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ANALYSIS OF HEAVY METALS IN GROUND WATER OF SMALL TEA GARDENS OF SONITPUR DISTRICT, ASSAM, INDIA

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ABSTRACT

Water is one of the most essential compounds for survival of life on the earth. Heavy metals viz. Mn, Mg, Fe, Ca, Zn, Cd, Pb, Cu and Hg in small tea gardens of Sonitpur district, Assam, have been analyzed in pre-monsoon season (month's April and May 2009). The correlations between nine chemical parameters have been calculated and analysis carried out. Clusters of linked and non linked variables were separated out following average linkage method. The results of contamination in ground water are reported, which may cause a serious health problems to human beings.

Key words: Heavy metals, Chemical parameters, Cluster analysis, Contamination.

INTORDUCTION

In modern world, "Environmental Pollution" is a burning topic affecting all of us directly or indirectly. Water is the most precious gift of nature to mankind and the terrestrial ecosystem cannot function without it. Due to great dissolving power of water, it is difficult, to get it in the purest form. Safe drinking water is a basic need for human development health and well being and because of this, it is an internationally accepted human right (WHO)[1]. The problem of environmental pollution, due to development in the agricultural and industrial sector, has assumed a serious dimension in the twenty first century. The natural water is one of the most precious and vital component of the environment and it is essential to all from of life.

The heavy metals are important components of pollutants, which not only causes phytotoxicity but also enters into the food chain causing hazardous impacts on human health and animals. The phytotoxic impact of heavy metal pollution is very commonly observed on

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crops. Chemicals in drinking water, which are toxic, may cause either acute or chronic health effects. An acute effect usually follows a large dose of a chemical and occurs almost immediately. It is important to understand that primary standards for drinking water contaminants do not guarantee that water with a contaminant level below the standard is risk-free. Several research studies have been published on the concentration of heavy metals and their toxicity, from different corners of the globe[2-5]. In tea garden areas, heavy amounts of fertilizers, pesticides, weedicides and other chemicals are used and therefore, these chemicals contaminate the water sources[6]. Bhuyan et. al.[7] studied the water quality in tea gardens of Lakhimpur district, Assam. There is no earlier statistics of heavy metals contamination in water sources of small tea gardens in Sonitpur district are available. The district Sonitpur, which is taken as study area is located in the north east part of Assam. The total area of Sonitpur district is 5103 sq. kms. and lies 100 meter above the mean sea level. It is surrounded by Arunachal Pradesh in north, the river Brahmaputra and Morgaon, Nagaon, Jorhat and Golaghat districts in south, Darrang district in the west and Lakhimpur district in the east. Sonitpur district is located on the north bank of river Brahmaputra within 26^{o}242 and 26^{o}592 N latitude and 92^{o}182 and 93^{o}482 E longitude. The biggest tea garden in Asia, the Monabari, tea estate is situated in Sonitpur district. There are 62 large tea garden and 207 registered small tea gardens in 2004 but still now, there are more than 500 registered tea gardens.

In the present study, scientific data are presented for heavy metals concentrations in water sources of small tea gardens of Sonitpur district, Assam to assess environmental impact for the purpose of maintenance of water sources in tea gardens. Water samples were collected from eight privately owned small tea gardens by adopting lottery method in April and May, 2009, where no appropriate testing of soils are done on a regular basis. The present research is undertaken with a specific view to strengthen the national and local quality database by evaluating chemical quality for better water quality management.

EXPERIMENTAL

Materials and methodology

Twenty four water samples were collected form eight selected tea gardens by adopting simple random sampling technique. The source of the water samples were shallow hand tube wells (HTW-60 ft deep), deep tube wells (DTW-120 ft to 180 ft deep), opens wells (25 ft. to 45 ft. deep), and drains (5 ft. to 15 ft. deep). Tube wells were operated at least 10 minutes before collection to flash out the stagnant water inside the tube and to get the fresh ground water. The water samples were collected in clean polypropylene bottles. All samples were analyzed for heavy metals like Mn, Mg, Fe, Ca, Zn, Cd, Pb, Cu and Hg by using Atomic Absorption Spectrophotometer (Model Perkin-Elmer 2A Analyst 200, USA) at North Eastern Regional Institute of Water and Land Management, Tezpur. The degree of accuracy of the results was checked by preparing two standards having absorption similar to sample range of 0.4 µm to 0.6 µm, respectively. The observed difference between these two standards is about 0.1 absorbency indicate the degree of accuracy of 0.1% to 0.2% of the results. The data obtained was subjected to cluster analysis to understand the interrelationship between the parameters. These have been compared to standard values of BIS and WHO.

