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Analysis of Physicochemical Parameters of Ground Water Around Silapathar and Simen Chapori Area of Dhemaji district, Assam

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Abstract: In Assam, for a rural district like Dhemaji, where the majority of the people live below the poverty line (BPL), the facility of drinking water is one of the requiring conditions for good health and all-round development. Several researchers have studied physico-chemical parameters of groundwater in selected areas of rural and sub urban areas of Dhemaji district. From the literature review, Buragohain et al. presented a statistically significant water quality database of Dhemaji district, Assam (India) with special reference to pH, fluoride, nitrate, arsenic, iron, sodium and potassium. But none have investigated the various parameters of ground water of Silapathar and Simen Chapori area of Dhemaji district. In this background, we have planned to instigate this work which is locally relevant and has lab to land orientation as well. Since the levels of certain physico-chemical parameters like pH, alkalinity, BOD, COD, total hardness, Ca, Mg, Chlorides, HCO3-, CO32-, NO3-, PO43-, Na, K, heavy metals and total dissolved solids found in ground water determine its demeanor as well as quality, it has been proposed to evaluate ground water in different areas separately so as to find reasons for the ground water problems in the said area.

Keywords: Drinking Water Quality; Ground Water; Physicochemical properties; Water Pollution

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1. Introduction

Water is one of the vital compounds crucial to sustain every type of living beings. About 97.0% of the water on earth is somewhat saline, while just 3.0% is fresh. Of which (freshwater), more than 67.0% is frozen in ice caps and glaciers, 30.0% is thawed as GW and only 3% is in surface water. Groundwater is an important source of drinking water and one-third of the world's population needs to rely on it for ingestion. In India, about 50% of the total irrigated area is dependent on groundwater irrigation (CWC 2006) and according to FAO (FAO 2003), groundwater constitutes about 53% of the total irrigation potential of the country and sixty percent of irrigated food production is from groundwater wells (Shah et al, 2000). The standard of public health of a community depends on the availability and purity of drinking water (Hossain et al, 2024). Safe potable water is very threatened in most of the developing countries. In the developing world, 80% of all diseases are directly related to poor drinking water and unsanitary conditions (Chatterjee et al, 2010). Assessment of quality of groundwater is a needed and immediate duty for current and upcoming groundwater quality analysers. Groundwater quality depends on number of factors – (i) general geology, (ii) degree of chemical weathering of the various rock types, (iii) quality of recharge water and (iv) inputs from sources other than water-rock interaction (Hussain et al, 2004). Kumar and co-authors investigated the variations of the groundwater quality and compared its suitability for irrigation and drinking purpose in two districts of Punjab. They collected the samples in pre-monsoon and post-monsoon seasons, respectively. The found high total hardness (TH) and total dissolved solids at numerous places which indicates the inappropriateness of groundwater for drinking and irrigation. (Kumar et al, 2007)

Ground water Arsenic (As) and Iron (Fe) contamination in the Brahmaputra River basin were recorded as 0.128 ppm and 5.9 ppm respectively which was above the WHO drinking water guideline values. In the Brahmaputra plains of Assam, fluoride content has been reported by many researchers in the district of Kamrup, Karbi Anglong, Golaghat, Guwahati. (Kalita et al, 2015). It was evaluated that the ground water quality of Brahmaputra plains of Assam found the pH of sediments to be slightly acidic (Sailo & Mahanta 2014). Sing et al analysed the TDS values of water samples from Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura, respectively and found maximum TDS in Assam and Tripura state respectively. (Sing et al, 2004). Swain et al. evaluated the groundwater quality over 28 places from Faridabad and Gurgaon districts and reported the highly polluted water quality due to rapid urbanization and industrial development in recent years. The overall quality of the 28 sites of collected samples was measured by WQI, which revealed 10 out of the 28 spots to be inappropriate for drinking purposes. (Swain et al, 2022) In the case-control study reported by Jena et al., found that 225 primary school children from 20 schools of Jorhat, Assam, India, consumed expected moderate and low levels of arsenic contaminated groundwater receiving from tube wells of the school campus. It was resulted that there was a significant positive relationship between arsenic and the developmental phenomena of primary school children. (Jena et al, 2020) The values of Iron reported in the study by Rahman et al is above the permissible limit which may be ascribed to variances in geographical sites, hydro geochemistry, structure of soil, types of rock, leaching from nearby surface industrialization. (Rahman et al, 2020). Chetia et al. (2011) reported that the total hardness of drinking water from shallow and deep well in Gamariguri, Golaghat district ranged between 50.4-139.7 and found that 76.4% of the total (220) ground water samples collected from shallow and deep well in Golaghat districts of Assam samples were contaminated with iron and crossed the WHO (2011) guideline value. In Gamariguri area 100% of the samples were contaminated with iron where concentration was found to be 5.9ppm. Chetia et al. (2011) in a study in Golaghat districts of Assam found that the sulphate con tent (ppm) of drinking water in Gamariguri area ranged from 15.3-98.3 (Chetia et al, 2011).

