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Assessment of Groundwater Quality Parameters of Shallow Tube Wells in Hilly Terrain of Cachar District of Assam

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Abstract—*Quality of water is an important criterion for evaluating the suitability of water for domestic, industry and agriculture. So, the present study was carried out to evaluate the groundwater quality parameters of four shallow tube wells constructed in hilly terrains of Assam University Silchar of Cachar District, Assam, India. The water samples were collected on regular interval and quality parameters were tested using standard procedure. The parameters like Temperature, Alkalinity, Acidity, Hardness, Total hardness (TH), Total dissolved solids (TDS), Iron (Fe), Fluoride, Nitrate (NO_3), pH, Sulphate (SO_4), Chloride (Cl), Residue chlorine (RC) and Turbidity were determined during Pre-Monsoon, Monsoon, and Post-Monsoon season to study the variation of parameters. The status of water quality parameters were compared with the water quality standards of BIS, ICMR and WHO, for drinking purpose. Overall the groundwater quality of the study area was found clear, soft and odourless. It was also observed that, the water quality parameters are within the standards limits. So, the groundwater could be used for both irrigation and drinking purpose.*

Keywords: *Cachar District, hilly terrain area, shallow tube wells, water quality, WHO.*

1. INTRODUCTION

Water quality parameters evaluation as well as water quality management practices should be carried out periodically to protect the water resources [7]. Groundwater is a source of drinking water and even today more than half of the world's population depends on ground water for survival [15]. Rapid increase in population and industrialization together with the lack of wisdom to live in harmony with nature has led to the deterioration of good quality of water resulting in water pollution [23]. The surface water regime is primarily monsoon dependent, although the trunk channels receive significant contribution from ground water during lean season [14]. The groundwater chemistry can be control by encouraging regular groundwater quality monitoring. [13]. Good quality of water resources depends on a large number of physico-chemical parameters and biological characteristics [25]. The water controlling pollution can prevent the local people from being affected by the possible health hazards [16]. Water quality index is one of the most effective tools to communicate information on the quality of water [11]. Monitoring and assessment provide the basic information on the condition of water bodies [17]. Accurate and reliable information on the water resource system can, therefore, be a vital aid to strategic management of the resources [10]. Natural and physical change in the area can also affect the water quality [24]. Due to increase in human population, use of fertilizers and man-made activities, the water quality is degrading day by day and due to the use of contaminated drinking water, human population suffers from water borne diseases [21]. According to WHO organization, about 80% of all the diseases in human beings are caused by drinking water [1, 2, and 12]. The groundwater must be managed in the hilly terrain area for human survival. It is, therefore, necessary to have most relevant information of the water quality for maximum benefit to the most people. Accurate and reliable information on the water can lead to a vital strategic management and sustainable development [4]. The hard fact of life is that about 97% of it's locked in oceans, sea which is too saline to drink and for direct use for agricultural or industrial purposes [18, 19]. The pollution load of water quality is relatively high during the summer season when compared to winter and rainy season [28].

The north-east part of the India is mostly covered by hilly terrain areas like Meghalaya, Assam, Sikkim, and Arunachal Pradesh. Having heavy rainfall in the area, availability of drinking water and agriculture status is very low in the hilly districts area. In order to study the exploration and feasibility of groundwater sources, the water quality status of the hilly terrain of Assam University, Silchar of Cachar district has been monitored and analyzed.

2. MATERIALS AND METHODS

2.1 Study area

The study area is considered in Agricultural Engineering Departmental Farm of Assam University Silchar, Cachar district, Assam in India. It is located in the southern part of the Assam.

2.2 Topographic survey

In order to assess the location of the shallow tube wells, topographical land survey was carried out using standard surveying instruments such as Global Positioning System (GPS) and Automatic Level. The observation site containing four shallow tube wells with the coordinates of STW (Shallow Tube Well)-1 (24^0 44' N and $92^0$61' E), STW-2 (24^0 82' N and $92^0$86' E), STW-3 (24^0 16' N and $92^0$34' E), STW-4 (24^0 47' N and $92^0$92' E), latitude and longitude and having an altitude of 40.805 m above the mean sea level (Figure1).

