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WATER QUALITY ISSUES IN THE TEA GARDEN BELT OF DARRANG DISTRICT, ASSAM

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ABSTRACT

The present research has been carried out to study some of the water quality parameters in and around the selected tea gardens of Darrang district, Assam. Sixteen water samples are analysed by adopting standard analytical techniques of APHA. In this study, the tools used for data analysis are mainly experimental, aimed at defining possible relationships, trends, or interactions among the measured variables of interest. Descriptive statistics in the forms of mean, variance, standard deviation, standard error, median, range of variation and percentile at 95%, 75% and 25% are computed for eight water quality parameters. t-test is done under null hypothesis (H_0) by taking the assumption that the experimental data are consistent with the mean rating given by W.H.O. One-way ANOVA and confidential limit at 95% is also calculated by using ORIGIN 6.1 version. It is found that the inherent quality of waters in the tea garden belt of Darrang district, Assam is low and a suitable socio-economic and policy environment to maintain and improve water quality is also required.

Key words: pH, ANOVA, Sulphate, Phosphate, Nitrate, Water quality, Tea garden belt.

INTRODUCTION

Water is the most precious gift of the nature. It is indispensable for sustenance of life and is one of most important component which influences economic, agricultural and industrial growth of mankind. The effect of water on almost everything in our environment is far more significant than might be imagined. There is growing shortage of usable water resources and it is going to be one of the major issues of the twenty first century. Human

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use of fresh water has registered a 35 fold increase in the last 300 years. As a whole, 3500 km^3 of fresh water was withdrawn from different sources throughout the world for human use every year[1]. Pollution of fresh water occurs due to three major reasons- excess nutrients from sewage, wastes from industries, mining and agriculture[2]. W.H.O has given a set of guideline values for drinking water quality[3]. These guideline values, along with tolerance limits prescribed by the Indian Standard Institute (ISI)[4] and EPA standards of USA are also important in determining water quality[5]. Every effort should be made to achieve a drinking-water quality as safe as practicable.

It is observed that the tea garden belt in Assam has lately been subjected to large-scale human interference and pollution of water is rising at alarming rates due to the use of huge amount of agrochemicals for better production which contaminates ground water through percolation and rivers and other water bodies through surface run-off [6]. The loss of quality is causing health hazards and death of human which disturbs the whole ecology system of this region. The present research has been undertaken to study some of the water quality parameters in and around the selected tea gardens of Darrang district, Assam.

Study area

The study area Darrang district is situated in the eastern parts of India on the northeast corner of Assam.

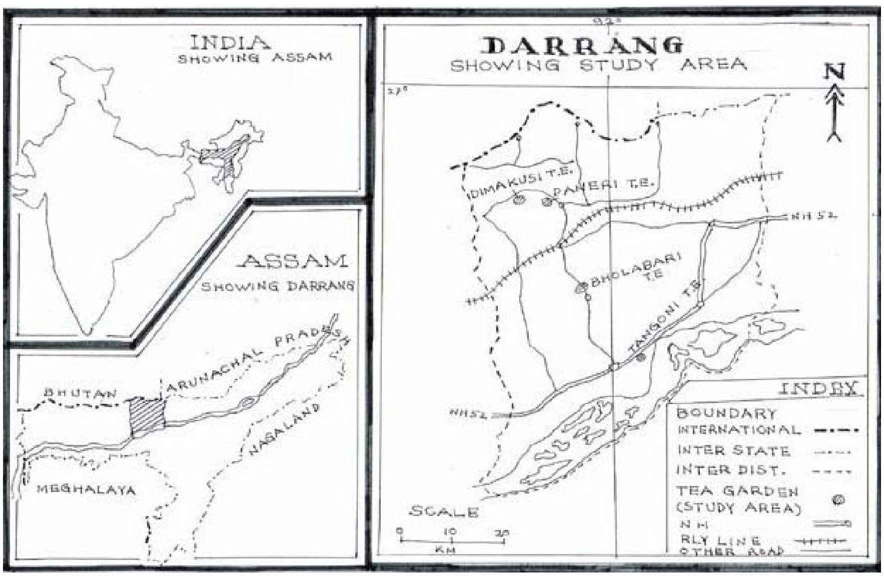

Fig. 1: Distribution of tea gardens in Darrang district

Located on the bank of mighty river Brahmaputra, the district is largely plain. The district lies between $26^0 25^/$ and $26^0 55^/$ northern latitude and $91^0 45^/$ and $91^0 20^/$ east longitude (approximately). The district covers an area of 3,465.30 sq. km and falls in the sub-tropical climatic region, and enjoys monsoon type of climate. There are twenty eight tea gardens apart from twenty privately owned tea gardens in the district (Fig. 1).