In Assam, for a rural district like Dhemaji, where the majority of the people live below the poverty line (BPL), the facility of drinking water is one of the requiring conditions for good health and all-round development. Unfortunately, the public are still unaware of about the consumption of safe drinking water, factors responsible for contaminated water and the probable effects of drinking contaminated water. Several researchers investigated the physico-chemical properties of ground water of different area of Dhemaji district. The researchers also focused on the heavy metal contaminations like fluoride, arsenic, mercury etc. (Buragohain et al, 2007, Buragohain et al, 2007, Buragohain et al, 2008, Buragohain et al, 2010, Buragohain et al, 2012) From the literature review, Buragohain et al. presented a statistically significant water quality database of Dhemaji district, Assam (India) with special reference to pH, fluoride, nitrate, arsenic, iron, sodium and potassium. They have collected 25 water samples from different sites of five development blocks in Dhemaji district and investigated separately. From the statistical observations it was found that all the parameters showed non uniform distribution with a long asymmetric tail either on the right or left side of the median. The width of the third quartile was consistently found to be more than the second quartile for each parameter. From the differences among mean, mode and median, significant skewness and kurtosis values, it was also observed that the distribution of various water quality parameters of the different study area is broadly off normal.

2. Significance of the Proposed Study

Several researchers have studied physico-chemical parameters of groundwater in selected areas of rural and sub urban areas of Dhemaji district. But none have investigated the various parameters of ground water of Silapathar area. In this background, the investigator of this project has planned to commence this work which is locally pertinent and has lab to land orientation as well. Since the levels of certain physico-chemical parameters like pH, alkalinity, BOD, COD, total hardness (Ca, Mg, Chlorides, HCO3-, CO32-, NO3-, PO43-, Na, K) and total dissolved solids found in ground water determine its demeanour as well as quality, it has been proposed to evaluate ground water in different areas separately so as to find reasons for the ground water problems in the said area.

3. Aim and Objectives of the Present Work

The study aims to determine the quality of ground water in the Silapathar area in order to evaluate their suitability for drinking and domestic use.

1. To examine the water quality with respect to physico- chemical parameters.

2. To investigate Silapathar and Simen Chapori ground water quality variations with respect to the ring well and tube well in different locations.

3. Determining the physical (pH, temperature, turbidity and TDS) and chemical (Chloride, total alkalinity, total hardness and sulphate) parameters of the water sources under study.

4. To compare the results of the present study with World Health Organization (WHO) guidelines and IS 10500:2012 standards.

5. To identify the potential sources of pollution and relative interactions to reduce the measures for controlling pollutants.