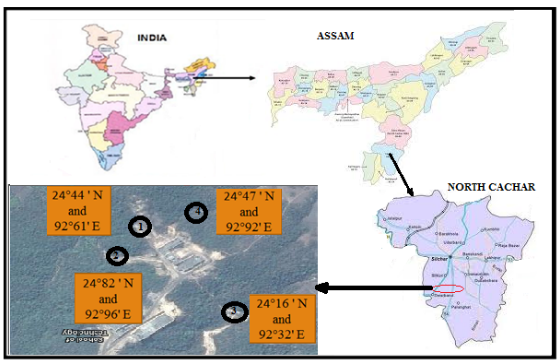

Fig. 1: Location of the study site

2.3 Analysis of groundwater quality

2.3.1 Sampling

The groundwater samples were collected from four shallow tube wells and used for testing the water quality parameter as per standard methods [6, 9, 8, 20] and the observations are shown Table 1.

2.3.2 Experimental approach

The physico-chemical parameters like pH, Total Dissolved Solid (TDS), Chlorine (Cl), Total Hardness (TH), Temperature, Turbidity, Residue Chlorine (RC), Ammonia (NH_{4}), Nitrates (NO_{3}), Fluorides (F), Alkalinity, Acidity, Hardness, Turbidity, Iron (Fe) were determined using water quality meter and water testing kits and it was compared with the BIS, ICMR and WHO of standard limits. The characterization of the study site is shown in Table 2.

Table 1: Preliminary observations of the ground water samples

Sample/Sources	Depth (m)	Colour	Odour
STW-1	69	Clean	No Odour
STW-2	23	Clean	No Odour
STW-3	24	Clean	No Odour
STW-4	57	Clean	No Odour

Table 2: Characterization of study sites

Shallow tube wells.	Geographical Locations			
	Longitudes	Latitudes	MSL(m)	Drilled depth (m)
STW-1	24°44´N	92°61´E	36.605	69
STW-2	24°82´N	92°82´E	19.684	23
STW-3	24°16´N	92°32´E	21.17	24
STW-4	24°47´N	92°92´E	29.135	57

3. RESULTS AND DISCUSSION

3.1 Temperature

The maximum water temperature was observed 29°C at STW-1 and minimum 21.02°C at STW-2 with an average value of 24.22°C. The temperature may vary due to different timing of collection of water samples. The temperature characteristics of water change due to the solubility of salts in water and due to the different depth of the shallow tube wells, there is no other factor that has much influence water temperature.

3.2 Alkalinity

The neutral waters contain maximum amounts of dissolved carbon dioxide, which is the main principle source of alkalinity. The capacity of the water to neutralize a strong acid is the measurement of an alkalinity. Seasonal variation in temperature, Alkalinity, Acidity and Hardness is shown in Fig. 2. The alkalinity of the water samples was found in the range of 6 to 16 mg/l which is below the standard limit (200 mg/l) prescribed by BIS.

3.3 Acidity

The maximum and minimum acidity of the water samples was found 34 and 12 mg/l, respectively. The average acidity value of the water samples was found 27.55 mg/l (Fig. 2). Acidity and alkalinity is an important index of drinking water which depends on the pH value. The resultant of the pH value also depends on the interaction of minerals and organic matters with one another. The pH value of the water samples lies within range of 6 and 7, which is below the limits of the prescribed value by the BIS and WHO.

3.4 Hardness

Water described as "hard" contains high amounts of dissolved calcium and magnesium. Hard water is not a health risk but is a nuisance because of mineral buildup on plumbing fixtures' and poor soap and or detergent performance. Hardness is not a specific constituent of water. It is due primarily to the presence of ions of calcium and magnesium in water. Hardness is expressed in terms of calcium carbonate ($CaCO_3$). Water with less than 75 milligrams per liter (mg/l) is considered soft, 76-150 mg/l moderately hard, and above 150 mg/l, hard water. The hardness of the water samples was found 14 mg/l in STW-1 and 12 mg/l in STW-2, STW-3, and STW-4 which is in the range of soft and also within the permissible limits of 300 mg/l as compared to the BIS, ICMR, and WHO (Fig. 2).

3.5 Total Hardness

Total hardness is a measure of the capacity of water to the concentration of calcium and magnesium in water and is usually expressed as the equivalent of CaCo3 concentration. Water hardness is usually due to the multivalent metal ions, which comes from minerals dissolved in the water [5]. Seasonal variation in Total Hardness, TDS, Iron and pH is shown in Fig. 3. In the study, the total hardness of the water samples was found in the range between 60 to 20 mg/l. The water samples were found below the standard limit (200 mg/l) prescribed by BIS.

