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An Assessment of Surface and Ground Water Quality of Some Selected Locations in Guwahati

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ABSTRACT

The study was carried out an assessment of water quality in Guwahati, the premier city of North East India as the city suffers lots of problem from water pollution. Brahmaputra river is the principal source of water for the residents of Guwahati city. The city is drained mainly by river Bharalu, a small tributary of the river Brahmaputra. In Guwahati city, the septic effluents and garbage from households are either released to municipal drains or nearby wasteland. The domestic refuge and garbage remain in the open for several days and thus lactates as well as storm water runoff carrying various toxic substances are likely to contaminate different water bodies including ground water. The main drained channel of the city is used for discharging household, municipal, industrial and commercial wastes and it also acts as the natural drained for storm water runoff. The Bharalu river is not used for drinking purpose, but the polluted water may deteriorate the quality of the ground water reserves near the banks. Analysis of physico-chemical parameters such as pH, temperature,

conductivity, turbidity, dissolved oxygen, biological oxygen demand, chemical oxygen demand, total dissolved solid, total hardness, calcium, magnesium, iron, nitrate, fluoride of Bharalu river or strom water runoff and ground water source with 30-35 meters has shown that the Bharalu water or storm water is thoroughly contaminated and the ground water sources near the banks are of poor quality. It seems that various stations are contaminated due to domestic waste or discharge of commercial, sewage into the Bharalu channel.

Finally, it may be concluded that, Guwahati city is suffering from water pollution due to natural and anthropogenic factors like urbanization and industrialization activities. Sewage, domestic and industrial wastes should be disposed through proper legislation and cooperation of residents. Moreover, proper management strategies should be adopted at this stage to save the city from pollution in near future.

Keywords: Surface water, groundwater, physico-chemical parameters, water quality.

INTRODUCTION

Water, being a good solvent, dissolves a large number of minerals which remain in water as positive and negative ions many of which are toxic. Natural water also holds a large number of other foreign constituents like as (i) soluble organic oxygen containing compound such as alcohol, sugar and acid, (ii) suspended particulates, (iii) living organisms and waste products of their metabolism, (iv) living organisms, namely pathogens and (v) floating matter such as oil by Turk et al [1].

Guwahati city, the nerve centre of North-East India has expanded at an accelerated rate in at fronts during the last decades. Population explosion, unplanned urbanization, industrialization, deforestation, inadequate drainage facilities combined with heavy rainfall, adverse geological conditions etc have increased the instances of different hazards in the city. Population explosion and unplanned urbanization without proper drainage facilities have resulted in an increasing volume of sewage and waste materials and consequent influence on surface and underground water quality. The city is drained mainly by river Bharalu, as small tributary of river Brahmaputra. The river flows through the heart of Guwahati through densely populated residential, industrial and commercial areas and meet the river Brahmaputra at Bharalumukh. The Bharalu receives domestic sewage, waste from municipal and commercial establishments, industrial effluents etc from a large part of the city through a series of mutually independent drains on both banks without any treatment. This has made the Bharalu water extremely polluted and silty. The Bharalu water is not generally used for drinking purposes but this polluted surface water may contaminate the groundwater reserves near the banks and may cause serious health hazard. In Guwahati city, the septic effluents and garbage from households are either released to municipal drains or nearby wasteland. The domestic refuge and garbage remain in the open for several days and thus lactates as well as storm water runoff carrying various

toxic substances are likely to contaminate different water bodies including ground water. The contamination of ground water may pose as grave hazard to the people of the city.

Water pollution and water quality assessment studies have been received tremendous importance in recent years. But most of the studies are confined to river; groundwater studies have received only limited and periodic attention. The study of water quality and pollution lead of the Indian rivers like Ganga and Jamuna has received tremendous momentum in recent years. In Assam, studies on water quality and water pollution are of quite recent origin. Most of the works are confined to the studies of surface water and waste water of Guwahati worth mentioning contributions are of Kakoti and Bhattacharyya (1989, 1990a, 1990b, 1990c), Kakati (1991), Lal and Bhattacharya (1989, 1990), and Sarma (1994) studied on water quality and pollution aspect of groundwater have not been reported so far [2-9].

