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Water Quality Analysis Of Ground Water Sources In Nalbari District, Assam

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ABSTRACT
The Nalbari District is situated in between 26°N and 27° N latitude and 91° E and 97°E longitude. The north and west side of the district is bounded by Baksa and Barpeta district Barpeta respectively. The southern and eastern side of the district is bounded by Kamrup district. Nalbari district with a geographical area of 1009 sq. km., a thick populated district of Assam. The district area forms a part of great Brahmaputra valley. In 2011 census Nalbari had population of 771639 of which male & female were 396006 and 375633 respectively. There was change of 11.99 percent in the population compared to population as per 2001. The District's population expansion has rendered the water supply plans run by the Municipal Board and PHE Department insufficient. As a result, the majority of the District's population is forced to use groundwater sources including hand tube wells, tara hand pumps, singur hand pumps, and others. For these water sources, a number of water quality parameters have been measured using standard techniques, including water temperature, pH, arsenic, iron, total hardness, DO, fluoride, BOD, total coliform, and TDS. These properties have been discovered to vary with time and location, and the differences have been explained. To determine the level of contamination in these water bodies, statistical techniques have been used to compare the results with the water quality criteria. In the Nalbari District, ten sampling stations in all were considered for the pre-monsoon, monsoon, and post-monsoon seasons.

INTRODUCTION:

There are two main sources of water: surface water and groundwater. Surface water is found in lakes, rivers, and reservoirs. Groundwater lies under the surface of the land, where it travels through and fills openings in the rocks. Water covers almost 71% of the earth's surface (Water vapor in the climate system,1995).On earth, it is found mostly in oceans, seas and other large bodies, with 1.6% of water below ground in aquifers and 0.001% in the air as vapour, clouds and precipitation. Adequate water resources for future generations are not only a regional issue but also a global concern Safe drinking water is a fundamental need of every human being despite of any socio economic status. The provision of clean drinking water has been given priority in the Constitution of India, with Article 47 conferring the duty of providing clean drinking water and improving public health standards to the State. The government has undertaken various programmes since independence to provide safe drinking water to the rural masses. Till the 10th plan, an estimated total of Rs.1,105 billion spent on providing safe drinking water. One would argue that the expenditure is huge but it is also true that despite such expenditure lack of safe and secure drinking water continues to be a major hurdle and a national economic burden. On one hand the pressures of development is changing the distribution of water in the country, access to adequate water has been cited as the primary factor responsible for limiting development.

Absolutely pure water is rarely found in nature. The impurities occur in three states- suspended, colloidal and dissolved. These may be present also in floating state. These impurities can basically be categorized according to their sizes. The health and happiness of the human race are closely related with the quality of drinking water. Man's requirement of water for drinking purpose score over all other uses of water. The mean daily intake of water by man is estimated to be 3.1 percent of the body weight. Thus, water for drinking and culinary purposes must not contain harmful substances that causes adverse physiological effects but at the same time, should be aesthetically acceptable to the consumer. Such water is termed as 'safe water' signifying that its consumption in any desirable amount will not impair health;

rather promote the health of the community. The safe water must be free from bacteriological & chemical contamination and must be good for housekeeping, palatable and odour free.

Although appearance, test and odour are useful indicators of the quality of drinking water, suitability in terms of Public Health is determined by micro biological, physical, chemical and radiological characteristics. Of these, the most important is microbiological quality. Also a number of chemical contaminants (Both inorganic & organic) may be found in water. Both bacteriological and chemical contamination of drinking water cause deleterious effect on human health.

The drinking water should be

a) Free from pathogenic (disease causing) organisms.
b) Clear & transparent.
c) Not saline. (Salty).
d) Free from offensive test and smell.
e) Free from chemical contaminations that may have adverse effects on human health.
f) Free from chemicals that may cause corrosion to pipe and appurtenances or stains clothes / utensils etc.

In Assam also, the contamination of ground water with excess Fluoride and Arsenic has become a major cause of concern coupled with the inherent problems of iron in almost all districts. In the year 1999, reports of presence of excess fluoride in ground water in Karbi Anglong and Nagaon district a serious threat.

A REVIEW OF LITERATURE

Water is a scarce & fading resource (Wetzel 1992, Niaman, 1996) & its management an impact on the flow and the biological quality of rivers and streams (Walmsley,1995; Tricot 1993).In Mediterranean areas, water has been one of the limiting factors of economic activity for many years.(Gleick, 1993, Hamdy et al 1995) even in the large rivers (Conway et al,1996) Ground water is only source of water supply through out the world. For many rural and small communities, ground water is the only source of drinking water (Canter 1987). The ground water chemistry is controlled by composition of its recharge components as well as by geologic and hydrologic variations within the aquifer (Narayana et al 1989). Bhuyan (1970) determined the physico chemical qualities of the water of twenty ancient tanks in Shibsagar, Assam. He found that, such tanks were slightly acidic with low alkalinity and they are potentially rich in essential nutrient elements. Desai (1982) studied the physical, chemical and bacteriological test for drinking water, which is one of the factors determining water qualities. He describes the Hazardous level of pollution in water, which may affects public health. Mori et al (1979) determined the metals like Na, K , Mg, Ca, Fe, Cu, Ph and Cl and NH_4-N IN the surface water of the ISUMI river, Japan, which was flowing by the Iodine factories. They found high concentration of Na and Cl in the river water, which are most typical characteristics of the wastewater of the Iodine factories.

Handa et al (1982) studied the pollution of ground water by nitrates in Uttar Pradesh. They found that pollution of natural water in the phreatic zone of the region areas occurring to an alarming extent. This pollution increased with passage of time due to increase of population and increasing use of nitrogen fertilizers.

Wells, tanks, ponds and rivers are main sources of water in rural India. But due to the short supply of municipal water, majority of city or town people are also to depend on these sources. Polluted water due to surface drainage collects in the ponds. The rainwater carries vegetables substance; unused fertilizers from fields to the pond and pollutes the water.

Heavy Metal are considered as major environmental pollutants and regarded to be Cytotoxic, Mutagenic, and Carcinogenic. The Heavy Metal pollution of natural environment has been consistently increasing through effluents, sedimentation of rocks and mining activities. High concentrations of all heavy metals are toxic to biological systems by (Ahluwalia and Manjit, 1988) were studied and same worked was also done by (Rai et al., 1981) in—Phycology and Heavy Metal Pollution

The WHO has given a set of guideline values for drinking water qualities. The guideline values for each water quality parameter sets out the level of concentration of the constituent ensuring aesthetically pleasant water without any significance risk to human health (WHO, 1984; Helmer et al 1991). These guideline values, along with tolerance limits prescribed by the Indian standard institute (Trivedy 1990) & EPA standards USA (Train, 1979) .

