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Reliability analysis of iron and fluoride distribution in some drinking water sources of Lakhimpur District, Assam

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ABSTRACT

Fluoride and iron distribution in some drinking water sources of Lakhimpur district, Assam, India has been presented in this communication. Twenty drinking water samples were collected from tubewells and ringwells at different sites from three development blocks, viz. Telahi, Lakhimpur and Boginadi, of North Lakhimpur sub-division during dry season. Iron was measured by 1, 10 Phenanthroline method using a uv-visible spectrophometer (Shimadzu 1240) at 510 nm. Fluoride in water was determined by SPADNS method (colorimetric) by using a uv-visible spectrophotometer (Shimadzu 1240) at 570 nm. A good number of water samples contain fluoride at an alert level. Statistical observations on pH, fluoride, and iron in water sources showed that their distribution pattern in the study area exhibit departure from symmetry.

Key Words: Water quality, iron, fluoride, statistics.

INTRODUCTION

The significance of environmental water quality monitoring has been increasingly recognised over the last few decades. Presently, drinking water quality has become a serious issue of concern for human health, mainly in developed and developing countries worldwide [1]. Most of the health problems affecting rural population in the developing countries like India can be ascribed to lack of wholesomeness of available water sources. Excess fluoride in ground water in 17 states of India has caused severe problem on human health and physiological activities [2]. Around 62.5 million people have been reported suffering from disorder of teeth or bones through fluorosis in India, which is due to consumption of fluoride-rich water [3]. Contamination of drinking water by iron and fluoride has also raised its ugly head recently in Assam. The occurrence of fluoride contamination in Darrang, Karbi Anglong and Nagoan district of Assam in the form of fluorosis were already reported [4,5]. High level of fluoride and iron distribution in ground water sources of certain districts of Assam has also been observed [6,7,8,9,10,11]. Thus, while selecting a source of water for domestic and drinking purposes, water should be tested for ascertaining the iron and fluoride level. Unfortunately, the basic facts in the study area are that the people are still unaware of water contamination and its hazardous effects. The need

is for a more systematic and careful study eliminating all possible sources of error and to build up a reliable database [12]. pH, iron and fluoride contents of some drinking water sources in three development blocks of Lakhimpur district, Assam have been presented in this study.

MATERIALS AND METHODS

The study area Lakhimpur district is situated in the eastern parts of India on the northeast corner of Assam. Located on the bank of mighty river Brahmaputra, the district is largely plain. Geographically, the district lies between $26^0 48^/$ and $27^0 53^/$ northern latitude and $93^0 42^/$ and $94^0 20^/$ eastern longitude (approximately). The district covers an area of 2,977 km^2 and falls under sub-tropical climatic region, and enjoys monsoon type of climate. Twenty water samples were collected in dry season (2010) from three different development blocks of North Lakhimpur sub-division of Lakhimpur district, Assam by random selection and combined together in clean and sterile one-litre polythene cans to obtain a composite sample as shown in Table 1. Samples were analysed by adopting standard procedures [13]. pH of the samples were measured quickly after collection by using a digital pH meter (ELICO, LI-127). Iron was measured by 1, 10 Phenanthroline method using a uv-visible spectrophometer (Shimadzu 1240) at 510 nm. Fluoride in water was determined by SPADNS method (colorimetric) by using a uv-visible spectrophotometer (Shimadzu 1240) at 570 nm.

Table 1 Block wise sample collection summary

Name of the Development Block	Sample Identification No	Number of Samples	Water Source	
			Tubewell	Ringwell
Lakhimpur	A1-A12	12	06	06
Telahi	B1-B5	05	03	02
Boginadi	C1-C3	03	02	01

RESULTS AND DISCUSSION

Univariate statistics were used to test distribution normality for each parameter. The confidence interval was calculated at 0.05 level. Sample data were also subjected to Reliability analysis (correlation and covariance matrix). Moment coefficients of skewness and kurtosis were calculated to express how the shapes of sample frequency distribution curves differ from ideal Gaussian (normal). Some more statistical estimates derived from the normal distribution in the form of Sample variance, 1^{st} , 2^{nd} , 3^{rd} Quartile, Inter Quartile Range (IQR) were also made in the present study to find out the distribution pattern of the data and other related information

Statistical data derived from normal distribution have been presented in Table 2. Correlation and covariance matrix are presented in Table 3 and 4.