The main aim of the present work is to study the ground and surface water and quality in some locations in Guwahati city. Amongst the three environmental components – soil, water and air water is recognized as one of the most important environmental constituent and major recipient of waste materials and pollution load. Rivers and ground waters are becoming polluted by industrial effluents, urban wastes, human sewage, garbage dump etc. The city is drained mainly by river Bharalu, as small tributary of river Brahmaputra. The river flows in the heart of Guwahati through densely populated residential, industrial and commercial areas and meet river Brahmaputra at Bharalumukh. So, the surface and ground water get polluted. So, a comprehensive study about the water quality in some locations in Guwahati city. The study area lies within lat. $26^0 00^/$N and $26^0 10^/$N and Long $91^0 46^/$E and $91^0 48^/$E.

The aims and objectives of the study are highlighted below:

- To study the quality of Bharalu or storm water runoff and ground water along the polluted stretch of Bharalu by sampling simultaneously surface and ground water near the banks within a distance of 30-35 meters.
- To study the nature of pollutants.
- To quantify certain water quality parameters in the surface and ground water.
- To study the variations in the contamination level from the station to station.

METHODOLOGY AND DATA BASE

The work under study has been divided into four stages: 1) Preliminary investigation, 2) Field investigation, 3) Laboratory investigation and 4) Analysis and Interpretation. As the study include in water pollution, different methodologies are followed in the study.

In the preliminary stage, extensive study of existing literature related to the subject is made to have a firsthand knowledge on the subject and to gather information about the study area. Map of the study area Top sheet on 1:50,000 scale (78N/12 and

78N/16). This map is used as base map. Preliminary studies also include reconnaissance survey of the study area to draw up a programme for detailed field investigation.

In the second stage of work, proper field works are conducted. In this stage, primary and secondary data are collected, primary data are collected during field study and secondary data are collected from various organizations as well as other sources including published work. Water samples are collected after a through survey of the study area with particular reference in possibilities of pollution.

The gap water samples are collected from 6 different sampling stations with 24 sampling points, considering the water quality of premonsoon, monsoon and postmonsoon. Water samples are collected in pre-cleaned plastic bottles of 2 litres capacity. Plastic bottles are rinsed a number of times with distilled water and dried thoroughly before collection. The samples are collected between 8 a.m to 11 a.m. and were stored and treated before analysis according to standard procedures (APHA, 1995) [10].

Ground water samples were collected from the shallow well near the bank of Bharalu river within a distance of 30-35 meters. Water samples from surface water i.e. Bharalu river or storm water runoff were collected by grap method. Samples were not taken directly from waste dumping sites and large non-homogenous matter including floating leaves, twigs etc. were audited. 17 parameters have been studied for each sample and average has been taken in 6 sampling stations (Fig. 1).

PHISICO-CHEMICAL PARAMETERS

The parameters for water quality characterization have been used the permissible limits prescribed by i) World Health Organization (WHO), ii) Indian Standard Institution (ISI) and iii) Environment Protection Agency (EPA), USA are given separately. These refer to domestic water supplies for drinking water. A few number of parameters have been studied in this work and these are mentioned below:

pH, Temperature, Conductivity, Turbidity and Total Dissolved Solid, Total Hardness, Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD), Dissolved Oxygen (DO), Chloride, Sulphate, Nitrate and Oil and grease, Calcium, Magnesium, Iron and Fluoride.

PHYSICAL PARAMETERS:

pH-Value:

The pH values measure the hydrogen ion concentration of water samples and measures the acid base equilibrium achieved by various dissolved compounds. The pH value of the water samples was determined with a digital pH meter.

Temperature:

It exerts an important effect on chemical and biological reactions of organism in water. Rate of chemical reaction increases with the rise in temperature. Rise in temperature reduces the solubility of the gaseous matters and amplifies the taste and odour. The temperature of the water samples were determined at the time of collection using mercury thermometer graduated between 0^0C and 100^0C.

Conductivity:

The Conductivity or specific electrical conductance indicates the degree of mineralization of water and bears a relationship to the total dissolved solid content of the water sample. Conductivity was measured with a digital conductivity meter which was calibrated before each measurement.

Turbidity:

Turbidity in water is caused by the presence of suspended matter, such as clay, silt, colloidal organic particles, plankton and other microscopic organisms. Turbidity is also caused from discharges of domestic and industrial waste water containing soaps, detergents etc. Turbidity was measured immediately after sample collection with a turbidimeter. The values are expressed in NTU (Nephelometric Turbidity Unit) after being calibrated with respect to a set of formazin suspension of known turbidity.

