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A HYDROCHEMICAL PROFILE OF GROUNDWATER QUALITY OF PUB NALBARI BLOCK OF NALBARI DISTRICT ASSAM, NORTH-EAST INDIA

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ABSTRACT

In this study, the groundwater of Pub Nalbari block of Nalbari district was investigated based on different water quality indices for drinking and agricultural purpose. Groundwater samples from hand pumps and tube wells were analyzed for pH, electrical conductivity, calcium, magnesium, total hardness, sodium, potassium, chloride, bicarbonate, carbonate and sulphate. All the physico-chemical parameters are found to be within the WHO permissible limit in most of the samples. Chemical analysis of the groundwater shows that mean concentration of cations in (meq/L) is in the order calcium > magnesium > sodium > potassium while for anions, it is bicarbonates > chlorides > carbonates > sulphates. The suitability of the groundwater for irrigation purpose was investigated by determining some factors such as sodium adsorption ratio (SAR), soluble sodium percentage (SSP), residual sodium carbonate (RSC) and electrical conductivity (EC). The value of the sodium absorption ratio and electrical conductivity of the groundwater samples were plotted in the US salinity laboratory diagram for irrigation water. Most of the groundwater samples fall in the field of C2S1 and C3S1 indicating medium to have high salinity and low sodium water, which can be used for irrigation on almost all types of soils with little doubt of exchangeable sodium. The hydrochemical facies shows that the groundwater is Ca-Mg-HCO_3 type.

Keywords: Groundwater quality, Hill-Piper diagram, Chemical weathering, USSL diagram.

INTRODUCTION

Fresh water is the fundamental base for all the life systems on the surface of the earth including human beings. Groundwater is particularly important as it accounts for 88 % of the drinking water in rural areas[1]. Water quality analysis is one of the most important aspects of groundwater studies. It is influenced by natural and anthropogenic practices. The

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quality is the function of the physical, chemical and biological parameters, and could be subjective as it depends on a particular intended use[2]. Further, the weathering of the primary and secondary minerals is also contributing cations and silica to the system[3-5]. Alluvial regions are more accessible to such variations due to high population density and intense agricultural activities.

Rural dwellers of Nalbari district of Assam rely basically on hand pumps for portable water supply, as the government water supply does not reach 70 % of the population. As the population is widely dispersed and unlike urban areas, where monitoring and treatment is generally available, people in this area suffer from lack of awareness regarding the quality of water. Moreover, the infrastructure needed for treatment and transportation of surface water does not exist. The neglect of rural areas in most developing countries in terms of basic infrastructure such as pipe borne water and sanitation facilities exposes the villagers to a variety of health related problems such as water borne diseases[6].

In Nalbari district, rainfall is mainly confined in the monsoon (June- August). Due to inadequate rainfall during the dry (winter) season, irrigation becomes heavily dependent on groundwater. In irrigation water evaluation, emphasis is given on chemical and physical characteristics of water[7]. Some of these ions are more or less beneficial and few ions in excess amount are more or less detrimental for crop growth and soil properties[8]. It has been reported that irrigation with poor quality irrigation water reduces soil productivity, changes physical and chemical qualities of soil and ultimately reduces crop yield[9]. Irrigation water quality can be judged by some determining factors such as sodium adsorption ratio (SAR), soluble sodium percentage (SSP), residual sodium carbonate (RSC) and electrical conductivity (EC)[10]. As groundwater is the only limiting resource for further intensification of agriculture, its rational use should be ensued in terms of quality and quantity[11]. In India, the suitability of the groundwater for irrigational purpose have been studied in Delhi, Karnataka, Rajasthan and many other states[2,12-14]. Many authors has assessed the groundwater quality of our neighboring country, Bangladesh for agricultural purposes[10,11]. But such studies is lacking in Nalbari district of Assam in North-east India, where agriculture is the primary occupation of 80 % of the population. Due to very poor irrigation facilities, people of the study area have to depend on the groundwater for agricultural purpose. In addition to this, 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 primary objective of the study is to investigate and interpret the groundwater quality of Nalbari district of Assam for drinking purpose, and also to assess its suitability for sustainable crop production. It can also be beneficial in detecting deterioration in the quality of drinking water and facilitate appropriate timely corrective actions with minimal negative impact on population health. As identification of the hydrochemical process is necessary for sustainable management and development of the groundwater resource in the area, a detailed study was carried out to define the hydrogeochemical process controlling groundwater based on major ion chemistry.