EXPERIMENTAL

Materials and methodology

Separate water samples were selected by random selection and compiled together in plastic bottles to set a representative sample. pH and conductivity were determined quickly after sampling. Samples were protected from direct sun light during transportation. The parameters studied are pH, conductivity, chloride (Cl^-), sulphate (SO_4^{2-}), nitrate (NO_3^-), phosphate (PO_4^{3-}), fluoride (F^-) and iron (Fe). Standard analytical techniques were adopted for physico-chemical analysis of water samples[7]. The instruments were used in the limit of précised accuracy and chemicals used were of analytical grade.

In this study, the tools used for data analysis are mainly experimental, aimed at defining possible relationships, trends, or interactions among the measured variables of interest. The observed parameters are related graphically (Figs. 2-9). Descriptive statistics in the forms of mean, variance (V), standard deviation (SD), standard error (SE), median, range of variation, and percentile at 95%, 75% and 25% (P95%, P75%, P25%) are calculated and summarized in tabular forms (Tables 2-9). t-test is done under null hypothesis (H_0) by taking the assumption that the experimental chemical water quality data are consistent with the mean rating given by W.H.O (2004). The calculated value of t is compared with tabulated value at 5% level of confidence. Confidential limit (CL 95%) at 95% is also computed by adopting standard statistical equations. Statistical analysis along with one-way ANOVA is carried out using ORIGIN 6.1 version.

Sampling information

Water samples were collected in and around four selected tea gardens of Darrang district during June to November, 2007 (Table 1).

Table 1. Water sampling locations

Sample No	Source	Place	Sample No.	Source	Place
A1	Tube Well	Tea Garden (Tangoni)	C1	Tube Well	Tea Garden (Dimakusi)
A2	Ring Well	Tea Garden (Tangoni)	C2	Supply Water	Tea Garden (Dimakusi)
A3	Tube Well	Outside Tea Garden (Tangoni)	C3	Tube Well	Outside Tea Garden (Dimakusi)
A4	Ring Well	Outside Tea Garden (Tangoni)	C4	Ring Well	Outside Tea Garden (Dimakusi)
B1	Tube Well	Tea Garden (Paneri)	D1	Tube Well	Tea Garden (Bhulabari)
B2	Supply Water	Tea Garden (Paneri)	D2	Ring Well	Tea Garden (Bhulabari)
B3	Tube Well	Outside Tea Garden (Paneri)	D3	Tube Well	Outside Tea Garden (Bhulabari)
B4	Ring Well	Outside Tea Garden (Paneri)	D4	Ring Well	Outside Tea Garden (Bhulabari)

RESULTS AND DISCUSSION

Table 2: Water test values for pH

Location	A	B	C	D
1	7.39	6.92	6.61	6.40
2	7.51	6.91	6.60	6.38

Cont…

Location	A	B	C	D
3	7.20	6.39	6.49	6.91
4	6.80	6.53	6.52	6.72
Statistical analysis				
Median	7.2	6.53	6.52	6.4
Mean	7.22	6.68	6.55	6.60
Variance	0.096	0.072	0.0035	0.066
SD	0.311	0.269	0.0599	0.257
SE	0.155	0.134	0.029	0.129
Range	0.71	0.53	0.12	0.53
WHO Rating	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
t-test	8.206	13.482	65.753	14.739
Comment (0.05 level)	S	S	S	S
P 25%	7.2	6.53	6.52	6.4
P 75%	7.39	6.91	6.6	6.72
P 95%	7.51	6.92	6.61	6.91
95% CL	[6.73 - 7.78]	[6.25-7.11]	[6.46-6.64]	[6.19-7.01]
One-Way ANOVA	F = 6.438, p = 0.0076			
Comment (0.05 level)	Means are significantly different			

Table 3: Water test values for conductance in mmho/cm

Location	A	B	C	D
1	2.6	2.0	2.5	2.4
2	2.4	2.4	2.4	2.2
3	0.6	2.5	3.8	2.3
4	2.2	2.4	3.6	2.1

Cont…

Location	A	B	C	D
Statistical analysis				
Median	2.2	2.4	2.5	2.2
Mean	1.95	2.33	3.08	2.25
Variance	0.837	0.049	0.529	0.017
SD	0.915	0.222	0.727	0.129
SE	0.457	0.111	0.364	0.065
Range	2	0.5	1.4	0.3
USPHS Rating (mmho/cm)	0.3	0.3	0.3	0.3
t-test	3.608	18.265	7.629	30.209
Comment (0.05 level)	S	S	S	S
P 25%	2.2	2.4	2.5	2.2
P 75%	2.4	2.4	3.6	2.3
P 95%	2.6	2.5	3.8	2.4
95% CL	[0.49-3.41]	[1.97-2.68]	[1.92-4.23]	[2.04-2.46]
One-Way ANOVA	F = 2.556, p = 0.104			
Comment (0.05 level)	Means are not significantly different			