Total Dissolved Solids (TDS):

A large number of solids are found dissolved in natural waters, the common ones are carbonates, bicarbonates, chlorides, sulphates, phosphates and nitrates of calcium, magnesium, sodium, potassium, iron etc.

CHEMICAL PARAMETERS:

Dissolved Oxygen:

Dissolved oxygen (DO) has been a fundamental requirement for plant and animal life in water. Depletion of DO is indicative of presence of substances collectively called oxygen demanding wastes. Low values of Do indicates presence of large amount of biodegradable organic matter which makes the water aesthetically unacceptable as anaerobic decomposition of organic matter leads to septic conditions and production of noxious gases. DO also influences the equilibrium between water and the sediments by controlling reduction/oxidation reactions as well as leaching of metal ions from the soil.

Biological Oxygen Demand (BOD):

Biological Oxygen Demand is the measure of the degradable organic matters present in the sample and can be defined as the amount of oxygen required by the microorganisms in degrading the biologically degradable organic matter under aerobic conditions. The principle of the method involves measuring the difference of oxygen concentration of a sample before and after incubating it for 3 days at 27^0c.

Chemical Oxygen Demand (COD):

Chemical Oxygen Demand (COD) is a measure of the concentration of organic matter, both biodegradable as well as non-biodegradable in water which are oxidizable by a strong chemical agent. COD was determined by using the dichromate oxidation technique.

Total Hardness:

Hardness is the measure of the capacity of water to react with soap.

Oil and grease:

Oil and grease are a class distinguished on the basis of its solubility characteristic, not is chemical composition. Oil and grease is defined as any material recovered as a substance soluble in the solvent.

Chloride:

Chloride is widely distributed in nature in the form of sodium, potassium and calcium salts. It is a major constituent of water and wastewater. The presence of chloride in natural waters can be attributed to the dissolution of salt deposits.

Sulphate:

Surface usually occurs in natural waters. Mine drainage waste contains high content of sulphate by virtue of pyrite oxidation. The presence of Na_2SO4 and $MgSO_4$ in drinking water beyond the prescribed limits may cause cathartic action.

Nitrate:

Fertilizer use, decayed vegetable and animal matter, domestic effluents, sewage sludge disposal to land, industrial discharges, leachates from refuse dumps and atmospheric washouts, all contribute to nitrate levels in water. These sources may contaminate streams, rivers, lakes and groundwater. Nitrate in the samples was determined spectrophotometrically.

Fluoride:

Fluoride is common in groundwater than surface water. The main sources of fluoride in groundwater are different fluoride being rocks.

Iron:

Iron plays an important role in biology, forming complexes with molecular oxygen in haemoglobin and myoglobin; these two compounds are common oxygen transport proteins in vertebrates.

RESULT AND DISCUSSION

The results of analysis of the water samples are given below.

Physico-chemical parameters of the surface and Ground water:

The experimental results of the different physcio-chemical parameters for the surface

water and ground water are given in the table respectively (Table-1 & 2). The results reveal the following:

pH:

The pH showed variation from 7.9 to 7.3 for ground water and 7.7 to 6.8 for the surface water. The minimum values of 7.3 for ground water at the sampling station 3 and 6.8 for surface water at the sampling station 3 are shown in figure (Fig. 2). Most of the water are slightly alkaline due to presence of carbonate and bicarbonate ions.

Table 1: Physico-Chemical Parameter of the surface water (Bharalu and storm water) at different sampling stations.

