WATER QUALITY ASSESSMENT OF GROUND WATER AND SURFACE WATER AT KALAIGAON AREA IN UDALGURI DISTRICT ASSAM

A dissertation
submitted in the partial fulfilment of the requirement for the Award of the Degree of

MASTER OF TECHNOLOGY
In
CIVIL ENGINEERING
(*With specialization in Water Resources Engineering*)
Of
Assam Science & Technology University
Session: 2023-2025

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DECLARATION

I hereby declare that the work presented in this report entitled "**WATER QUALITY ASSESSMENT OF GROUND WATER AND SURFACE WATER AT KALAIGAON AREA IN UDALGURI DISTRICT ASSAM"** in the partial fulfilment of the requirement for the award of the degree of Master of Technology in Civil Engineering with specialization in Water Resources Engineering submitted in the Department of Civil Engineering, Assam Engineering College, Jalukbari, Guwahati-13 under Assam science and Technology University, is a real record of my work carried out in the said college under the supervision of Dr Utpal Kumar Misra, professor, Department of Civil Engineering, Assam Engineering College, Jalukbari, Guwahati-13, Assam.

Do hereby declare that this project report is solemnly done by me and is my effort and that no part of it has been plagiarized without citation.

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CERTIFICATE

This is to certify that the work presented in this report entitled "**WATER QUALITY ASSESSMENT OF GROUND WATER AND SURFACE WATER AT KALAIGAON AREA IN UDALGURI DISTRICT ASSAM**" is carried out by Akib Javed Rahman, Roll No: PG/C/23/20 , a student of M. Tech 3rd semester, Department of Civil Engineering, Assam Engineering College, under my guidance and supervision and submitted in the partial fulfilment of the requirement for the award of the Degree of Master of Technology in Civil Engineering with specialization in Water Resources Engineering under Assam Science and Technology University.

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ACKNOWLEDGEMENT

I would like to extend my sincere appreciation to Dr. Utpal Kumar Misra, Professor in the Department of Civil Engineering at Assam Engineering College, for her extensive support and encouragement throughout the project. His guidance, constant supervision and provision of necessary information were invaluable to me. Working under him was an inspiring and great experience, and I am highly indebted to him.

This project would not have been possible without the help of my seniors; laboratory assistants and staffs, for their guidance in various ways. Without their guidance and support it would have not been possible for me to prepare and complete this study.

I am also grateful to Dr. Jayanta Pathak, Professor and Head of the Department of Civil Engineering at Assam Engineering College as well as the entire community of the Department of Civil Engineering at Assam Engineering College for providing us with the necessary infrastructure and comfort throughout the course, particularly during my project.

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ABSTRACT

Water quality is a critical aspect of environmental sustainability, public health, and socio-economic development. This research thesis aims to evaluate the water quality of both **groundwater** and **surface water** sources, utilizing a comprehensive approach that incorporates the **Water Quality Index (WQI)** to assess the overall health and suitability of water for domestic, industrial, and agricultural use. The study was conducted in a kalaigaon area in udalguri district in assam to represent variations in water quality across different landscapes and human activities. Sample was collected from three groundwater and three surface water sites, focusing on key physicochemical parameters such as **PH**, **TDS , Turbidity, Electronic Conductivity, Chloride, Total Alkalinity, Sulphate, Total hardness, Calcium, Magnesium, Total Iron, Fluoride,** and **Nitrate.** Each parameter was analyzed using standard methodologies, and the results were compared against **BIS Standard** and **Indian Standard (IS 10500:2012)**. The Water Quality Index (WQI) was calculated for each sample using a weighted arithmetic index method (Brown et. al. 1972), where each parameter was assigned a specific weight based on its perceived importance to water quality and human health. WQI scores were categorized into **excellent**, **good**, **poor**, and **very poor** categories, allowing for an easy-to-understand evaluation of the overall water quality status. The findings of the study highlight significant regional variations in water quality, with groundwater in hand pump showing higher levels of **total Iron concentration**. River water in the region is comparatively of better quality, with lower levels of contaminants, making it suitable for domestic use. This thesis underscores the importance of ongoing water quality monitoring and the adoption of sustainable water uses practices to protect water sources. The use of the Water Quality Index in this research provides a useful tool for decision-makers to prioritize areas for intervention and improve water quality management strategies, ensuring safe and adequate water for all sectors of society.

CHAPTER 1

INRODUCTION

1.1 GENERAL

Water is one of the most vital resources for sustaining life, driving ecosystems, and supporting economic activities across the globe. As populations grow and industrialization accelerates, the demand for clean and accessible water is rising, leading to significant concerns about water quality, availability, and sustainability. Most human activities involve the use of water in one way or other. It may be noted that man's early habitation and civilization sprang up along the banks of rivers. Although the surface of our planet is nearly 71% water, only 3% of it is fresh. Of these 3% about 75% is tied up in glaciers and polar icebergs, 24% in ground water and 1% is available in the form of fresh water in rivers, lakes and ponds suitable for human consumption. Due to increasing industrialization on one hand and exploding population on the other, the demands of water supply have been increasing tremendously. More over considerable part of this limited quality of water is polluted by sewage, industrial waste, and a wide range of synthetic chemicals. Fresh water which is a precious and limited vital resource needs to be protected, conserved, and used wisely by man. But unfortunately, such has not been the case, as the polluted lakes, rivers and streams throughout the world testify. According to the scientists of National Environmental Engineering Research Institute, Nagpur, India, about 70% of the available water in India is polluted. In many regions, water bodies face increasing pressure from various factors, including pollution, over-extraction, climate change, and land use changes. These challenges not only affect the environment but also pose threats to human health, agriculture, and economic stability. Consequently, accurate water assessment is vital for developing effective management strategies and policies that ensure water resources are used sustainably, preserved for future generations, and remain accessible for all.

Kalaigaon is a village in north-eastern India. It is situated in the Udalguri district of Assam state. The average altitude is 37 meters. The climate is humid and congenial, while the relative humidity is around 82%. The annual rainfall is around 2,000 mm. According to 2011 census records, the total population of Kalaigaon sub-division was 110862, of whom 56285 (50.77%) were males and 54577 (49.22%) were females. Some villages of Kalaigaon fall in Darrang district, and the population there was 24246 (12723 males and 12523 females).The remaining majority of villages are in Udalguri district, and the population there was 85616 (43562 males and 42054 females). The primary river Noa River, flowing near Kalaigaon town in Assam, India, is a small but significant waterway that frequently causes flooding issues due to its tendency to change course and overflow its banks, particularly during monsoon season.

1.2 OBJECTIVE OF THE STUDY

- To study the water quality parameter of the water available in both ground water and surface water at Kalaigaon area in Udalguri district via a systematic water quality analysis.
- To Study the water Quality index of the samples and compare it among them.

CHAPTER 2

LITERATURE REVIEW

Water is essential for existence of life. it seems to be in abundance on the earth. Nevertheless, its 97.5 percent is saline whereas the fresh water just make 2.5 percent. Water has a profound influence on human health. At a very basic level, a minimum amount of water is required for consumption on a daily basis for survival and therefore access to some form of water is essential for life. The water demand is continuously increasing mainly due to population growth and raising needs in agriculture, industrial uses and domestic services. Integrated water management has a strong impact on long-term protection and sustainability. For survival of human beings' clean water is an essential commodity whereas contamination in drinking water threatens to mankind.