STUDY AREA

The Nalbari District is situated in between 26ºN and 27º N latitude and 91º E and 97ºE longitude. The northern side of the district is bounded by the Baksa District and the southern side by the mighty Brahmaputra. The Kamrup District falls in the east and the Barpeta The entire area of Nalbari District is situated at the plains of the Brahmaputra valley. The tributaries of Brahmaputra namely Buradia, Pagaldia, Borolia and Tihu which originate from the foothills of the Himalayan Range are wild in nature. These rivers have enormous contribution towards the agrarian economy of the district.

Major Rivers of the District

1. Brahmaputra
2. Mara Pagaldia
3. Burhadia
4. Nona
5. Tihu River

AIMS AND OBJECTIVES

The primary goal of groundwater quality analysis is to determine its suitability for drinking, based on physical and chemical properties. The Bureau of Indian Standards (IS:10500:1991) classifies groundwater as desirable, permissible, or unfit for consumption. Clean drinking water is essential for life and has long been recognized in developed countries as a basic right and a preventive health measure. In Nalbari district, rising population and industrial growth have strained existing water supply systems, forcing residents to rely on hand pumps and tube wells, whose water quality is increasingly suspected to be deteriorating.

In this study, attempt has been made to find out water quality of a few water bodies like Hand Tube Well, Tara Hand Pump which is common water source of the District. For this purposes, HTW and THP namely Nalbari Basic School, Bonbhag Khata High School, Kothra Primary ME School, Guwakuchi Post Office , Banekuchi Chowk , Barbhag Chowk, Karia Hathbazaar, Sandheli L P School, Panigaon Market and Balilecha Mandir have been selected.

The water quality of the above stated water bodies, are assessed at regular intervals ten parameters like Water temperature, pH, Arsenic, Iron, Total Hardness, DO, Fluoride, BOD, Total Coliform and TDS.

Variation of these water quality parameters in respect of time and places are found out and the differences explained by the statistical methods.

MATERIALS AND METHODS

The sample of water for chemical analysis were collected from different sources such as Hand Tube Well and Tara Hand Pump and transported to the laboratory for analysis observing all the guide line. Analysis was made for the parameters such as Water temperature, pH, Arsenic, Iron, Total Hardness, DO, Fluoride, BOD, Total Coliform and TDS.

2.2 SAMPLING POINT

The following sources are selected for sampling.

Sampling Points

1. Nalbari Basic School ------ HTW(Hand Tube Well)
2. Bonbhag Khata High School ------ THP(Tara Hand Pump)
3. Kothra Primary ME School -- HTW
4. Guwakuchi Post Office ------ HTW

5.	Banekuchi Chowk	---	---	HTW
6.	Barbhag Chowk	---	---	HTW
7.	Karia Hathbazaar		---	HTW
8.	Sandheli L P School		---	HTW
9.	Panigaon Market		---	THP
10.	Balilecha Mandir	---	---	THP

2.3 COLLECTION OF SAMPLE

Samples were collected, stored and dispatched in suitable sterilized bottles. The volume of water collected adequate enough to permit an accurate analysis. The sampling point is selected to represent sufficient possible area of the district. In order to prevent significant alternation in the composition of a collected sample prior to analysis, the sample is dispatched to laboratory under the Iced condition as soon as practicable. The samples are collected once in pre monsoon, monsoon and post monsoon i.e. May, July & October. The dates of sampling are 10^{th} May, 8^{th} July and 8^{th} October, 2024. Plastic bottles were used to collect the water sample for chemical analysis. All samples are taken from ground water for each source and identified the sources by attaching a label in the body of the bottle.

Sample pre treatment and storage

Determination of some parameters is affected by sample storage and these need to be estimated immediately after collection. For example, certain cations are subject to loss by adsorption on, or ion exchange with, the walls of the glass containers. These include aluminum, cadmium, chromium, copper, iron, lead, manganese, silver and zinc. The water samples immediately after collection were acidified to a pH < 2.0 (APHA, 1995) by adding 1.5 mL concentrated HNO_3 /L or an appropriate volume required to achieve the desired pH. After acidification, the samples were stored in a refrigerator at ~ 4oC.

Some of the parameters need to be determined immediately after collection while others require certain precautionary measures. Both temperature pH may change significantly in a matter of minutes. To avoid this, temperature (^{0}C) and pH of the water samples were measured on the spot with the help of a thermometer and portable pH meter (Philips). Dissolved gases (oxygen, carbon dioxide) may be lost during transit, temperature change and standing over a length of time. To eliminate these sources of error in measurement, DO was fixed on the spot by following azide modification method.

Iron and manganese are readily soluble in their lower oxidation states but relatively insoluble in their higher oxidation states; therefore these cations may precipitate or they may dissolve from sediment, depending on the redox potential of the sample.

Colour, odour and turbidity may increase, decrease, or change in quality if the same were not measured immediately.

To avoid the above uncertainties related to measurement of different parameters, some of the parameters like total dissolved solids (TDS), and hardness were determined in the laboratory within twenty-four (24) hours of collection. The parameter F^- is measured within one week after preserving the samples according to standard methods (APHA, 1995).

2.4 SAMPLING TIME

Sampling time was uniformly maintained from 8 A.M. to 9.30 A.M.

2.5 CHEMICAL ANALYSIS

(1) Water Temperature :

For determination of ground water temperature, water samples are collected in a bucket and temperature is measured with a mercury thermometer.

(2) pH:

pH is the negative $\log_{10}$ of the hydrogen ion concentration ion solution. Electrometric methods are used employing the hydrogen sensitive electrode. It is measured with the help of a digital pH meter.

In this work, pH was determined immediately after water sample collection with a digital pH-meter (Elico pH-Meter Model LI 127) using standard buffers for calibration purposes.

(3) Iron (Fe):

Iron is brought into solution and reduced to the ferrous state by boiling with hydrochloric acid and hydroxylamine and treated with 1, 10 phenonthroline at ph 3.2 – 3.3. Three molecules of phenanthrline chelate each atom of ferrous iron to form an orange-red complex. The coloured solution obeys Bee's law, and therefore, can be determined calorimetrically. The Iron content is calculated from the standard curve. The standard curve is prepared in the range of 1 to 4 mg/l of iron using various dilution of standard iron solution.

(4)Fluoride (F^-)

Fluoride was determined by Alizarin Red – S method using a UV- visible spectrophotometer (Hitachi 3210) at 520 nm. Sodium fluoride was used to prepare the standard solutions.

