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Distribution of Fluoride and Arsenic Contents in the Ground Water System, Jorhat District, Assam, India

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Abstract: ***Exploratory investigations have been made on the ground water system of the Jorhat district, Assam to evaluate the geochemical association (Fe, As, F, K, Mn, Zn, Ni, Ca, Mg and Na with pH and Conductivity) in it. The environmentally significant fluoride and arsenic contents have shown their distribution as 0.01 to 0.72 mg/l and 0.50 to 162µg/l respectively. The distribution of fluoride has evidenced less concern with respect to environment and human health as the concentration is much lower than the prescribed tolerance level of WHO and BIS. However, thirty three per cent (33%) out of seventy locations under study covering entire Jorhat district, Assam, have evidenced higher level of arsenic (>10.0µg/l) in the associated water system. The observation bears a significant imprint not only in health sector but also with wider implication in societal and economic perspectives.***

Keywords: Fluoride, Arsenic, Groundwater, Jorhat, Assam

1. Introduction

Water is one of the Primary components of nature. It is indispensable for sustaining life. During early ages, availability of surface water easily could fulfill the needs of living world. But, stupendous increase in population through the centuries of human civilization has created a scarcity of usable water and people started using underground water as an alternative source. With passing time, the changing natural, political, social and economic perspectives of the globe has made groundwater an essential natural resource. Intensive utilization of ground water for different purposes such as drinking, agricultural, industrial, sanitary etc. on the other hand has evolved some health as well as environmental problems throughout the world. Groundwater management is a major economic consideration now a day for every nation and mitigation of ground water born health and environmental hazards is a major scientific issue. Moreover, water is essential to sustain life and has long been suspected of being the source of many illnesses in human beings. It was not until a little over 100 years ago that definite proof of disease transmission through water was established. At least, 170 million people in different urban areas of the world still lack a source of potable water near their homes, and in rural areas, although access has increased rapidly in the past decade, more than 855 million people are still without safe drinking water [1].

Thy water resources of many of the states of Indian union already have alarming quantities of arsenic and fluoride above their permissible limit to human beings [2]. The studies available so far have shown enough evidences that the environmental segments in North Eastern region of India specifically Assam with respect to water quality of the region is not at all satisfactory [3,4,5,6]. The problem of arsenic in Assam is authentically detected only in very recently. Assam is reported as the fifth arsenic endemic states of India. The recent report from Jorhat District (6th June 2006), Assam, bears a significant imprint not only in health sector but also with wider implication in societal and economic perspectives. The first report of arsenic was obtained from the Sadarashi village of Karimgang, Mancachar area of Dhubri and Dhemaji districts in 2004. Moreover, very recently groundwater arsenic contamination was reported by a joint study of Assam Public Health Engineering Department (APHED) and UNICEF with School of Environmental Studies (SoES), Jadavur University, India from Jorhat and Golaghat districts of Assam. Manifestation of raindrop pigmentation on hand was observed which was considered as the symptoms of Arsenocosis. It has been reported that the arsenic content in the drinking water of the state at some places goes up to more than 200ug/l. The maximum permissible limit of arsenic in drinking water is reduced to 10µg/l from 50µg/l. Both skeletal and dental fluorosis is reported from the Karbi Anglong and Nowgaon districts of Assam with area and population are 10,526km^2 and 700,000 respectively. Available evidence has revealed that one tenth of total population is suffering from fluorosis, which finally leads to paralysis [7,8]. The severity of the problem with respect to fluoride and arsenic is now a critical concern. A group of workers reported the presence of fluoride up to 6.88ppm in drinking water samples of various parts of Guwahati and suburbs [9, 10]. Considering all these an attempt has been made to understand the status of water resources of Jorhat districts of Assam. The study has also included the data from areas within recently created Majuli district, which was earlier a subdivision under the Jorhat district.