Study area

Nalbari district lies between latitude 26° 08' 03" and 26° 52' 15’’ and east longitudes 91°14' 30" and 91°38' 10" and is located in the western part of the state of Assam, India. Pub Nalbari is a developmental block in the central part of the district. It forms a part of great Brahmaputra valley and is underlain by thick alluvial sediments of quaternary groups deposited over granite and gneisses. These deposits consist of sand, silt, clay and gravels. Groundwater occurs under unconfined to confined conditions in the unconsolidated sands and gravels lying at shallow and deeper horizons. The depth of the water level lies below 2 meters below ground level. The sediments have originated from the igneous rocks and tertiary sedimentary rocks of Himalayan range, which were brought by multitude of streams and valley. They comprise unconsolidated sediments of clay, silt, mica, sand, gravels and boulders of quartz, feldspar and hornblende pyroxene etc [15].

Methodology

The samples were collected from hand pumps during the post-monsoon period of October 2007. The depth of the tube wells ranged from 20 meters to 60 meters. Manually operated hand pumps can easily be installed in the study area and are extensively used to pump out groundwater. First the water was left to run from sampling source for 4-5 minutes, before taking the final sample. Samples were collected in pre-cleaned sterilized polyethylene bottles of 2L capacity. The groundwater samples were analyzed to assess various chemical water quality parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), sodium (Na^+), potassium (K^+), calcium ($Ca^{2+)}$, magnesium (Mg^{2+}), chloride (Cl^-), bicarbonate (HCO_3^-), carbonate ($CO_3^{2-)}$, sulphate (SO_4^{2-}), according to the standard methods[16]. TDS and pH were determined on site by TDS kit and portable pH meter. The EC was determined by conductivity meter. The value of TDS was calculated from EC by multiplying a factor that varies with the type of water. Na and K were determined with the help of flame photometer. Carbonates and bicarbonates were determined using titration method. TH and Ca^{2+} were determined by tritrimetric method with standard EDTA solution. Mg^{2+} was calculated by the difference between TH and Ca^{2+} concentration. Cl^- was determined by argentometry. SO_4^{2-} was determined by UV spectrophotometry.

The sampling locations were fixed with the help of hand held global positioning system (GPS) receiver and are reported in universal transverse mercator (UTM) co-ordinates.

Piper tri-linear diagram to evaluate the geochemistry of groundwater of the study area was plotted with the help of GWW- software. The results of statistical analysis were used as input for Special Package for Social Sciences (SPSS 16).

RESULTS AND DISCUSSION

The physicochemical parameters of the groundwater of the study area are illustrated in Table 1. The range of all the chemical constituents of groundwater and their respective mean, median and standard deviation is presented in Table 2. The pH of the groundwater varies from 7.14 to 8.62, with a mean of 7.77, which indicates the groundwater is slightly alkaline in nature. The desirable limit of pH in drinking water is 6.5 to 8.5, and it is seen only one sample (N-7) exceeds this limit. EC and TDS signify the organic load of any water body. The EC of the groundwater varies from 640 to 1800 μS/cm. The maximum limit for EC in drinking water is 1500 μS/cm. Only one sample (N-10) shows EC of 1800 μS/cm, which exceeds the permissible limit. The higher EC may be attributed to high salinity and high mineral content of the sampling point.

In the study area, the dominant cations are in the order $Ca^{2+} > Mg^{2+} > Na^{+} > K^{+}$. Ca^{2+} and Mg^{2+} are important ions for total hardness. In the study area, the Ca^{2+} concentration varies from 18.7 mg/L to 138 mg/L, with a mean of 59.47 mg/L. The desirable limit of calcium in drinking water is 75 mg/L. Nearly 25 % of the sample (N-5, N-10, N-13, N-19, N-20) exceeds this limit. The Mg^{2+} concentration in the study area varies from 8.02 mg/L (N-18) to 52.10 mg/L (N-5). A concentration of 30 mg/L is recommended for magnesium in drinking water, whereas only 2 water samples (N-5 and N-10) exceeds this limit in the area. The Na^{+} in the study area varies from 3.1 mg/L (N-20) to 122.2 mg/L (N-13) and the K^{+} concentration varies from 1.4 mg/L (N-1) to 28.4 mg/L (N-13), which are well within the permissible limits of WHO. The dominant anions of the study area are in the order of $HCO_3^{-} > Cl^{-} > CO_3^{2-} > SO_4^{2-}$. Bicarbonates represent the major source of alkalinity. The HCO_3^{-} varies from 21.3 mg/L (N-7) to 300 mg/L (N-5), and the CO_3^{2-} in the water samples varies from 16.8 mg/L (N-1) to 48 mg/L (N-10). The desirable limit of chloride and sulphate in drinking water is 200 mg/L. The Cl^{-} in the study area varies from 10 mg/L (N-7) to 78 (N-5) mg/L while the SO_4^{2-} concentration varies from 3.2 mg/L (N-7) to 15.7 (N-15) mg/L, indicating that they are within the safe limit.