(5) Arsenic (As)

Water testing for Arsenic can either be done in a laboratory, where the water samples are delivered, or can be done using field-testing Kits. Each methodology has its own advantages and disadvantages that vary according to the resources available within each country.

(6)Total Dissolved Solids (TDS)

A well-mixed 100 ml sample was filtered through a standard glass filter, and the filtrate was evaporated to dryness in a pre-weighed borosil beaker on a hot plate. The residue in the beaker was then dried in an oven at 103^0-105^0 C till a constant weight was obtained. The increase in the beaker weight represents the total dissolved solids. The TDS is given by

$$\text{TDS, (mg/L)} = \frac{(A\text{-}B) \times 10^6}{V}$$

where A = Final weight of the beaker and residue in mg

B = Initial weight of the beaker in mg

V = Volume of the sample taken in ml.

(7)Total hardness

Total hardness is defined as the sum of the calcium and magnesium concentrations in the water sample and is expressed as milligram calcium carbonate per liter. Total hardness of the water samples was determined by EDTA complexometric titration using Eriochrome Black T indicator.

(8)Dissolved oxygen (DO)

Dissolved oxygen levels in natural water depend on the physical, chemical, and biochemical interactions taking place inside the water body. The analysis for DO is a key test in water quality studies. DO in the water samples was determined by azide modification method (APHA,1995) based on oxidation of Mn^{+2} to Mn^{+4} in alkaline medium by DO in water and then oxidation of I^- to free iodine in acidic medium by Mn^{+4}. The iodine released is titrated with a standard solution of sodium thiosulphate and the volume of thio used up is equivalent to DO originally present in the water sample. In this method, alkaline NaN_3 is used to destroy the interference of oxidizing agents such as nitrite.

(9)Biochemical Oxygen Demand (BOD)

The biochemical oxygen demand (BOD) determination is used to determine the relative oxygen requirement of wastewaters, effluents, and polluted waters. The test measures the oxygen utilization during a specified incubation period for the biochemical degradation of organic material and the oxygen used to oxidize inorganic material such as sulphides, and ferrous irons (APHA, 1989). It may also measure the oxygen used to oxidize reduced forms of nitrogen unless an inhibitor prevents their oxidation.

(10) Microbiological quality

Coliforms are a group of gram-negative, rod shaped bacteria that are nonpathogenic and nonspore forming. The most common coliform genera are *Escherichia, Enterobacter, Citrobacter, Serratia,* and *Klebsiella*, with *E. coli* being the most abundant in the gut of humans and other warm-blooded animals. Coliform bacteria are identified by their ability to ferment lactose to produce acid and gas within 48 h, when incubated at 35 °C. Because they are found in the intestines of humans, domestic animals, and wild animals, coliforms are shed in feces along with pathogenic organisms present in the gut of infected animals, and can be detected in water with relative ease; total coliforms have been used by the US Public Health Service since 1914 as the standard for sanitary quality of water.

Presence-Absence (P-A) faecal coliform test

The presence-absence (P-A) test for the coliform group associated with faecal wastes is a simple modification of the multiple tube procedure. In this method, one large test portion (100 mL) of the water sample is taken in a single culture bottle to obtain qualitative information on the presence or absence of coliform organisms. The method is based on the assumption that not a single coliform organism should be present in 100 ml of drinking water samples.

3.1 ANALYSIS

For analysis of data for various parameters, statistical term such as correlation co-efficient(r) determination was performed. Samples of water were taken from three seasons namely Pre Monsoon, Monsoon and Post monsoon for analysis of various parameters of Ground water.

Analysis of water samples taken from the different sources is given in the table no 3.1 to 3.10. Each table gives all season average values for each water source along with the standard deviation (S.D.).

Table 3.1 **Results of Analysis of various Parameters**

Sources: HTW- (Nalbari Basic School)

Parameter	May (Pre monsoon)	July (Monsoon)	October (Post monsoon)	Average	Standard Deviation
pH	6.7	6.5	6.75	6.5	0.1848
Temperature °C	23	24	22	22.33	1.2472
Total Dissolved Solids (mg/l)	651	663	649	654.33	6.1824
Iron (mg/l)	0.05	0.04	0.06	0.05	0.0081
Fluoride (mg/l)	0.41	0.30	0.41	0.373	0.0518
Arsenic (mg/l)	0.009	0.01	0.01	0.0096	0.0005
Total Hardness (mg/l)	128	125	124	125.66	1.6996
D.O. (mg/l)	7.0	6.9	7.1	7.0	0.0816
B.O.D. (mg/l)	0.6	0.7	0.59	0.63	0.0496
Total Coliform /100 ml	BDL	BDL	BDL	BDL	BDL

Table 3.2 **Results of Analysis of various Parameters**

Sources : Tara Hand Pump- (Bonbhag Khata High School)

Parameter	May (Pre monsoon)	July (Monsoon)	October (Post monsoon)	Average	Standard Deviation
pH	6.16	6.2	6.0	6.12	0.08640
Temperature °C	22	24	23	23	0.7071
T DS (mg/l)	660	670	649	659.66	8.5764
Iron (mg/l)	0.6	0.7	0.6	0.45	0.2811
Fluoride(mg/l)	0.30	0.40	0.41	0.37	0.2186
Arsenic (mg/l)	0.005	0.01	0.001	0.0053	0.00365

Total Hardness (mg/l)	48	40	45	44.33	3.2998
D.O. (mg/l)	10.00	8.9	9.1	9.33	0.3880
B.O.D. (mg/l)	0.4	0.6	0.59	0.53	0.0920
Total Coliform /100 ml	BDL	BDL	BDL	BDL	BDL

Table 3.**Results of Analysis of various Parameters**
Sources : Hand Tube Well- (Kothra Primacy ME School)

Parameter	**May (Pre monsoon)**	**July (Monsoon)**	**October (Post monsoon)**	**Average**	**Standard Deviation**
pH	6.7	6.5	6.75	6.5	0.1848
Temperature °C	24	25	22	23.66	1.2472
Total Dissolved Solids (mg/l)	500	521	529	516.66	12.2323
Iron (mg/l)	0.6	0.7	0.5	0.6	0.0816
Fluoride (mg/l)	0.31	0.25	0.40	0.32	0.0616
Arsenic (mg/l)	0.007	0.006	0.003	0.0053	0.0017
Total Hardness (mg/l)	116	125	120	120.33	3.6818
D.O. (mg/l)	12	11	7.10	10.03	0.5600
B.O.D. (mg/l)	0.4	0.9	0.59	0.63	0.2061
Total Coliform /100 ml	BDL	BDL	BDL	BDL	BDL

Table 3.4 **Results of Analysis of various Parameters**
Sources : Hand Tube Well- (Guwakuchi Post Office)

