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International Journal of Current Research
Vol. 7, Issue, 05, pp.15531-15537, May, 2015

INTERNATIONAL JOURNAL
OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

TOXIC ELEMENTS OF RIVER MYNTDU IN JAINTIA HILLS DISTRICT MEGHALAYA, INDIA

***Pyrbot, W. and Laloo, R. C.**

Ecology Research Laboratory, Centre for Advanced Studies in Botany, North Eastern, Hill University, Shillong, Meghalaya

ARTICLE INFO

Article History:
Received 05th February, 2015
Received in revised form
25th March, 2015
Accepted 30th April, 2015
Published online 25th May, 2015

Key words:

River Myntdu, Coal mine seepage,
Domestic discharge, Metal contents.

ABSTRACT

The water quality of Myntdu River at Jaintia Hills District Jowai has been studied as a comparative analysis of toxic metal seasonally during spring, monsoon, autumn and winter. The results showed the maximum metal content was obtains from the tributaries as compared from the originate source of Myntdu River in which value exceeded the permissible limit according to WHO (2006). The quality of river has deteriorated year by year due to the continuous discharge of domestic waste and coalmine seepage from various drains to the tributaries of Myntdu River. Therefore the water supply for domestic purposes from the Myntdu River should be treated and immediate action should be taken in order to stop the pollution load into the river water.

INTRODUCTION

Water is the most important and precious natural resources, essential for the survival of living organisms which is one of the abundantly substances in nature, which man has exploited more than any other resources for the sustenance of life. Water of good quality is required for living organisms. Nowadays, due to increased human population and manmade conditions, the water quality is deteriorating everywhere (Jayabhaye *et al.*, 2008). River water pollution can be linked to the type of waste water produced by urban, industrial, and agricultural activities that flows into surface and subsurface waters (Vittori *et al.*, 2010). It becomes polluted due to the unscientific disposal of the waste water has caused immense environmental problems not only to the aquatic environment but also to human beings worldwide. Municipal sewage is a turbid fluid arising from domestic sewage and contains semi-decomposed and decomposed organic matter, inorganic nutrients, and different trace elements, including various heavy metals such as cadmium, chromium, nickel, lead, copper, zinc, manganese, etc. These elements being highly persistent have the potential to be toxic to living organisms including human beings (Clements and Newman, 2002). Heavy metal pollution has become a major issue in many countries because their existence in drinking waters and waste waters often exceed the permissible standards (Ahmet and Mustafa, 2008). Some heavy metals, such as zinc, copper, chromium, iron and manganese are essential for metabolic functioning in small amounts, but, in elevated quantities, these elements become toxic (Sari *et al.*, 2007; Mohan *et al.*, 2007).

MATERIALS AND METHODS

Study area and sampling sites

The Myntdu River is located in West Jaintia hills District of Meghalaya, in the north eastern part of India, in the southern slope of the state adjoining Bangladesh (Plate-A). The area is narrow and steep, lying between central upland falls of the hills of Meghalaya. The River Myntdu originates at a place called Mihmyntdu at an elevation of 1306 msl. Altogether seven sampling station was selected along the river Myntdu, to select the water sampling locations in such a way to get the representative water quality data of river and their tributaries to record the river water uses and human activities along its course (Plate-B). The following sampling stations are:

(1).**Control (Station-1):** This sampling Station located at the village called Mihmyntdu which mean the origin of the river. Here the river it comes out as a spring in between two big rocks on either side. This place is considered very sacred which is properly maintained by this village. Therefore, the water is free from human activities.

(2).**Wahthanat (Station-2):** This is the first tributary that joins the Myntdu River which is located near the Iawmusiang (main

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Corresponding author: Pyrbot Wansah,
Ecology Research Laboratory, Centre for Advanced Studies in Botany, North Eastern, Hill University, Shillong, Meghalaya.

market) which is one of the commercial areas of West Jaintia Hills called Wahthanat. The river is surrounded by the paddy field on both sides. The site is characterized by dumping of solid wastes from nearby dwellings, shops, restaurants and raw sewage into the river.