Table 1: Physico-chemical parameters of groundwater of Nalbari District

Code	pH	EC	Units	TH	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}
N-1	8.2	1000	mg/L	60	640	43.96	16.03	31.3	1.4	16.8	202.5	14.2	15.6
	--	--	meq/L			2.20	1.32	1.36	0.04	0.56	3.32	0.40	0.32
N-2	7.3	1080	mg/L	44	691	28.77	15.23	31.1	2.8	16.8	202.5	12.1	8.6
	--	--	meq/L			1.44	1.25	1.35	0.07	0.56	3.32	0.34	0.18
N-3	7.69	650	mg/L	44	420	25.57	18.44	13.7	1.5	24	146.4	14.2	7.8
	--	--	meq/l			1.27	1.52	0.60	0.04	0.80	2.40	0.40	0.16
N-4	7.69	640	mg/L	70	410	45.16	24.84	21.5	1.8	19.2	195.2	19.9	15.6
	--	--	meq/L			2.25	2.04	0.94	0.05	0.64	3.20	0.56	0.32
N-5	8.24	800	mg/L	190	512	137.87	52.10	50.3	3.4	24	300.1	78	11.6
	--	--	meq/L			6.88	4.29	2.19	0.09	0.80	4.92	2.20	0.24
N6	7.3	720	mg/L	36	461	22.38	13.63	31.3	2.3	19.2	187.9	21.3	13.3
	--	--	meq/L			1.12	1.12	1.36	0.06	0.64	3.08	0.60	0.28
N-7	8.62	880	mg/L	60	563	40.77	19.23	18.9	1.7	31.2	21.3	10	6.1
	--	--	meq/L			2.03	1.58	0.82	0.04	1.04	0.35	0.28	0.13
N-8	7.75	920	mg/L	50	589	31.56	18.43	27.8	1.9	35.6	172.0	14.2	7.5
	--	--	meq/L			1.57	1.52	1.21	0.05	1.19	2.82	0.40	0.16
N-9	7.75	720	mg/L	77	461	62.40	15.00	33.1	1.8	35	280	25.56	6.94
	--	--	meq/L			3.11	1.23	1.44	0.05	1.17	4.59	0.72	0.14
N-10	8.35	1800	mg/L	160	1152	121.55	38.55	6	2.4	48	43.9	25.6	5.3
	--	--	meq/L			6.07	3.17	0.26	0.06	1.60	0.72	0.72	0.11

Cont...