Sl. No	Parameter	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
1.	pH	7.45	7.78	6.81	7.62	7.58	7.46
2.	Conductivity Microsiemens/cm	290	356	371	341	280	329
3.	Turbidity in NTU	32	227	189	124	89	133
4.	Total Hardness as $CaCO_3$ in mg/l	96	84	100	104	80	120
5.	Calcium mg/l	50	50	80	80	60	80
6.	Magnesium mg/l	46	34	20	24	20	40
7.	BOD mg/l	23.0	22.8	17.0	23.8	35.0	37.0
8.	COD mg/l	52.3	52.42	42.22	49.50	69.88	74.25
9.	Oil and grease mg/l	1.6	1.62	2.6	2.0	1.4	2.7
10.	Fluoride mg/l	0.50	0.49	0.44	0.42	0.47	0.46
11.	Iron mg/l	1.6	1.4	2.8	1.0	0.5	1.6
12.	Chloride mg/l	104	134	146	84	90	146
13.	Total Dissolved Solid mg/l (TDS)	210	224	239	245	215	230
14.	Nitrate mg/l	7	40	7	42	40	43
15.	Sulphate mg/l	40	80	28	27	22	34
16.	Temperature ^0C	24	25	24	25	24	24
17.	DO mg/l	11.5	11.4	8.5	11.9	17.5	18.5

Table 2: Physico-Chemical Parameter of the groundwater at different sampling stations (BDL – Below Detection Limit)

Sl. No.	Parameter	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
1.	pH	7.55	7.81	7.32	7.61	7.94	7.81
2.	Conductivity Microsiemens/cm	349	380	367	334	254	376
3.	Turbidity in NTU	8	10	7	5	10	47
4.	Total Hardness as $CaCO_3$ in mg/l	220	85	375	260	120	212
5.	Calcium mg/l	120	64	280	218	110	120
6.	Magnesium mg/l	100	21	95	42	10	92
7.	BOD mg/l	1.5	1.6	1.0	2.5	2.0	2.1
8.	COD mg/l	11.7	11.9	8.40	16.1	30.0	23.0
9.	Oil and grease mg/l	BDL	BDL	BDL	BDL	BDL	BDL
10.	Fluoride mg/l	0.31	0.70	0.36	0.68	0.82	1.06
11.	Iron mg/l	0.3	0.4	1.6	0.2	0.2	0.2
12.	Chloride mg/l	144	128	148	110	128	148
13.	Total Dissolved Solid mg/l (TDS)	244	242	256	225	202	268
14.	Nitrate mg/l	8	9	8	7	5	7
15.	Sulphate mg/l	19	10	12	19	15	20
16.	Temperature ^0C	21	22	21	23	22	22
17.	DO mg/l	0.75	0.8	0.5	1.25	1	1.05

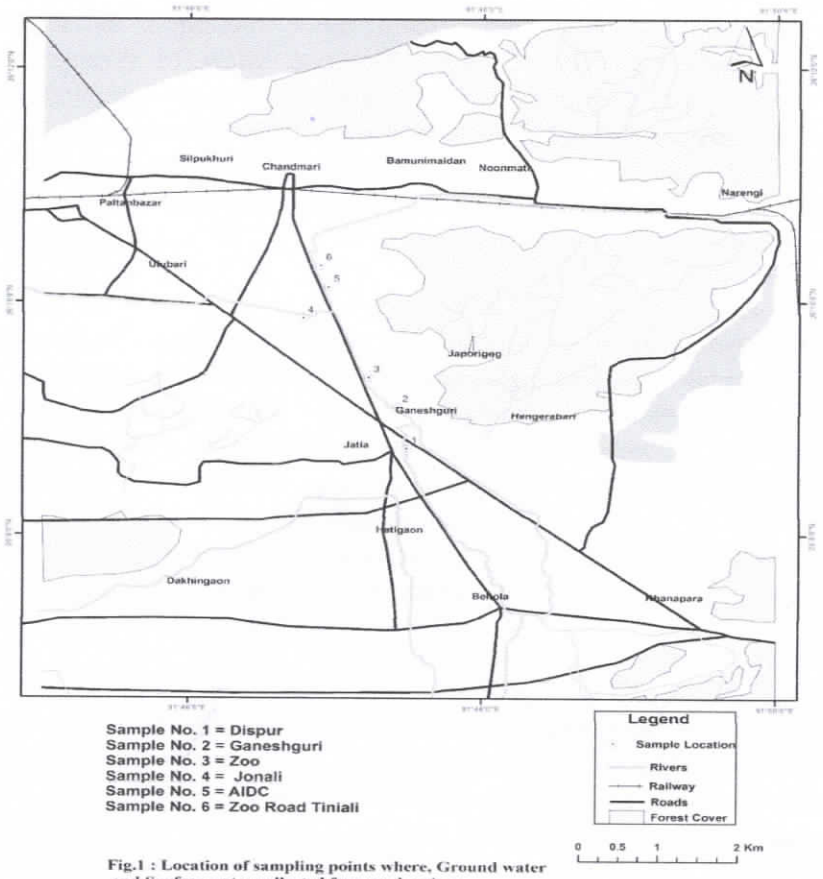


Fig.1 : Location of sampling points where, Ground water and Surface water collected from each points.