3.6 Total Dissolved Solid

The total dissolved solids (TDS) values of the sampling area are found to be within the permissible limits of WHO (500-2000 mg/l). The average TDS values of the studies were between 29 mg/l and the maximum value is found to be 60 mg/l in STW-1 and the minimum average value of the TDS is found to be 20 mg/l in STW-2 and STW-3. Thus, the TDS of the water sample are in within the permissible limit prescribed by BIS and WHO. Total dissolved solid indicates the general nature of water quality or salinity [5].

3.7 Iron

Iron concentrations in this study was found in the range from 0.04 to 0.03 mg/l with an average value of 0.0325 mg/l (Fig. 3). The water samples were found within the standard limit (0.30 mg/l) prescribed by BIS. Iron is a common metallic element found in the earth's crust Iron can affect the flavor, taste and color of food and water. Iron is biologically an important element which is essential to all organisms and present in hemoglobin system. Thus, the water can be used for drinking purpose directly without treatment.

3.8 Fluorides

The fluoride values in the study area of the water sample are found to be zero (0 mg/l). The fluorides concentration in all the samples is below the BIS standards limit 1.0 mg/l. Fluoride is beneficial for human beings as a trace element, this protects tooth decay and enhances bone development.

3.9 Nitrate (NO3)

The mean nitrate values are not observed for all groundwater samples. Nitrate values are within the permissible limit 50 mg/l prescribed by WHO and BIS. The desirable limit of 45 mg/l and permissible is 100 mg/l. The effects of the nitrate may lead to methemoglobinemia or blue baby disease in infants (IS 10500-1991). The low nitrate content encountered may be due to the less usage of nitrogen fertilizers and less disposal of wastes around these stations.

3.10 pH

The pH of a solution is the negative logarithm of Hydrogen ion concentration in moles per liter. pH is dependent on the carbon dioxide-carbonate-bicarbonate equilibrium. pH values ranged from 6 to 7 with an average value of 6.5 of the water samples (Fig. 3). When groundwater was exposed to the atmosphere, CO_2 will escape and the pH will rise. For consumption point of view, all the samples may be considered fit, as they are neither acidic nor strongly alkaline in nature. The factors like temperature bring about changes the pH of water [22, 23].

3.11 Sulphate (SO_4)

Sulphate occurs naturally in water as result of leaching from gypsum and other common minerals. Sulphate may come into the groundwater by industrial and anthropogenic addition in the form of Sulphate as fertilizers. Sulphate is absent in all water samples. Since, the milky solid with form was found to be absent after treating the Barium Chloride and Hydrochloric acid. The values of Sulphate are within the permissible limit. The desirable value of Sulphate is 200 mg/l and permissible limit is 400 mg/l. prescribed by BIS and WHO. Thus, the all groundwater samples are suitable for drinking purpose without treated.

3.12 Chloride

Chloride in the form of Cl is one of major inorganic anions in water. According to the Indian standards for drinking water the recommended values have been set as 250 mg/L while 1000 mg/l has been set as the maximum permissible limit for chloride concentration. Seasonal variation in Chloride, Turbidity and Ammonia is shown in Fig. 4. The chlorine concentration is between 32.0352 mg/l to 27.0297 mg/l. High concentration of chlorine can produce hypertension, effect metabolism of body, and increase the electrical conductivity of water.

3.13 Residue Free Chlorines

The residue free chlorine in the study area of the water samples was found to be absent. The desirable limit prescribed by the BIS is 0.2 mg/l. Thus, it's indicating that the water sample is within the permissible limits as compared to the BIS and WHO.

3.14 Turbidity

The turbidity is a measure of the extent to which light is either absorbed or scattered by suspended material in water. The turbidity for all the samples is below the BIS Standards limit 1.0 NTU (Fig. 4). The highest value of turbidity was found 0.2579 NTU in STW-4. Turbidity in water causes the degradation in the clarity. The values of turbidity in the present study are found to lie in between 0.2572- 0.2579 NTU.

3.15 Ammonia

The ammonia NH4 concentration in the studied water samples ranged from 1.45 mg/l to 1.82 mg/l (Fig. 4) and this concentration of ammonia indicates that it is origin from leachate of solid waste.