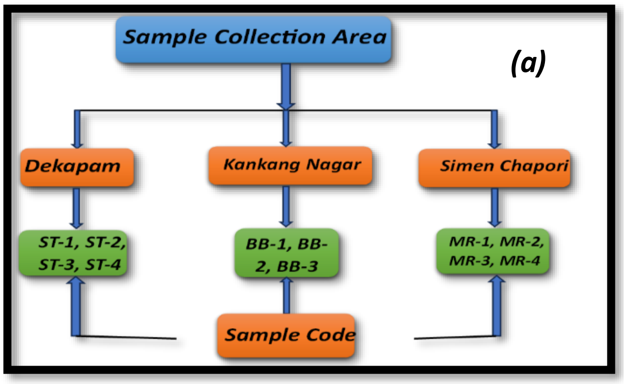
4. Methodology

- Sterilized and disinfected sample bottle will be used for sampling purpose.
- Analysis of various parameters will be carried out in the laboratory using the water testing kit.
- The observable parameters of the collected samples will be compared with the standard values.
- Analysis of water sample will be done to investigate its utility in various sectors.
- Analysis the factors responsible for pollution of water.

5. Study Area

5.1 Selection of study area

The study area, Silapathar and Simen Chapori was selected for this study because of the fact that ground water sources are extensively used for drinking and domestic purposes. The ground water quality of some areas appeared to be poor, because of extracting the color of ground water which changes yellowish color in some hours.



(b)

Water Sample Sources

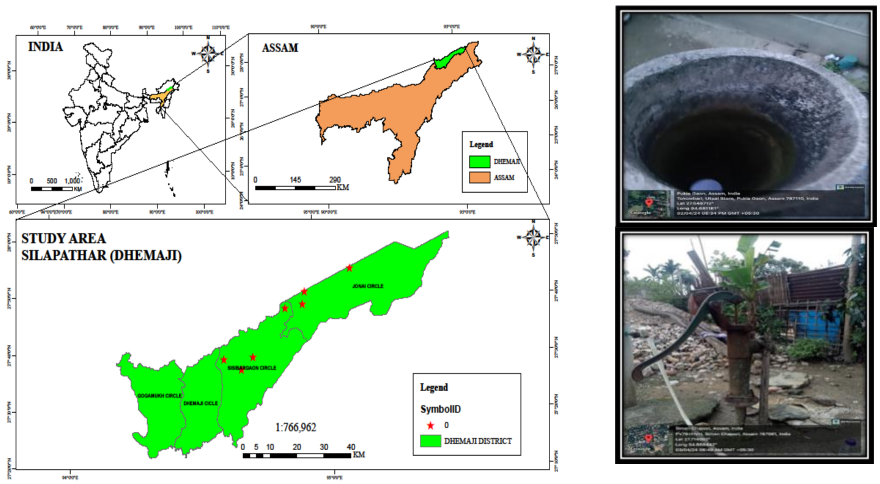
Sample code	Source	Sample code	Source	Sample code	Source
ST-1	Hand Pump	MR-1	Hand pump	BB-1	Hand pump
ST-2	Hand pump	MR-2	Hand pump	BB-2	Ring Well
ST-3	Ring Well	MR-3	Ring Well	BB-3	Ring Well
ST-4	Hand pump	MR-4	Ring Well		

Fig 1: (a) Naming of Collected Samples, **(b)** Sources of the Samples

5.2 Location

Silapathar is located in the Dhemaji district of Assam. The Dhemaji district is situated in the eastern parts of India on the northeast corner of Assam. Located between mighty river Brahmaputra and Himalayan foothills of Arunachal Pradesh, the district is largely plain with some hills. The district is located between 270 05/27// and 270 57/ 16// northern latitudes and 940 12/18// and 950 41/ 32// eastern longitudes. The district consists two sub-divisions viz. Dhemaji and Jonai and is divided into five development blocks viz. Dhemaji, Sissiborgaon, Bordoloni, Machkhowa and Morkongselek. Sampling points were carefully chosen in order to assess the general characteristics of ground water quality in Silapathar and its environs.