Fig. 2: Variation in Temperature and pH at different sampling stations

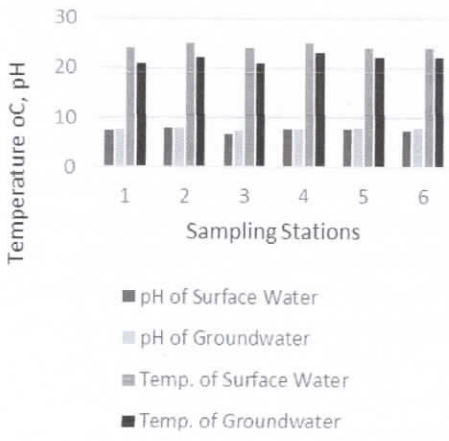
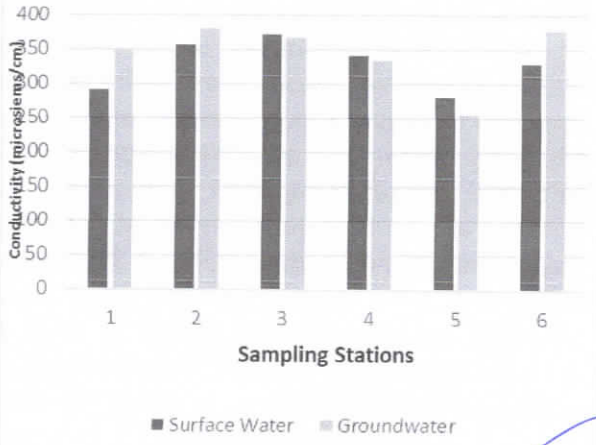


Fig. 3: Variation of Conductivity at Different Sampling Stations



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Temperature:

Temperature is an important water quality parameter which affects the self-purification capacity of water and influence the aesthetic quality of water. At temperature above normal, oxygen solubility in water will be appreciably less leading to total oxygen depletion and obnoxious septic condition. For the surface temperature varies from 24^0C (at sampling station 1,3,5,6) to 25^0C (at sampling station 2,4). While for ground water the temperature ranges from 21^0C (at sampling station 1, 3) to 23^0C (at sampling station 4).

Conductance:

Conductance values range from 254 to 380 microsiemens/cm for ground water and 280 to 371 microsiemens/cm for surface water. The minimum value for the ground water (at sampling station 5) and for surface water at (sampling station 5) are shown in figure (Fig. 3). While the maximum value of ground water at Ganeshguri and for surface water at Zoo. Conductance, which shows the presence of ionic matter. The low electric conductivity indicates that dissolved ions present in water are in less quantity, the higher values of conductivity are generally associated with pollution. Conductance is due to the presence of domestic wastes and other discharges received by the surface water i.e. Bharalu river.

Turbidity:

The turbidity value ranges from 32 NTU to 227 NTU for the surface water and 5 NTU to 47 NTU for the ground water. The minimum value for the surface water of Bharalu water and the storm water is recorded at the (sampling station 1) and for ground water at (sampling station 4) are shown in figure (Fig. 4). While maximum value for Bharalu water and storm water is recorded at (sampling station 2) and for ground water at (sampling station 6). Surface water has higher turbidity value due to domestic waste and other refuse discharge into the Bharalu river.