Code	pH	EC	Units	TH	TDS	Ca^{2+}	Mg^{2+}	Na^+	K^+	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}
N-11	7.79	716	mg/L	60	458	48.00	12.23	20.3	1.5	24	207.4	23.0	7.4
	--	--	meq/L			2.40	1.01	0.88	0.04	0.80	3.40	0.65	0.15
N-12	7.97	720	mg/L	60	461	43.96	16.03	23	1.6	28.8	163.5	14.2	9.4
	--	--	meq/L			2.19	1.32	1.00	0.04	0.96	2.68	0.40	0.20
N-13	7.15	920	mg/L	106	589	81.96	24.04	122.2	28.4	25	160.5	26.98	4.98
	--	--	meq/L			4.09	1.98	5.32	0.73	0.83	2.63	0.76	0.10
N-14	7.23	1044	mg/L	84	668	63.96	20.04	6	2.5	28.8	117.1	35.5	14.5
	--	--	meq/L			3.19	1.65	0.26	0.06	0.96	1.92	1.00	0.30
N-15	7.5	872	mg/L	80	558	63.97	16.03	27.6	1.6	28.8	278.2	21.3	15.7
	--	--	meq/l			3.19	1.32	1.20	0.04	0.96	4.56	0.60	0.33
N-16	8.05	840	mg/L	36	538	18.70	17.63	16.9	1.4	19.2	205.0	20.3	3.6
	--	--	meq/L			0.93	1.45	0.74	0.03	0.64	3.36	0.57	0.07
N-17	7.14	760	mg/L	90	486	75.40	14.60	23	1.6	30	150	22.72	3.2
	--	--	meq/L			3.76	1.20	1.00	0.04	1.00	2.46	0.64	0.07
N-18	7.69	960	mg/L	50	614	41.98	8.02	33.1	1.8	16.8	131.8	18.5	10.8
	--	--	meq/L			2.09	0.66	1.44	0.05	0.56	2.16	0.52	0.23
N-19	8.1	1000	mg/L	134	640	106.75	27.25	26.5	2.2	25	150	56.8	3.58
	--	--	meq/L			5.33	2.24	1.15	0.06	0.83	2.46	1.60	0.07
N-20	7.93	1008	mg/L	110	645	84.40	25.65	3.1	2.0	26.4	158.6	46.9	14.5
	--	--	meq/L			4.21	2.11	0.13	0.05	0.88	2.60	1.32	0.30

EC is determined in µS/cm.

Table 2: Comparison of statistical data of different water quality parameters

Parameters	Range		Median	Mean	Std Deviation
	Min	Max			
pH	7.14	8.62	7.75	7.77	0.41
EC	640	1800	876	902	251.3
TDS	410	1152	560	577.3	160.76
Ca^{2+}	18.7	138	46.6	59.47	33.28
Mg^{2+}	8	52	18	20.63	10
TH	36	190	65	80.05	41.72
Na^+	3.1	122.2	24.75	28.33	24.71
K^+	1.4	28.4	1.8	3.28	6
CO_3^{2-}	16.8	48	25	26.13	7.17
HCO_3^-	21.3	300	167.75	173.6	68.84
Cl^-	10	78.1	21.3	26.06	16.83
SO_4^{2-}	3.2	15.7	8.2	9.3	4.35

All parameters are given in mg/L, except pH and EC is given in µS/cm

Major cations and anions such as Ca^{2+}, Mg^{2+}, Na^+, K^+, CO_3^{2-}, HCO_3^-, SO_4^{2-}, and Cl^- in mg/L were plotted in Piper tri-linear diagram[17] to evaluate the geochemistry of groundwater of the study area with the help of GWW-software (Fig. 1). The hydrochemical facies analysis reflects the chemical process operative in certain lithological environment under certain geochemical conditions**.** These plots include two triangles, one for plotting cations and the other for plotting anions. The cation and anion fields are combined to show a single point in a diamond shaped field, from which influence is drawn on the basis of hydrogeochemical facies concept. These trilinear diagrams are useful in bringing out chemical relationships among groundwater samples in more definite terms rather than with other possible plotting methods. In the present study, the plot shows that the alkaline earth (Ca^{2+} + Mg^{2+}) exceeds alkalis (Na^+ + K^+) in 90 % of the samples. Again weak acids (CO_3^{2-} + HCO_3^-) exceed strong acids (SO_4^{2-} and Cl^-) in 100 % of the samples. A few samples also show a mixed type (no cation-anion exceeds 50 %). Hence, the groundwater samples fall in the field of Ca^{2+} – Mg^{2+} – HCO_3^- type of water.