(a)



(b)

Fig 2: (a) Map showing Sample Collection Sites, **(b)** Sources of BB-2 and ST-1

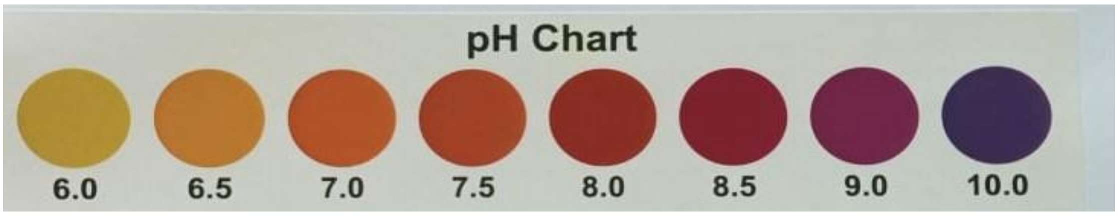
6. Experimental Procedures

The water samples were analysed for various parameters using water testing kit provided by PHED, Dhemaji. Various physical and chemical parameters like Temperature, pH, Turbidity, Total Dissolved Solids (TDS), Hardness, Chloride, Alkalinity, sulphate have been monitored for the ground water of different locations by using the water testing kit.

Fig 3: Water Testing Kit provided by PHED, Dhemaji

6.1. Test for Water PH:

- 4ml of water sample was taken in a small screw cap bottle to mark.
- Added 1 drop of reagent from Bottle no.1 and mixed it gently.
- Comparing the colour developed in the tube with the color chart to find out the pH value.



6.2. Test for Turbidity:

- Filled a glass cylindrical tube with 100ml of water to marked.
- The tube was placed on the dotted turbidity estimation chart-A.
- The tube was looked down at the dots to examine the difference in clarity.

6.3. Test for hardness:

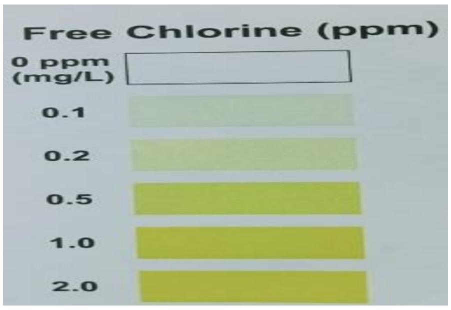
- 10ml of water sample was taken in the "T" marked glass bottle.
- Added 3-4 drops of reagent from Bottle no.2 and mixed properly for half minute.
- Now added reagent from Bottle no.3 dropwise (1 drop at a time) till the colour of the sample changes from wine red to blue.
- The number of drops consumed and multiply with 20 to know the total hardness as $CaCO_3$ in ppm.

6.4. Test for Chloride:

- 5ml of water sample was taken in the "T" marked glass bottle.
- Added 2 plastic spoon of reagent from Bottle no.4 and mixed properly the sample will turn blue to purple.
- Now while shaking and added 1 or 2 drops of reagent from Bottle no 5 till the colour of the sample changes to golden yellow.

- Now added reagent from bottle no 6 drop wise (one drop at a time) till the first colour change is observed. (colour change would be from golden yellow to purple).

- The number of drops counts and multiply with 20 to know the chlorides in ppm.



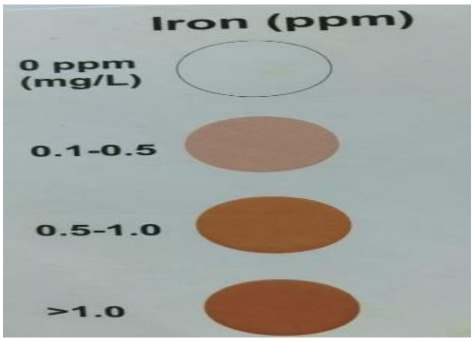
6.5. Test for Iron:

- 10ml of water sample was taken in the black screw capped glass bottle.

- 4 drops of reagent were added from Bottle no.9 and allow it to react for 2-3 minutes with gentle mixing.

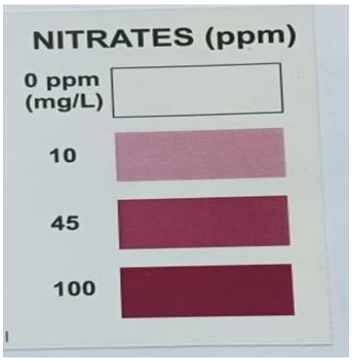
- 2 levels of plastic spoons of reagent from Bottle no.10 and mixed it till the powder gets dissolved completely.