Table 2 Normal distribution statistics for pH, iron and fluoride

Descriptive Statistics	**pH**	**Fe (mg/l)**	**F^- (mg/l)**
No of parameter	20	20	20
Mean	7.11	1.15	0.66
Std. Error of Mean	0.10	0.38	0.04

Median		7.00	0.40	0.63
Mode		7.00	0.10	0.50
Std. Deviation		0.43	1.71	0.17
Variance		0.18	2.94	0.03
Skewness		0.21	1.89	1.03
Std. Error of Skewness		0.51	0.51	0.51
Kurtosis		-0.51	2.06	0.16
Std. Error of Kurtosis		0.99	0.99	0.99
Range		1.50	4.90	0.50
Minimum		6.50	0.10	0.50
Maximum		8.00	5.00	1.00
Sum		142.20	23.00	13.20
Confidence Limit	Lower Bound	6.91	0.35	0.58
	Upper Bound	7.31	1.95	0.74
Percentiles	25	7.00	0.20	0.50
	50	7.00	0.40	0.63
	75	7.50	0.95	0.73
Inter Quartile Range		0.50	0.75	0.23

Table 3 Pearson Correlation Matrix among pH, iron and fluoride in the study area

		pH	**Fe**	**F^-**
Pearson Correlation	**pH**	1.000	-0.152	-0.236
Significance Test. (2-tailed)		.	0.521	0.317
Pearson Correlation	**Fe**	-0.152	1.000	0.196
Significance Test. (2-tailed)		0.521	.	0.408
Pearson Correlation	**F^-**	-0.24	0.20	1.00
Significance Test. (2-tailed)		0.32	0.41	.

pH is an operational parameter that indicates the degree to which a water is acidic or alkaline. In all the sampling stations studied pH are within the WHO guide line values for safe drinking water. In the study area, the variation of pH is narrow and the mean pH value is 7.1. Significant positive skewness and negative kurtosis values for pH indicates a flat asymmetric tail extending towards higher values in the area.

Table 4 Covariance Matrix among pH, iron and fluoride in the study area

Covariance	pH	Fe	F^-
pH	0.1841	-0.1121	-0.0174
Fe	-0.1121	2.9363	0.0577
F^-	-0.0174	0.0577	0.0296

The permissible iron concentration in ground water is less than 1.0 mg/litre as per the BIS Standard for drinking water. Iron is one of the most disturbing constituents in water supplies throughout India. Water with high iron concentration causes most of the staining problems which appear around toilet bowls or on fixtures where water stands or drips. Although iron occurs naturally in groundwater, the higher concentration of iron in tubewell waters with respect to other water sources in the area may be due to soil origin and age-old corroded iron pipes used. Iron content in all the drinking water sources in the area exceeds the WHO guideline value of 0.3 mg/l. A broad third quartile and positive skewness in case of iron represents a long asymmetric tail on the right of the median. Heaviness of the tail for iron distribution in the area is evident from very high positive kurtosis value.

The WHO permissible limit for fluoride content in drinking water is 1.0 mg/L. It is observed that as many as eight samples under observation contain fluoride either at toxic or alert level. Significant positive skewness value for fluoride in the study area shows a departure from symmetry. Sharp distribution for fluoride in the area is indicated by positive kurtosis value. Although the drinking water sources of the study area are by and large safe with regard to fluoride, its distribution is still not uniform in the area.

Reliability analysis with reference to Pearson's correlation coefficient and correlations matrix as given in Table 3 provide the variations among the water quality parameters with one another. Since the directions of association of the measured variables are unknown in advance, two-tailed test of significance was carried out. Covariance matrix as given in Table 4 displays the variance-covariance matrix of regression coefficients with covariances off the diagonal and variances on the diagonal.

CONCLUSION

A comprehensive statistical analysis of pH, iron and fluoride contents in groundwaters of three development blocks of North Lakhimpur sub-division of Lakhimpur district, Assam has been presented. Statistical observations show all the parameters under investigation exhibit an asymmetric distribution with a long tail either on the right or left side of the median. This study outlines that academia is needed to make water related research more strategic and effective at a local level. It is hoped that the present study has fulfilled the limited purpose of strengthening database which may be helpful in formulating strategy for future protection of water in the area.

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