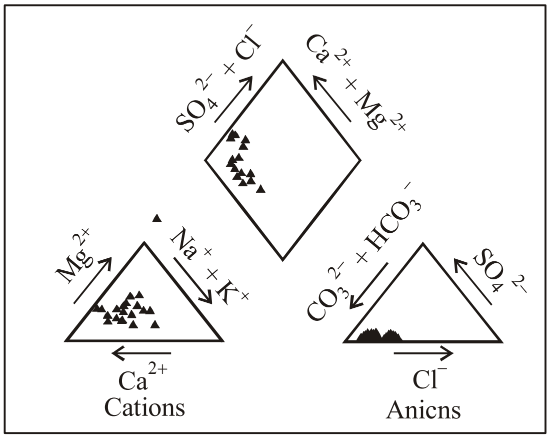

Fig. 1: Groundwater samples plotted in Piper trilinear diagram

Ca^{2+} and Mg^{2+} are the dominant cations while among anions, HCO_3^- is the most dominant. The Ca^{2+} is mainly associated with carbonate minerals like calcite and dolomite, which occurs in the veins and secondary minerals in igneous granite. 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. In $Ca^{2+} + Mg^{2+}$ verses $SO_4^{2-} + HCO_3^-$ scatter diagram (Fig. 2), the points falling along the equiline ($Ca^{2+} + Mg^{2+} = SO_4^{2-} + HCO3^-$) suggest that these ions have been resulted from weathering of carbonates and silicates[18-20]. Some of the points, which are placed in the $Ca^{2+} + Mg^{2+}$ verses $SO_4^{2-} + HCO_3^-$ side, indicates that carbonate weathering is the dominant hydrochemical process, while those below the 1 : 1 line are indicative of silicate weathering.

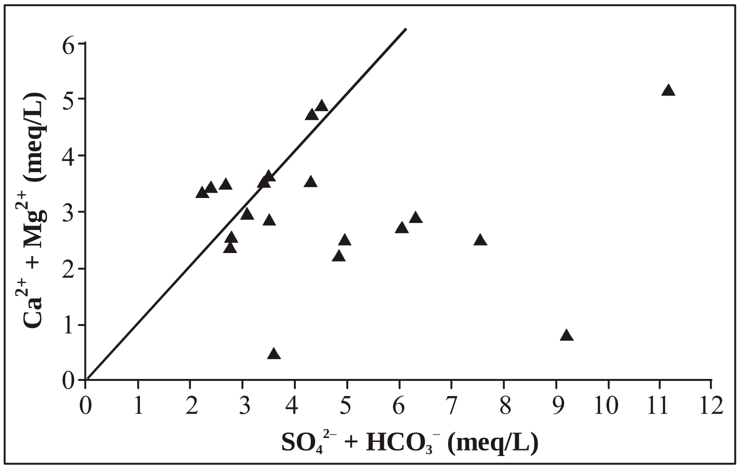

Fig. 2: Relation between $Ca^{2+} + Mg^{2+}$ and $SO_4^{2-} + HCO_3^-$

The plot of Ca/Mg ratio of the groundwater suggests the dominance of dissociation of dolomite and silicate that is present in the alluvium of Nalbari district (Fig 3). That is, if the ratio of Ca : Mg = 1, dissociation of dolomite should occur, while higher ratio is indicative of greater calcite contribution[21]. Higher Ca/Mg molar ratio (> 2) indicates the dissociation of silicate minerals, which contributes calcium and magnesium to the groundwater. Most of the samples in the study area were found to be near line 2, which indicates silicate weathering. A few samples, which are near to line 1, indicate dominance of dolomite dissolution.

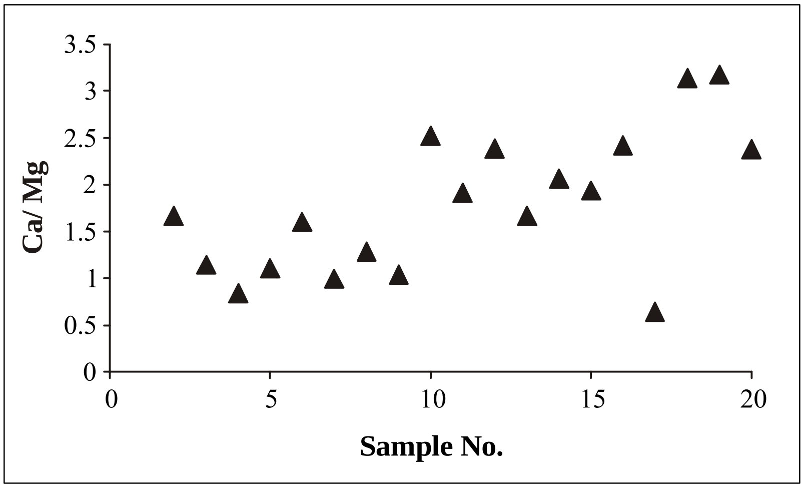

Fig. 3: The scatter diagram of Ca^{2+} and Mg^{2+} molar ratio

The suitability of the groundwater for irrigation purpose was determined on the basis of alkalinity hazards, salinity hazards, soluble sodium percentage (SSP) and residual sodium carbonate (RSC) (Table 3). Sodium absorption ratio is also used to determine the suitability of groundwater for irrigation as it gives a measure of alkali/sodium hazard to crops. The sodium/alkali hazard is typically expressed as the sodium adsorption ratio (SAR). This index quantifies the proportion of sodium (Na^+) to calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions in a sample. Sodium hazard of irrigation water can be well understood by knowing SAR. Sodium absorption ratio (SAR) is given by the following relation[10] -