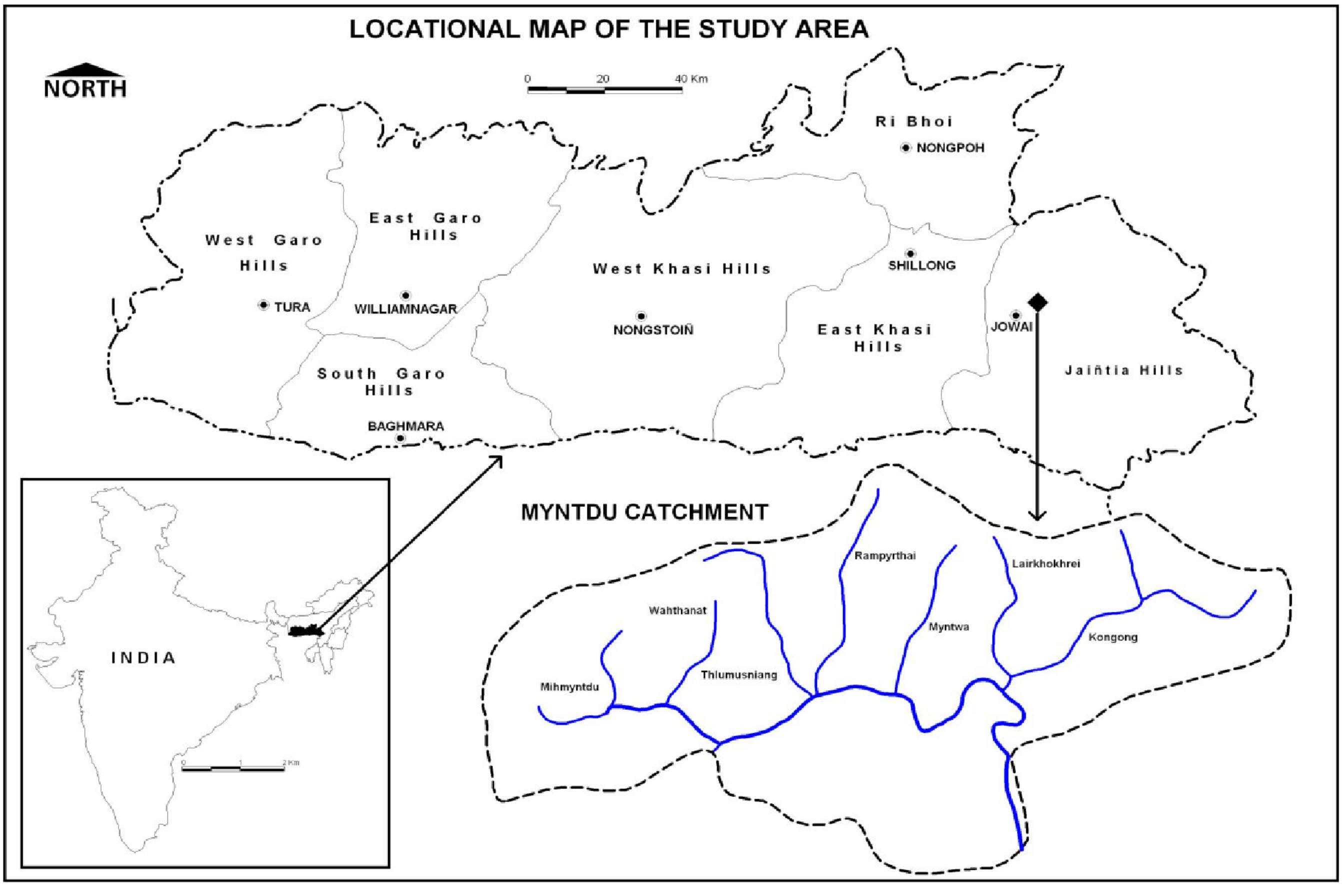

Plate (A). Map showing the study sites

(3).**Tlumusniang (Station-3):** This station is located at Chiliangenraij Jowai which is the second tributary. The water quality of this river has degraded from year to year due to increase in number of human settlements on both the sides.

(4).**Rampyrthai (Station-4):** This Station is located at Khlieh-et-nar in between Chiliangenraij and Panaliar which is the third tributary of Myntdu River. Most of the raw sewage and domestic effluents emanating from this locality are directly discharged into this tributary which is carried from the Hume pipe.

(5).**Myntwa (Station-5):** This station is located downstream near Jowai Mission hospital compound called Salaroh which is the fourth tributary of Myntdu River. This site is characterized by dumping of solid wastes from the nearby dwellings raw sewage from the hospital are directly discharged into the river.

