ASSESSMENT OF GROUND WATER QUALITY IN NALBARI DISTRICT OF ASSAM USING DIFFERENT PHYSICOCHEMICAL PARAMETERS: A REVIEW

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Abstract : Nalbari District is situated between 26^0 N and 26.51^0 N latitude and 91^0EAnd 91.47^0 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 Sex ratio (Females per1000 males) is 949 and Density (Total persons per 1000 males) is 733. If things are looked out at gender wise, male and female literacy were 84.36 and 72.57 respectively. For 2001 census, same figures stood at 80.95 and 63.71 in Nalbari District. Total literate in Nalbari District were 531771 of which male and female were 293184 and 238587 respectively. The growth of population in the District has made the water supply schemes under PHE Deptt and Municipal Board inadequate. Therefore, the major part of population of the District has been compelled to use ground water source like Hand Tube Well, Tara Hand Pump, Singur Hand Pump etc. Various water quality parameters such as Water temperature, pH, Turbidity, Total Solids, Total suspended solids, Total dissolved solids. Chloride, Total Hardness, Calcium, Magnesium, Sulphate, Fluoride, Arsenic, Nitrates, Iron, DO, BOD, EC, Alkalinity, Copper, Zinc, Cadmium, Lead & Nickel have been determined for these water sources by using standard methods. Variation of these parameters with respect to time and place has been found out and difference explained. The results have been compared with the water quality standards to find out the degree of pollution in these water bodies by using statistical methods. Total 25 nos sampling stations were taken into consideration in Nalbari District for three seasons as pre monsoon , monsoon and post monsoon.

IndexTerms **– Groundwater quality, Physicochemical parameters, Groundwater pollution, Drinking water**

I. 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 nd 0.001% in the air as vapour, clouds and precipitation. Oceans covers 97.2% of surfacewater,1.8% is glaciers and polar ice caps, 0.02% is other land surface water such as rivers, lakes and ponds, 0.9% is ground water and 0.001 is atmospheric water vapour at any given time. 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 rural population of India comprises more than 700 million people residing in about 1.42 million habitations spread over 15 diverse ecological regions. It is true that providing drinking water to such a large population is an enormous challenge. Our country is also characterized by non-uniformity in level of awareness, socio-economic development, education, poverty, practices and rituals which add to the complexity of providing water. The health burden of poor water quality is enormous. It is estimated that around 37.7 million Indians are affected by waterborne diseases annually, 1.5 million children are estimated to die of diarrhea alone and 73 million working days are lost due to waterborne disease each year. The resulting economic burden is estimated at $600 million a year. The problems of chemical contamination is also prevalent in India with 1,95,813 habitations in the country are affected by poor water quality. The major chemical parameters of concern are fluoride and arsenic. Iron is also emerging as a major problem with many habitations showing excess iron in the water samples. 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.

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.

About three quarter of the earth's surface is covered with water. Hodges (1973) stated that the total amount of water on the earth is about 1.35 billion Km^3 ($3.5X10^{26}$gal). However relatively a very small percentage that is approximately 0.036 p.c. of the total resources of water is really available for potable purpose in the form of surface and ground water. There is water in seas, rivers, lakes, springs and wells. However water is not pure and always contains some impurities. This impurity depends on the sources of supply and site condition. Another point is that when water begins to fall from the clouds, it is very pure. However, as it falls through the air some of the gases in the air get dissolved in it. It also collects bits of dusts and germs that are floating in the air. When the rain reaches the ground it begins to pick-up more .Dust and dirt. Some minerals are also dissolved in water. In this way the water becomes impure or polluted.

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.

II. 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 geology of a particular area has a greater influence on quality of water and its movement. Changes in ground water quality with the passage of time have a hydrologic significance. The quality also varies due to change in chemical composition of formations. Geochemical studies of Ogallala aquifer, south high plains of texus and New Maxico were conducted by Native and Smith (1987) and concluded that the geochemistry of the aquifer is controlled by the surface topography of the underlined formations, the thickness and permeability of the Alluvial deposits. 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..

III. 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 District has a sub-tropical climate with semi – dry hot summer and cold winter. During summer, generally during the months from May to August, heavy rainfall occurs for which the district experiences flood. The District experiences annual (average) rainfall and humidity 1500 mm and 80% respectively.

Table 3.1(Information(As per 2011 Census

Description	Rural	Urban
Population (%)	89.28%	10.72%
Total Population	688909	82730
Male Population	353,677	42,42329
Sex Ratio	948	954
Child Sex Ratio (0-6)	968	958
Child Population (0-6)	87759	7574
Male Child(0-6)	44589	3,869
Female Child(0-6)	43170	3,705
Child Percentage (0-6)	12.74 %	9.16 %
Male Child Percentage	12.61 %	9.14%
Female Child Percentage	12.88 %	9.17 %
Literates	464211	67560
Male Literates	257140	36044
Female Literates	207071	31516
Male Child Percentage	12.61 %	9.14%
Female Child Percentage	12.88 %	9.17 %

IV. AIMS AND OBJECTIVES

One of the main objectives of the ground water quality analysis is to assess the suitability of ground water for drinking purposes. The physical and chemical quality of ground water is important in deciding its suitability for drinking purposes.