Tyagi et al., (2010) conducted a research work for analysis of moveable water by Water quality index (WQI) which deliver whole water quality grade and also help for suitable remediation methods for related problems. However, WQI labels the combined impression of different drinking water quality parameters and connection water quality statistics to the governmental and community decision makers. The current study also brings thought towards the progress of a worldwide and novel accepted "Water Quality Index" in a relaxed form.

Memon et al., (2011) conducted a study that in particular in young children in developing countries, unsafe drinking water is a major cause of the diseases. Pathogens which are present in drinking water including many bacterial and viral agents caused about 2.5 million deaths from prevalent diarrheal disease each year (M. Kosek et al., 2010). Major health problems were stated as gastroenteritis (40%-50%), dysentery (28%-35%), diarrhoea (47%-59%), hepatitis A (32%-38%), hepatitis C (6-7%) and hepatitis B (16%-19%) by respondents (Khan et al., 2015). In Sindh, water related diseases such as diarrhoea, gastroenteritis, vomiting, dysentery, and kidney problem are caused by polluted drinking water.

Pavender et al., (2011) conducted work to analyse biological and physiochemical parameter of moveable water in India. From digging well water samples were collected. Firm water and open well were analysed open. Well water was contaminated with huge level of total hardness, total dissolved solid, while in bore well results large amount of fluorides water result shown that microbial contagion of water samples of study area and unhealthy for drinking purpose.

Jadhav et al. (2012) have explained, in order to understand the water quality of Triveni Lake, Physico-chemical parameters were studied and analyzed for the period of one year i.e., December 2010 to November 2011. Various physicochemical parameters, such as water temperature, air temperature, pH, humidity, conductivity, free Co2, total solid, dissolved oxygen, Total alkalinity, Total hardness, $CaCo_3$, Ca^{2+}, Mg^{2+} were studied. The results revealed that there was significant seasonal variation in some physicochemical parameters and most of the parameters were in normal range and indicated better quality of lake water. It has been found that the water is best for drinking purpose in winter and summer seasons.

Khalik (2013) a methodical study was done to assess the change in physiochemical characteristics of water with respect to period. For this purpose, from Bertram rivers six localities were selected Cameron highland for sample collection. Specific locations were nominated where human activities are high. Water Sampling was completed in months of august to November 2012. Following parameters were selected. Ph, temperature, salinity, electrical conductivity, total dissolved solid, total suspended solids, hardness, ammonia nitrogen, biochemical, biological oxygen demand nitrate phosphate. Results are showed and associate with Malaysian national standard for drinking water quality NSDWQ Category II.

Sorlini et al., (2013) designed a research work by ACRA foundation of logon valley to defining the impacts on health and aesthetic beauty and the water quality. through bore wells, open holes, river and piped water samples were collected. physio chemical and microbiological testing were subjected. Results showed that most of these parameters had thoughtful concern with health and aesthetic. negatively impact on the health of ground water contamination was due to high level of turbidity, iron, and manganese. by installing water treatment plant and improve and repair water distribution system the problem could be solved.

Shukla et al., (2013) conducted a study to checking the quality of water whether water is suitable for drinking purpose as well as investigate physiochemical features of water and its impact on an ecosystem. Then consequences of all parameters match with permissible limit suggested by Who. Study to tells effect the biological growth in water of city Ahmadabad that changed in physiochemical characteristics.

Singla et al., (2014) Research study was conducted to analyse the physiochemical and biological parameters of bottled and pack water in different markets of Delhi (India). 16 samples of water bottles and 4 samples of sachets water were selected lab analysis, from different local places in study area and at national test house their lab analysis was done, Ghaziabad. l results revealed that bottled water quality was far way better than sachets water quality. The main values of selenium, lead and copper in sachet water was found to surpass from the limits of IS and international standards. The biological analysis results revealed that, for coliform total the mean rate for bottles was nil while the mean rate for sachets was 16.75, which revealed that sachet water was dangerous for drinking purposes.

Nagamani (2015) conducted research work for purpose of water quality status in 5 locations including urban and rural areas of Bangalore. Samples include, bore water, mineral water and bore well water. Then samples were exposed to physio-chemical parameters include TDS, TSS, PH, hardness specific conductivity, and results associate with permissible limit. TDS, pH, hardness, conductance seems as neutral. Range increases in urban a compare to ruler area.

A. Kumar et al. (2015) Evaluation of water quality of Ganga River using Water Quality Index tool to analyze water samples from five designated locations along the river (Rishikesh to Allahabad) using Weighted Arithmetic WQI Method to measure various physio-chemical parameters and to observe trends in the water quality downstream and correlate these with environmental pollutants to understand how local factors contribute to water quality deterioration.The results point to the significant consequences of mindless anthropogenic activities and poorly regulated industrial discharges along the river. They found that, using WQI calculation the study reports a significant trend of degrading water quality along the downward path of the river which may serve as a guide to planning strategies to control pollution.

Ojo et al., (2016) conducted aa research work on chemical and microbial analysis of drinkable water within university Lagos state university campus sampling was done in four designated areas and relocation to university lab for chemical and microbial analysis. Outcomes are associating with who recommended level. Finding stated that magnesium, iron, and calcium was present in normal concentration although at high rates coliform present in water. So, it’s not suitable for drinking. The following Study suggested that fixing of distribution system was necessary to decrease microbial contamination.

Kumar et al., (2017) In this research study from different site of central university of Jharkhand campus surface and ground water were collected for analysis of its physical and chemical parameters. Using titrimetric method laboratory experiments were done, for analysis of various parameters was done using drying oven (105 C). The results of all parameters are within Indian Standards (IS) expecting alkalinity.

The literature on water quality demonstrates that maintaining safe and clean water is a complex and multifaceted issue. The factors influencing water quality, such as pollution, climate change, and human activity, require ongoing research and effective management strategies. As the global population grows and environmental pressures increase, the need for comprehensive water quality assessments and sustainable water management practices will become even more critical. This thesis will contribute to this body of knowledge by providing insights into the current state of water quality in the study area and offering recommendations for improving its sustainability and resilience.

CHAPTER 3

STUDY AREA

Water and Environmental quality of the area deteriorates mainly as a result of the increasing industrial activity and urbanisation. In order to find out the current status of the pollution in the area, due to the increasing trend in the industrial activities, it is very much essential to identify the various sources of pollution. Water is essential for the survival of any form of life. On an average a human being consumes about 2 litre of water every day during his whole life period. The exploding population, increasing industrialization and urbanization causes water pollution. The water pollution by agricultural, municipal, and industrial sources has become a major concern for the welfare of mankind.

In our study we have collected the samples from different areas of Kalaigaon in Udalguri district. Three samples have been collected from Noa River and three samples have been collected from Ground sources from different hand pump. The following is the list of locations from where the water samples has been collected for our study.