$$\text{SAR} = \frac{Na^{+}}{\frac{\left(Ca^{2+} + Mg^{2+}\right)^{1/2}}{2}} \qquad \ldots(1)$$

where concentrations of all the ions are expressed in meq/L. Sodium adsorption ratio (SAR) also influences infiltration rate of water. So, low SAR is always desirable. In the studied samples, SAR values varied 0.08 to 3.05 (Table 3). The classification of groundwater samples from the study area with respect to SAR is represented in Table 4.

Table 3: Groundwater parameter for irrigation purpose

Code	SAR	Na (%)	RSC
N-1	1.03	28	0.37
N-2	1.17	35	1.19
N-3	0.50	19	0.41
N-4	0.64	19	Nil
N-5	0.93	17	Nil
N-6	1.29	39	1.48
N-7	0.61	19	Nil
N-8	0.97	29	0.91
N-9	0.98	25	1.41
N-10	0.12	3	Nil
N-11	0.68	21	0.80
N-12	0.75	23	0.13
N-13	3.05	50	Nil
N-14	0.17	6	Nil
N-15	0.80	22	1.01
N-16	0.67	24	1.62
N-17	0.64	17	Nil
N-18	1.23	35	Nil
N-19	0.59	14	Nil
N-20	0.08	3	Nil

Table 4: Sodium hazard classes based on USSL classification

Parameter	Sodium hazard class	Range	Water class	Samples
Sodium hazards	S1	< 10	Excellent	All sample (0.08 –3.05)
	S2	10 to 18	Good	Nil
	S3	18 - 26	Doubtful	Nil
	S4	> 26	Unsuitable	Nil

The SAR value is excellent for all the water samples. When SAR and EC of water are known, the classification of water for irrigational purpose can be determined by graphically plotting these values on the US Salinity Laboratory (USSL) diagram (Fig. 4). The analytical data plot on the US salinity diagram illustrates that most of the groundwater samples fall in the field of C2S1 and C3S1 indicating medium to high salinity and low sodium water, which can be used for irrigation on almost all types of soils with little doubt of exchangeable sodium.

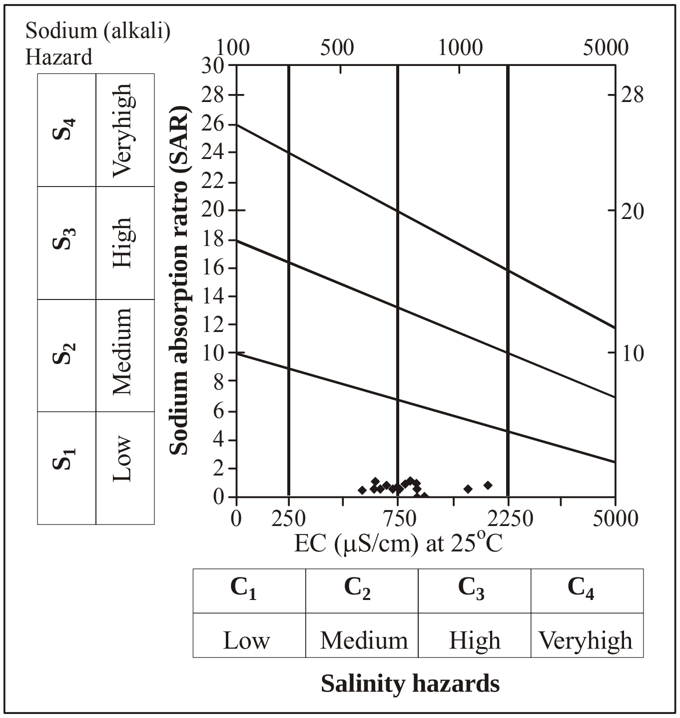

Fig. 4: Water classification according to EC and SAR values (USSL diagram)

Electrical conductivity is a good measurement of salinity hazard to crop as it reflects the TDS in groundwater. All sampling points were found suitable with respect to EC for irrigation purpose. According to Wilcox classification[22], the groundwater sample in the study area are ranging between good to permissible limit for irrigational use (Table 5). The primary effect of high EC reduces the osmotic activity of plants and thus, interferes with absorption of water and nutrient from soil.

