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Groundwater quality assessment of Pachim Nalbari block of Nalbari district Assam based on major ion chemistry

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Abstract: Groundwater quality assessment study was carried out in Paschim Nalbari block of Nalbari district of Assam, northeast India. 12 tube well water samples were collected and analyzed for pH, electrical conductivity, calcium, magnesium, chloride and alkalinity. Groundwater was well within the permissible limit for the different water quality parameters. The dominant cation was calcium and the dominant anion was bicarbonate. The study reveals that the water quality is mainly influenced by natural weathering process.
Keywords: Groundwater quality, Correlation matrix, Nalbari district.

Introduction

Water is the essence of life. Fresh water is a finite and a vulnerable resource, essential to sustain life, development and the environment. Groundwater though contributes only 0.6% of the total water resources on earth, it accounts for nearly 80% of the rural domestic water needs and 50% of the urban water needs in the developing countries like India (1).(Meenakshi and Maheshwari 2006). Till recently it had been considered a dependable source of uncontaminated water. Ground water is less susceptible to bacterial pollution than surface water because the soil and rocks through which ground water flows screen out most of the bacteria. But freedom from bacterial pollution alone does not mean that the water is fit to drink. Many unseen dissolved mineral and organic constituents are present in ground water in various concentrations.

Rural dwellers of Nalbari district of Assam in India, like their thousands of counterparts elsewhere in the country, rely basically on hand pumps for potable water supply, as the government water supply does not reach to more than two third of the population. Since habitations are widely dispersed and unlike urban areas monitoring and treatment is not available, people in this area have little knowledge about the quality of their drinking water. The infrastructure needed for treatment and transportation of surface water does not exist. Besides drinking water requirements, due to very poor irrigation facilities, people of the study area have to depend on the groundwater for agricultural purpose as well. Further, the high yield rice variety, which is cultivated in these areas, requires huge quantity of water, which is extracted from shallow aquifers, ignoring its present and long-term consequences. The study was hence conducted to determine the drinking water quality of the region.

Methodology

Nalbari district lies between latitude 26^0 08' 03"N and 26^o 52' 15"N and longitudes 91^o14' 30" E and 91^o38' 10"E. It is located in the western part of the state of

Assam in North-east India. The groundwater samples were collected from 12 location in the district. When water is collected from tube wells the water is made to run from the sampling source for 4 to 5 min before taking the final sample. Pre washed sterilized polyethylene bottles of 2 liters capacity was used for storing the water samples. Parameters like pH and EC were measured immediately after collection using portable pH meter and conductivity meter respectively. Calcium and magnesium is determined by EDTA titrimetric method. Chloride is determined by Argentometric Method. Alkalinity was determined by titration with 0.1 N HCl using methyl orange indicator.

Table 1: Physico-chemical parameters of groundwater of 12 locations

Code No.	Location	pH	EC	Ca	Mg	Cl	Alkalinity
1	Kumarikata	6.8	372	30	14	21	164
2	Barnardi	7.01	444	50	20	24	222
3	Bongoan	7.2	411	37	14	14.2	190
4	Bihampur	6.7	435	52	18	15	229
5	Chamata	6.4	338	34	12	15	160
6	Belsor	6.8	441	40	14	21	204
7	Batsor	6.9	375	32	15	18	175
8	Goalpara	7.01	306	30	12	22	132
9	Solmara	6.8	284	25	14	20	120
10	Bar Helacha	6.9	278	27	12	12	124
11	Natkuchi	6.8	302	30	10	11	136
12	Morowa	7.2	328	30	14	24	140

Table 2: Statistical analysis of the water quality parameters.

	Minimum	Maximum	Mean	Std deviation	WHO permissible limit
	mg/L	mg/L	mg/L		DL-PL (mg/L)
pH	6.4	7.2	6.8	0.22	6.5- 8.5
EC	278	444	359.5	62.15	750-1500
Ca	25	52	34.75	8.61	75-200
Mg	10	20	14.08	2.71	30-100
Cl	11	24	18.1	4.5	250-600
Alkalinity	120	229	166.33	37.96	200-600

EC is given in μS/cm. DL- Desirable limit, PL-Permissible limit.

Table 3: Correlation matrix for the water quality parameters

	pH	EC	Ca	Mg	Cl	Alkalinity
pH	1					
EC	0.06	1				
Ca	-0.061	0.866	1			
Mg	0.163	0.737	0.791	1		
Cl	0.346	0.247	0.111	0.456	1	
Alkalinity	-0.04	0.976	0.941	0.777	0.137	1

Results and Discussions

The physico-chemical parameters of groundwater of 12 locations of the study area is given in Table 1. The pH of the study area varies between 6.2 to 7.4 with a mean of 6.8. The pH of drinking water should be between 6.5 to 8.5 (2). (WHO, 2008). The pH of the water is within the WHO permissible limits. The minimum pH is observed in Chamata and the highest is observed in pH and Morowa and Bongoan.