(6) **Laikhokhrei (Station-6):** This station is located at Tuber village which is the fifth tributary of Myntdu River. From this station the river has crossed through the coal mining area which is far away from human settlement. The deteriorated of water quality at this station is the temporary storage of coal near the river site.

(7). **Kongong (Station-7):** This Station is located at a place called Kongong along the national highway of Ladrymbai, Khliehriat and Silchar. This is the sixth tributary of Myntdu River. Active coal mining was done at different places of the forested area which is very crude un-economic and un-scientific known as rat hole near this station. This place is also considered as the maximum storage of coal for business owned by different owner. The water quality of this river become very poor and the colour of the water sediments become typically red, with orange-yellow which may be due to ferric iron present in the water. There were no aquatic plants with only few shrub and herbaceous present near the river bank.

Collection of water samples

Water sample was collected from all the seven points at each station was collected separately in a polyethylene bottles acidifying with concentrated 1.5 ml nitric acid (AR) were added to the samples in the field itself. Water samples were stored at 4°C for further analysis. 300 ml of water was transfer to the beaker and acidified with 5 ml of ultra pure nitric acid and digested on a hot plate till the volume reduced to around 30 ml. The digested samples were then filtered with 0.45µm and final volume was made up to 100 ml with deionised water and stored at 4°C for total metal analysis (APHA, 2005). All the elements were detected after concentrating the sample 40-1000 times by evaporating in an oven. A Perkin-Elmer Atomic Absorption Spectrometer (Perkin Elmer, Analyst model 3110) was analysis of metal for (Zn, Cu, Fe, Cd, and Cr). Average values of three replicates were taken for each determination.

Statistical analysis

The samples were analyzed in triplicate, seasonal mean difference of each triplicate were analyzed statistically using one-way ANOVA at $p < 0.05$ to see the variations due to sites and seasons by using the statistical software Origin 8. Pearson's correlation coefficient (r) was correlated between all the parameters data using XLSTAT 2009 Software. Standard errors of means were calculated.

RESULTS AND DISCUSSION

Zinc (Zn): The Zn content varied from 0.052±0.0003 mg/L to 1.63±0.009 mg/L at different sampling Stations and seasons (Fig. 1).

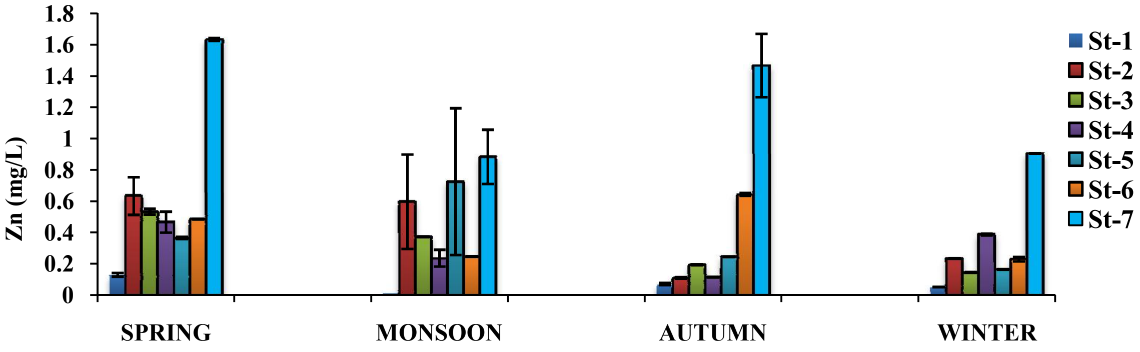

Fig. 1. Seasonal variation of Zn. Line on top of the bar indicates standard error. St indicates station

The maximum of 1.63±0.009 mg/L at Station-7 in spring and autumn of 1.47±0.20 mg/L and the minimum was recorded of 0.015±0.000 mg/L in monsoon at Station-1. Zn concentration varied significantly at $p < 0.05$ was observed in different seasons. The correlation coefficiency of Zn showed positive and significance correlation with Fe ($r = 0.561$; $p \leq 0.001$); Cr ($r = 0.308$; $p \leq 0.002$) and Cu ($r = 0.011$; $p \leq 0.598$) (Table 1.1 & Fig. 6).