Biological Oxygen Demand (BOD) and Dissolved Oxygen (DO):

BOD is to measure the amount of biologically oxidisable organic matter present in waste. BOD is a major criterion parameter in stream pollution control. The BOD shows higher concentration in the surface water than ground water. Generally, ground water have negligible amount of BOD but due to percolation of leachate of domestic waste or other refuse it contaminated the ground water. For the surface water the values ranges from 17.0 mg/l (sampling station 3) to 37.0mg/l (sampling station 6) while for ground water the values range from 1.0mg/l (sampling station 3) to 2.5 mg/l (sampling station 4). In the sampling station 4 i.e. Jonali the ground water have higher BOD value due to percolation of domestic waste from the Bharalu river. DO values ranges from 8.5mg/l (sampling station 3) to 17.5 mg/l (sampling station 5) in the surface water while for ground water its ranges from 0.5 mg/l (sampling station 3) to 1.25mg/l (sampling station 4) are shown in figure (Fig. 5). Depletion of DO is indicate of the presence of considerable amount of biodegradable organic

Chemical Oxygen Demand (COD):

COD test determines the oxygen required for chemical oxidation of most organic matter and oxidization inorganic substances with the help of strong chemical oxidant. For the surface water the values ranges from 42.2 mg/l (sampling station 3) to 74.2 mg/l (sampling point 6). While for ground the values ranges from 8.4 mg/l (sampling station 3) to 30.0 mg/l (sampling station 5) are shown in figure (Fig. 6). So, COD values are not much in water i.e. less polluted in COD.

Total Dissolved Solid (TDS):

The values for the total dissolved solid range from 210 mg/l to 250 mg/l for the surface water of Bharalu water. The minimum value is recorded (at the sampling station 1) and the maximum value if found (at the sampling station 6). For the ground water, the values range from 202 mg/l to 268 mg/l. The minimum value is shown (at the sampling station 5) and the maximum value is shown (at the sampling station 6) are shown in figure (Fig. 7). Normally, ground water has higher TDS load completed to surface water. It is due to infiltration of the contaminated Bharalu water or the storm water into the ground reserves. The presence of more solids in water indicates pollution which can lead to a laxative effect (Karuna Karan et. al., 2009) [11].

Total Hardness (TH):

Both Calcium and Magnesium salts contribute to the total hardness of water. Hard water is unsuitable for industrial and domestic use of water. The ground water source at the present work recorded total hardness from 10 mg/l (sampling station 5) to 110 mg/l (sampling station 1). While for the surface water of Bharalu water and storm water value ranges from 20 mg/l (sampling station 3 & 5) are shown in figure (Fig. 8).

Calcium:

The calcium concentration shows wide variation for both surface water and ground water. For the Bharalu water, it shows minimum value of 80 mg/l (at the sampling station 3, 3, 4 & 6). Ground water shows higher concentration of calcium. The values are in the range of 64 mg/l (sampling station 2) to 280 mg/l (sampling station 3) are shown in figure (Fig. 9). It indicates harmful effect.

Magnesium:

The magnesium concentration shows higher values for ground water. For the ground water values were found to be 10 mg/l (sampling station 5) to 110 mg/l (sampling station 1). While for the Bharalu river the values varies from 20 mg/l (sampling station 3 & 5) to 46 mg/l (sampling station 1) are shown in figure (Fig 10). Higher values of magnesium is not good for health.