- After 5 minutes of comparing the developed colour from the top of the tube with the colour chart and noted down the iron concentration in ppm.



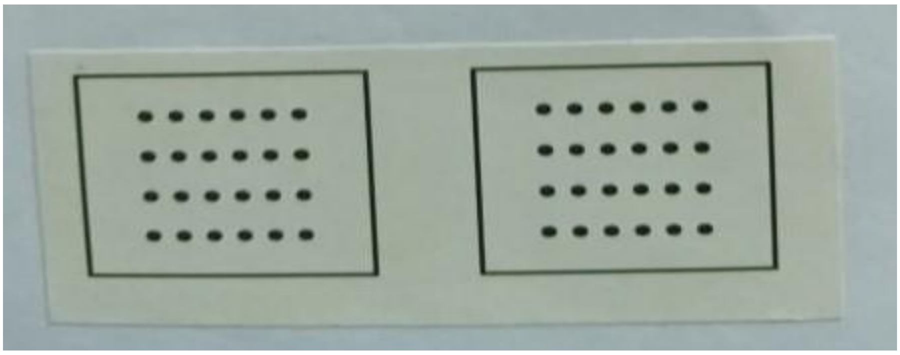
6.6 Test for Nitrate:

- 10ml of water sample was taken in the black screw capped bottle.
- 1level plastic spoon of reagent from **Bottle no.SA** and 2 plastic spoons of reagent from **Bottle no.11**
- The plug and capped replaced and mixed till the powder get dissolved completely.
- After 10 minutes, immediately compared the colour developed from the sides of the bottle with the colour chart and note down the concentration of nitrate in ppm



6.7 Test for Alkalinity:

- 10ml of water sample was taken in the "T" marked glass bottle.
- Add one level plastic spoon of powder reagent from Bottle no.7and mixed properly so that blue colour appear.
- Added reagent from Bottle no.8 drop wise till the colour of the sample changes from blue to reddish pink colour.
- The number of the drop consumed and multiply with 25 to know the total alkalinity as mg/L.



6.8 Test for Sulphate:

- 1ml of water sample was taken in a 10ml black capped glass tube.
- 10ml of distilled water was added to fill the volume.
- Added 1 level steel spoon of reagent from Bottle no.12
- Shaked gently to dissolved and kept it for 5 minutes.
- After 5 minutes, placed the tube on the dotted chart and observed from the tap at normaleye level.

6.9. Test for TDS (Total dissolve solid):

- Calculation for TDS (ppm) as per Formula given below

  TDS(PPM) = (Hardness + chloride + Alkalinity) ×1.2

Depending on the intended water parameters of concern, chemical, physical, and biological characteristics of water were analysed or monitored. Turbidity, pH, conductivity, total dissolved solids, temperature and dissolved oxygen were the major parameters that were commonly measured for water quality.

Parameters	WHO – standard		BIS -Standard
	HDL	MPL	
Odour	Unobjectionable		Unobjectionable
Turbidity NT units	5	10	1
Total dissolved solids mg/L	500	2000	500
Electrical conductivity in µS/cm	Nil	Nil	Nil
Chemical parameters			
pH	6.5-9.5	No relaxation	6.5-8.5
Alkalinity total as $CaCO_3$ (mg/L)	200	600	200
Total hardness as $CaCO_3$ (mg/L)	300	600	200
Calcium as Ca^{2+} mg/L	75	200	75
Magnesium as Mg^{2+} mg/L	30	150	30
Sodium as Na^{+} mg/L	Nil	Nil	Nil
Potassium as K^{+} mg/L	Nil	Nil	Nil
Iron as Fe^{2+} mg/L	0.3	1.0	0.1
Manganese as Mn^{2+} mg/L	0.1	0.1	0.05
Chromimum as Cr^{3+} mg/L	Nil	Nil	Nil
Nitrite as NO_2 mg/L	Nil	Nil	Nil
Nitrate as NO_3^- mg/L	50	No relaxation	45
Chloride as Cl^- mg/L	250	1000	200
Fluoride as F^- mg/L	1	1.5	1
Sulphate as SO_4^{2-} mg/L	200	400	200