Parameter	**May (Pre monsoon)**	**July (Monsoon)**	**October (Post monsoon)**	**Average**	**Standard Deviation**
pH	6.39	6.5	6.51	6.46	0.05477
Temperature°C	22	25	23	23.33	1.2472
T.D.S (mg/l)	554	529	560	547.666	13.4246
Iron (mg/l)	0.4	0.35	0.38	0.376	0.02055
Fluoride(mg/l)	0.31	0.42	0.40	0.376	0.0478
Arsenic (mg/l)	0.004	0.006	0.003	00043	00013
Total Hardness(mg/l)	72	80	85	79.00	5.3541
D.O. (mg/l)	7.0	7.2	7.10	7.1	0.08124
B.O.D.(mg/l)	0.2	0.4	0.4	0.333	0.0943
Total Coliform /100 ml	BDL	BDL	BDL	BDL	BDL

Table 3.5
Results of Analysis of various Parameters
Sources : Hand Tube Well- (Banekuchi Chowk)

Parameter	May (Pre monsoon)	July (Monsoon)	October (Post monsoon)	Average	Standard Deviation
pH	6.68	6.6	6.51	6.59	0.0697
Temperature °C	23	25	22	23.33	1.2472
T. D.S. (mg/l)	650	700	639	663	26.5455
Iron (mg/l)	0.8	0.7	0.8	0.766	0.0471
Fluoride (mg/l)	0.21	0.20	0.20	0.2033	0.0047
Arsenic (mg/l)	BDL	BDL	BDL	BDL	BDL
Total Hardness (mg/l)	199	190	189	192.666	4.4969
D.O. (mg/l)	3.0	3.2	3.10	3.1	0.0816
B.O.D. (mg/l)	1.4	1.39	1.4	1.396	0.0047
Total Coliform /100 ml	BDL	BDL	BDL	BDL	BDL

Table 3.6 **Results of Analysis of various Parameters**
Sources : Hand Tube Well- (Barbhag chowk)

Parameter	May (Pre monsoon)	July (Monsoon)	October (Post monsoon)	Average	Standard Deviation
pH	6.47	6.60	6.50	6.52	0.0557
Temperature °C	24	25	23	24	0.8165
T D S (mg/l)	656	600	639	631.66	23.4426
Iron (mg/l)	1.0	0.90	1.0	0.966	0.0471
Fluoride (mg/l)	0.11	0.12	0.10	0.11	0.0057
Arsenic (mg/l)	BDL	BDL	BDL	BDL	BDL
Total Hardness (mg/l)	110	115	112	112.33	2.0548
D.O. (mg/l)	5.0	5.2	5.10	5..1	0.8165
B.O.D. (mg/l)	0.5	0.51	0.5	0.50	0.0057
Total Coliform /100 ml	32	40	28	33.33	4.9889

Table 3.7 **Results of Analysis of various Parameters**
Sources : Hand Tube Well- Karia Hathbazaar

Parameter	May (Pre monsoon)	July (Monsoon)	October (Post monsoon)	Average	Standard Deviation
pH	6.13	6.12	6.2	6.15	0.0356
Temperature °C	23	24	23	24	0.8165
T.D. S. (mg/l)	656	662	645	654.33	7.0396
Iron (mg/l)	BDL	BDL	BDL	BDL	BDL
Fluoride (mg/l)	0.10	0.12	0.10	0.11	0.0082
Arsenic (mg/l)	BDL	BDL	BDL	BDL	BDL

Total Hardness (mg/l)	221	229	223	224.33	3.3993
D.O. (mg/l)	8.0	9.2	10.1	9.1	0.8602
B.O.D. (mg/l)	0.49	0.51	0.53	0.51	0.0163
Total Coliform /100 ml	45	60	38	47.66	9.1773

Table 3.8 **Results of Analysis of various Parameters**

Sources : Hand Tube Well- (Sandheli L P School)

Parameter	**May (Pre monsoon)**	**July (Monsoon)**	**October (Post monsoon)**	**Average**	**Standard Deviation**
pH	6.88	6.87	6.7	6.8	0.0825
Temperature°C	23	25	23	23.66	0.9428
T. D. S. (mg/l)	556	560	545	553.66	6.3421
Iron (mg/l)	BDL	BDL	BDL	BDL	BDL
Fluoride (mg/l)	0.10	0.09	0.10	0.09	0.0082
Arsenic (mg/l)	0.006	0.005	0.005	0.005	0.0008
Total Hardness (mg/l)	168	170	181	173	5.7155
D.O. (mg/l)	3.0	3.2	3.1	3.1	0.0816
B.O.D. (mg/l)	0.51	0.69	0.53	0.576	0.0805
Total Coliform /100 ml	BDL	BDL	BDL	BDL	BDL

Table 3.9**Results of Analysis of various Parameters**

Sources : Hand Tube Well- (Panigaon Market)

Parameter	**May (Pre monsoon)**	**July (Monsoon)**	**October (Post monsoon)**	**Average**	**Standard Deviation**
pH	6.35	6.30	6.36	6.33	0.0271
Temperature°C	24	25	23	24	0.8165
T. D. S, (mg/l)	756	758	760	758	1.6329
Iron (mg/l)	BDL	BDL	BDL	BDL	BDL
Fluoride (mg/l)	0.09	0.08	0.10	0.09	0.0082
Arsenic (mg/l)	0.004	0.005	0.0049	0.0046	0.0005
Total Hardness (mg/l)	56	58	60	58	1.6329
D.O. (mg/l)	7.0	7.2	7.1	7.1	0.0816
B.O.D. (mg/l)	0.41	0.45	0.43	0.43	0.0163
Total Coliform /100 ml	BDL	BDL	BDL	BDL	BDL

Table 3.10 **Results of Analysis of various Parameters**

Sources : Tara Hand Pump- (Balilecha Mandir)

Parameter	**May (Pre monsoon)**	**July (Monsoon)**	**October (Post monsoon)**	**Average**	**Standard Deviation**
pH	6.30	6.30	6.31	6.30	0.00577

Temperature °C	25	25	24	24.66	0.4714
Total Dissolved Solids (mg/l)	456	458	465	459.66	3.8592
Iron (mg/l)	0.8	0.7	0.8	0.7666	0.0471
Fluoride (mg/l)	0.08	0.08	0.10	0.08	0.00476
Arsenic (mg/l)	0.002	0.003	0.001	0.002	0.00258
Total Hardness (mg/l)	36	38	37	37	0.8164
D.O. (mg/l)	5.0	5.2	6.1	5.43	0.4784
B.O.D. (mg/l)	0.31	0.40	0.43	0.38	0.0509
Total Coliform /100 ml	BDL	BDL	BDL	BDL	BDL

4. RESULTS AND DISCUSSION

Inter Source variation:

The physico chemical and bacteriological analysis of the water sample collected from the different sources are presented in Graphs and shown in Figure............