Table 1.1. Spearman correlation coefficients among different elements

Variables	Zinc	Copper	Iron	Cadmium	Chromium
Zinc	1	0.598	0.0001	0.455	0.002
Copper		1	0.878	0.156	0.034
Iron			1	0.372	0.004
Cadmium				1	0.002
Chromium					1

Values in bold are different from 0 with a significance level alpha=0.005

The highest value was recorded in the coal mining areas at Station-7 and Station-6 during monsoon during the entire study may be due to mining activities and AMD discharged. The high Zn value of the water content in the coal mining areas was observed by several workers (Trivedi, 2000; Monterroso and Macias, 1998; Gundersen and Steinnes, 2001). During spring the high Zn content was also observed at Station-2 followed by Station-3 and Station-4 may be due to domestic activities, which include washing of cloths, vehicles and bathing at these sampling Stations (Onwerenmadu *et al.,* 2007). The Zn concentration throughout the study period at all the sampling Stations does not exceed the WHO (2006) maximum permissible limit of 3 mg/L. Zn is considered non-toxic, but excess amount can cause system dysfunctions that result in impairment of growth and reproduction (Nolan, 2003). Zn also showed positive correlations with Fe and it may be due to the effluents where it comes from the same source from the mining activities and untreated domestic sewage discharges contribute to it.

Copper (Cu): The value of Cu at different sampling stations it ranged from 0.007±0.001 mg/L to 0.433±0.067 mg/L at different sampling Stations and seasons (Fig.2).

The maximum of 0.433 ±0.067 mg/L at Station-2 in monsoon followed by Station-4 of 0.357±0.015 mg/L in spring and the minimum of 0.007±0.001mg/L recorded at Station-1 in winter. The significant variations of copper were observed in different seasons at $p < 0.05$. The correlation coefficiency of Cu it does not showed any significant among the parameter (Table 1.1). The Cu content at Station-4 and Station-5 during dry seasons was very high and it may be due to the stagnant of waste and other household activities which carried out waste from the drain and Hume pipe which is a major source of pollution which contributed the high copper content in the water bodies. Similarly, Ishaq *et al.* (2012) municipal effluents and leakages from solid waste dumps could be contributing factor to high Cu levels in the river. The Cu content throughout the study period was much lower than the WHO (2007, and 2006) maximum permissible limit of 2 mg/L for drinking water. Abundant levels of Cu in drinking water can be neurotoxic and result in mental diseases like Alzheimer's disease (Dieter *et al.*, 2005).

Iron (Fe): The Fe content ranged from 0.51±0.00 mg/L to 24.93±0.88 mg/L at different sampling stations and seasons (Fig.3).

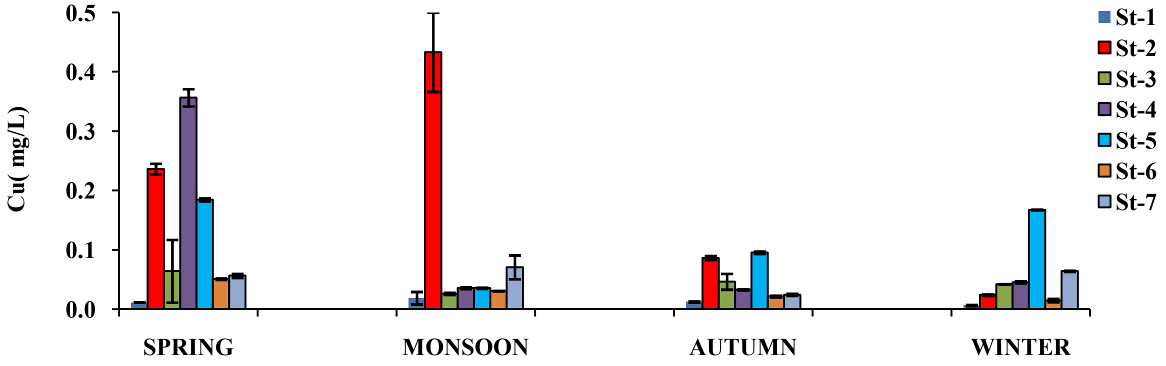

Fig. 2. Seasonal variation of Cu. Line on top of the bar indicates standard error. St indicates station