Table 4: Water test values for chloride in mg/L

Location	A	B	C	D
1	85.2	21.3	22.3	35.5
2	90.9	21.4	22.7	34.0
3	10.0	17.1	25.6	31.2
4	26.0	24.1	25.3	30.4

Cont…

Location	A	B	C	D
Statistical analysis				
Median	26	21.3	22.7	31.2
Mean	53.03	20.98	23.98	32.78
Variance	1683.75	8.356	2.943	5.683
SD	41.034	2.891	1.715	2.384
SE	20.517	1.445	0.858	1.192
Range	80.9	7	3.3	5.1
WHO Rating (mg/L)	250	250	250	250
t-test	9.601	158.459	263.529	182.251
Comment (0.05 level)	S	S	S	S
P 25%	26	21.3	22.7	31.2
P 75%	85.2	21.4	25.3	34
P 95%	90.9	24.1	25.6	35.5
95% CL	[0-118.3]	[16.38-25.57]	[21.25-26.70]	[28.98-36.57]
One-Way ANOVA	F = 1.965, p = 0.173			
Comment (0.05 level)	Means are not significantly different			

Table 5: Water test values for sulphate in mg/L

Location	A	B	C	D
1	4.9	0.7	1.3	23.6
2	2.5	0.8	1.3	21.1
3	22.0	2.1	11.1	20.2

Cont…

Location	A	B	C	D
4	68.0	0.6	10.2	19.9
		Statistical analysis		
Median	4.9	0.7	1.3	20.2
Mean	24.35	1.05	5.98	21.2
Variance	922.19	0.497	29.275	2.820
SD	30.368	0.705	5.411	1.679
SE	15.184	0.352	2.705	0.839
Range	65.5	1.5	9.8	3.7
WHO Rating (mg/L)	250	250	250	250
t-test	14.861	706.495	90.201	272.497
Comment (0.05 level)	S	S	S	S
P 25%	4.9	0.7	1.3	20.2
P 75%	22	0.8	10.2	21.1
P 95%	68	2.1	11.1	23.6
95% CL	[0-72.67]	[0.07-2.17]	[0-14.84]	[18.53-23.87]
One-Way ANOVA	F = 2.168, p = 0.145			
Comment (0.05 level)	Means are not significantly different			

Table 6: Water test values for nitrate in mg/L

Location	A	B	C	D
1	0.03	0.5	0.3	0.8
2	0.02	0.9	0.2	0.9
3	0.05	0.4	0.1	0.7

Cont…

Location	A	B	C	D
4	0.7	0.3	0.06	0.8
Statistical analysis				
Median	0.03	0.4	0.1	0.8
Mean	0.2	0.525	0.165	0.8
Variance	0.111	0.069	0.012	0.007
SD	0.334	0.263	0.108	0.082
SE	0.167	0.132	0.054	0.041
Range	0.68	0.6	0.24	0.2
WHO Rating (mg/L)	50	50	50	50
t-test	298.591	376.242	926.745	1205.149
Comment (0.05 level)	S	S	S	S
P 25%	0.03	0.4	0.1	0.8
P 75%	0.05	0.5	0.2	0.8
P 95%	0.7	0.9	0.3	0.9
95% CL	[0-0.73]	[0.11-0.94]	[0- 0.34]	[0.67-0.93]
One-Way ANOVA	F = 7.2168, p = 0.005			
Comment (0.05 level)	Means are significantly different.			

Table 7: Water test values for phosphate in mg/L

Location	A	B	C	D
1	2.60	0.05	0.71	0.65
2	0.15	0.49	0.02	0.78
3	0.12	0.51	0.52	0.75
4	0.09	0.70	0.48	0.69

Cont…

Location	A	B	C	D
Statistical analysis				
Median	0.12	0.49	0.48	0.69
Mean	0.74	0.4375	0.4325	0.7175
Variance	1.538	0.076	0.087	0.003
SD	1.240	0.275	0.292	0.059
SE	0.620	0.138	0.146	0.029
Range	2.51	0.65	0.69	0.13
USPHS Rating (mg/L)	0.1	0.1	0.1	0.1
t-test	1.032	2.453	2.272	21.103
Comment (0.05 level)	NS	NS	NS	S
P 25%	0.12	0.49	0.48	0.69
P 75%	0.15	0.51	0.52	0.75
P 95%	2.6	0.70	0.71	0.78
95% CL	[0- 2.71]	[0- 0.88]	[0- 0.89]	[0.62-0.81]
One-Way ANOVA	F = 0.271, p = 0.845			
Comment (0.05 level)	Means are not significantly different			