Table3.1: Sample numbers and sampling locations

Sample number	Location	Latitude N in degrees	Longitude E in degrees
S1	Kalaigaon rakh mela field ghat (NOA river)	26°34'42.53"N	91°58'38.53"E
S2	Kalaigaon town bridge dump site (NOA river)	26°34'28.43"N	91°58'35.99"E
S3	Gorubandha Ghat (NOA river)	26°34'6.43"N	91°58'42.16"E
S4	Singrimari (Ground water)	26°34'20.52"N	91°58'51.75"E
S5	Rakh mela Field (Ground Water)	26°34'45.34"N	91°58'42.47"E
S6	Garubandha mandir (Ground Water)	26°34'6.34"N	91°58'50.90"E

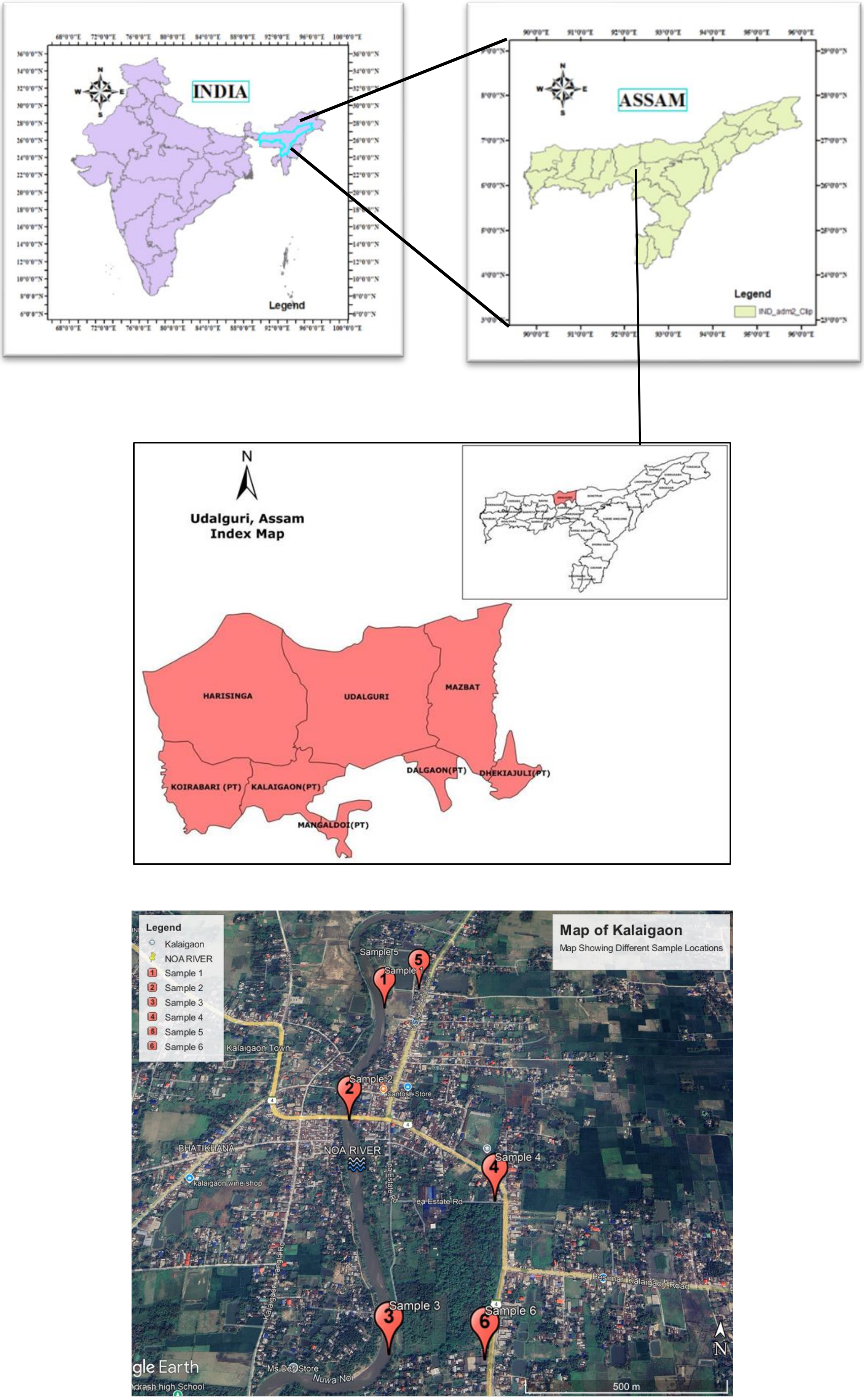


Fig 3.1 : Map showing different location of sample sites

CHAPTER 4

EXPERIMENTAL METHODS

4.1 WATER SAMPLING PROCEDURE

Water samples were collected by using plastic bottle from study sites of Noa River and Ground water sources of kalaigaon area. Two samples were collected from each location. These bottles were properly washed, dried, and labelled and again rinsed with the river water to be sampled just prior to sampling. The river water samples were taken from the sampling points 1 foot below the surface of the river. Once the bottles were filled, they were securely sealed. Precautions were taken during sampling to avoid aeration. Once collected, the samples were warily transported to the laboratory and analysis was done instantaneously.

Fig 4.1 Different Sample Collection site

4.2 STANDARD WATER QUALITY PARAMETERS

Table 4.1: Standard drinking water quality parameters (As per IS 10500 : 2012)

Parameter	Requirement (Acceptable limit)	Permissible limit in the absence of alternate sources
PH	6.5-8.5	No relaxation
TDS (ppm)	500	2000
Turbidity (NTU)	1	5
Chloride(mg/l)	250	1000
Total Alkalinity (mg/l)	200	600
Sulphate	200	400
Total hardness(mg/l)	200	600
Calcium(mg/l)	75	200
Magnesium(mg/l)	30	100
Total Iron(mg/l)	0.3	No relaxation
Fluoride (ppm)	1.0	1.5
Nitrate	45	No relaxation

4.3 MATERIALS AND METHODS

4.3.1 METHODOLOGY FOR MEASUREMENT OF pH VALUE

The pH of a solution is a measure of its acidity or alkalinity, defined as the negative logarithm of the hydrogen ion concentration ($[H^+]$) in a solution. The pH scale ranges from 0 to 14, with values less than 7 indicating acidic conditions, values greater than 7 indicating alkaline conditions, and a value of 7 representing a neutral solution. Determining the pH of water or any solution is an essential task in water quality analysis, environmental monitoring, and industrial processes.

The pH value is determined by measurement of the electromotive force of a cell consisting of an indicator electrode (an electrode responsive to hydrogen ions such as a glass electrode) immersed in the test solution and a reference electrode (usually mercury/calomel electrode), Contact between the test solution and the reference electrode is usually achieved by means of a liquid junction, which forms part of the reference electrode. The electromotive force is measured with a pH meter, that is, a high impedance voltmeter calibrated in terms of pH. Several types of electrodes have been suggested for electrometric determination of pH value. Although the hydrogen gas electrode is recognized as primary standard the glass: electrode in combination with calomel electrode is generally used with reference potential provided by saturated calomel electrode. The glass electrode system is based on the fact that a change, of 1 pH 13 unit produces an electrical change of 59.1 mV at 25°C. The active element of a glass electrode is a membrane of a special glass. The membrane forms a partition between two liquids of differing hydrogen ion concentration and a potential is produced between the two sides of the membrane which is proportional to the difference in pH between the liquids.