V. 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, Turbidity, Total Solids, Total suspended solids, Total dissolved solids. Chloride, Total Hardness, Calcium, Magnesium, Sulphate, Fluoride, Arsenic, Nitrates, Iron, DO, BOD, EC, Alkalinity, Copper, Zinc, Cadmium, Total Coli form.

VI. SAMPLE PRESERVATION TECHNIQUES

For this study secondary data has been collected. From the website of KSE the monthly stock prices for the sample firms are obtained from Jan 2010 to Dec 2014. And from the website of SBP the data for the macroeconomic variables are collected for the period of five years. The time series monthly data is collected on stock prices for sample firmsand relative macroeconomic variables for the period of 5 years. The data collection period is ranging from January 2010 to Dec 2014. Monthly prices of KSE - 100 Index is taken from yahoo finance.

Table 6.1

Parameters	Sample volume (ml)	Container	Preservation
Alkalinity	200	Polythene, Glass	Refrigeration at 4°C in dark
BOD	1000	Polythene, Glass	Refrigeration at 4°C in dark
Conductivity	500	Polythene, Glass	Refrigerate
Fluoride	300	Polythene	Not required
Hardness	100	Polythene, Glass	Add HNO_3 to pH < 2
Nitrate	100	Polythene, Glass	Analyze as soon as possible or refrigerate
Oil and grease	1000	Glass, wide- mouth calibrated	Add H_2SO_4 to pH <2, refrigerate
Dissolved Oxygen	300	Glass, BOD bottle	Titration may be delayed after DO fixation
pH	--	Polythene, Glass	Analyze immediately
Sulphate	--	Polythene, Glass	Refrigerate
Temperature	--	Polythene, Glass	Determine immediately
Turbidity	--	Polythene, Glass	Analyze same day; store in dark up to 24 h, refrigerate

VII. SAMPLING POINTS

The following sources are selected for sampling.

1. Nalbari College Chowk ---- HTW(Hand Tube Well)
2. Dihjari LP School ---- THP(Tara Hand Pump)
3. Asomi Girl's ME School, Kothra --- HTW
4. Guwakuchi Post Office ---- HTW
5. Shiv Mandir ,Banekuchi ---- HTW
6. Durga Mandir,Bagalchowk ---- --- HTW
7. Bijulighat (Near RCC Bridge) HTW
8. Haribhanga HSS ---- --- HTW
9. Milan HS ---- THP
10. JRB LP School,Chamata ---- --- THP
11. Kaithalkuchi HS ---- --- THP
12. Billeswar Dewalaya,Belsor ---- --- HTW
13. Jagara LP School --- --- THP
14. Raghunath Choudhury HSS Mukalmuwa HTW
15. Kamarkuchi Chowk ---- --- --- HTW
16. Kakaya S.Than LP School --- --- HTW
17. Katakia LPS. --- HTW
18. Kardoitola LPS. --- HTW
19. Barhelacha Mandir --- HTW
20. Solmara Bazar --- --- HTW
21. Piplibari Chowk --- --- HTW
22. Bihampur Chowk--- --- HTW
23. Balitara Chowk --- --- HTW
24. Doulashal Chowk --- --- HTW
25. Loharkatha Bazar--- --- HTW

VIII. CHEMICAL ANALYSIS

- **Water Temperature**

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

- **Turbidity**

The turbidity of a sample is measured from the amount of light scattered by the sample taking a reference with standard turbidity suspension by using turbidimeter and sample tubes. This method is known as Nephelometric method.

- **Total Solids (TS)**

Total solids are determined as the residues left after evaporation of the unfiltered sample. 50 ml of unfiltered sample is taken in an evaporating dish and kept in a water bath. The final weight of the cup is taken after evaporation of the sample and putting the cup for some time in an oven maintained at 100^0c.Calculations are made and the result is expressed in mg/L.

- **Total suspended solids (TSS)**

Total suspended solids are the difference between the total solids and total dissolved solids.

TSS = TS -- TDS

So, it is found from the difference in values of total solids and total dissolved solids, in all the cases.

- **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.

- **Sulphate ($SO^{//}_4$)**

Turbidimetric method is used for determination of sulphate.

- **Magnesium (Mg^{++})**

Calcium and magnesium form a complex of wine-red colour with Eriochroma Black T at pH 10.00. The EDTA has got a stronger affinity for Ca^{++} and Mg^{++}, the former complex is broken down and a new complex of blue colour is formed. The value of Mg^{++} can be obtained by subtracting the value of calcium from the total of Ca^{++} + Mg^{++}.

Amount of magnesium present in mg/L is given by

Mg^{++} mg/L = Total Hardness (as mg/L $CaCO_3$) – Calcium Hardness (as mg/L $CaCO_3$).