Table 8: Water test values for iron in mg/L

Location	A	B	C	D
1	0.41	0.28	3.0	3.0
2	0.28	0.31	2.9	3.1
3	0.35	2.9	0.36	3.0
4	0.65	2.9	0.39	3.0

Cont…

Location	A	B	C	D
Statistical analysis				
Median	0.35	0.31	0.39	3.0
Mean	0.423	1.598	1.663	3.025
Variance	0.026	2.262	2.212	0.003
SD	0.1607	1.50405	1.48729	0.05
SE	0.080	0.752	0.744	0.025
Range	0.37	2.62	2.64	0.1
WHO Rating (mg/L)	0.3	0.3	0.3	0.3
t-test	1.525	1.725	1.832	109
Comment (0.05 level)	NS	NS	NS	S
P 25%	0.35	0.31	0.39	3.0
P 75%	0.41	2.9	2.9	3.0
P 95%	0.65	2.9	3.0	3.1
95% CL	[0.17-0.68]	[0-3.99]	[0-4.03]	[2.94-3.11]
One-Way ANOVA	F = 4.024, p = 0.034			
Comment (0.05 level)	Means are significantly different.			

Table 9: Water test values for fluoride in mg/L

Location	A	B	C	D
1	0.70	0.61	0.51	0.60
2	0.62	0.58	0.46	0.51
3	0.61	0.58	0.42	0.30
4	0.34	0.45	0.38	0.29

Cont…

Location	**A**	**B**	**C**	**D**
		Statistical analysis		
Median	0.61	0.58	0.42	0.3
Mean	0.5675	0.555	0.4425	0.425
Variance	0.025	0.005	0.003	0.024
SD	0.157	0.071	0.056	0.155
SE	0.078	0.036	0.028	0.077
Range	0.36	0.16	0.13	0.31
WHO Rating (mg/L)	1.5	1.5	1.5	1.5
t-test	11.885	26.465	38.038	13.907
Comment (0.05 level)	S	S	S	S
P 25%	0.61	0.58	0.42	0.3
P 75%	0.62	0.58	0.46	0.51
P 95%	0.70	0.61	0.51	0.60
95% CL	[0.32-0.81]	[0.44-0.67]	[0.35-0.53]	[0.18-0.67]
One-Way ANOVA	F = 1.550, p = 0.253			
Comment (0.05 level)	Means are not significantly different			