Table 1: General parameters with respect to drinking water quality

7. Results and Discussions:

7.1. pH

pH stands for power of hydrogen. The pH specifies the strength of the water to react with the acidic or alkaline material present in the water. It is measured by carbon dioxide, carbonate and bicarbonate equilibrium. The combination of CO2 with water forms carbonic acid, which affects the pH of the water. For practical purposes, the pH of a solution is calculated using the negative logarithm of the hydrogen ion. The ranged of pH between 0 to 7 indicates acidic nature, similarly pH between 7 to 14 indicates alkaline nature, pH of 7 determines neutral behavior. The permissible limit of pH set by the BIS for drinking water is 6.5 to 8.5. Water below 6.8 is beyond slightly acidic and approaching extremely corrosive (4.0-5.9). Green stains on sinks indicates this condition of corrosiveness of porcelain. Water with a pH above 7.2 will leave deposits such as calcium and magnesium that will, over time, clog the pipes. The present study reveals thar the sample ST1 (Tap) has the highest pH value of 8.5 and ST3, MR1 and MR2 (Hand pum p) have the lowest value of pH 6.

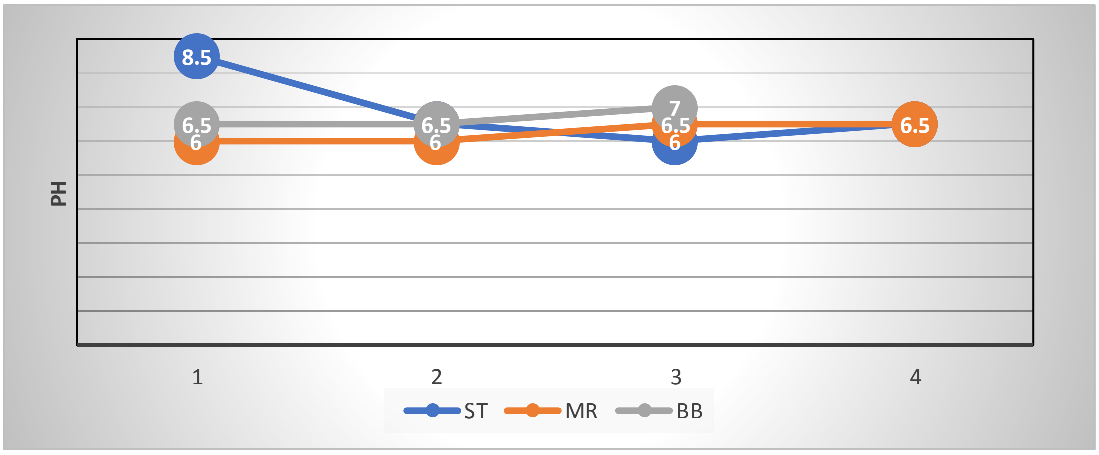


Fig 4: pH of collected samples

7.2. Turbidity

Turbidity is a particle suspension in water that prevents light from passing through. A wide range of suspended particles can create turbidity and it can be quantified using a variety of methods, by turbid meter or by methodology of attenuation of beam of light. The unit of turbidity is N.T.U. (Nephlometric turbidity unit). Permissible limit is set by BIS for drinking water and groundwater is 5 NTU and 10 NTU. The present work finds the sample ST2 has the highest turbidity value and it is due to Colloidal and extremely fine dispersion. The other samples have the values within the permissible limit. (Table 3). If we observe the source, then it can be observed that the samples from ring well have lower value of turbidity in comparison to the other sources.

Sample code	Turbidity (NTU)	Sample code	Turbidity (NTU)	Sample code	Turbidity (NTU)
ST-1	0 to 5	MR-1	5.0	BB-1	0
ST-2	25	MR-2	5.0	BB-2	0
ST-3	0 to 5.0	MR-3	5.0	BB-3	0
ST-4	10	MR-4	0 to 5.0		

Table 2: Turbidity of water samples

7.3. Total Hardness (TH)

"Hardness" refers to the amount of calcium and magnesium in the water and is measured in grains per gallon. The TH can be classified as soft, if the TH is less than 75 mg/L; moderately hard, if the TH is varied from 75 to 150 mg/L; hard, if the TH is between 150 and 300 mg/L; and very hard, if the TH is more than 300 mg/L (Davis and Dewiest 1966). From the Table no. 4, it can be seen that sample B1 is hard, the samples ST1, ST2, BB2, BB3, MR1, MR3 and MR4 are moderately hard., ST3, ST4 and M2R can be classified as soft.

