.0
6.	Chlorides	mg/L	6	6	5	5.7
7.	DO	mg/L	8.7	9.2	9.1	9.0
8.	BOD	mg/L	1	1	1	1.0
9.	COD	mg/L	6	6	6	6.0

Table 3. Heavy Metals in Ichchamati River water and sediment

S.No.	Heavy Metals	Unit	Ichchamati River water				Ichchamati Sediment (mg/kg)
			Winter	Summer	Monsoon	Mean	-
1.	Cadmium	mg/L	BDL	BDL	BDL	BDL	BDL
2.	Copper	mg/L	BDL	BDL	BDL	BDL	24
3.	Iron	mg/L	0.8	0.62	0.17	0.53	2000
4.	Lead	mg/L	BDL	0.02	BDL	0.01	59
5.	Manganese	mg/L	0.04	0.06	0.01	0.04	100
6.	Zinc	mg/L	BDL	0.02	0.03	0.02	79

Table 4. Physico-chemical characteristics of Ichchamati river sediment

S.No.	Parameters	Unit	Ichchamati Sediment	Method
1.	Texture	-	Silty sand	IS: 2720 p-4
2.	Grain size analysis Sand Silt Clay	% by mass	 71 28 1	IS: 2720 p-17
3.	Moisture Content	% by mass	7.4	IS: 2720 p-2
4.	pH	-	8.3	IS: 2720 p-26
5.	Conductivity	µmho/cm	110	Conductivity meter
6.	Calcium	% by mass	0.3	APHA (1998)
7.	Magnesium	% by mass	0.2	APHA (1998)
8.	Chlorides	% by mass	0.1	Volhard's method

Table 5. Transfer factor of Heavy Metals from Ichchamati River water to Sediment

S.No.	Heavy Metals	Transfer factor		
		Winter	Summer	Monsoon
1.	Cadmium	0.0	0.0	0.0
2.	Copper	4800.0	4800.0	4800.0
3.	Iron	2500.0	3225.8	11764.7
4.	Lead	11800.0	2950.0	11800.0
5.	Manganese	2500.0	1666.7	10000.0
6.	Zinc	15800.0	3950.0	2633.3

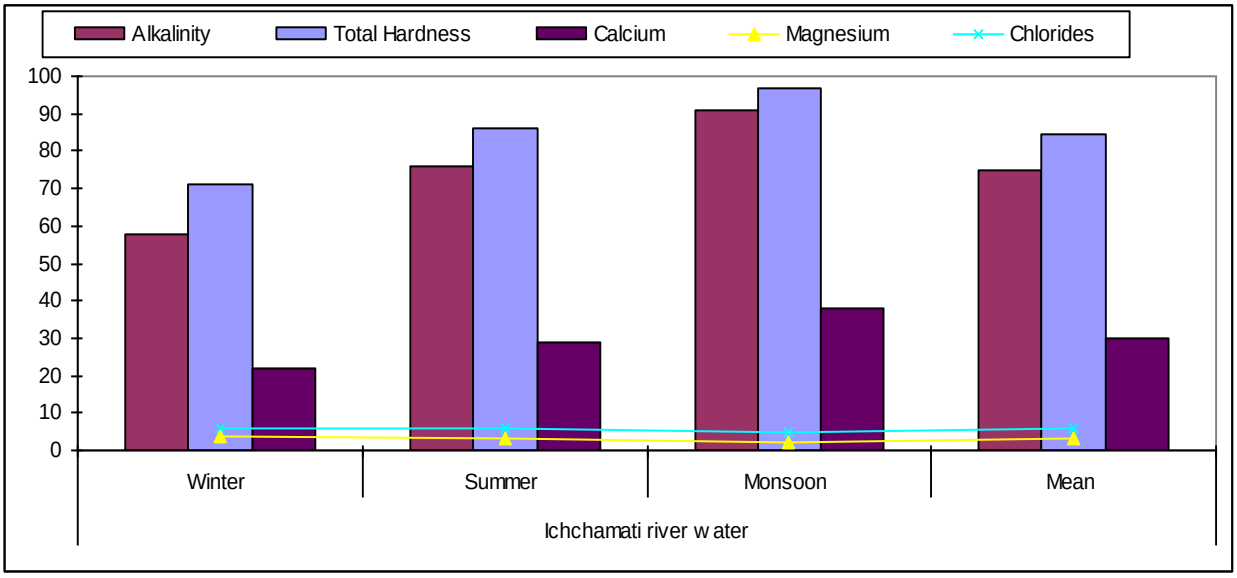

Figure 3: Showing the Nutrients concentration in Ichchamati River during the study period

CONCLUSION

The present results conclude that significant differences in river water nutrient concentrations in different seasons. The spatial variations in TDS are attributed to climatic and lithological control over the ionic concentrations. Absence or low concentration of Heavy Metals shows that the water is still industrial pollution free. Heavy Metals never cross the limits during the study period. On the basis of nutrients and Heavy Metals, the water may be considered for other purposes.

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