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GROUNDWATER ARSENIC CONTAMINATION STATUS IN DHAKUAKHANA SUB-DIVISION OF LAKHIMPUR DISTRICT, ASSAM, INDIA

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ABSTRACT

The present work describes the occurrence and distribution of arsenic and iron in six Gaon Panchayat of Dhakuakhana sub-division of Lakhimpur district, Assam. The focus of the study is on rural areas because of the difficulties associated with applying mitigation measures in scattered rural communities. No detailed analysis of the water quality of the selected sources with respect to arsenic and iron had been undertaken before. Thirty groundwater samples were collected from tubewells and ringwells at different sites from Dhakuakhana sub-division during dry season (February, 2011 – March, 2011). Arsenic was analysed by using an atomic absorption spectrometer as per the standard procedures. Iron was measured by 1, 10-phenanthroline method using a UV-visible spectrophometer. It is observed that a sizeable number of groundwater samples contain arsenic and iron at a toxic level. Statistical observations also show that arsenic in groundwater exhibit non-uniform distribution with a long asymmetric tail on the right of the median. We ran one population t-test to compare the concentrations of arsenic among the sampling sites and used an alpha level of 0.05 and considered differences to be significant if $P \leq 0.05$. The present study has shown that naturally occurring arsenic in groundwater is more widespread in the study area than is generally recognized and that, with continuous testing, more contaminated groundwater aquifers are bound to be identified.

Key words: Arsenic, Iron, Skewness, Quartile, Kurtosis.

INTRODUCTION

Arsenic in drinking water is a hazard to human health. It has attracted much attention since recognition in the 1990s of its wide occurrence in well-water in Bangladesh. Groundwater arsenic contamination in West Bengal, India and adjoining Bangladesh is well publicized and perhaps one of the biggest natural calamities of the world related to drinking water[1,2]. The first case of arsenicosis in India were identified in 16 patients from one village of a district in July 1983[3,4]. Arsenic contamination of water is also reported from North Eastern India[5-9]. Despite common associations between arsenic and a number of other metals (for example iron) in groundwater, observed correlations in water samples are usually weak. Hence, the present study was carried out to provide an overview of the current state of knowledge on the occurrence and distribution of arsenic and iron problems in water supplies in Dhakuakhana sub-division of Lakhimpur district, Assam. As the elevated level of arsenic in groundwater is a new public concern in Assam, the need is for a more systematic and careful study eliminating all possible sources of error and to build up a reliable database[10].

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EXPERIMENTAL

Materials and methodology

The study area Dhakuakhana is a vast area comprising of a great number of villages and some growing towns. Geographically, it is situated between $27^0 60^/$ degree and $27^0 35^/$ northern latitude and $94^0 24^/$ and $94^0 42^/$ eastern longitude. After careful study of the topography and other aspects, thirty groundwater samples were collected from five different Gaon Panchayats of Dhakuakhana sub-division of Lakhimpur district (Table 1 and Fig. 1). All the tube wells are shallow in depth (6-12 m) as the water level is very high in the whole area. Samples were collected once in a week by random selection and combined together in clean and sterile one-litre polythene cans to obtain a composite sample and stored in an ice box[11]. All probable safety measures were taken at every stage, starting from sample collection, storage, transportation and final analysis of the samples to avoid or minimize contamination. Arsenic was analysed by using an atomic absorption spectrometer (Perkin-Elmer AAnalyst 200) with flow injection analyze mercury hydride generation system (Model FIAS-100) at 189 nm analytical wavelengths as per the standard procedures[12]. The spectrometer has minimum detection limit of 0.002 µg/L for arsenic. Sample data were also subjected to statistical treatment using normal distribution statistic[13]. We used ran one population t-test to compare the concentrations of arsenic among the sampling sites and used an alpha level of 0.05 and considered differences to be significant if $P \leq 0.05$.

Table 1: Water sampling locations

Name of the Gaon Panchayat	Sample No.	Total number of samples
Harhi	A1 - A5	05
Dhakuakhana	B1 - B5	05
Subansiri	C1 - C5	05
Deolia	D1 - D5	05
Ghilamara	E1 - E5	05
Bordoibam	F1 - F5	05