2. Methodology

The area covering entire Jorhat district, Assam, was selected from the Survey of India, toposheets and prepared a detailed map. Detailed survey of the area has been carried out to locate the sample collection points giving due consideration to its representativeness and accessibility. Altogether seventy sampling points were selected. The locations were Nagabat Bus Stand, Borhola Teagarden, Lohang Bebajia, Rajabari, Mahimabari, Charaipani, Lahangaon, Mandalgaon (Deogharia), Titabar Tinali, Bandar Chalia, Titabar Chariali, Thengalgaon, Dhalajan, Raidang Kamargaon, Chaodanggaon, Cinnamara, Rangajangaon, Mariani, Holongapar, Gohainbari, Deoghariagaon, Nakachari, Motokgaon (Balata), Jhanji (Near Bridge), Tamulichiga, Hahchara, Kaliapani, Teok Jagduar, Satai Bhakatgaon (Dakhinpat Satra), Patiagaon, Neematighat, Gayangaon

(Gharphalia), Deurigaon (Karengchapori), Garumara, Borbheti, Chakalani (Kakodonga), Napamua, Tekelagaon, Pakimuri, Nehru Park, Dhakai Patti, Purana Civil, Dhenususa, Near Bhogdoi Bridge (Engg. College Road), Salmara, Brahmaputra River (Salmara), Kamalabari, Kahalgaon, Phulani, Moamari, Dakhinpat Satra, Ratanpur, Jengraimukh, Garamur, Garamur Satra, Auniati Satra, Kaniajan, Majgaon, Boroguri, Haldibari, Malapindha, Gajera, Meragarh, Balisapori, Gayangaon, Karatipar, Brahmaputra River (Karatipar), Sumoimari, Nayabazar and Bongaon (identified with sample numbers as S-1 to S-70). The water sample from each of the locations were collected from Deep Tube Wells (DTW), Tube Wells (TW) and Ring Wells (RW). Fluoride content in the water samples were determined with the help of Orion Five Star Ion Meter. 10ml of water samples were taken in a plastic beaker and mixed with equal amount of Ion Suppressing Agent (ISA) and subjected to analysis of fluoride content in them by ion analyzer. A part of the samples were acidified with HNO_3 to reduce the pH below 2.0 and were utilized for determination of trace element concentrations. The water samples were digested with a mixture of HNO_3 and HCl in a Teflon beaker following the procedure of [11] and prepared solutions were subjected to trace element analysis using Atomic Absorption Spectrophotometer. Arsenic content in the water samples were determined with the help of cold vapour atomic absorption spectrometry through hydride generation technique. The established standard methodology [12] have been followed to generate precision based knowledgebase and utilized for interpretative use of the present study.

3. Results and Discussion

The database generated with their statistical significance are Tabulated in Table 1**.** The study on fluoride concentration in the water system of the Jorhat district, Assam, along with thirteen trace elements (Figures 1a-d) and environmentally significant arsenic contents have contributed significantly towards generation of a strong database with precision and accuracy.

Table 1: Statistical parameters of the physicochemical characteristics in the water samples, Jorhat district, Assam