The figure from 1 to ...show that variation of water quality parameters with months.

The symbols are used in the figure in the following way :

1. Nalbari Basic School ---- --- NBS
2. Bonbhag Khata High School ---- --- BKH
3. Kothra Primary ME School --- --- KPS
4. Guwakuchi Post Office ---- --- GPO
5. Banekuchi Chowk ---- --- BKC
6. Barbhag Chowk --- --- BBC
7. Karia Hathbazaar --- ---- KHB
8. Sandheli L P School ---- --- SLS
9. Panigaon Market ---- --- PGM
10. Balilecha Mandir ---- --- BLM

Physical Characteristic:

Temperature:

The temperature increased up to 25^{0}c in almost all the locations during monsoon. The variation for pre monsoon is more significant than variation for post monsoon. This is due to scattered rainfall in few of the sampling points.

From the graph of water temperature (Fig-4.1), the temperature value of all the sources is not similar with ambient temperature. This is because the sources of water are ground water sources.

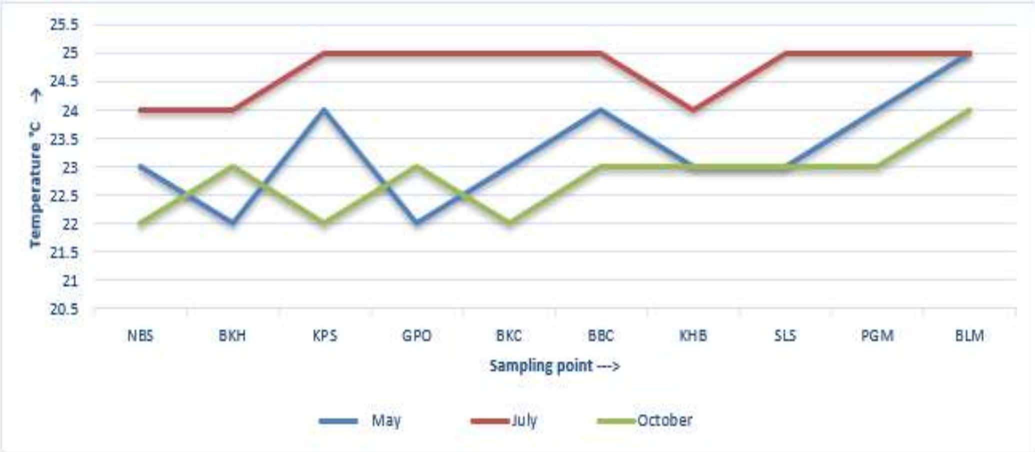

Fig 4.1- Variation of Temperatures

Odour:

Due to some odd odour , people may suffer from severe nasal itching that cause temporary and semi permanent discomfort (Young et al 1996).Chlorination may produce chlorine residues that are perceptible by the consumers, but lowering the chlorine does to overcome taste and odour problems must not compromise the microbiological safety of the water. Most of the times bacterial contamination is the cause of bad smell of water.

It is observed that the water in the Hand Tube well at Karia Hathbazaar, Tara Hand Pump of Bonbhag Khata High School and Tara Hand Pump of Panigaon Market is odourless and other sources have characteristic odour. This may be due to the high content of iron.

Colour:

The reddish colour of water may be due to the precipitated form of iron when exposed to air. It is found in ferrous state (Fe^{++}) in deeper layers of some water reserves lacking oxygen or in ground water, in which case it is in a reduced form (Fe^{++}) and often. Highly coloured water is objectionable for drinking and other uses and are also aesthetically unacceptable. Colour in water can be caused by a number of contaminations such as iron which changes in the presence of oxygen to yellow or red sediment. When chlorinated, colour causing organic matter may form chlorinated organic compounds such as trihalomethanes.

From visual eyes it is observed that the all the sample of water except Karia Hathbazaar, Sandheli LP School and Panigaon market are reddish in colour. This may be due to excess iron content in the sample of water.

Chemical Characteristics:

pH:

pH is the measure of the intensity of acidity or alkalinity.

$PH = -\log_{10} [H^+]$

pH scale ranges from 0 to 14 with 7 as neutral, below 7 being acid and above 7 alkaline.

The pH value of water sample shown in the Table and (Fig- 4.2). It is observed that the pH value of all the water sources is almost the same which lies between the ranges 6 to 6.9 and is acceptable as laid down by WHO for drinking water.

For effective disinfections with chlorine, the pH should preferably be less than 8.

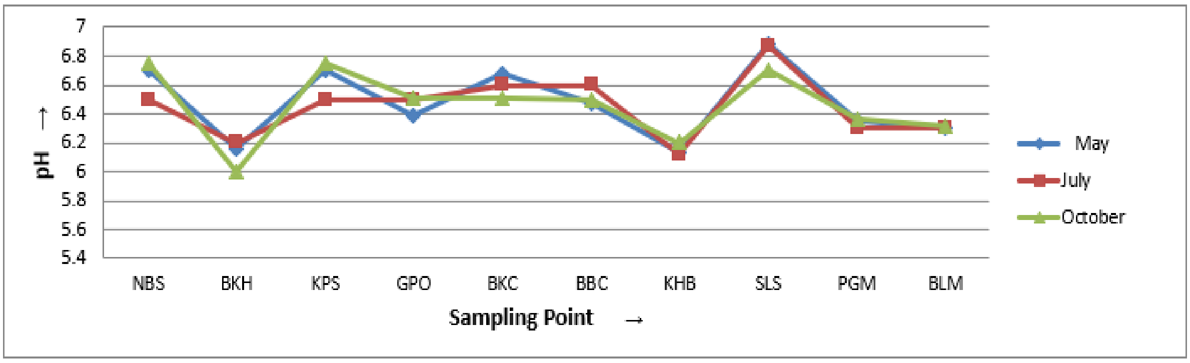

Fig 4.2- Variation of pH→

Arsenic (As):

Water with high concentrations of Arsenic, if used over 5- 20 years, results in problems such as colour changes on the skin, hard patches on palms and souls, skin cancer, cancers of the bladder, kidney, lung and diseases of the blood vessels of the legs and feet.

It has found from the Table and graph (Fig- 4.3), the value of Arsenic is below the guideline value laid down by WHO in almost all the sampling points.