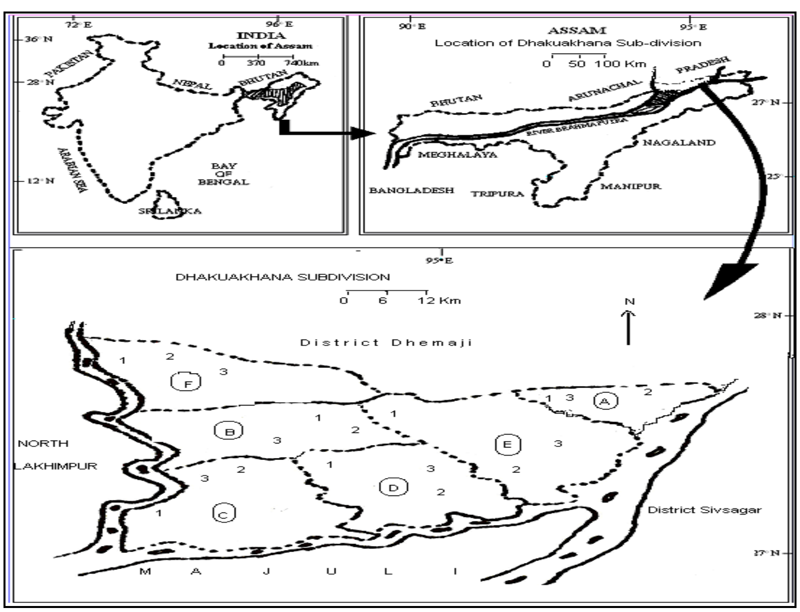

Fig. 1: Study area showing sampling locations

RESULTS AND DISCUSSION

To look into the trend and distribution patterns of arsenic in groundwater, analytical data were exposed to several statistical treatments. The experimental results of pH, arsenic and iron distribution in the study area was presented in Table 2. Various statistical estimates derived from NDA are summarized in Table 3.

Table 2: Water test data of the study area

Sample No.	Source	pH	As (in ppm)	Fe (in ppm)
A-1	Tube well	6.5	0.001	3.5
A-2	Ring well	6.6	0.002	1.3
A-3	Tube well	6.7	0.007	2.6
A-4	Ring well	6.8	0.002	1.6
A-5	Tube well	6.6	BDL	3.2
B-1	Tube well	6.7	0.014	3.1
B-2	Tube well	6.4	0.001	2.9
B-3	Ring well	6.6	0.002	1.6
B-4	Tube well	6.9	0.011	3.0
B-5	Tube well	6.8	0.009	2.3
C-1	Tube well	6.6	0.007	2.1
C-2	Tube well	6.6	0.010	2.6
C-3	Tube well	6.3	0.003	2.7
C-4	Tube well	6.5	0.013	3.0
C-5	Ring well	6.6	BDL	1.4
D-1	Tube well	6.8	0.002	1.5
D-2	Tube well	6.6	0.004	1.7
D-3	Tube well	6.4	0.015	2.7
D-4	Tube well	6.4	0.001	1.5
D-5	Tube well	6.7	0.011	3.2
E-1	Tube well	6.6	0.019	3.1
E-2	Tube well	6.8	0.012	3.3
E-3	Ring well	6.5	0.006	0.5
E-4	Tube well	6.8	0.012	2.6
E-5	Tube well	6.7	0.007	1.8
F-1	Tube well	6.4	0.006	1.6
F-2	Tube well	6.3	0.013	3.0
F-3	Tube well	6.4	0.004	1.3
F-4	Ring well	6.3	0.005	1.2
F-5	Ring well	6.6	0.003	0.7

Table 3: Descriptive statistics of experimental data

Descriptive statistics		pH	As	Fe
No of parameter		30	30	30
Mean (ppm)		6.58	0.007	2.22
Std. error of mean		0.03	0.001	0.16*
Median		6.60	0.006	2.45
Mode		6.60	0.002	1.60
Std. deviation		0.17	0.005	0.85
Variance		0.03	0.000	0.72
Skewness		-0.09	0.534	-0.29
Std. error of skewness		0.43	0.427	0.43
Kurtosis		-0.86	-0.702	-1.13
Std. error of kurtosis		0.83	0.833	0.83
Range		0.60	0.019	3.00
Minimum		6.30	BDL	0.50
Maximum		6.90	0.019	3.50
Sum		197.50	0.202	66.60
Confidence limit	Lower bound	6.5	0.005	1.90
	Upper bound	6.6	0.009	2.54
Percentiles	25	6.4	0.002	1.50
	50	6.6	0.006	2.45
	75	6.7	0.011	3.00
Inter quartile range		0.30	0.009	1.50