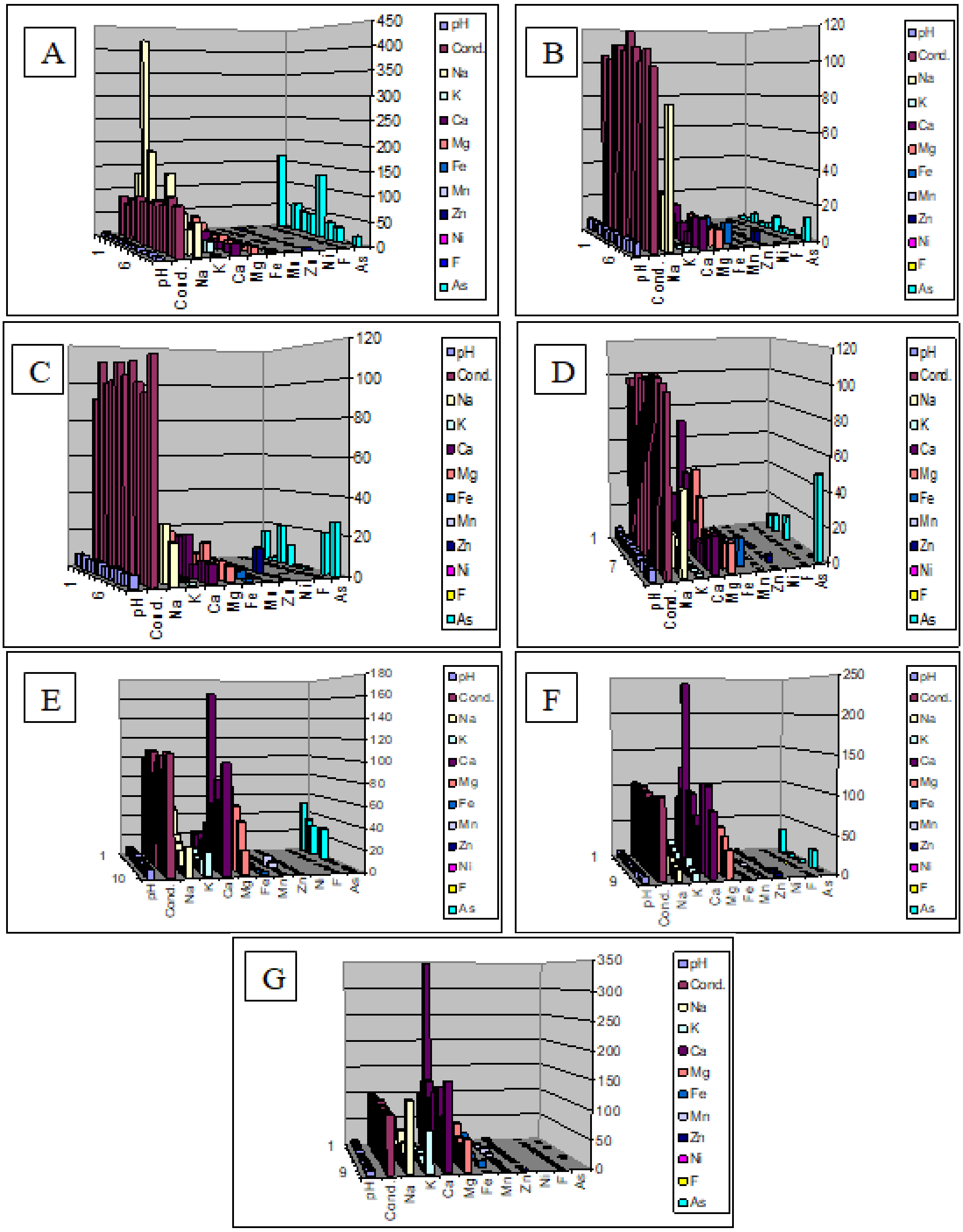
Parameters	Min	Max	25% Percentile	75% Percentile	Median	Mean	Std. Dev.	Std. Error	Lower 95%CI	Upper 95%CI	Co. Var. (%)	*Geo. Mean*
Con. (mV)	71.20	116.2	98.05	105.7	100.8	100.6	7.323	0.875	98.88	102.4	7.28	100.3
pH	5.790	10.01	6.475	8.460	6.945	7.377	1.015	0.121	7.135	7.619	13.75	7.309
Fe	0.0700	46.60	0.530	4.770	1.170	4.614	8.843	1.080	2.457	6.771	191.67	1.491
As	0.5000	162.0	1.050	28.00	5.300	18.56	30.19	4.147	10.24	26.88	162.64	6.027
F	0.0076	0.717	0.080	0.155	0.110	0.135	0.106	0.013	0.110	0.161	78.69	0.105
K	0.9100	71.98	1.990	14.48	3.230	9.151	11.29	1.350	6.458	11.84	123.43	4.949
Mn	0.0200	11.50	0.065	0.885	0.365	1.170	2.270	0.284	0.603	1.737	194.07	0.316
Zn	0.0400	12.60	0.090	0.705	0.175	1.027	2.111	0.252	0.524	1.530	205.53	0.282
Ni	0.0500	0.130	0.050	0.115	0.070	0.081	0.032	0.011	0.056	0.106	39.68	0.076
Ca	6.500	348.0	14.85	93.50	22.55	54.83	61.12	7.305	40.25	69.40	111.48	32.79
Mg	5.000	147.0	10.50	46.50	16.75	29.71	25.43	3.040	23.64	35.77	85.61	21.21
Na	*7.000*	*417.0*	*19.50*	*54.65*	*28.75*	*46.31*	*55.63*	*6.650*	*33.04*	*59.57*	*120.14*	33.32