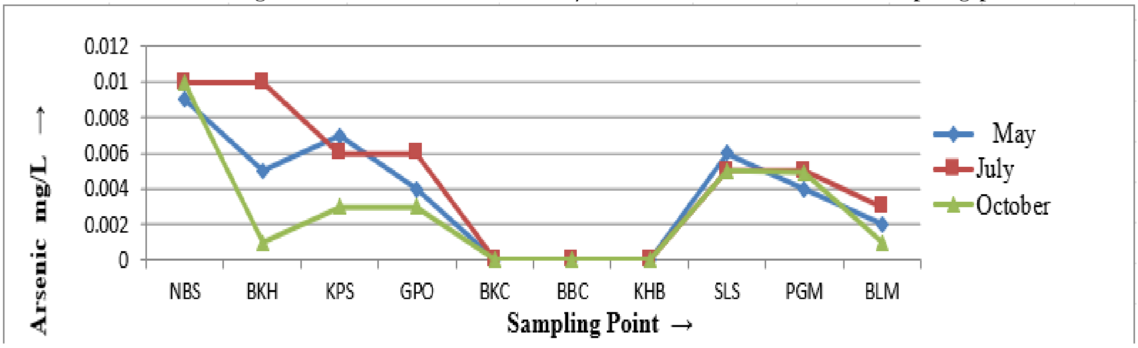

Fig4.3-Variation of Total Arsenic→

Fluoride (F⁻)

These studies clearly establish that fluoride primarily produces effects on skeletal tissues (bones and eeth). However, fluoride can also have an adverse effect on tooth enamel and may give rise to mild dental fluorosis (prevalence: 12–33%) at drinking-water concentrations between 0.9 and 1.2 mg/litre; the period of greatest susceptibility is at the time of mineralization of the secondary upper central incisor teeth at about 22–26 months of age.

However, concerns have arisen regarding fluoride's effect on health, including problems with bones, teeth, and neurological development.

It has been found from the Fig-4.4, the value of Fluoride in all sampling points are found within the permissible limit laid down by WHO.

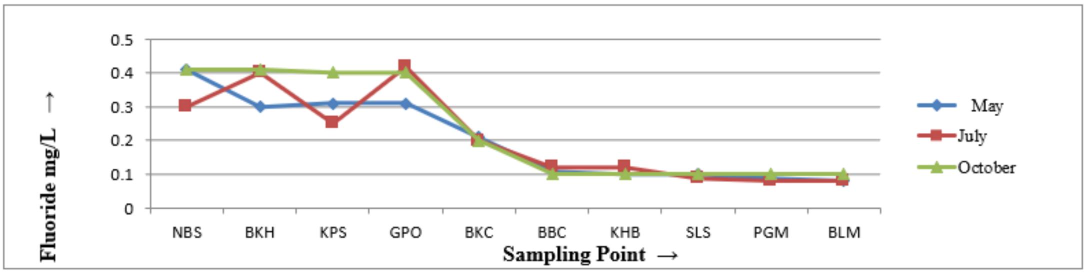

Fig-4.4 Variation of Total Fluoride →

Iron (Fe):

Water containing ferrous iron is clear and colorless because the iron is completely dissolved. When exposed to air in the pressure tank or atmosphere, the water turns cloudy and a reddish brown substance begins to form. This sediment is the oxidized or ferric form of iron that will not dissolve in water. Dissolved ferrous iron gives water a disagreeable metallic taste. When the iron combines with tea, coffee and other beverages, it produces an inky, black appearance and a harsh, unacceptable taste. Vegetables cooked in water containing excessive iron turn dark and look unappealing.

The concentration of Iron, except in the water of the source Guwakuchi Post Office, Karia Hathbazar, Sandheli LP School, and Panigaon Market, all other sources have much higher than the guideline value of WHO.

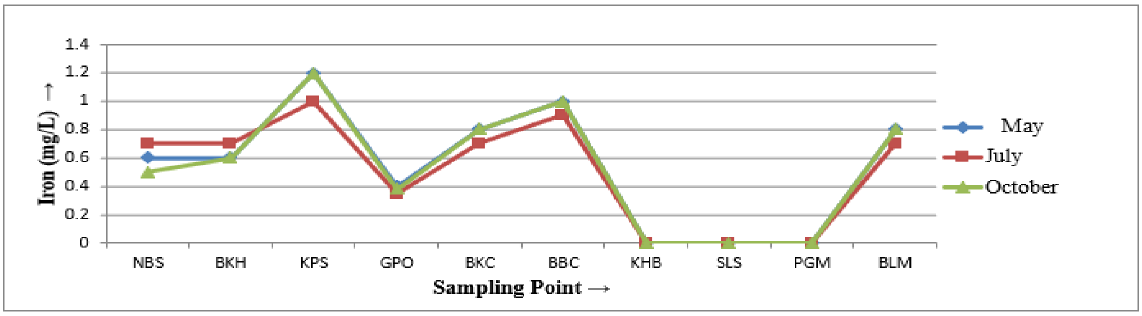

Fig- 4.5 Variation of Iron →

Total dissolved solids (TDS)

Total dissolved solids (TDS) comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulfates) and some small amounts of organic matter that are dissolved in water. It has been found from the Fig-4.6, the value of Total dissolved solids (TDS) in most of the water sources is above the guideline value laid down by WHO. Most often, high levels of TDS are caused by the presence of potassium, chlorides, and sodium. These ions have little or no short-term effects, but toxic ions (lead arsenic, cadmium, nitrate, and others) may also be dissolved in the water.

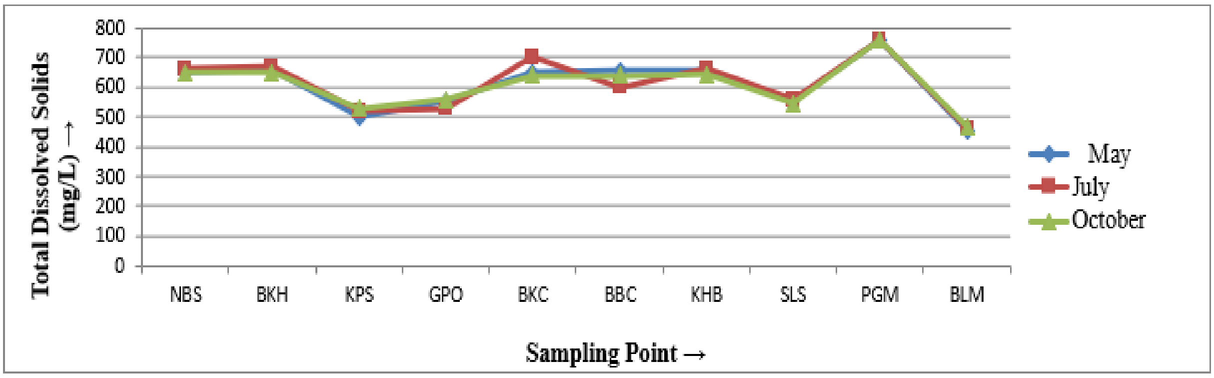

Fig- 4.6 Variation of Total Dissolved Solids →

Total Hardness

The two main cations that cause water hardness are calcium (Ca2+) and magnesium (Mg2+). Calcium is dissolved in water as it passes over and through limestone deposits.