Fig. 4: Variation of Turbidity at Different Stations

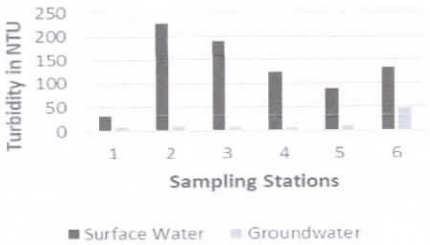


Fig. 5: Variation of DO and BOD at different stations

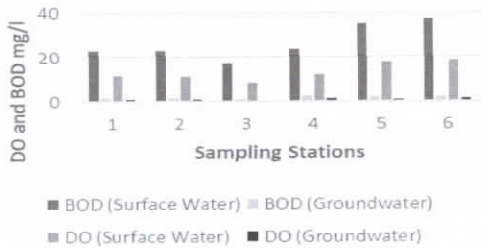


Fig. 6: Variation of Chemical Oxygen Demand at different sampling stations

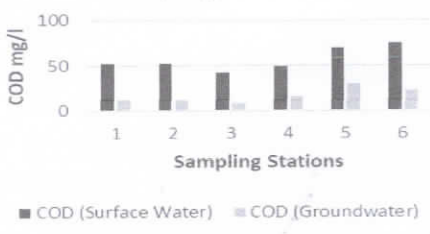


Fig. 7: Total Dissolved Solids at different sampling stations

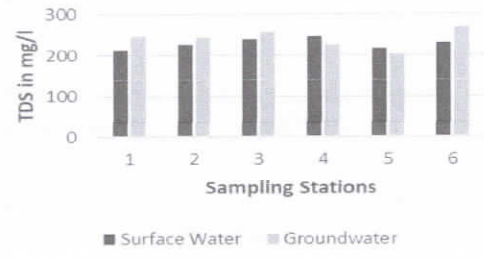


Fig. 8: Variations of Total Hardness at Different Sampling Stations

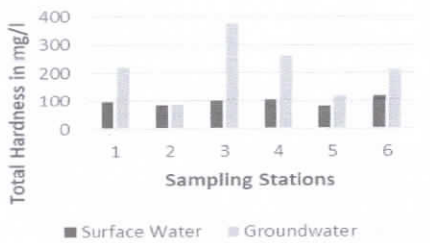
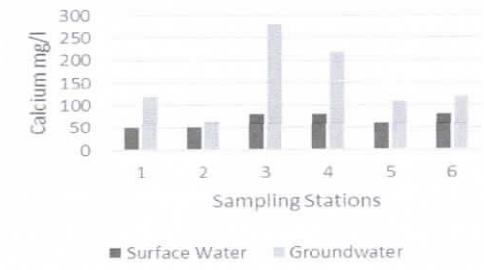


Fig. 9: Variation of Calcium at Different Sampling Stations



Oil and Grease:

Oil and Grease is applicable to natural water and domestic wastewater. In general oil and grease is mostly due to domestic waster, refinery waste discharge in the natural bodies like stream, river etc. Due to this the surface water gets contaminated. If the percolation of surface water into the groundwater it can possible to contaminate. For the surface water the values ranges from 1.4 mg/l (sampling station 3) to 2.7 mg/l (sampling station 6) are shown in figure (Fig. 11). For the groundwater the oil and grease value are BDL below detection limit.

Chloride:

The Chloride load varies from 84 mg/l (at sampling station 4) to 146 mg/l (at sampling station 3) for Bharalu water and the storm water. While 110 mg/l (at sampling station 4) to 148 mg/l (at sampling station 6) for the ground water are shown in figure (Fig. 13). The surface and ground water is contaminated due to domestic waste discharge into Bharalu river. It contaminated the ground water due to infiltration of the waste. It may be an indication of pollution from industrial or domestic use. (Raina et. al, 1984) [12].

Nitrate:

The nitrate content shows higher values for surface water than groundwater. The nitrate load varies from 7 mg/l (at sampling station 1 & 3) to 43 mg/l (at sampling station 6) for surface water of Bharalu and storm water from 5 mg/l (at sampling station 5) to 9 mg/l (at sampling station 2) are shown in figure (Fig. 12). For surface water the nitrate content is more due to discharge of domestic wastes or other refuse.

Sulphate:

The sulphate content for the ground water varies from 10 mg/l (at sampling station 2) to 20 mg/l (at sampling station 6) while for the surface water of Bharalu and storm water varies from 22 mg/l (at sampling station 5) to 80 mg/l (at sampling station 2) are shown in figure (Fig. 13). It shows that surface water have high sulphate value than ground water, but below the permissible limit as per the standards.

Iron:

Iron shows higher concentration in surface water than ground water. The values ranges from 0.5 mg/l (sampling station 5) to 2.8 mg/l (sampling station 3) in surface water while 0.2 mg/l (sampling station 5) to 1.6 mg/l (sampling station 3) in the ground water are shown in figure (Fig. 14). It indicates harmful for using as potable water.

Fluoride:

The fluoride concentration is higher in ground water than surface water. Fluoride is mainly found in ground water. For the ground water the value ranges from 0.31 mg/l (sampling station 1) to 1.06 mg/l (sampling station 6). It notices that Zoo-Tiniali area are higher concentration of fluoride. While for the surface water of Bharalu river the value ranges from 0.3 mg/l (sampling station 1) to 0.5 mg/l (sampling station 1) shown in figure (Fig. 15). Fluoride is more in ground water due to natural and anthropogenic effects. It is harmful for our health.

CONCLUSION:

In Guwahati city, although Brahmaputra river is the principal source of drinking water, with increase in the population, ground water has become an important source of water has become an important source of water, specially in newly developed areas.