*Multiple modes exist. The smallest value is show

BDL= Below detection limit

To understand the distribution pattern of arsenic in groundwater in the study area, a frequency count was made and it was observed that 33.3% of groundwater samples fall under alert category as they contain arsenic in between the maximum desirable limit of 0.01 ppm and maximum permissible limit of 0.05 ppm as set by WHO[14]. The rest 66.7% groundwater sample can be termed as safe as they contain arsenic below the WHO maximum desirable limit of 0.01 ppm. Statistical observations imply non-uniform distribution of arsenic in groundwater in the study area. This observation is supported by large differences among mean, median and mode. The width of the third quartile is greater than the second quartile, which for a symmetric distribution should be equal. Negative kurtosis and positive skewness value point toward flat arsenic distribution with a long right tail in the study area. Wide data range in case of arsenic content of groundwater indicates the presence of extreme values, which are likely to bias the normal distribution statistic. t-test is also performed under null hypothesis (H_0) by taking the assumption that the experimental arsenic content of groundwater are consistent with the maximum permissible limit given by WHO. One population t-test on analytical data at the 0.05 level indicates that the mean value of arsenic in the study area is significant (t = -44.89228, p = 6.63249E-27). This also implies that samples are at alert level and are not completely safe, which can reach toxic level if not managed properly.

Iron is a non-hazardous element that can be a nuisance in a water supply. Iron is the more frequent contaminants in water supplies. As for iron, all most all the samples under investigation contain iron much above the guideline value of 0.3 ppm as set by WHO. A broad third quartile and negative skewness in case of iron represents a long asymmetric tail on the left of the median. Sharpness of the tail for iron distribution in the area is evident from negative kurtosis value. The iron contamination of groundwater in the area should be accorded maximum attention. Appreciable difference in iron contents in ring well and tubewell waters indicated a depth correlation with iron content. The results of one population t-test on analytical data for iron at the 0.05 level indicate that the mean value of iron in the study area is significant (t = 12.42094, p = 3.90313E-13).

CONCLUSION

This study established the increasing trend of arsenic and iron contamination in groundwater of the study area. This study has also show that naturally occurring arsenic and iron in groundwater is more widespread than is generally recognized and that, with continuous monitoring, more contaminated groundwater sources are likely be identified. It may be seen from our results that over 30% of the groundwater samples of the study area were unsafe with regard to arsenic. This observation is of concern as arsenic concentration in groundwater is prone to sharp fluctuation depending upon geochemical conditions. Populations in the study area are likely to be affected through drinking arsenic contaminated groundwater for a long time. This study outlines the importance of making water related research more strategic and effective at a regional level so that early identification of the affected sources can be made.

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REFERENCES

1. P. Bhattacharya, S. H. Frisbie, E. Smith, R. Naidu, G. Jacks and B. Sarkar, Arsenic in the Environment, A Global Perspective, in B. Sarkar (Ed.), Handbook of Heavy Metals in the Environment, Marcell Dekker, New York (2002) pp.147-215.
2. B. K. Mandal and K. T. Suzuki, Talanta, **58**, 201-35 (2002).
3. R. Garai, A. K. Chakraborti, S. B. Dey and K. C. Saha, J. Indian Med. Assoc., **82**, 34-35 (1984).
4. D. Chakraborti, M. M. Rahman, K. Paul, U. K. Chowdhury, M. K. Sengupta and D. Lord, Talanta, **58**, 3-22 (2002).
5. B. Bhuyan, Der Chemica Sinica, **2(4),** 158-165 (2011).
6. B. Bhuyan, Report and Opinion, **2(6),** 82-87 (2010).
7. K. K. Borah, B. Bhuyan, and H. P. Sharma, Environmental Monitoring and Assessment, **169 (1),** 347-352, DOI 10.1007/s10661-009-1176-2 (2010).

8. M. Buragohain, B. Bhuyan and H. P. Sharma, Environmental Monitoring and Assessment, Springer, **170 (1-4),** 345-351, DOI 10.1007/s10661-009-1237-6 (2010).

9. NERIOWLM, 2004, Pre-seminar Proceedings from National Seminar on Arsenic and Fluoride Contamination in Groundwater Organized by North Eastern Regional Institute of Water and Land Management, Tezpur, Assam, October 2004. Tezpur, North Eastern Regional Institute of Water and Land Management, (2004) pp. 1-10.

10. K. G. Bhattacharya, Contamination of Groundwater by Arsenic, Distribution, Health Effects and Treatment, Silver Lining, Gauhati University, (2007) pp. 32-53.

11. A.P.H.A, Standard Methods for the Examination of Water and Wastewater, 20^{th} Edition, APHA, AWWA and WEF (1998).

12. D. P. H. Laxen and R. M. Harrison, Anal. Chem., **53**, 345-350 (1981).

13. M. Meloun, J. Militky and M. Forina, PC-aided Statistical Data Analysis, in Chemometrics for Analytical Chemistry, **Vol. 1** Chichester, England Ellis Horwood Ltd., (1992).

14. W.H.O. Guidelines for Drinking Water Quality, 3^{rd} Edition, Geneva, World Health Organization (2004).