APPARATUS USED :

1. pH meter With glass and reference electrode (saturated calomel), preferably with temperature compensation.
2. Thermometer With least Count Of 0.5°C

SAMPLE HANDLING AND PRESERVATION

1. Samples should be analysed as soon as possible, preferably in the field at the time of sampling.
2. High purity water and water not at equilibrium with the atmosphere (ground water or lake water collected at depth) are subject to changes when exposed to the atmosphere, Therefore the sample containers should be filled completely and kept sealed prior to analysis.

PROCEDURE

After required warm-tip period, standardize the instrument with a buffer solution of pH near that of the sample and check electrode against at least one additional buffer of different pH value.

Measure the temperature of the water and if temperature compensation is available in the instruments adjust it accordingly. Rinse and gently wipe the electrodes with solution. If field measurements are being made, the electrodes may be immersed directly in the sample stream to an adequate depth and moved in a manner to ensure sufficient sample movement across the electrode sensing element as indicated by drift free readings (< 0.1 pH unit). If necessary, immerse them into the sample beaker or sample stream and stir at a constant rate to provide homogeneity and suspension of solids. Rate of stirring should minimize the air transfer rate at the air-water interface of the sample. Note and record sample pH and temperature However, if there is a continuous drift, take a second reading with the fresh aliquot of sample without stirring and report it as the pH value.

Fig 4.2 : A pH meter

4.3.2 METHODOLOGY TO DETERMINE TOTAL DISSOLVED SOLIDS (TDS)

Total Dissolved Solids (TDS) refers to the combined content of all inorganic and organic substances dissolved in water. These substances include minerals, salts, metals, cations, and anions that are present in the water in a dissolved state. TDS is often measured in milligrams per liter (mg/L) or parts per million (ppm). High TDS levels can indicate pollution or contamination, while low levels might suggest very pure or distilled water. Here , TDS have been found using 'thermo scientific' TDS meter. A TDS meter is an electronic device that measures the electrical conductivity of water and directly provides a TDS reading in ppm or mg/L. It is an efficient and widely used method for quick on-site measurements.

Fig 4.3 : A TDS meter

4.3.3 METHODOLOGY TO DETERMINE TURBIDITY

Turbidity measurement is crucial for assessing water quality in India, particularly for ensuring safe drinking water and monitoring environmental conditions. The method involves using a turbidimeter to measure the amount of suspended particles that scatter light, with results reported in NTU. The process is standardized and ensures that water treatment processes are functioning effectively, in line with national and international water quality standards. The procedure for determining the turbidity of water typically involves using a **turbidimeter** or **nephelometer** to measure the scattering of light caused by suspended particles in the water. It is based on comparison of the intensity of light scattered by the sample under defined
conditions with the intensity of light scattered by a standard reference suspension under the same conditions. Turbidity measurement is crucial for assessing water quality in India, particularly for ensuring safe drinking water and monitoring environmental conditions. The method involves using a turbidimeter to measure the amount of suspended particles that scatter light, with results reported in NTU. The process is standardized and ensures that water treatment processes are functioning effectively, in line with national and international water quality standards.

Fig 4.4 : A Microprocessor Turbidity Meter

4.3.4 METHODOLOGY TO DETERMINE ELECTRONIC CONDUCTIVITY

Electrical conductivity (EC) is a measure of the water's ability to conduct electricity, which is directly related to the concentration of dissolved ions (such as salts, acids, and bases) in the water. The EC is an important water quality parameter and can be used to estimate the Total Dissolved Solids (TDS) in water. Measuring the electrical conductivity of water is a quick and reliable method to assess water quality, especially for understanding the concentration of dissolved ions. It is widely used in various fields, including environmental monitoring, industrial processes, and water treatment. Regular calibration and maintenance of the conductivity meter are essential for obtaining accurate and consistent results.

Fig 4.5 : A conductivity meter

4.3.5 METHODOLOGY TO DETERMINE CHLORIDE

Chloride can be titrated with mercuric nitrate because of the formation of soluble, slightly dissociated mercuric chloride. In the pH range 2.3 to 2.8. diphenyl carbazone indicates the end point by the formation of a purple complex with excess mercuric ions. Use a 100 ml sample that the chloride content is less than 10 mg. Add 1.0 ml indicator acidifier reagent. For highly alkaline or acid waters, adjust pH to about 8 before adding indicator-acidifier reagent. Titrate with 0.41 1 N mercuric nitrate to a definite purple end point. The solution turns from green blue to blue a few drops before the end point. Determine the blank by titrating 100 ml distilled water containing 10 mg of sodium bicarbonate.

Calculation :

$$\text{Chloride , mg/L} = [(V_1\text{-}V_2)XNX35450]/V_3$$

Where,

V_1= volume in ml of silver nitrate used by the sample,

V_2 = volume in ml of silver nitrate used in the blank titration,

V_3 = volume in ml of sample taken for titration and

N = normality of silver nitrate solution.

Fig 4.6 : Titration Process

4.3.6 METHODOLOGY TO DETERMINE TOTAL ALKALINITY INDICATOR METHOD (IS 3025 PART 23)

Total alkalinity (TA) refers to the capacity of water to neutralize acids. It is an important parameter in water chemistry, especially in pools, aquariums, and natural water systems. Alkalinity is primarily contributed by bicarbonates, carbonates, and hydroxides, which act as buffers to stabilize pH levels. A proper level of alkalinity helps maintain a stable pH, preventing sharp changes that could harm aquatic life, cause corrosion, or affect the effectiveness of chemicals used in water treatment.

PROCEDURE

- Take 50 ml sample in a 100 ml conical flask.
- If the pH of the sample is over 8.3 then add 2 to 3 drops of phenolphthalein indicator and titrate with standard 0.02 N Sulphuric acid (H_2S0_4) solution till the pink colour observed by indicator just disappears.
- Record the volume of 0.02 N standard sulphuric acid solution from the burette.
- If pH of the sample is below 8.3 then eliminating the step 2 and 3, Add 2-3 drops of mixed indicator (Bromocresol green-Methyl Red indicator) solution. The colour of sample changes to Blue.
- Titrate with 0.02 N Sulphuric Acid solution (Colour changes from Blue to Pink)

Calculation:

Total alkalinity (as $CaCO_3$), in mg/L = (A X N X 5000) / V

Where,

A = ml of standard sulphuric acid used to titrate to pH 8.3

N = normality of Standard acid used, and

V = volume in ml of sample taken for test.