N.B.: NS = Non Signifiant, S = Signifiant

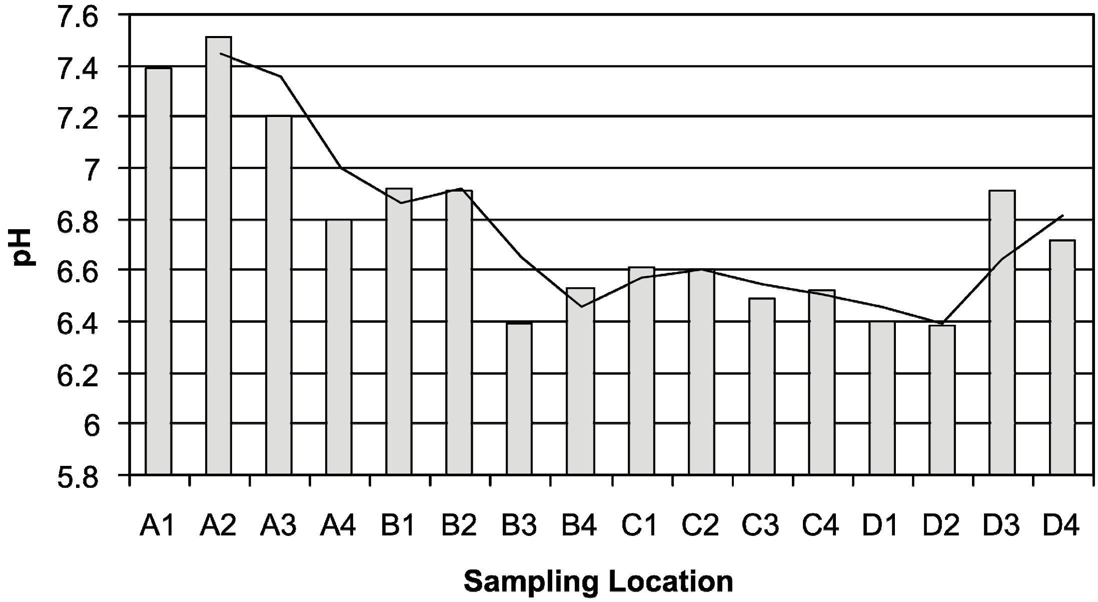

Fig. 2. Variation of pH among different sampling stations

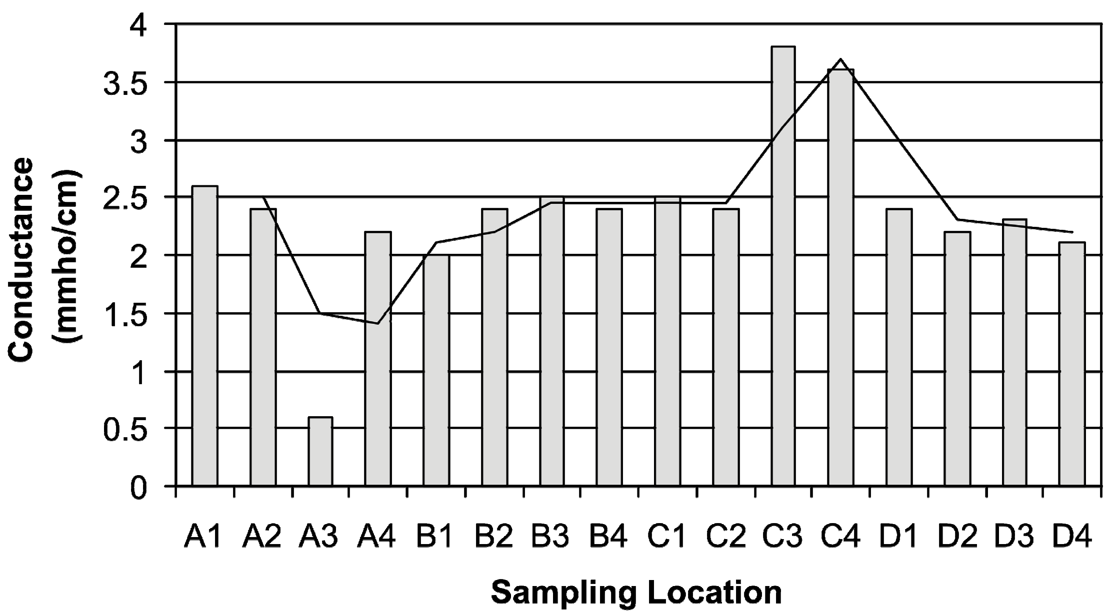

Fig. 3. Variation of conductance among different sampling stations

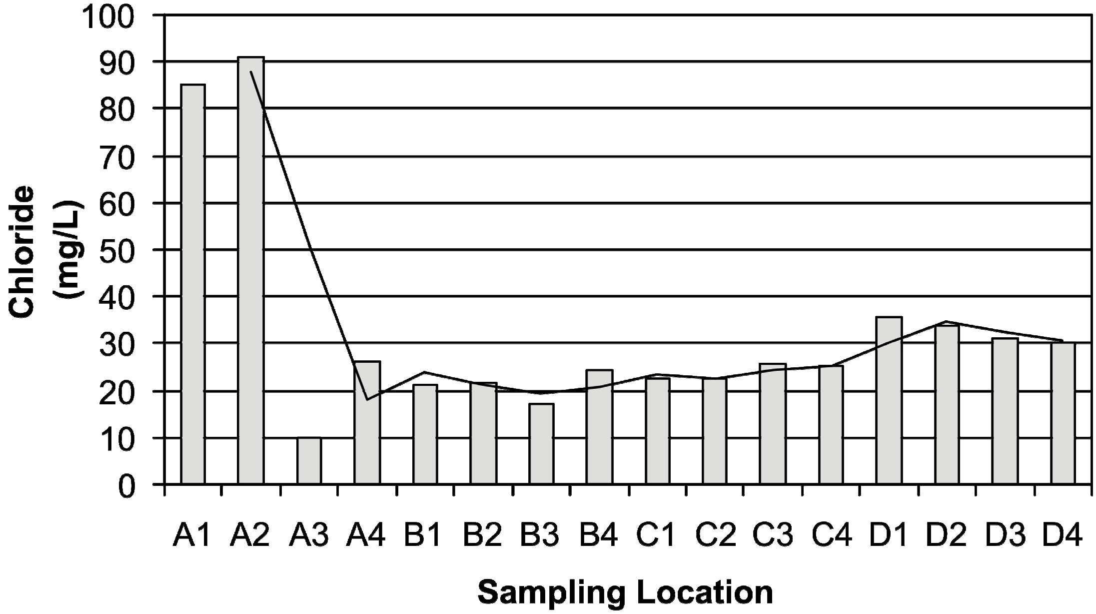

Fig. 4. Variation of chloride among different sampling stations

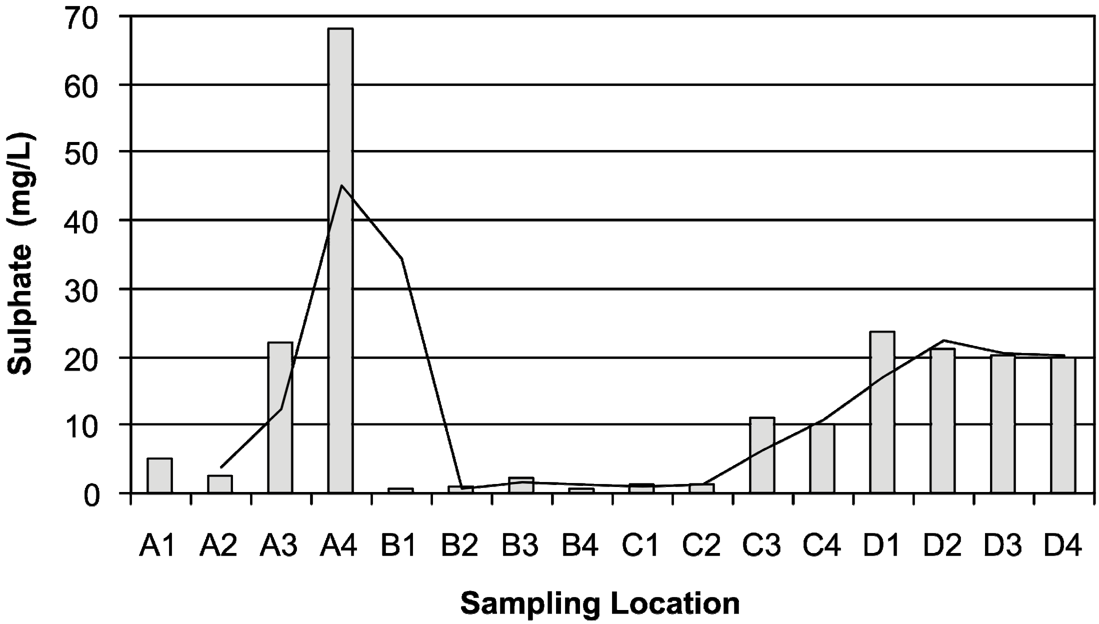

Fig. 5. Variation of sulphate among different sampling stations

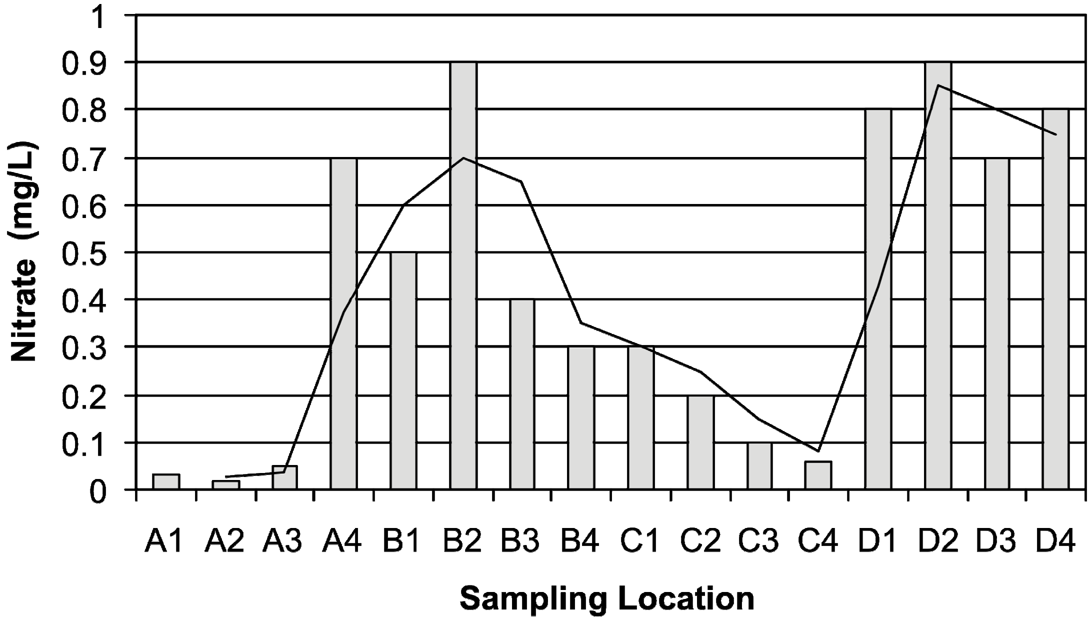

Fig. 6. Variation of nitrate among different sampling stations

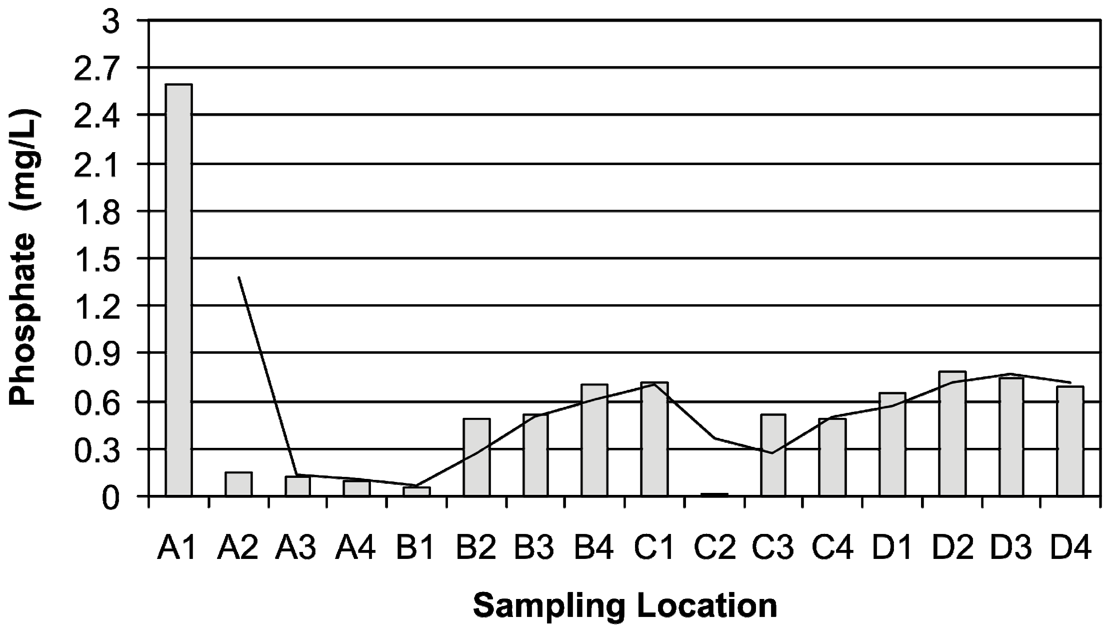

Fig. 7 Variation of phosphate among different sampling stations

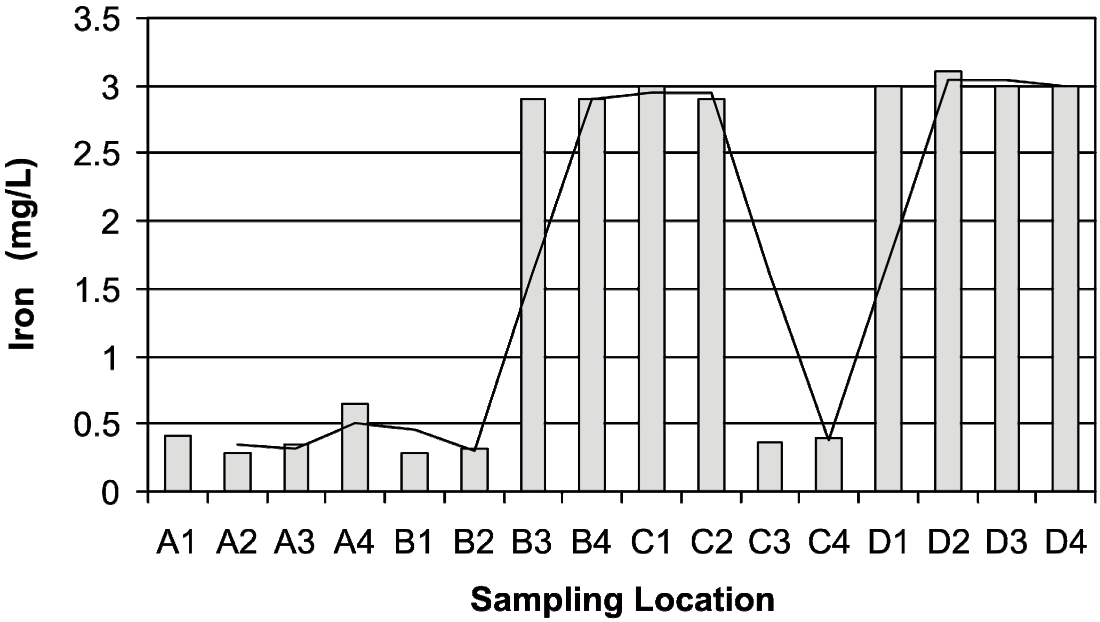

Fig. 8 Variation of iron among different sampling stations

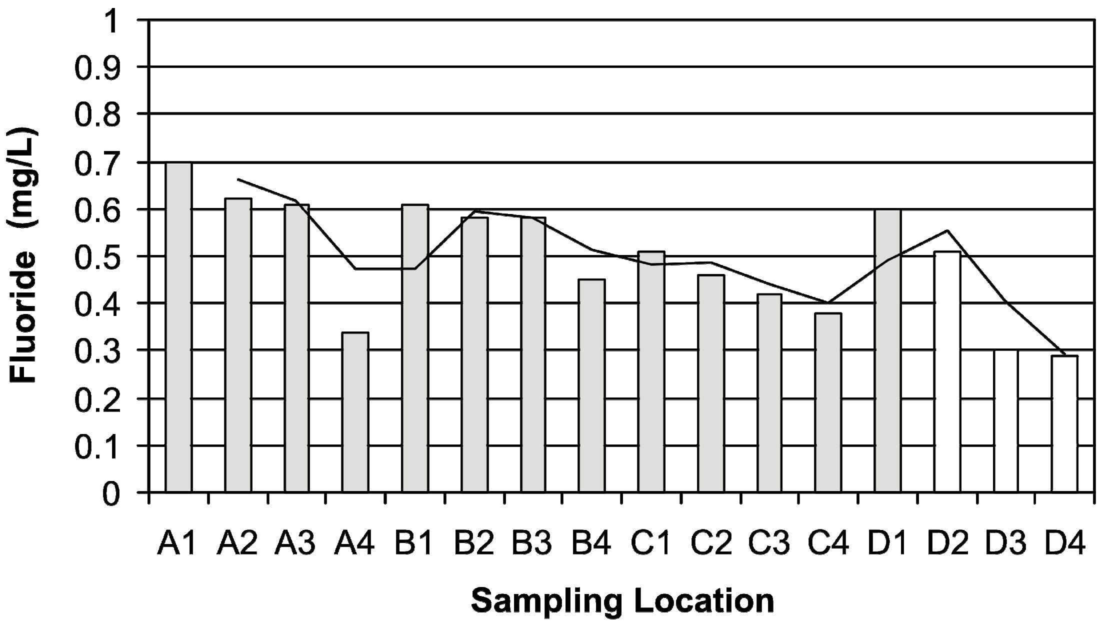

Fig. 9 Variation of fluoride among different sampling stations

Statistical observations