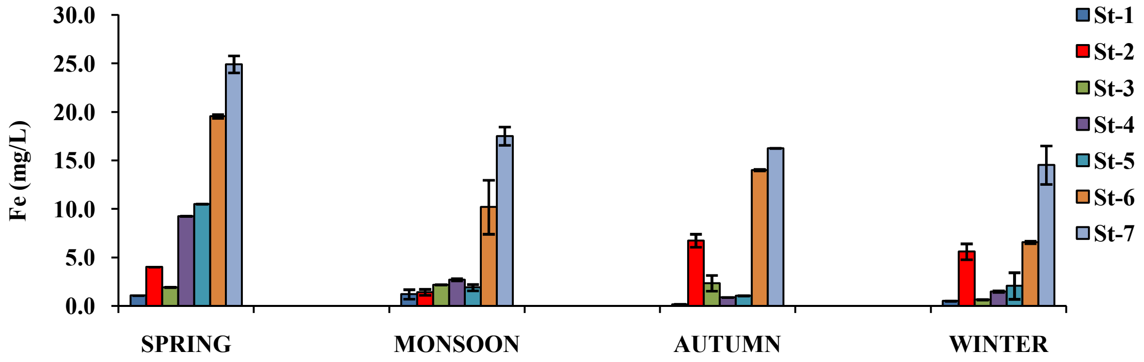

Fig. 3. Seasonal variation of Fe. Line on top of the bar indicates standard error. St indicates station

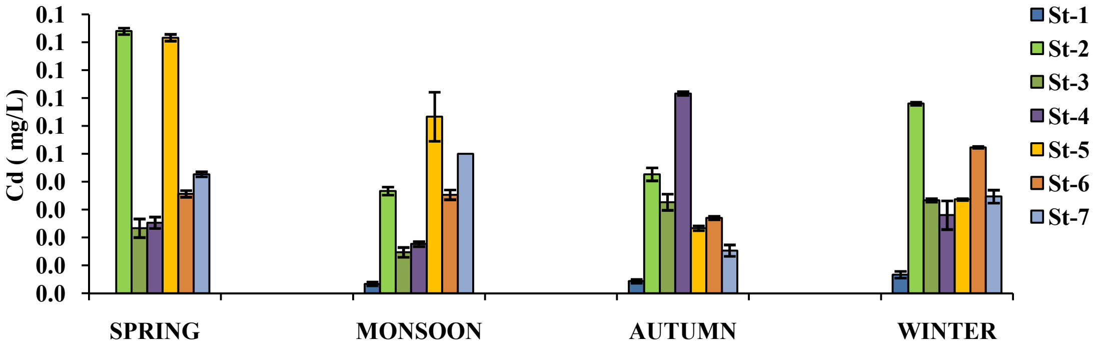

Fig. 4. Seasonal variation of Cd. Line on top of the bar indicates standard error. St indicates station

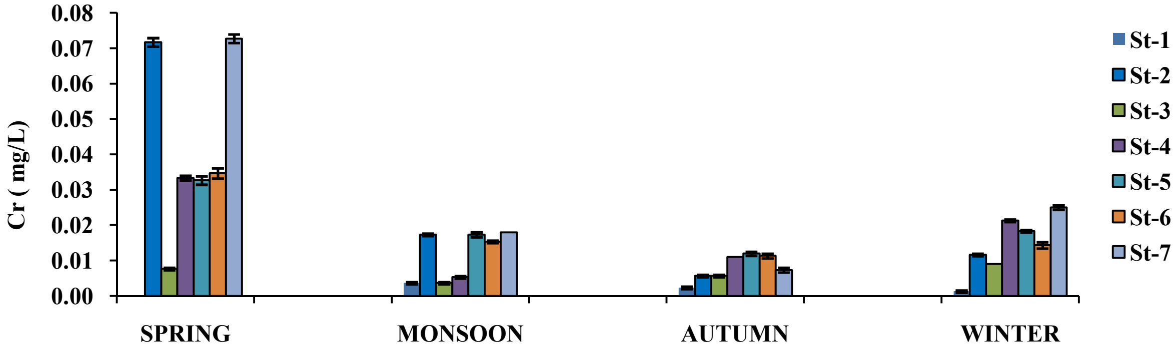

Fig. 5. Seasonal variation of Cr. Line on top of the bar indicates standard error. St indicates station

The Fe content showed significant variation in different seasons at $p < 0.0$. Iron showed weak correlation coefficients with Cd ($r = 0.031$; $p \leq 0.372$) however a strong positive correlation were absorbed with Cr ($r = 0.279$; $p \leq 0.004$) and (Table 1.1 & Fig. 6).