Sample code	Hardness	Sample code	Hardness	Sample code	Hardness
ST-1	120ppm	MR-1	80ppm	BB-1	240ppm
ST-2	100ppm	MR-2	60ppm	BB-2	140ppm
ST-3	60ppm	MR-3	120ppm	BB-3	80ppm
ST-4	60ppm	MR-4	120ppm		

Table 3: Hardness of water samples

7.4. Chloride ion

Chloride ion is an anion of chlorine which forms negative charged particle of salt which includes hydrogen and sodium salts. Chloride Higher concentration of chloride in water is often found in combination with higher sodium concentration. BIS has prescribed 250 mg/l as the maximum permissible value. Sources of chlorides are from soluble salts such as sodium chloride. From our present work, it can be observed that all the samples have very low values of chloride ion.

Sample code	Chloride	Sample code	Chloride	Sample code	Chloride
ST-1	20mg/L	MR-1	20mg/L	BB-1	20mg/L
ST-2	20mg/L	MR-2	40mg/L	BB-2	20mg/L
ST-3	40mg/L	MR-3	20mg/L	BB-3	40mg/L
ST-4	20mg/L	MR-4	20mg/L		

Table 4: Chloride concentration of water samples

7.5. Iron Test

Iron is the second most abundant metal in the earth's crust. Dissolved iron in water, causes the water to taste metallic. The water may also be discolored due to suspended solids containing minerals of iron that appear brownish in color. Iron will leave red or orange rust stains in the sink, toilet and bathtub. The permission limit for iron content is 0.1 mg/l. **The samples ST2 and ST4 have iron content above the permissible limit.**

Sample code	Iron	Sample code	Iron	Sample code	Iron
ST-1	0.0 ppm(mg/L)	MR-1	0 ppm(mg/L)	BB-1	0.1 ppm(mg/L)
ST-2	1.0 ppm(mg/L)	MR-2	0 ppm(mg/L)	BB-2	0.1 ppm(mg/L)
ST-3	0 ppm(mg/L)	MR-3	0 ppm(mg/L)	BB-3	0.0 ppm(mg/L)
ST-4	0.1 ppm(mg/L)	MR-4	0 ppm(mg/L)		

Table 5: *Iron Content of water samples*

7.6. Nitrate Test

Nitrate is the combination of oxygen and nitrogen. The permissible limit for Nitrate as per BIS is 45 mg/l. Nitrate The total concentration of nitrate is 47 mg/**l (Table: 2).** Our study finds all the samples are within the permissible limit. High level of Nitrate encourages growth of algae and other organism's types here.

Sample code	Nitrate	Sample code	Nitrate	Sample code	Nitrate
ST-1	0 ppm	MR-1	0 ppm	BB-1	10 ppm
ST-2	0 ppm	MR-2	0 ppm	BB-2	0 ppm
ST-3	0 ppm	MR-3	0 ppm	BB-3	0 ppm
ST-4	0 ppm	MR-4	0 ppm		

Table 6: Nitrate concentration of water samples

7.7. Alkalinity Test

The total of water elements that tend to boost pH to the alkaline side of neutrality is known as alkalinity. It's usually given in milligrams per litres of $CaCO_3$.The permitted limit of alkalinity for drinking water defined by BIS is 200 mg/l. It Shows the presence of bicarbonates, carbonates and hydroxides. Above the permissible limit, the taste of water turns into unpleasant. High alkalinity should be modified for both economic and health concerns. In the present work, the alkalinity of all the samples is within permissible limit.