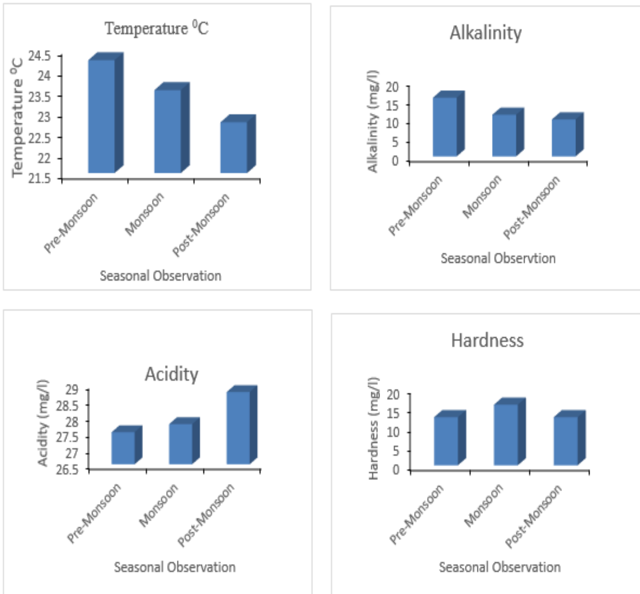

Fig. 2: Seasonal variation in temperature, Alkalinity, Acidity and Hardness.

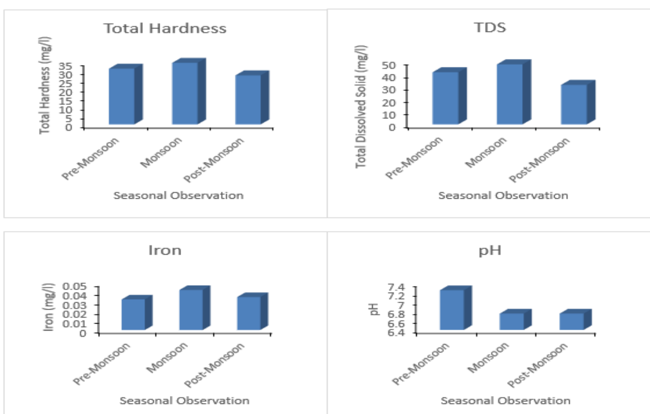

Fig. 3: Seasonal variation in Total Hardness, TDS, Iron and pH.

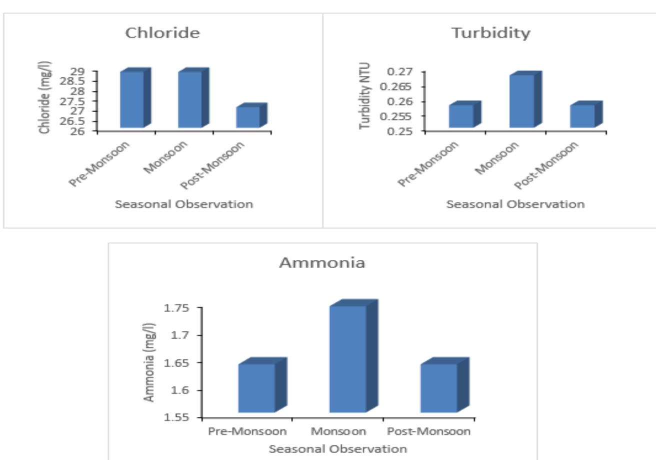

Fig. 4: Seasonal variation in Chloride, Turbidity and Ammonia.

Table 3: Comparison of groundwater quality with drinking water standards WHO

Parameter	Unit	Min.	Max.	Avg.	WHO Standard
Temperature	°C	22.02	29	25.51	------
Alkalinity	mg/l	6	16	11	120
Acidity	mg/l	12	34	23	------
Hardness	mg/l	12	14	13	600
TH	mg/l	20	60	40	300
TDS	mg/l	20	60	40	500
NO3	mg/l	0	0	0	20
pH		6	7	6.5	7 to 8.5
SO4	mg/l	0	0	0	150
Chloride	mg/l	27.03	32.04	29.53	250
Turbidity	NTU	0.26	0.26	0.26	5
Ammonia	mg/l	1.45	1.92	1.69	0.5

4. CONCLUSIONS

The study of the water quality parameters in the present investigation indicates that the groundwater quality is almost within the standard limits at all locations of the study area. During the study period the water quality variation were within the standard limits in Pre-Monsoon, Monsoon and Post-Monsoon, as per (BIS), (ICMR) and (WHO). Since the values are almost within the limit for all sampling locations therefore the groundwater can be deemed fit for drinking purposes as well as agricultural use in hilly terrains of Cachar District of Assam.

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