Table 5: Groundwater quality based on salinity hazard classes

Parameter	**Salinity hazard**	**Range (EC)**	**Water**	**Sample**
	Class	microhm/cm	Class	
Salinity	C1	< 250	Excellent	Nil
hazard	C2	250 - 750	Good	N3, N4, N6, N9, N11
class	C3	750-2250	Permissible	N1, N2, N5, N7, N8, N10, N13, N14, N15, N16, N17, N18
	C4	> 2250	Unsuitable	Nil

Sodium percentage values reflected that the water was under the category of 'good' (20–40 Na %), 'permissible' (40–60 Na %) and 'doubtful' (60–80 Na %) class[22]. The sodium percentage is calculated by following equation

$$\text{Na \%} = \frac{Na^+}{(Na^+ + K^+ + Ca^{2+} + Mg^{2+})} \text{ x } 100 \qquad \ldots(2)$$

Here, all the concentrations are expressed in meq/L. The values of sodium percent are varying from 3 % to 50 % (Table 3). 95 % of the water samples fall under excellent to good category water. Only one sample (N 13) lies in the permissible category (Table 6). When the concentration of sodium ion is high in irrigation water, Na^+ tends to be absorbed by clay particles, displacing magnesium and calcium ions. This exchange process of sodium in water for Ca^{+2} and Mg^{+2} in soils reduces the permeability and eventually results in soil with poor internal drainage.

Calcium and magnesium has a tendency to precipitate as carbonate, when there is high percentage of bicarbonate in the groundwater. To quantify this effect, an experimental parameter termed as Residual Sodium Carbonate [23] was used. RSC is given by -

$$\mathrm{RSC} = (\mathrm{HCO_3^-} + \mathrm{CO_3^{2-}}) - (\mathrm{Ca^{2+}} + \mathrm{Mg^{2+}}) \qquad \ldots(3)$$

All the samples fall in good category, except N-6, N-9 and N16, which falls in doubtful category (Table 7).

Table 6: Classification of groundwater based on percentage of sodium

Parameter	Range (%)	Water class	Samples
	< 20	Excellent	N-3, N-4, N-5, N-7, N-10, N-14, N-17, N-19, N-20
Percentage	20 - 40	Good	N-1, N-2, N-6, N-8, N-9, N-11, N-12, N-15, N-16, N-18
Sodium	40 - 60	Permissible	N-13
	60 - 80	Doubtful	Nil

Table 7: Groundwater quality based on RSC (Residual sodium carbonate)

Parameter	Range (ppm)	Water Class	Sample
Residual	< 1.25	Good	N1, N2, N3, N4, N5, N7, N8, N10, N11, N12, N13, N14, N15
Sodium	1.25 - 2.50	Doubtful	N6, N9, N16
Carbonate	> 2.5	Unsuitable	Nil

CONCLUSION

The physico-chemical analysis of the groundwater reveals that the water is slightly alkaline in nature. The major cations (meq/L) are in the order Calcium > Magnesium > Sodium > Potassium; while for anions. it isBicarbonates > Chloride > Carbonates > Sulphates. Most of the water quality samples are within the permissible limit for 90 % of the samples. Hence, it is suitable for drinking purpose after treatment with respect to the major cations and anions. However, the estimation of arsenic and fluoride in the water samples will be considered in the future studies. The trilinear diagram shows that groundwater samples fall in the field of $Ca^{2+} – Mg^{2+} – HCO_3^-$ type of water. The scatter plot of $Ca^{2+} + Mg^{2+}$ verses $SO_4^{2-} + HCO_3^-$ indicates that carbonate weathering is the dominant hydrochemical process in most of the samples. Most of the water samples in Pub Nalbari block fall in the suitable range for irrigation purpose from USSL diagram. For efficient management of the water resources, information about their magnitude and dynamicity is essential. Regular monitoring of the groundwater resource is essential for maintaining proper health conditions of the population. Therefore, it is highly appreciable, if water resource of Assam is managed properly to develop agriculture and its allies operations.

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