RESULTS AND DISCUSSION

pH is the most important parameter that serve as an index for pollution. The range of pH (BIS limit: 6.5-8.5) is 6.5 to 7.7. In the present study, the variation of pH is narrow and in general, the pH is towards alkaline side.

Managense (Mn) causes organic growth. It is one of the important trace elements essential for organisms. The BIS standard is 0.1 mg/L. Mn^{2+} ions are soluble in water and with aeration of water, they form manganese dioxide, which have unpleasant taste as well as colour. The chronic Mn poisoning leads to progressive deterioration of the central nervous system and symptoms resembling to those of Parkinson's diseases are observed. Mn deposited on food during cooking[8]. In the present study, the range of Mn is from 0.002 to 6.499 mg/L.

Magnesium (Mg) concentration in water is comparatively less than Ca possibly due to lesser occurrence of a laxative effect and as a result, its concentration remains lower than Ca in water samples of tea gardens. It is supposed to be non-toxic but high concentration is toxic. The range of Mg is 0.684 mg/L to 29.814 mg/L. in the study area. The BIS and WHO limit is 30 mg/L.

Iron (Fe) is fourth most abundant element in the earth's crust. The BIS and WHO limit is 0.3 mg/L in natural waters. Its solubility is controlled by pH-Eh system. There may be 1 to 10 mg/L concentration of Fe in ground water[9]. Although, it is abundant in the earth's crust, it is absorbed in different forms at different rates and iron deficiency is quite common among people throughout the world[10]. It occurs in water in Fe^{2+} and Fe^{3+} oxidation states. Iron is one of the less toxic element but at 1.0 mg/L, it can cause bitter astringent taste to water. In the study area, it is found from 0.684 mg/L to 29.814 mg/L, which is above the standard limit and hence, iron bacteria problem frequently occurs.

Calcium (Ca) has no hazardous effect on human health but high Ca is associated with hardness. Sewage and industrial wastes are also important sources of Ca[11]. Ca is responsible for various functioning of the human body. Its low content may cause defective teeth, but high content plays a role in heart disease[12]. In this study, Ca found from all sources ranges from 0.790 mg/L to 37.380 mg/L, which is below the permissible limit of BIS and WHO.

Table 1: Water quality parameters in tea gardens

Sample No.	pH	Mn mg/L	Mg mg/L	Fe mg/ L	Ca mg/L	Zn mg/L	Cu mg/L	Cd mg/L
Aw1	6.7	2.037	5.290	**18.194**	12.518	0.041	0.021	0.007
Aw2	**6.2**	1.542	4.298	3.125	10.294	BDL	0.001	**0.002**
Aw3	6.8	0.353	**0.684**	6.893	**0.790**	0.010	0.011	0.014
Bw1	7.3	1.179	1.775	13.041	18.890	0.021	0.030	0.023
Bw2	7.5	0.691	5.89	3.329	1.806	0.036	BDL	0.012
Bw3	7.4	0.109	8.481	**0.310**	7.9.9	BDL	BDL	0.005
Cw1	7.5	0.100	5.111	0.691	6.612	BDL	BDL	0.024
Cw2	7.4	0.031	6.090	4.538	4.878	BDL	0.035	0.046
Cw3	7.3	0.034	25.112	3.361	10.671	BDL	0.150	0.051
Dw1	7.1	**0.002**	13.664	1.107	2.512	0.03	BDL	0.050
Dw2	6.8	0.145	9.626	0.594	4.375	BDL	0.056	0.081
Dw3	7.2	0.177	17.121	2.249	5.828	BDL	0.032	0.003
Ew1	7.1	0.342	10.715	4.821	9.238	0.030	0.065	0.050
Ew2	6.8	0.235	7.822	2.346	7.896	BDL	0.059	0.061
Ew3	7.7	1.34	26.231	6.167	7.210	BDL	0.045	**0.079**
Fw1	6.9	1.101	12.626	7.051	18.592	0.021	0.020	0.021
Fw2	6.9	0.210	9.526	5.320	9.871	0.010	0.032	0.052
Fw3	7.1	0.245	21.034	66.58	0.681	BDL	0.078	0.011
Gw1	7.6	**6.499**	14.332	13.221	**37.380**	BDL	BDL	0.018
Gw2	7.4	0.432	1.012	4.908	13.65	0.094	**0.089**	0.012