The electrical conductivity in the study area varies between 278 µs/cm to 444 µs/cm with a mean of 359.5 µs/cm. The minimum is found in Bar Helacha and the maximum concentration is seen in Barnardi. The calcium concentration in the study area varies between 25 mg/L to 52 mg/L with a mean of 34.75 mg/L. The minimum is found in Solmara and the maximum concentration is seen in Bihampur. The calcium is much within the permissible limit. The Ca is mainly associated with carbonate minerals like calcite and dolomite, which occurs in the veins and secondary minerals residual boulders of igneous granite. The magnesium concentration varies between 10 mg/L to 20 mg/L with a mean of 14.08 mg/L. The minimum is observed in Natkuchi and the maximum in Barnardi. The predominant source of magnesium in groundwater is through dissociation of dolomite ($CaMg(CO_3)_2$). The chloride in the study area varies between 11 mg/L to 24 mg/L with a mean of 18.1 mg/L. The minimum is observed in Nathkuchi and the maximum in Morowa. The Cl^- concentration is seen to be very low in the study area. The permissible limit of Cl^- in groundwater is 600 mg/l (2). Alkalinity in the study area varies between 120 mg/L to 229 mg/L with a mean of 166.33 mg/L. The minimum concentration is observed in Solmara and the maximum in Barnardi. The high concentration of bicarbonates in the study area may be derived mainly from the soil zone CO_2 and weathering of parent minerals. It could be released from the dissolution of carbonate minerals via biodegradation of organic matter (3). The dissolved organic matter may also be an active source for HCO_3^- in groundwater (4). The box and whisker plot for the different water quality parameters is given **in figure 1.**

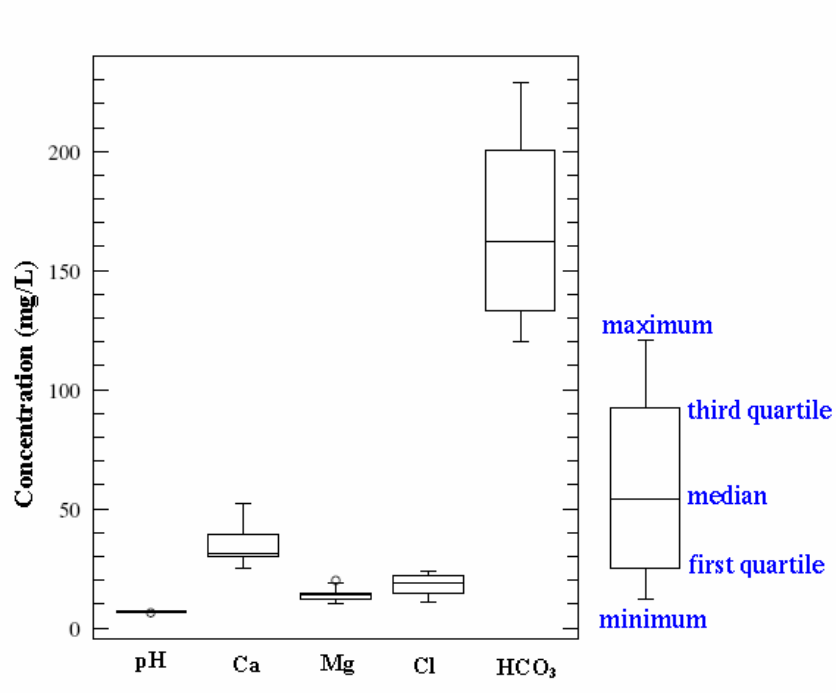

Fig 1: Box and wishker diagram for the different water quality parameters

Correlation studies

Correlation is a simplified statistical tool to show the degree of dependency of one variable to the other (5). Pairs having very high positive correlation between them shows the dependency of one parameter on the other while pair having very negative correlation between them shows inverse relation between them (6).

Weathering processes and anthropogenic inputs are the two main contributors for changing the geochemical composition of the groundwater (3). A strong positive correlation is observed between EC and calcium (R^2= 0.866), EC and magnesium (R^2 = 0.737) and EC and alkalinity (R^2 = 0.976). This indicated that the major ionic concentration in the groundwater of the study area is contributed by calcium, magnesium and alkalinity. Calcium also shows good positive relation with magnesium (R^2=0.791) and alkalinity (R^2= 0.941). The high concentration of HCO_3 and its significant correlation with Ca and Mg indicates their common source (7). The carbonate from this source might have been dissolved and added to the ground water system with recharging water during irrigation, rainfall or leaching and mixing process. pH does not show any significant correlation with any of the parameters.

Conclusion

The analysis of the water quality parameters of groundwater from twelve different stations in Pashim Nalbari block of Nalbari district shows that the pH, electrical conductivity, calcium, magnesium, chloride and bicarbonate are well within the permissible limits. The dominant cation in the water is calcium whereas the dominant anion being bicarbonate. Bicarbonate is high in the study area indicating the biodegradation of the organic matter in the sub surface environment. With the electronic media playing an active role in creating awareness among the resident of the area there is great concern among the people regarding the quality of water they are consuming. Systematic and periodic monitoring of the water may prove to be useful in achieving the goal of safe drinking water for all.

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