. It is observed from the Fig 4.7, the value of Total Hardness recorded as low as 40 mg/L and highest as 230 mg/L . Hence all the water sources are safe as per WHO's guide line value.

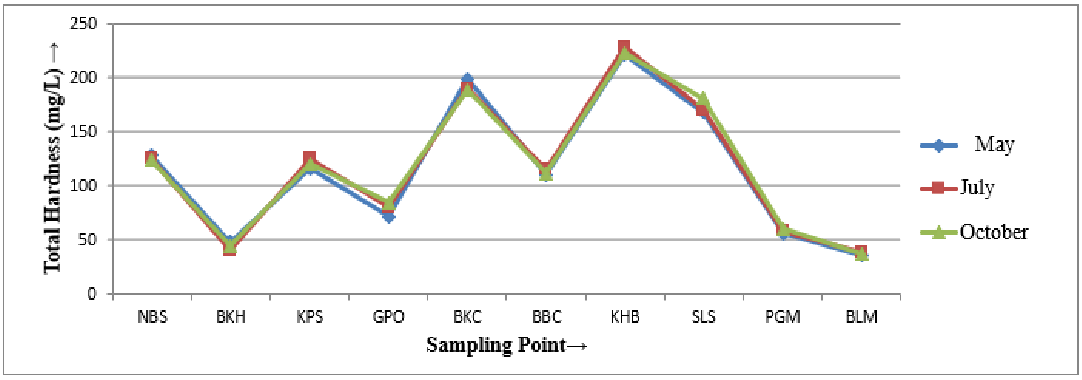

Fig- 4.7 Variation of Total Hardness→

Dissolved oxygen(DO):

As dissolved oxygen levels in water drop below 5.0 mg/l, aquatic life is put under stress. The lower the concentration, the greater the stress. Oxygen levels that remain below 1-2 mg/l for a few hours can result in large fish kills.

The values of DO of the different water sources are shown in the Fig-4.8. The values of DO of the drinking water samples varies in the ranges from 0.41 to 12 mg/L in the month of May, 0.45 to 11 mg/L in the month of July and from 0.43 to 10.9 mg/L.in the month of October in the source of HTW and THP. The highest value of DO is recorded for Kothra Primary ME School for pre monsoon and monsoon and Lowest at Panigaon Market for all the three periods.

A slightly higher value of DO was seen in the months of May and October compared to the month of July for most of the sampling points. This is probably due to a difference in atmospheric temperature.

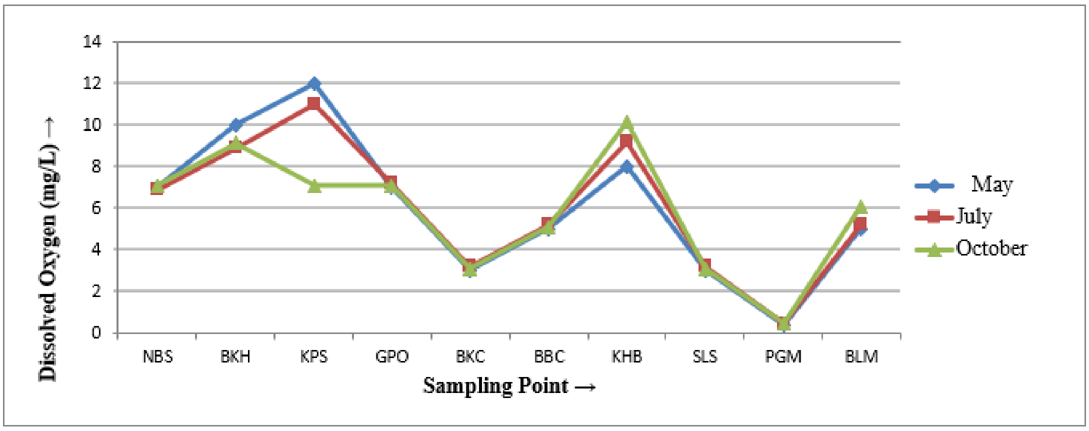

Fig-4.8 Variation of Dissolved Oxygen →

Biochemical Oxygen Demand(BOD):

The value of BOD of all the water sources are shown in the Fig-4.9. The values of BOD of the drinking water samples varies in the ranges from 0.20 to 1.66 mg/L in the month of May , 0.40 to 1.85 mg/L in the month of July and from 0.40 to 1.93 mg/L.in the month of October in the source of HTW and THP. The highest value of BOD is recorded in the HTW of Bonbhag Khata High School as 1.40 mg/L for the month of May and October. A water supply with a BOD level of 3-5 ppm is considered moderately clean. In water with a BOD level of 6-9 ppm, the water is considered somewhat polluted because there is usually organic matter present and bacteria are decomposing this waste.

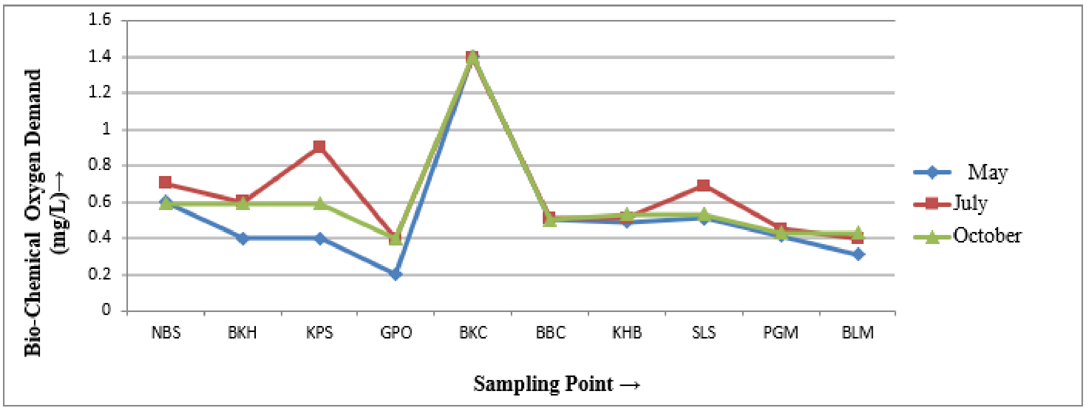

Fig- 4.9 Variation of Bio- Chemical Oxygen Demand→

Total Coliform:

There are three groups of coliform bacteria. Each is an indicator of drinking water quality and each has a different level of risk. Total coliform is a large collection of different kinds of bacteria. Fecal coliform are types of total coliform that exist in feces. E. coli is a subgroup of fecal coliform. Labs test drinking water samples for total coliform. If total coliform is present, the lab also tests the sample for E. coli. Coliform should not be present more than 10 per 100 ml samples according to WHO guide line. But in this study it is observed that the value of most of the water samples are below the detection level (BDL) except the water sample of Barbhag Chowk and Karia Hathbazar. The value of Coliform are found very high in some water source of HTW and Tara Hand Pump. This is because of leakage of boring pipe. The highest coliform bacteria45,60,38 (MPN/100ml) for the all the three months of May , July and October respectively were recorded at sampling point Karia Hathbazar.