The highest value of Fe content was recorded in the coal mining areas at Station-7 in winter followed by Station-6 in which the valued ranged from 2.67 to 24.93 mg/L which exceeded the permissible limit of 1 mg/L set by WHO. According to WHO (2006) Fe concentration above the permissible limit of 0.33 mg/L gives stringent taste for drinking water.

This higher concentration of dissolved iron is probably due to the lower pH found in these rivers, as iron remains in solution (Langmuir, 1997). High concentration of Fe from the surface sediment due to seepage of the mining region was also reported in different streams and rivers by various workers (Tiwary, 2001; Borrego *et al*., 2002; Stamatis *et al*., 2001). The high concentrations of Fe content may be due to of dumping of wastes near the river and domestic waste water discharges receiving wastes from different sources. Similarly, Renoldi *et al*. (1997) observed high Fe concentration which was attributed due to surface discharge in their study on the highly polluted area of Lambro River (N.Italy). The minimum value of Fe was recorded at Station-1(Control) during autumn of second year.

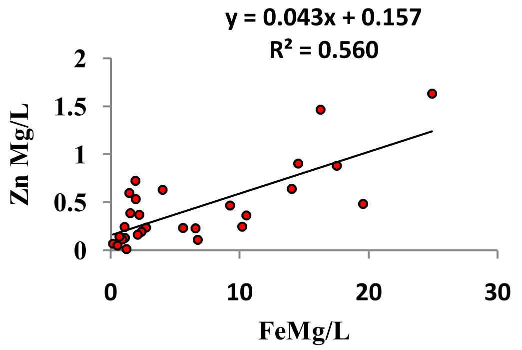

Fig-6

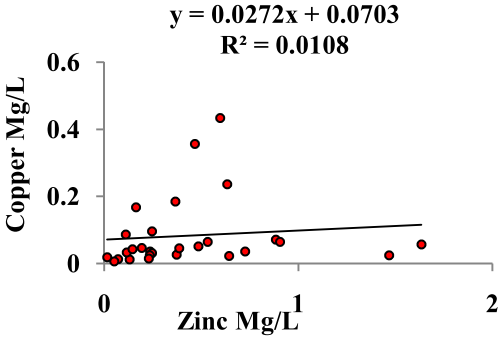

Fig-7

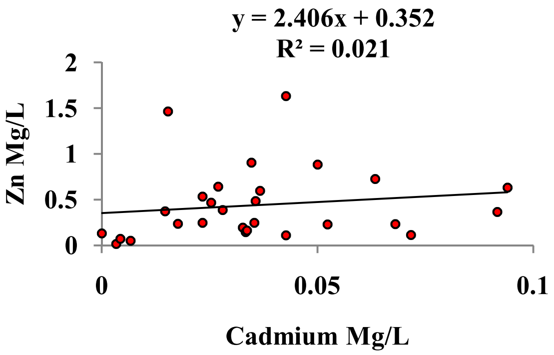

Fig-8

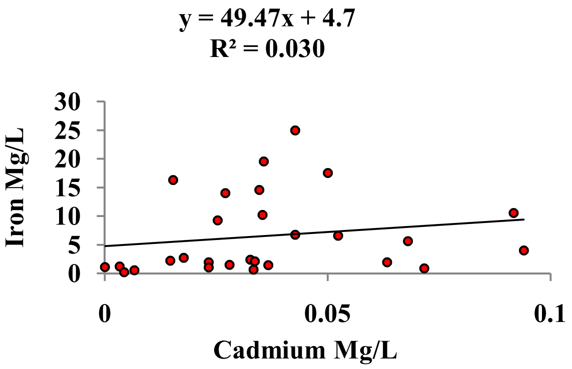

Fig-9

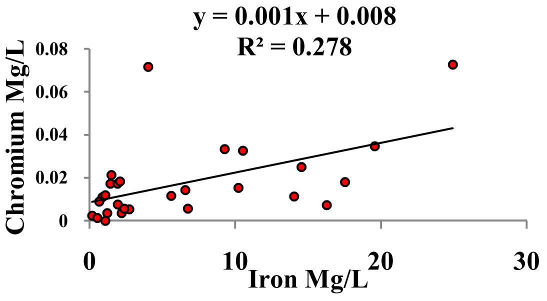

Fig-10

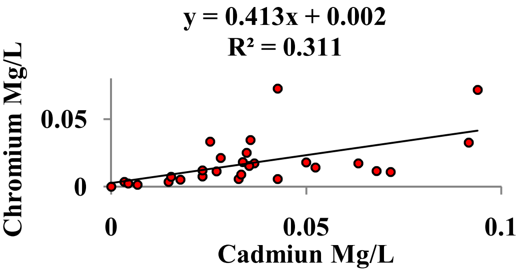

Fig-11

Figure 6. Scatter plot showing relationship between Zn, Cu, Fe, Cd and Cr throughout the study period

Fe content if present in high concentration can cause damage to the cells of gastrointestinal tract and may also damage the cells in the heart and liver (Adraino, 2001).

Cadmium (Cd): The Cd value ranged from ND to 0.092±0.001 mg/L at different sampling stations (Fig.4). The significant variation of Cd in different season was observed at $p < 0.05$. The correlation coefficiency of Cd showed positive correlation with Cr ($r = 0.311$; $p \leq 0.002$) (Table 1.1 & Fig. 6).

The maximum value of Cd was observed at Station-2, Station-4 and Station-5 during the dry season which was above permissible limit of 0.003 mg/L. However Cd was below detection limit at Station-1throughout the year. The high value of Cd may be due to the dumping of sewage effluents (Sobha *et al*., 2009) which contributed to the elevated level of Cd. The Cd content is extremely toxic and the consumption of water with high in Cd could cause adverse health effect since Cd has been found to be toxic to fish and other aquatic organisms (Friberg *et al*., 1986; Kjellstroem, 1986 and DWAF, 1998). Consumption of food or drinking water with high levels of Cd can severely irritate or bother the stomach and cause vomiting and diarrhoea. Breathing high doses of Cd can damage the lungs and can cause death (WHO, 2006). During monsoon high Cd content was also recorded the highest value at Station-2, Station-5, Station-6 and Station-7 which was above the WHO, (2007) permissible limit of 0.003 mg/L. The high Cd content may due to runoffs from agricultural fields where Cd is a common impurity in phosphate fertilizers (Fianko *et al.,* 2007).