Sample code	Alkalinity mg/L	Sample code	Alkalinity mg/L	Sample code	Alkalinity mg/L
ST-1	125mg/L	MR-1	100mg/L	BB-1	125mg/L
ST-2	150mg/L	MR-2	75mg/L	BB-2	150mg/L
ST-3	75mg/L	MR-3	125mg/L	BB-3	125mg/L
ST-4	125mg/L	MR-4	100mg/L		

Table 7: Alkalinity of water samples

7.8. TDS Test

TDS stands for total dissolved solids and is used to calculate filterable solids by subtracting total solids from suspended solids. Conductivity measurements can also be used to estimate it in a water sample. The acceptable limit for TDS as per BIS for drinking water is 500mg/l.

Sample code	TDS mg/L(ppm)	Sample code	TDS mg/L(ppm)	Sample code	TDS mg/L(ppm)
ST-1	318 mg/L(ppm)	MR-1	220 mg/L(ppm)	BB-1	462 mg/L(ppm)
ST-2	324 mg/L(ppm)	MR-2	190 mg/L(ppm)	BB-2	372 mg/L(ppm)
ST-3	210 mg/L(ppm)	MR-3	318 mg/L(ppm)	BB-3	294 mg/L(ppm)
ST-4	246 mg/L(ppm)	MR-4	288 mg/L(ppm)		

Table 8: TDS values of water samples

7.9. Sulphate Test

The nitrogen fertilizers and gypsum are the main sources of oxyanions in soil which leads to the pollution of water bodies as well as ground water. The BIS limit is 200 mg/l. The probable sources for sulphate ion in the study area are fertilizers, domestic wastes etc. However, in our work, sulphate ions are within the permissible limits.

Sample code	Sulphate mg/L	Sample code	Sulphate mg/L	Sample code	Sulphate mg/L
ST-1	100 mg/L	MR-1	100 mg/L	BB-1	100 mg/L
ST-2	100 to 200 mg/L	MR-2	100 to 200 mg/L	BB-2	100 mg/L
ST-3	100 mg/L	MR-3	100 mg/L	BB-3	100 mg/L
ST-4	100 to 200 mg/L	MR-4	100 to 200 mg/L		

Table 9: Sulphate ion concentration of water samples

8. Conclusions

The ground water samples were analyzed for physico-chemical study for its suitability for human consumption and agriculture. The assessment of the physico- chemical parameter concentration in groundwater in Silapathar and Simen Chapori area, revealed the following recommendations and conclusions:

1. The evaluation of physico-chemical parameter concentration in 11 groundwater samples has provided useful insight into the extent of physico-chemical parameter toxicity in the study area. It was found that physico-chemical parameter turbidity in the samples from ring well have lower value of turbidity in comparison to the other sources.

2. The test result of pH reveals that the sample from tap water has the highest pH value of 8.5 and the samples from hand pump have the lower value.

3. The sample from Kangkan Nagar, Silapathar area is categorized as hard water from the total hardness value. The samples have the values within permissible limit.

4. The chemical parameters chloride, nitrate, alkalinity, sulphate, TDS are all within the permissible limit of WHO.

5. The samples ST2 and ST4 from Dekapam area have iron content above the permissible limit. The sample sources are handpump.

All over study represents that some of samples have poor quality for consumption and required regular monitoring for avoid further contamination. From the analysis, it is observed that some of the samples are safe for drinking purpose. But, in case of the samples having high iron content, the people should use filter for safe drinking water. There is an increasing risk of groundwater pollution not only in municipal areas but also in rural areas. To recover from the risk of further contamination and improve groundwater quality, the following recommendations can be concluded.

(a) quality of groundwater sources i.e. dug wells and boreholes, should be frequently checked in both urban and rural areas and awareness programs should be organized on the importance of drinking water quality.

(b) The water purification setup from the government must be in good condition and functional.

(c) efficient, economical and environmentally-friendly sewerage systems should be designed.

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Public Health Engineering Department (PHED), Dhemaji, for providing water testing kit and training to us to carryout the work. We would wish to express our sincere obligation to Dr. L.N. Pegu, Principal, Silapathar College, Silapathar.

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