4.3.7 METHODOLOGY TO DETERMINE SULPHATE

Sulphate is a naturally occurring compound, primarily found in water as **sulphate ions (SO_4^{2-})**, which come from various sources such as natural mineral deposits, industrial discharge, and agricultural activities. In water, sulphates can be dissolved as salts, most commonly as calcium sulphate (gypsum) or sodium sulphate. Sulphates are not usually harmful in low concentrations but can impact water quality and taste when present in higher amounts. In India, the presence of sulphate in water is of particular concern, especially in regions with high industrial activity or mining operations. In India, sulphate contamination in water is a growing concern, especially in regions with high industrial, agricultural, or mining activities. While sulphates at low concentrations are generally not harmful, high levels can affect the taste of water and pose health risks, particularly for infants and individuals with sensitive digestive systems. Monitoring and managing sulphate levels through water treatment and regulation are essential to maintaining safe water quality standards across the country. Here, we have used UV-VIS Spectrophotometer for finding Sulphate.

Procedure : SULPHATE TURBIDITY METHOD (IS 3025 PART 24)-1986 , Reaffirmed 1992

- Filter the sample through 0.45 µm , membrane filter, if there is any turbidity.
- Take 20 ml sample in a 100 ml conical flask
- Add 1 ml Hydrochloric acid solution and 1 ml conditioning reagent and mix well for 30 sec.
- Add a spoonful or 3 gm of $BaCl_2$ (Barium Chloride) crystals and stir at constant speed for 1 min.
- Read Absorbance at 420 nm.


Fig 4.7 : A UV-VIS Spectrophotometer

4.3.8 METHODOLOGY TO DETERMINE TOTAL HARDNESS

Total hardness refers to the concentration of dissolved minerals in water, primarily **calcium (Ca^{2+})** and **magnesium (Mg^{2+}) ions**, which are responsible for the water's hardness. The hardness of water is typically measured in terms of **calcium carbonate ($CaCO_3$)** equivalents. Hard water is characterized by a higher concentration of these minerals, and its presence can have both beneficial and adverse effects on water systems, appliances, and health. Total hardness is commonly measured in terms of **milligrams per liter (mg/L)** or **parts per million (ppm)** of **calcium carbonate ($CaCO_3$)**. The hardness level can be determined by **Titration method**, where The water sample is titrated with a standard solution of a known concentration, often using a reagent like **EDTA** (ethylenediaminetetraacetic acid) that binds with calcium and magnesium ions to determine their concentration.

Procedure :

- Take 25 ml sample in a 250 ml conical flask.
- Add 1 ml Hydroxylamine hydrochloride solution.
- Adjust the pH in between 10-10.1 by adding 1-2 ml Buffer Solution.
- Add 1/2 drops of EBT (Eriochromc Black T) indicator (Colour changes to wine red)
- Titrate with 0.02N EDTA solution (Colour changes from wine red to
- Note down the end point from the burette
- Blank titration is carried out in a similar way

Calculation

$$\text{Total Hardness} = [\ 1000 \times (V_1 - V_2) \times CF\ ] / V_3$$

Where,

V_1 = Volume of EDTA std solution used in the titration for sample

V_2 = Volume of EDTA std solution used in the titration for the blank sample

V_3 = Volume of the sample taken for the test

X_1 = Volume of std Calcium solution taken for standardization

X_2 = Volume of EDTA solution used in the titration

Correction Factor (CF) = X1/X2

4.3.9 METHODOLOGY TO DETERMINE CALCIUM HARDNESS AND CALCIUM ION

Calcium hardness refers to the amount of **calcium** dissolved in water, which is primarily due to the presence of calcium salts like **calcium bicarbonate ($Ca(HCO_3)_2$)** and **calcium sulphate ($CaSO_4$)**. When these salts dissolve in water, they release **calcium ions** into the water, increasing its hardness. The **calcium ion (Ca^{2+})** is a **positively charged ion** (cation) of calcium. Calcium is an essential element found in many natural minerals and is a major contributor to **water hardness**. It is commonly derived from the dissolution of calcium-based minerals like **limestone**, **gypsum**, and **dolomite**, or from agricultural and industrial activities. In water, calcium ions exist in **dissolved form** (Ca^{2+}) and can combine with other ions, especially **carbonate ions (CO_3^{2-})**, to form insoluble compounds such as **calcium carbonate ($CaCO_3$)**, contributing to water hardness. Here we have determine calcium harness and calcium ion using Calcium EDTA Titration Method (IS 3025 part 40) .

Procedure :

- Take 25 ml sample in a 250 ml conical flask
- Adjust the pH in between 12-13 by adding 1N NaOH solution drop wise
- Add Murexide indicator 1 pinch (Colour changes to Pink)
- Add Sodium Chloride 2 pinch
- Titrate with 0.01M EDTA solution (Colour changes from pink to purple)
- Note down the end point from the burette

Calculation :

$$\textbf{Calcium (} \mathbf{Ca^{2+}} \textbf{)}\text{ , mg/L} = (A\times CF\times 1000\times 0.4008)/V$$

$$\textbf{Calcium Hardness (} \mathbf{CaCO_3} \textbf{)}\text{ , mg/L} = [A\times CF\times 1000]/V$$

Where ,

A= Volume in ml of EDTA std solution used for titration

CF= Mass in mg of calcium equivalent to 1 ml of EDTA solution (X1/X2 Correction factor for standardize ion of EDTA)

X_1 = Volume in ml of std calcium solution taken for standardization

X_2= Volume of ml of EDTA solution used in the titration

V = Volume in ml of the sample taken for the test

4.3.10 METHODOLOGY TO DETERMINE MAGNESIUM HARDNESS AND MAGNESIUM ION

Water sample containing Calcium as CaC03 is estimated and Total Hardness is the sum of $CaC0_3$ and $MgC0_3$. Magnesium hardness is determined by subtracting Calcium hardness from total hardness.

Procedure:

- Calculate the Total hardness as follows: Determine Total Hardness (as CaC03 mg/L) as discussed previously at pH 10 using Erichrome Black T indicator.
- Calculate the Calcium Hardness as follows: Determine Calcium Hardness (as CaC03 mg/L) as discussed previously at pH 12 — 14 by using murexide indicator.

Calculation :

Magnesium hardness = Total hardness - Calcium hardness (mg/L)

Magnesium (as Mg^{2+}) = Magnesium hardness x 0.243 (mg/L)

4.3.11 METHODOLOGY TO DETERMINE TOTAL IRON

Iron is one of the most common elements found in groundwater and surface water in India. It is typically present in water in its dissolved form as **ferrous ions (Fe^{2+})** or in its oxidized state as **ferric ions (Fe^{3+})**. The presence of iron in water can have both beneficial and detrimental effects depending on its concentration and the form in which it exists. In India, iron contamination in drinking water is a widespread concern, especially in rural and semi-urban areas. The **Indian Standard (IS 10500:2012)** sets the permissible limit for **iron concentration** in drinking water at **0.3 mg/L** (milligrams per liter), but many regions across the country exceed this limit.