- **Chloride ($Cl^/$)**

By using silver nitrate 028 N solution and 5% potassium chromate, we get

$$\text{Chloride in mg/l} = \frac{(\text{ml} \times \text{N}) \text{ of } AgNO_3 \times 1000}{\text{ml of sample}}$$

- **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.

- **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. Absorbances were plotted against different concentration of standard fluoride solution and by comparing the absorbance of the sample with the calibration curve; the content of fluoride was computed.

- **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.

- **Total hardness**

Total hardness of the water samples was determined by EDTA complexometric titration using Eriochrome Black T indicator.

- **Nitrate**

Nitrate is determined with the help of ion meter (Cyberscan 510). Standard nitrate solutions 0.1ppm, 1 ppm and 10 ppm were prepared to calibrate the instrument.

- **Metals**

Arsenic was estimated by hydride generation atomic absorption spectrometry (HGAAS) using Varian VGA-77 vapour generation assembly with ETC-60 temperature controller as a heat source to atomize the hydride generated with the reducing agent $NaBH_4$ (Merck) and 8M HCl acid.

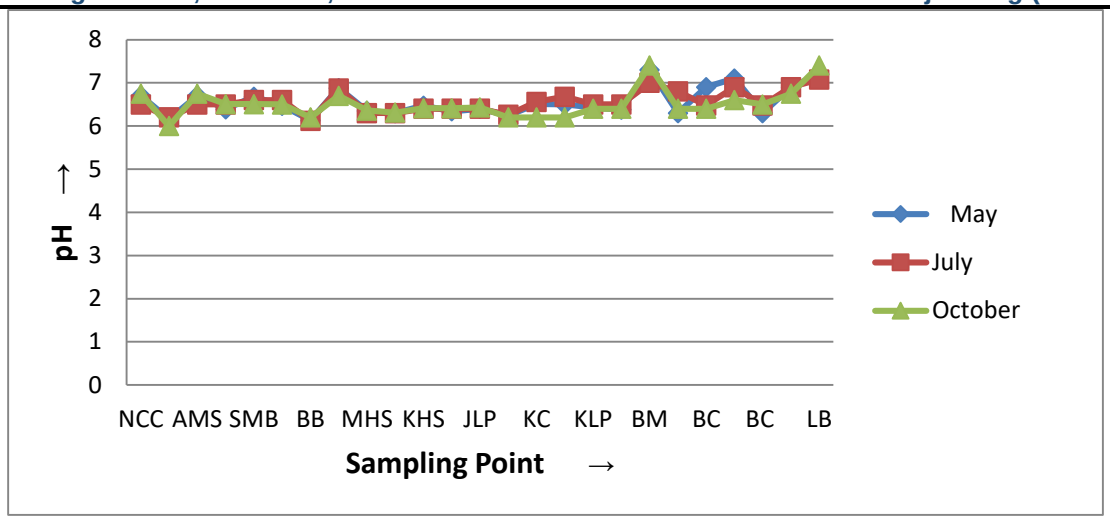

Fig - 8.1 Variation of pH

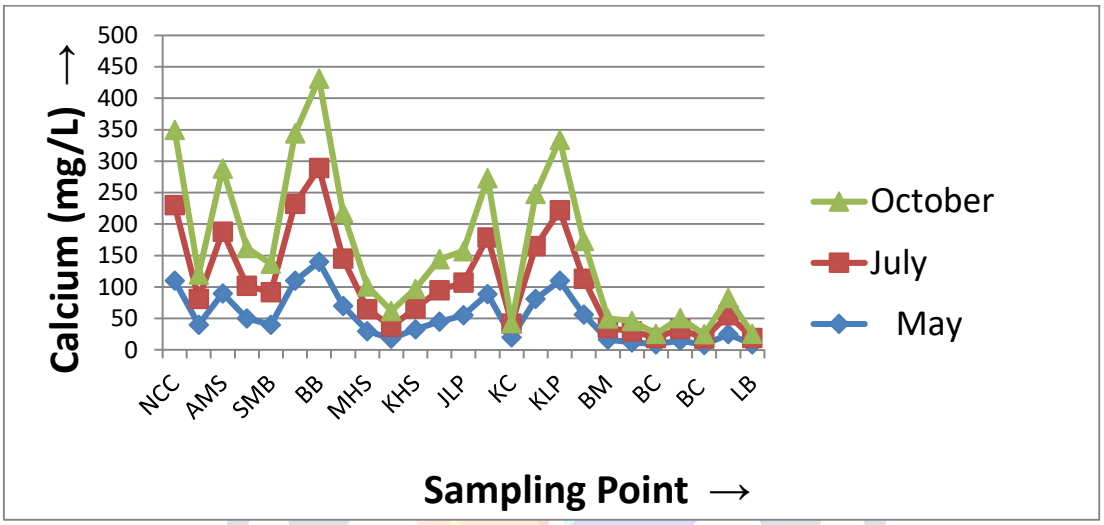

Fig- 8.2 Variation of Calcium

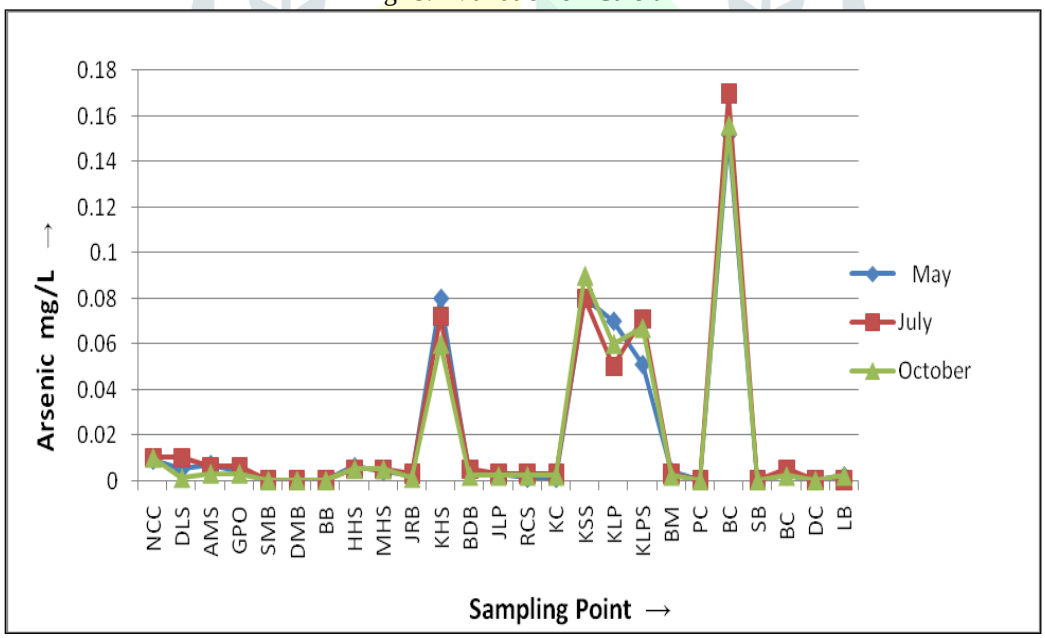

Fig- 8.3 Variation of Total Arsenic

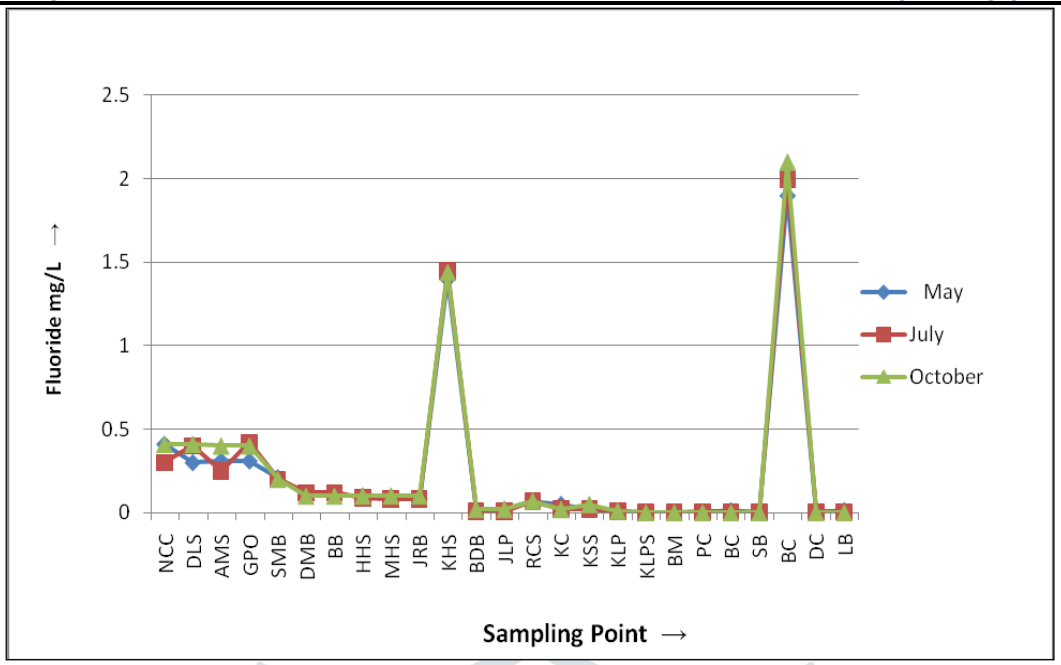

Fig- 8.4 Variation of Total Fluoride

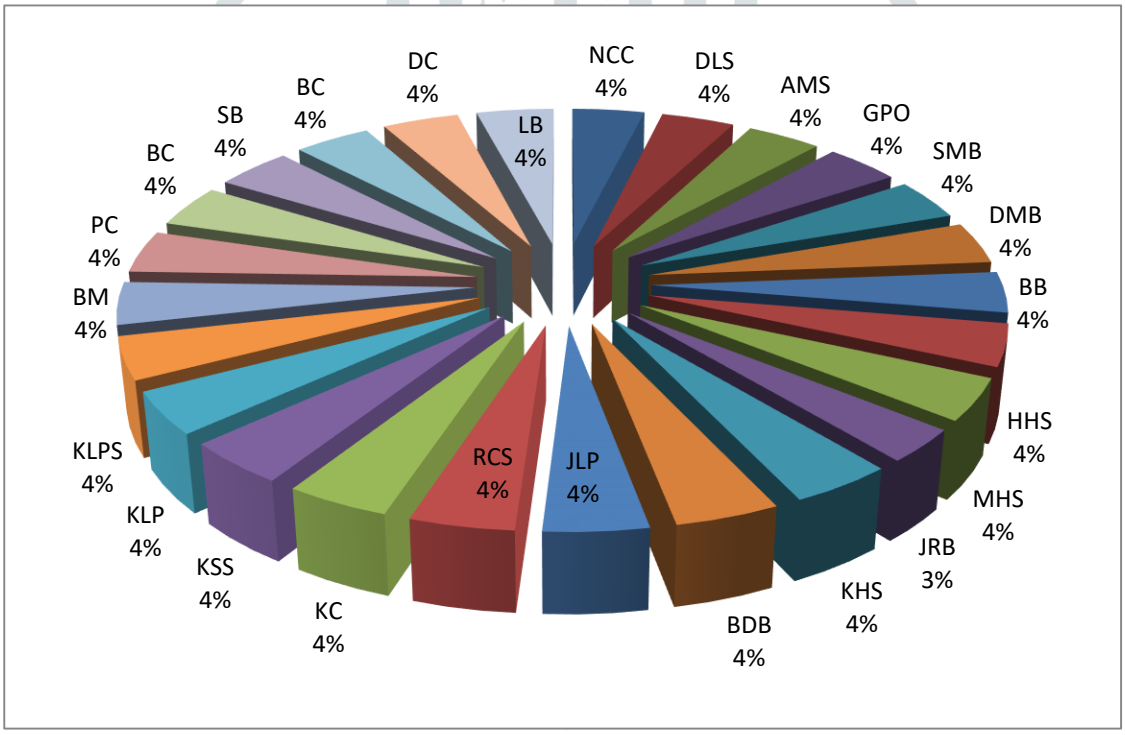

Fig-8.5 Pie diagram of Temperature of all sources.

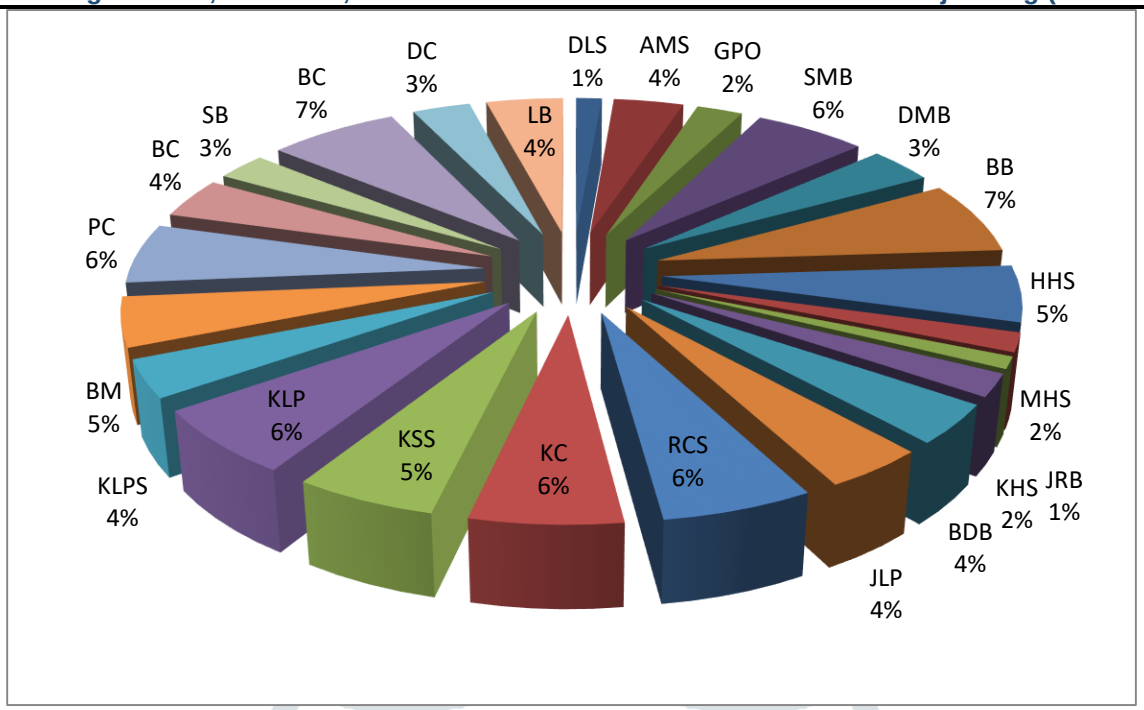

Fig-8.6 Pie diagram of Total Hardness of all sources (All season average)