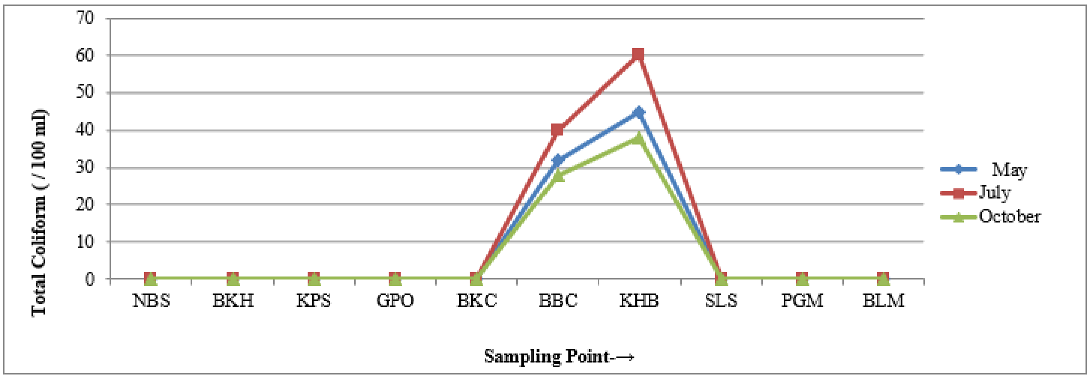

Fig- 4.10 Variation of Total Coliform→

5.1 CONCLUSION:

From the Chemical analysis of 10 nos water quality parameters within a period from May to October, that is pre-monsoon, monsoon and post monsoon season in ten different ground water sources across the Nalbari District.

The pH value for all the water sources is almost similar, and all are within the permissible limit prescribed by WHO for drinking water. The Chemical analysis data shows that ground water in general, is nearly neutral to Alkaline with pH value ranging between 6.0 to 7.4 and that quality of ground water is genrally good.

The temperature increased up to 25^0c in almost all the locations during monsoon. The variation for pre monsoon is more significant than variation for post monsoon. This is due to scattered rainfall in few of the sampling points.

All the sources of Tara Hand Pump and Hand Tube Wells in all sampling points are free from Arsenic.(Desirable limit of WHO 0.05 mg/L)

It is observed from this study that Fluoride is within the desirable limit 1.0 mg/L(WHO value) in all the sources of water.
Iron content in 40% of the drinking water sources contain Iron content beyond the permissible limit of WHO(1mg/L).
The value of Total dissolved solids (TDS) in most of the water sources is above the guideline value laid down by WHO. Most often, high levels of TDS are caused by the presence of potassium, chlorides, and sodium.
The Hardness in Ground water for different sources in the district showing that ground water are generally soft to moderately hard. Waters having a hardness of more than 180 mg/L requires to be treated for domestic purposes.
The values of BOD as recorded in the investigated sources were low as compared to other values.
In 20% of Water Sources Most Probable Number (MPN) of Total Coliform found to be above guide value of set by WHO i.e,(10/ 100 ml water sample)

5.2 GENERAL OBSERVATIONS

A large section of the population relies solely on ordinary sandstone filters for treating water before using it for drinking and cooking. However, these basic filters are inadequate for ensuring safe water consumption. The municipal water treatment plant lacks proper enforcement and maintenance, resulting in substandard water quality. The existing water supply cannot be deemed safe. Furthermore, the district suffers from the absence of adequate sanitation infrastructure, scientific drainage, and a proper sewage disposal system. The indiscriminate dumping of garbage and municipal solid waste is a common sight, which contributes to the contamination of groundwater through leachate from landfill sites—a major environmental concern in the district.

Waterborne diseases such as diarrhea, gastroenteritis, cholera, dysentery, and hepatitis are common among residents, especially during the high flood season, likely due to the contamination of water sources. This study highlights the urgent need for systematic water quality monitoring and the implementation of effective water management strategies across rural Assam.

Immediate improvement of the existing sewage treatment facilities is crucial to prevent further degradation of raw water sources. With the rising population, the capacity of sewage treatment plants must be proportionately expanded. Advanced treatment methods should be adopted in water treatment plants, particularly for the removal of suspended and dissolved solids. The district's current drinking water distribution network is outdated and defective. It must be overhauled, especially in critical areas, with careful consideration given to the placement of pipelines.

5.3 SUGGESTION

To ensure continued access to safe drinking water, it is essential to protect both water sources and their catchment areas. Complex and costly treatment systems can often be avoided through proactive protection measures. Discharging polluted effluents into water bodies or catchments must be strictly prohibited. Surface water sources such as rivers, reservoirs, and tanks are highly vulnerable to pollution from urban and industrial waste, while groundwater can become contaminated through seepage from domestic and industrial discharges. Clearly marked protection zones should be established where harmful activities like waste dumping, effluent discharge, drilling, mining, and the use of chemical fertilizers and pesticides are restricted. Groundwater sources must also be protected from contamination due to on-site sanitation leach pits, as pollutant movement through soil depends on soil type, water table, and pit conditions. For instance, contamination travels short distances through clay or loam, but can extend far in gravel or fissured rock. The safe distance between sanitation pits and water sources must therefore be locally assessed. Dug wells often face faecal contamination if left uncovered, and should be equipped with proper lining, aprons, covers, and drainage systems. Similarly, tube wells should be installed with reinforced plinths, sloped concrete aprons, and sanitary seals, with latrines located at least 10 meters downhill. While protected groundwater generally requires minimal treatment, special treatment may be needed when contaminants like iron, fluoride, or arsenic exceed permissible limits. Treatment methods vary based on the raw water's quality and may include aeration, flocculation, sedimentation, filtration, disinfection, and softening.

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