Here we determine the iron in sample using Iron Phenanthroline Method (APHA 3500-Fe B)

Procedure :

- Take 50 ml sample in a 125 ml Erlenmeyer flask
- Add 2 ml Conc. Hydrochloric Acid
- Add 1 ml Hydroxylamine Hydrochloride ($NH_20H.HCl$)

- Add few glass bead and heat to boiling. To ensure dissolution of all the iron, continue boiling until volume is reduced to 15-20 mL
- Cool to room temperature
- Transfer to a 50 or 100 mL volumetric flask
- Add 10 ml Ammonium Acetate ($NH_4C_2H_30_2$) buffer solution
- Add 4 ml Phenanthroline solution and dilute to mark with distilled water
- Mix thoroughly and allow a minimum Of 10 min for maximum colour development
- Read Absorbance at 510 nm

Fig 4.8: A VIS -Spectrophotometer

4.3.12 METHODOLOGY TO DETERMINE FLUORIDE

Fluoride is a naturally occurring mineral that can be found in soil, water, and various types of rock formations. In water, fluoride typically exists in the form of **fluoride ions (F^-)**. Fluoride concentrations in water can vary significantly depending on the geographical region, geological conditions, and local sources of contamination. While fluoride is beneficial in small amounts, particularly for dental health, excessive fluoride in drinking water can cause several health issues. In India, fluoride contamination in drinking water has become a major public health concern in several states, especially in rural areas. Fluoride contamination in drinking water is a major public health issue in several parts of India, particularly in rural areas where groundwater is the primary source of water. While fluoride is beneficial for dental health at low concentrations, excessive levels of fluoride in water can lead to serious health problems such as dental and skeletal fluorosis.

Addressing this issue requires effective water treatment methods, increased awareness, and the implementation of policies to ensure safe drinking water for the affected populations.

Here , we have used Fluoride Ionometric Method to determine Fluoride in water sample .(IS 3025 part 60: 2008)

Procedure :

- Calibrate 0.1 ppm, 1 ppm, 10 ppm standard solution in ion meter
- Take 10 ml sample in a flask
- Add 1 mi TISAB III
- Record the readings displayed against respective standards

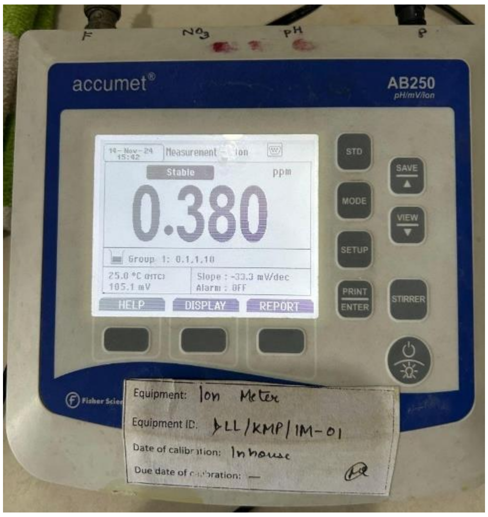


Fig 4.9 A ion meter

4.3.13 METHODOLOGY TO DETERMINE NITRATE

Nitrate (NO_3^-) is a chemical compound that naturally occurs in the environment, primarily in soil, water, and plants, as part of the nitrogen cycle. However, when nitrate concentrations in drinking water exceed safe levels, it can pose significant health risks to humans and animals. Nitrate contamination in drinking water is a significant environmental and public health issue, primarily due to agricultural runoff, wastewater discharge, and improper waste management. High levels of nitrates in water pose serious health risks, especially for infants, and can contribute to long-term health issues such as cancer and thyroid dysfunction. It is essential to monitor and regulate nitrate levels in drinking water sources to ensure safe water for communities. Implementing sustainable agricultural practices, improving wastewater treatment, and using effective water treatment technologies are critical steps in mitigating nitrate contamination and protecting public health. Here we have used Nitrate UV Screening Method to determine the Nitrate in water sample.

Procedure :

- Pipette 50 ml sample in a dry 100 ml Volumetric flask
- Add 1 ml 1M Hcl
- Read Absorbance

4.3.13 METHODOLOGY TO DETERMINE WATER QUALITY INDEX

The Water Quality Index (WQI) was calculated for each sample using a weighted arithmetic index method (Brown et. al. 1972), where each parameter was assigned a specific weight based on its perceived importance to water quality and human health. Water quality index indicates single number like a grade that express overall water quality index at certain area and time. It gives general idea of the possible problem with water in a particular region to public. WQI scores were categorized into **excellent**, **good**, **poor**, and **very poor** categories, allowing for an easy-to-understand evaluation of the overall water quality status.

Calculation of WQI by Weighted Arithmetic Water Quality Index Method

Weighted arithmetic water quality index method classified the water quality according to the degree of purity by using the most commonly measured water quality variables. The method has been widely used by the various scientists and the calculation of WQI was made by using the following equation:

$$WQI = \sum Qi\ Wi / \sum Wi$$

The quality rating scale (Qi) for each parameter is calculated by using this expression:

$$Qi = 100[(Vi - Vo)/ (Si - Vo)]$$

Where,

Vi is estimated concentration of ith parameter in the analysed water.

Vo is the ideal value of this parameter in pure water

Vo = 0 (except pH =7.0 and DO = 14.6 mg/l)

Si is recommended standard value of ith parameter

The unit weight (Wi) for each water quality parameter is calculated by using the following formula:

$$\mathbf{Wi = K / Si}$$

Where, K = proportionality constant and can also be calculated by using the following equation:

$$\mathbf{K = 1/ \sum (1/Si)}$$

The computed WQI can be interpreted using the following typical classification:

Table 4.2 : Table for water quality range and their interpretation

WQI Range	Water Quality	Interpretation
0–25	Excellent	Clean and suitable for all uses.
26–50	Good	Minor treatment needed for most uses.
51–75	Moderate	Requires treatment for specific uses.
76–100	Poor	Unsuitable for human consumption.
>100	Very Poor	Highly polluted, requires treatment.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 VALUE OF DIFFERENT PARAMETER

5.1.1 pH VALUE

The pH is a measure of the intensity of acidity or alkalinity and measures the concentration of hydrogen ions in water. It has no direct adverse affect on health, however, a low value, below 4.0 will produces our taste and higher value above 8.5 shows alkaline taste. A pH range of 6.5–8.5 is normally acceptable as per guidelines suggested by IS code 10500:2000. In the present study, the fluctuation of pH in the samples is from 7.46 to 8.08.

Table 5.1 : pH values of samples

Sample number	Location	pH Value
S1	Kalaigaon rakh mela field ghat (NOA river)	8.08
S2	Kalaigaon town bridge dump site (NOA river)	8
S3	Gorubandha Ghat (NOA river)	7.6
S4	Singrimari (Ground water)	7.46
S5	Rakh mela Field (Ground Water)	7.68
S6	Garubandha mandir (Ground Water)	7.5