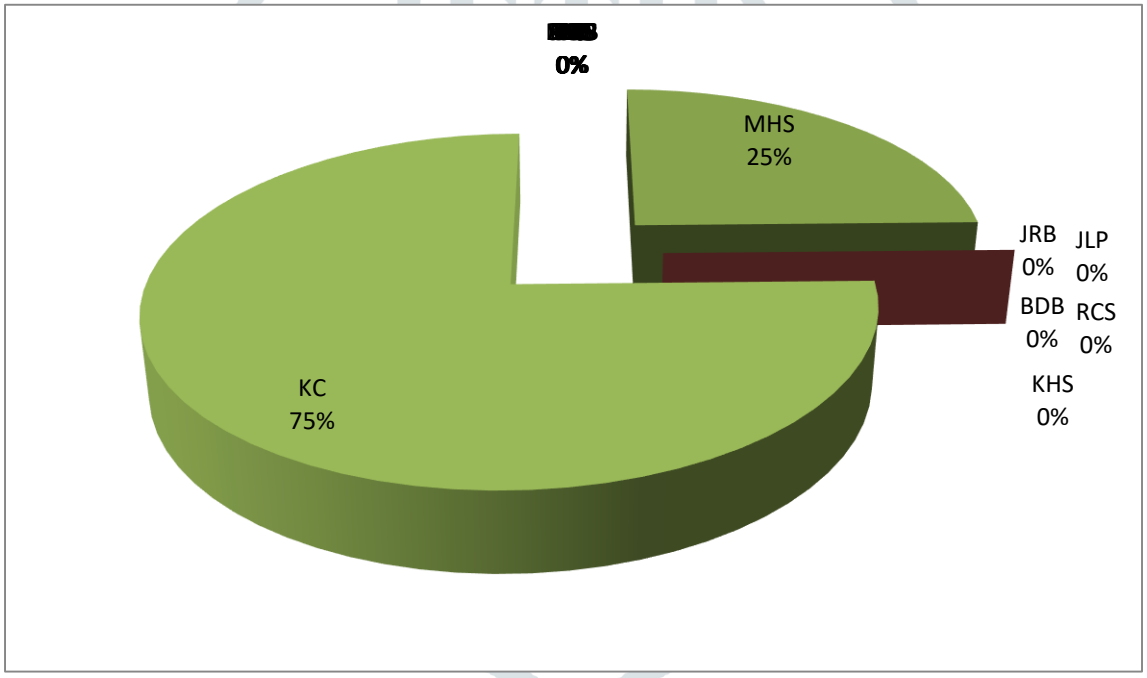

Fig- 8.7 Pie diagram of Nitrate of all Sources.(All Season average)