Chromium (Cr): The Cr content it varied from ND to 0.073±0.00 mg/L at different sampling stations (Fig.5).The maximum of 0.073±0.001mg/L was observed at Station-7 in winter followed by Station-2 of 0.072±0.001mg/L in spring and the minimum of 0.001±0.0003 mg/L at Station-1 in winter. The significant variations of Cr were observed in different seasons at $p < 0.05$. The Cr content at Station-7 obtains the maximum value throughout the study period. The high Cr content may be due to the minerals released from the coal remained in the water bodies and also due to evaporations and absent of rainfall it remain stagnant in the water sediments (Adikpoh *et al*., 2005). High Cr was also recorded at Station-2 during the dry seasons and it may be from the different sources of pollution dumped to the river bodies such are plastic wastes, sewages and septic tank wastes. The originate source of Cr in the surface waters are from Anthropogenic sources, municipal wastes, laundry chemicals, paints, leather, road run off due to tire wear, corrosion of bushings, brake wires, radiators etc. (Dixit and Tiwari, 2008). The Cr content in these sampling Stations exceeded the WHO (2006) permissible limit of (0.05 mg/L) for drinking water. At Station-1(Control) the concentration of Cr present in the water bodies was very low with the valued ranged from ND to 0.004 mg/L which was well within the permissible limit.

Conclusion

The quality of water was observed to be vastly deteriorated mainly due to unscientific waste disposal improper water management and carelessness towards the environment and this had led to the scarcity of potable water in which it may be affecting human health. The influx of untreated acidic mine drainage into streams can severely degrade both habitats and water quality and often produce an environment devoid of most aquatic life and unfit for healthy habitation. Therefore, comprehensive river water quality monitoring program is becoming a necessity in order to safeguard public health and to protect the valuable and vulnerable freshwater resources.

Acknowledgment

The authors are thankful to Head, Centre for Advanced Studies in Botany, Department of Botany, North-Eastern Hill University for providing laboratory facilities. The first author is also thankful to University Grant Commission (UGC) of Rajiv Gandhi National Fellowship, New Delhi for financial support in the form of senior research fellowship.

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