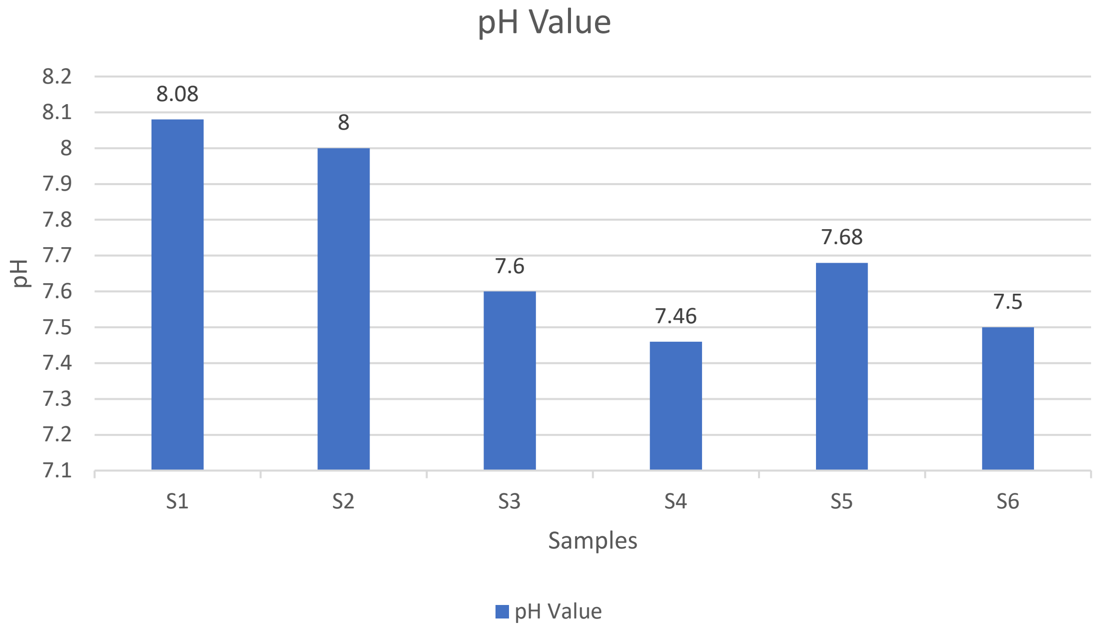


Fig 5.1: Graph showing the pH values of all samples

5.1.2 TOTAL DISSOLVED SOLIDS (TDS)

Table 5.2: Values of TDS of all samples

Sample number	Location	TDS (ppm)
S1	Kalaigaon rakh mela field ghat (NOA river)	74
S2	Kalaigaon town bridge dump site (NOA river)	120
S3	Gorubandha Ghat (NOA river)	91
S4	Singrimari (Ground water)	206
S5	Rakh mela Field (Ground Water)	195
S6	Garubandha mandir (Ground Water)	305

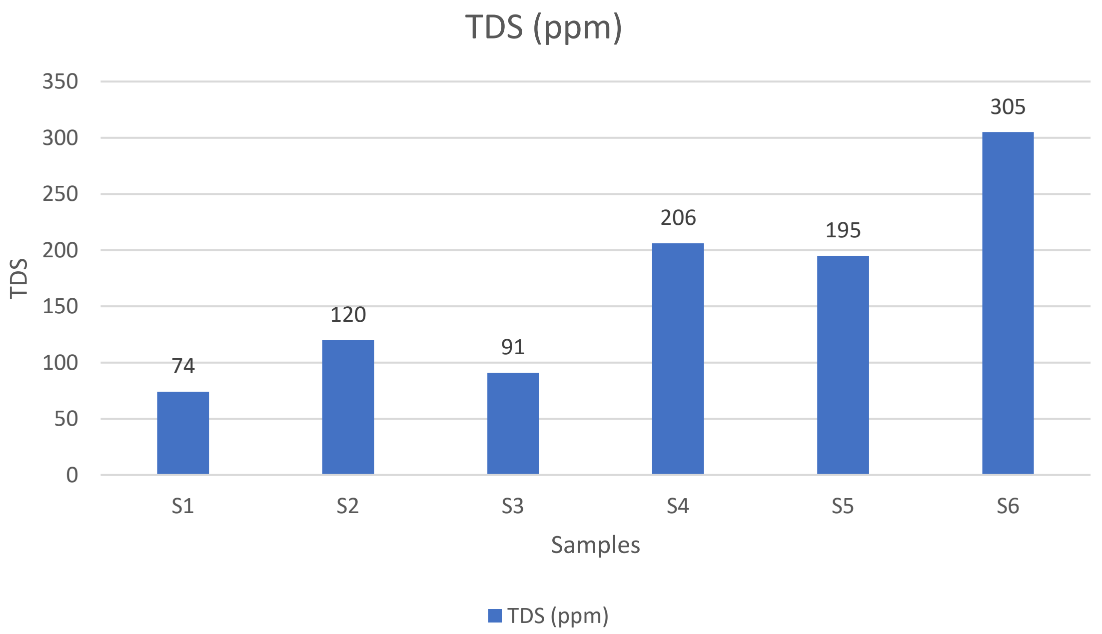


Fig 5.2 : Graph showing TDS values of all samples

5.1.3 TURBIDITY

Table 5.3 : Values of Turbidity of all samples

Sample number	Location	Turbidity
S1	Kalaigaon rakh mela field ghat (NOA river)	1.5
S2	Kalaigaon town bridge dump site (NOA river)	2.9
S3	Gorubandha Ghat (NOA river)	2.8
S4	Singrimari (Ground water)	31.2
S5	Rakh mela Field (Ground Water)	25.8
S6	Garubandha mandir (Ground Water	20.9

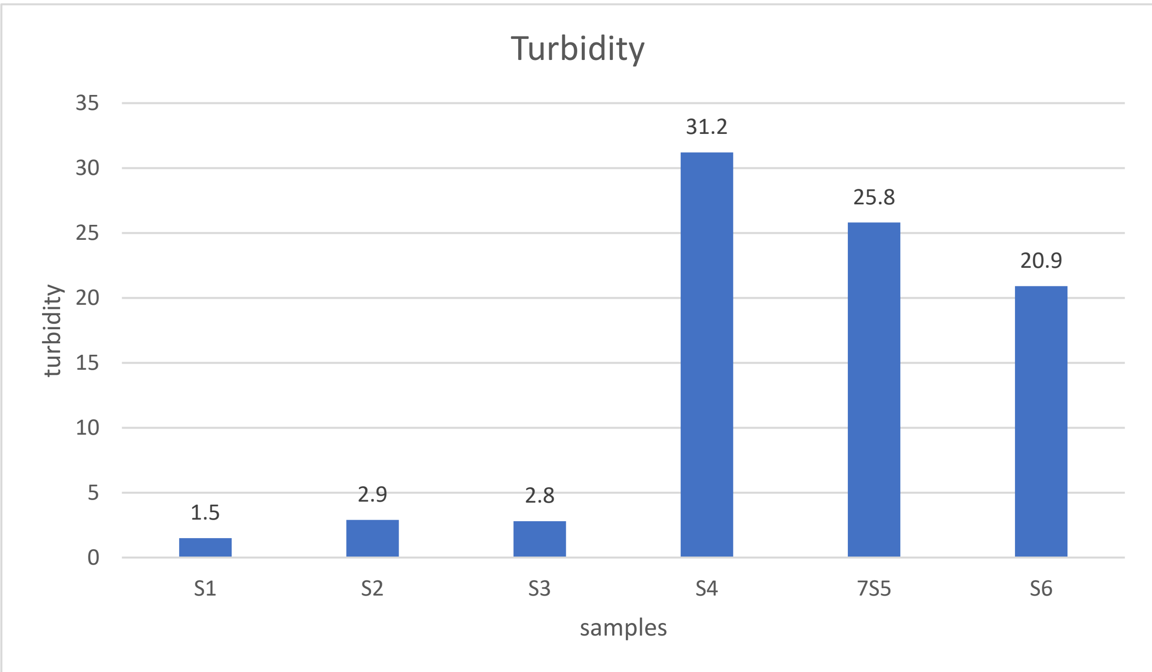


Fig 5.3 : Graph showing Turbidity values of all samples

5.1.4 ELECTRONIC CONDUCTIVITY

Table 5.4 : Values of Electronic Conductivity of all samples

Sample number	Location	Electronic Conductivity
S1	Kalaigaon rakh mela field Ghat (NOA river)	103.1
S2	Kalaigaon town bridge damp site (NOA river)	120.4
S3	Gorubandha Ghat (NOA river)	149.5
S4	Singrimari (Ground water)	350
S5	Rakh mela Field (Ground Water)	319
S6	Garubandha mandir (Ground Water	298