By comparing calculated | t | value with tabulated t at 5% probability level of significance, we may either reject or accept our null hypothesis H_0. If the value is significant then there will be evidence provided by our samples against our H_0. It is clear from the Tables 2-9 that proper water management is of urgent concern in the study area. The statistical values also show that most of the studied water quality parameters are significant implying that the null hypothesis may be rejected. The calculated confidential limit will give the range within which the unknown value of the parameter is expected to lie.

Environmental observations

In all the sampling stations, the variation of pH is narrow and in general, the pH is towards the acidic side except at sampling location No. A1, A2 and A3, where water is alkaline. The conductance of water in the study area have values greater than the maximum permissible limit (0.3 mmho cm^{-1}) of USPH and indicates that water is markedly polluted with its reference.

Chloride, sulphate and nitrate contents above the permissible limits can cause serious health problems to the consumer. Their concentrations in water under study are within the approved WHO guide line values for safe drinking water and no fixed trend of variation among the sampling stations could be ascertained, which may be due to precipitation, evaporation, human activity and waste disposal. The phosphate content of water needs serious attention as all of the samples except for A4, B1 and C2 exceeded the USPH guide line value of 0.1 mg/L.

The iron concentration is highest at source D2 that is 3.1 mg/L and minimum at source at A2 that is 0.28 mg/L. The data exceeds the WHO guideline value of 0.3 mg/L in most of the cases. The concentration of iron in water in the area is not suitable for food processing, dyeing, bleaching and many activities. The values for fluoride in water are ranging from 0.29 mg/L to 0.70 mg/L. In the present investigation, the fluoride concentrations were found to be within the permissible limit of W.H.O., but in some locations, where the fluoride concentration in water is less than 0.7 mg/L may cause dental carries.

CONCLUSION

The inherent quality of waters in and around the tea gardens of Darrang district, Assam is low and a suitable socio-economic and policy environment to maintain and improve water quality is also lacking. It is, therefore, immediately required that the water sources be properly protected from potential contaminants, and that appropriate treatment be selected for future use of water in the region. Thus, village level - microanalysis of the impact of water availability and water quality on the quality of life of people needs to be done in the study area.

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