Total Number of Observations: 70 : conductivity in mv : As in µg/l *and all other elements in* mg/l.

The pH value of the water system under study varies from 6.00 to 10.01 indicating neutral to alkaline nature of the existing water system. The fluoride content varies from 0.01 to 0.72 mg/l. The result has evidenced much below the tolerance limit (up to 1.5mg/l) of [13, 14] for fluoride content in the water system of the present area of study. However, combining with geohydrologic conditions of the region under study a continuous monitoring is highly essential as the neighbouring regions have exceedingly high fluoride contents (Karbianglong and Naogaon districts, Assam, reported up to 8.65mg/l). The iron content in the water system varies from 0.02 to 46.6 mg/l which appears to be much higher than the prescribed tolerance limit for human consumption. The evaluated environmentally significant arsenic content in the water system varies from 0.50 to 162µg/l. Out of seventy locations, thirty three per cent of locations (33%) under study covering entire Jorhat district, Assam, have evidenced higher level of arsenic (>10.0 µg/l) in the associated water system. The locations with contaminant more than the prescribed level of tolerance are mainly confined within Titabar and Majuli subdivisions (very recently Majuli is declared as separate district) under Jorhat district, Assam, indicating the level of arsenic concentration ranging from 11µg/l to 162µg/l. The problem of arsenic in Assam is authentically detected only in very recently. Assam is reported as the fifth arsenic endemic states of India. The recent report from Jorhat District (6th June 2006), Assam, bears a significant imprint not only in health sector but also with wider implication in societal and economic perspectives. The first report of arsenic was obtained from the Sadarashi village of Karimgang, Mancachar area of Dhubri and Dhemaji districts in 2004. Moreover, very recently groundwater arsenic contamination was reported by a joint study of Assam Public Health Engineering Department (APHED) and UNICEF with School of Environmental Studies (SoES), Jadavur University, India from Jorhat and Golaghat districts of Assam. Manifestation of raindrop pigmentation on hand was observed which was considered as the symptoms of Arsenocosis. It has been reported that the arsenic content in the drinking water of the state at some places goes up to more than 200ug/l. The maximum permissible limit of arsenic in drinking water is reduced to 10µg/l from 50µg/l. This has clearly opened up an important area with a scope for further studies with wider eco-societal implications.

4. Conclusions

The present study has attributed enough evidence that the water system of the Jorhat district including the newly created Majuli district is not environmentally safe with reference to arsenic content. However, the water system with reference to fluoride content of the area under study has shown its distribution much lower than the prescribed tolerance level of WHO and BIS. Therefore, it can clearly be attributed that the area needs an in-depth investigation in view of the environmental aspects towards improving the quality of life around. It is believed that the generated environmental knowledgebase with precision and accuracy will fill up a critical domain in improving the quality of life and people around.



Figures 1(a-d): Variation of elemental concentrations in the water system of Jorhat District, Assam, (A) Sample Numbers 1-10; (B) Sample Numbers 11-20; (C) Sample Numbers 21-30; (D) Sample Numbers 31-40; (E) Sample Numbers 41-50; (F) Sample Numbers 51-60; (G) Sample Numbers 61-70

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