The Bharalu river, flowing from the heart of the city has long lost the characteristics of a natural river. This polluted surface water body may be deteriorating the quality of ground water source close to the river. The analysis of water quality of Bharalu or storm water and ground water near its bank at 6 (six) different locations throughout the course of Bharalu has shown that the Bharalu water is highly degraded with a large amount of organic load coming from municipal and industrial waste.

Fig. 10: Variation of Magnesium at Different Sampling Stations

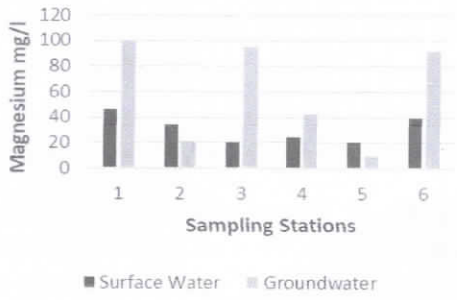


Fig. 11: Variation of Oil and Grease at Different Sampling Stations

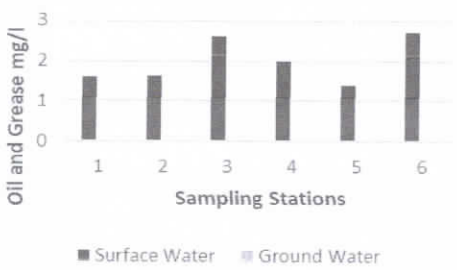


Fig. 12: Variation of Chloride and Nitrate at Different Sampling Stations

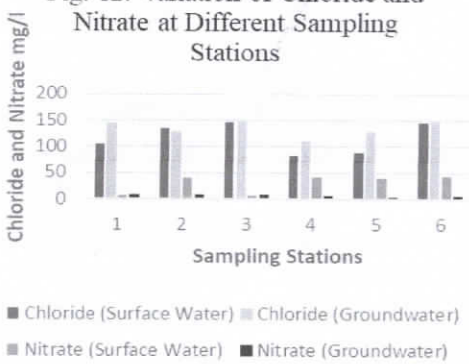


Fig 13: Variation of Sulphate at Different Sampling Stations

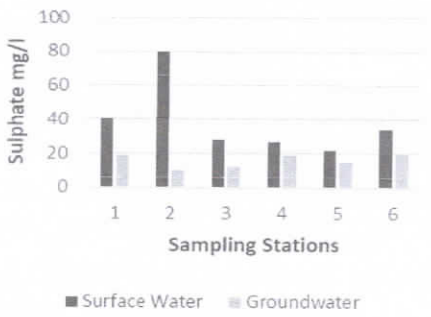


Fig. 14: Variation of Iron at Different Sampling Stations

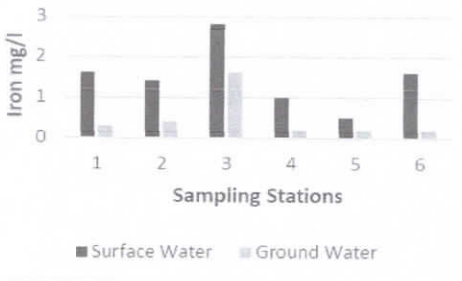
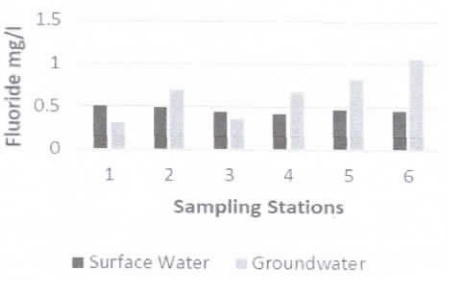


Fig. 15: Variation of Fluoride at Different Sampling Stations



The ground water near Bharalu river or storm water has appreciable load of pollutants. In case of some of the parameters like conductivity, pH, turbidity, sulphate, chloride there distinct parallelity between Bharalu water and ground water. However, calcium, magnesium, total hardness, chloride, fluoride are shown higher values in ground water than Bharalu or storm water. Although no distinct correlation should be ruled out. During monsoon period, large amount of Bharalu water or storm water submerges areas along its bank. There is every likelihood of contamination various drinking water sources along its bank. Due to natural or anthropogenic activities contaminated the quality of water. However, a more exhaustive and detailed study will be required to bring clear cut correlation between surface water and ground water quality.

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