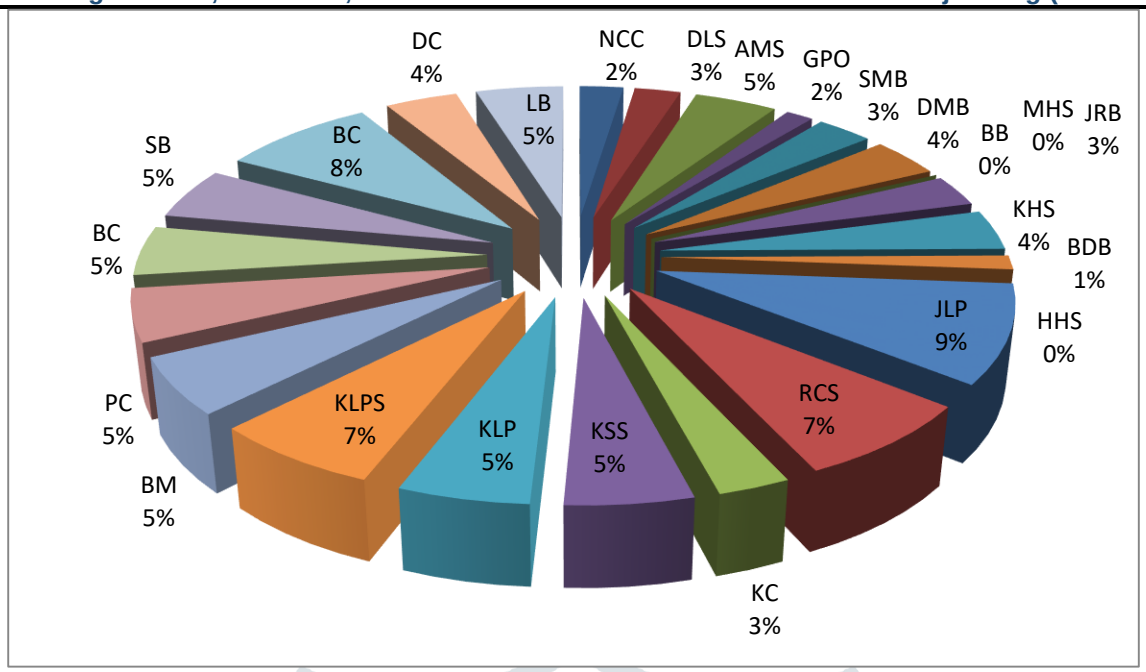

Fig-8.8 Pie diagram of Iron of all Sources.(All Season average)

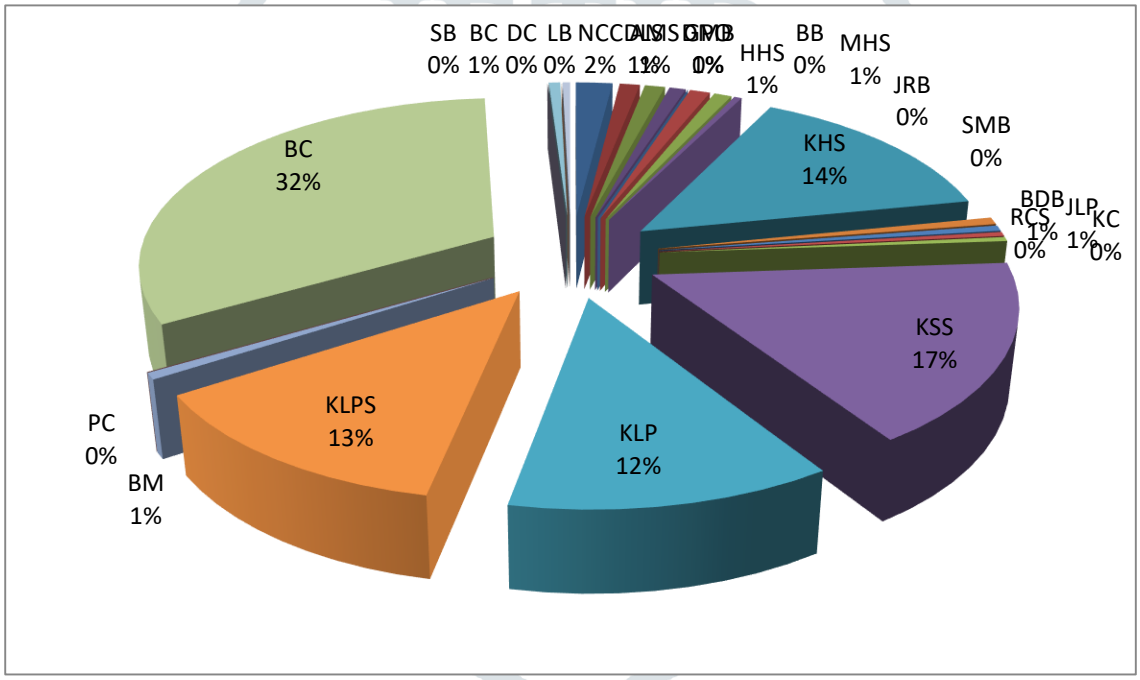

Fig – 8.9 Pie diagram of Arsenic of all Sources .(All Season average)

IX. ANALYSIS OF DATA

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.

X. CORRELATION COEFFICIENT

Determination of correlation is an important tool finding out the relationship between the two independent variables. If a graph is plotted between two variables, a straight line will indicate a strong relationship, when the scattering of points will show a very key relationship. In quantitative terms, calculating and index called correlation co-efficient ‘r’, which can be determined.

XI. CONCLUSION

From the Chemical analysis of 26 nos water quality parameters within a period from May to October, that is pre monsoon, monsoon and post monsoon season in twenty five different ground water sources covering almost the Nalbari District.

It is found that the water from the Tara Hand Pump of Kaithalkuchi HS is safer than other sources for drinking purposes as compared to the standard prescribed by WHO for drinking water. All the water samples in this study were taken from the ground water only. Other conclusions are :

1. 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, are nearly neutral to Alkaline with pH value ranging between 6.0 to 7.4 and that quality of ground water is generally good.
2. The Water Temperature of the Tara Hand Pump of JRB LP School, Chamata and other sources of water are not similar with ambient temperature.