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Sample No.	pH	Mn mg/L	Mg mg/L	Fe mg/ L	Ca mg/L	Zn mg/L	Cu mg/L	Cd mg/L
Gw3	7.5	0.500	**29.814**	1.854	23.46	**0.729**	0.067	0.049
Hw1	7.7	0.055	10.216	3.710	25.616	0.021	0.043	0.015
Hw2	**7.7**	0.475	9.860	1.610	11.179	BDL	0.063	0.013
Hw3	7.5	0.028	26.705	3.572	9.912	0.001	0.012	0.022
SPL BIS (mg/L)	6.5-8.5	0.10	30	0.3	75.0	5.0	0.05	0.01
SPL WHO mg/L	7-8.5	0.4	-	0.3	75.0	5.0	1.0	0.01

SPL: Standard permissible limits; BIS: Bureau of Indian Standard

WHO: World Health Organization; BDL: Below Detectable Level.

Zinc (Zn) is a metal and its inorganic compounds are non-toxic but its high limit is dangerous to human being. Zinc, when present above permissible limit of 0.5 mg/L (WHO, 1984), impacts unpleasant taste to drinking water. Symptoms of Zn toxicity include irritability, muscular stiffness, loss of appetite and nausea[10]. It is found in the study area from BDL to 0.729 mg/L. It is almost safer limit with reference to drinking as well as irrigation in the garden areas.

Copper (Cu) is a trace element required for the proper nutrition of plants and animal. It is essentially non-toxic at low concentration but excessive ingestion of Cu is responsible for specific disease of the bone[12]. The Cu content of water increases with the decrease of chlorinity[13]. The BIS limit is 0.5 mg/L, but the range of Cu was found BDL to 0.089 mg/L.

Cadmium (Cd) is a soft metal and its low concentration is quite toxic to human health[12]. The ground water Cd content has been observed below detectable limits[8]. The BIS and WHO limit is 0.01 mg/L. The present findings in tea garden water sources are 0.002 to 0.079 mg/L which reflects not a healthy sign towards water quality as far as Cd is concerned.

CONCLUSION

The variations of heavy metals are observed in the water sources of tea garden areas and it is it not a healthy sign towards water quality for drinking purposes. The concentrations of trace metals Mn, Fe, are not within limit. The iron contents of the water sources need immediate attention. Moreover, outbreak of water borne diseases are very common among the people of the study area. To trace the interrelationship between the various chemical parameters, the data was subjected to Correlation matrix table (Table 2) and cluster analysis to obtain a dendrogram (Fig. 1). This facilitates to arrive at the closet parameters, which are linked and dependent with other parameters. From this study, it is clear that most of the heavy metals are not symmetric distributed and therefore, a proper monitoring is very essential.

Table 2: Correlation matrix

	pH	**Mn**	**Mg**	**Fe**	**Ca**	**Zn**	**Cu**	**Cd**
pH	1.000							
Mn	0.061	1.000						
Mg	0.315	0.004	1.000					
Fe	-0.113	0.633	-0.128	1.000				
Ca	0.232	0.307	-0.383	0.211	1.000			
Zn	0.014	-0.035	-0.416	0.245	-0.068	1.000		
Cu	0.097	-0.286	0.317	-0.099	-0.168	0.114	1.000	
Cd	-0.014	-0.175	0.299	-0.219	-0.140	-0.207	0.331	1.000

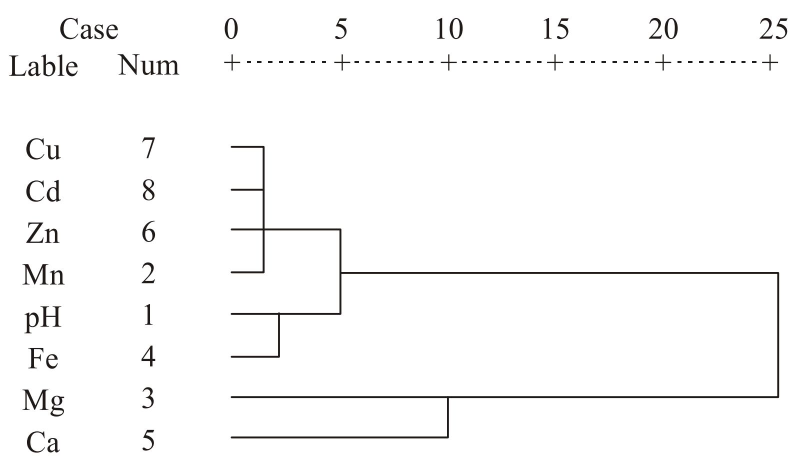

Fig. 1: Dendogram using average linkage (between groups) rescaled distance cluster combine

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