3. The Turbidity level of Tara Hand Pumps are low with compare to Hand Tube Well of other water sources. On the other hand the level Turbidity is within permissible level in only three nos of water sources.
4. Calcium concentration in the major part of the district is within the maximum permissible limits of 200 mg/L as per guide line set by WHO .
5. In all the water sources, the value of Magnesium is below the desirable limit.
6. The value of Chloride in some of the sources are low which is below the desirable limit.
7. In case of Sulphate three nos sources have found very low value and three nos sources have recorded very high value of Sulphate.
8. All the sources of Tara Hand Pump and Hand Tube Wells are free from Arsenic.(Desirable limit of WHO 0.05 mg/L)
9. 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.
10. Iron content in the drinking water sources 50% of the water samples Iron content beyond the permissible limit of WHO(1mg/L).
11. As investigated the average variation of TS, TSS and TDS concentration not exceeding the permissible limit of WHO.
12. 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.
13. In this study, Nitrate content in 92% of water sources have found nil and only two nos sources have recorded a very low value of Nitrate which is not within the permissible limit of WHO.
14. The values of BOD as recorded in the investigated sources were low as compared to other values.
15. The values of conductivity were small, it may be due to small quantities of TDS,Chloride, Magnesium,Calcium and Sulphate.
16. The all season's Aaverage value of Alkalinity were found within the permissible limit set by WHO.
17. In case of Copper 31% of Investigated sources found below detection level and 46% of Investigated sources found below desirable level as per WHO guide line.
18. The all season's value of Zinc & Cadmium for all the water sources were found below WHO guide line value. As an essential, drinking water should contain the metals in a permissible level. The determination has found lower Zinc content for all the samples of Nalbari District . This may have a negative impact on human health. The children and the pregnant women could be the worst sufferers. So, the authorities that supply the drinking water in the area must ensure the adequate amounts of Zinc content in water by ensuring proper treatment of water.
19. It is observed from this study that Lead is within the desirable limit 0.05 mg/L(WHO value) in all the sources of water.
20. Nickel content in 65% of Investigated sources below detection level and in other investigated sources found as per desirable level of WHO guide line value.
21. In 27% 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)
22. 73% of Water Sources are free from Oil & Grease as per investigation and in only one source has recorded slightly high value of Oil & Grease . The concentration of high value of Oil & Grease for drinking water quality, it can cause surface films and shoreline deposits leading to environmental degradation and can induce human health risk.

The analysis of Ground water from most of the Tube well revealed that the concentration of Iron much higher than the tolerance limit prescribed for drinking water. Ground water having pH 6 & 8 can be sufficiently reducing to retain up to 50 mg of ferrous iron per liter at equilibrium. Such water appears clear when drawn from the tube well, but it turns cloudy on standing and then brownish due to precipitation of ferric hydroxide. This has also been the case with the water from the most of the tube wells in Nalbari District. All other aesthetic quality parameters for tube well water are within the permissible limit for drinking water except high turbidity.

XII. SUGGESTIONS

- **Need for protection of water sources**

If water supplies are to remain potable, both the sources and catchments need protection. Determination of the quality of water at source may necessitate complex treatment system, which may not be economically viable. Discharge of any polluted effluent at source or in the catchments area must be prohibited.

- **Protection measures Catchment Protection**

Surface water and Ground waters are both vulnerable. Surface water reservoirs, tanks, etc. can be protected from pollution caused due to various human, activities. Rivers are polluted due to receiving discharges from urban centers and Industries. Ground water may be contaminated due to seepage from domestic and Industrial discharges. Where possible, protection zones should be clearly demarcated and activities that may affect water quality should be restricted or prohibited within their boundaries. Such activities may include the dumping of toxic waste, the discharge of undesirable effluents, drilling, mining, quarrying and the use of agricultural fertilizers & pesticides.

- **Safe – distance between water source and on – site sanitation**

The Ground water sources naturally must be protected from on – site sanitation leach pits. Bacterial contamination in leachate from leaches pits travel through soil grain. But such movements of contaminants through soil strata are restricted since faecal micro organisms are arrested to a large extent and many chemical compounds are broken down. The pollution travels from leach pits are dependent on characteristics of soil, ground water table, rate of ground water flow, hydraulic gradient, pit condition etc. It has been found that microbiological pollution could travel a short distance through sandy loam and clay whereas it could travel an indefinite distance through coarse gravel, fissured rock, dried out cracked clay etc. The safe distance of ground water source, therefore, need to be assessed on the basis of under ground pollution travel in different soil and other condition.

- **Protection of wells**

i. Dug Wells

Uncovered or poorly covered dug wells are generally faecally contaminated. Dug Well with proper lining, apron, parapet wall, cover, lead drain and pumping system will protect the Dug Well from faecal contamination.

ii. Hand Pump and mechanically pumped Well

To ensure adequate sanitary protection of a Tube Well, a reinforced plinth should be built on to the well-head. A concrete apron should be laid around the well head and plinth, at least 2 meters in diameter and sloped towards the drainage channel, which should run on to a soak way located away from the tube well. Latrines with on – site sanitation pit may be located at least 10 meters (in case of sandy soil) downhill from the well.

- **Treatment of water**

If Ground water sources protected, it generally does not require any treatment. Special treatment may be necessary for Ground water in case if contains Iron, Fluoride, Arsenic etc beyond maximum permissible limit.

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