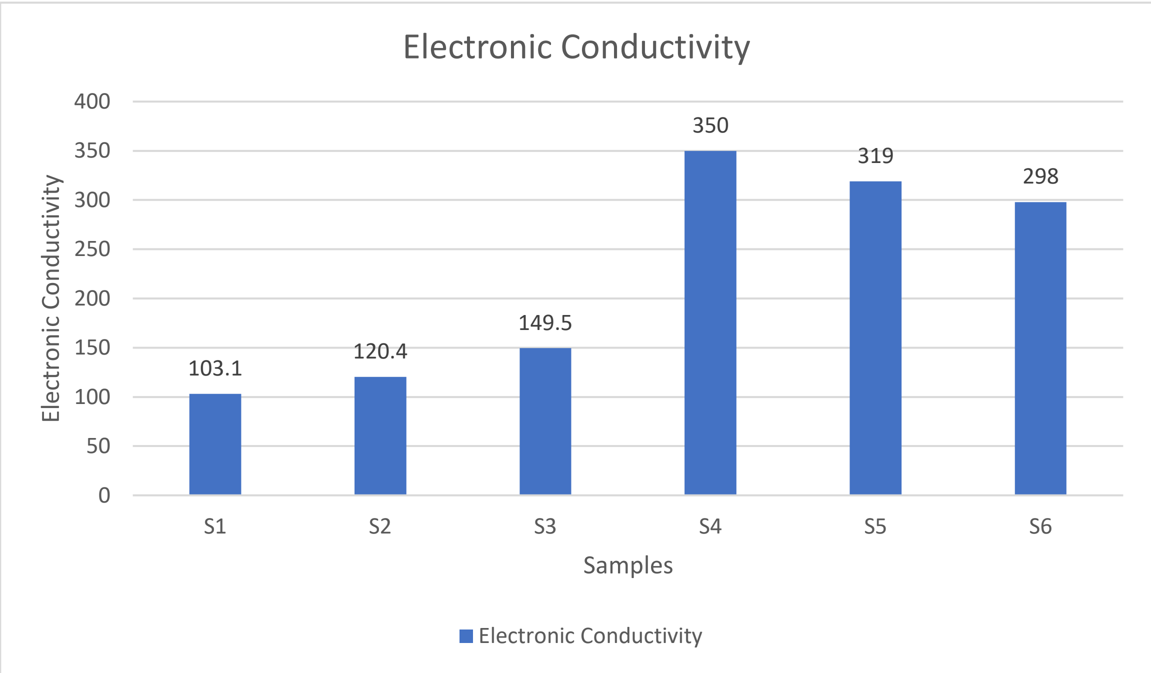


Fig 5.4 : Graph showing Electronic Conductivity of all samples

5.1.5 CHLORIDE

Table 5.5 : Values of Chloride of all samples

Sample number	Location	Chloride
S1	Kalaigaon rakh mela field ghat (NOA river)	55.33
S2	Kalaigaon town bridge dump site (NOA river)	60.67
S3	Gorubandha Ghat (NOA river)	79.45
S4	Singrimari (Ground water)	26.51
S5	Rakh mela Field (Ground Water)	20.59
S6	Garubandha mandir (Ground Water)	21.58

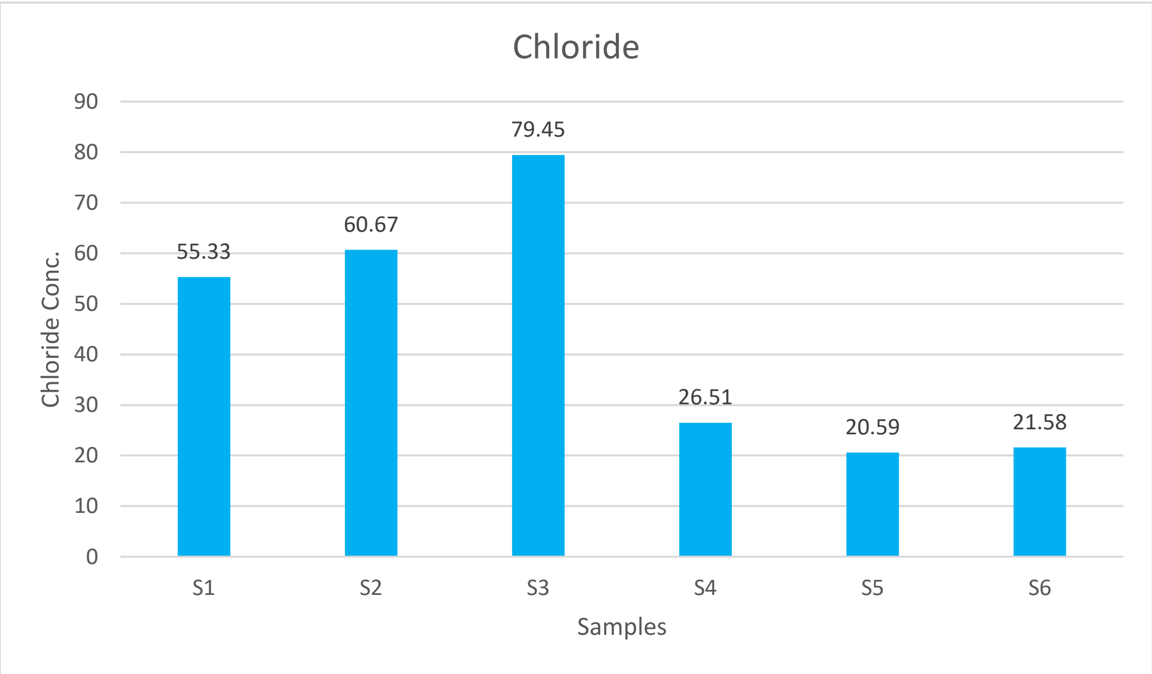


Fig 5.5 : Graph showing Chloride value of all samples

5.1.6 TOTAL ALKALINITY

Table 5.6 : Values of Total Alkalinity of all samples

Sample number	Location	Initial burette Reading	Final burette Reading	Difference between initial and final	Total Alkalinity
S1	Kalaigaon rakh mela field ghat (Noa river)	10	10.5	0.5	10.5
S2	Kalaigaon town bridge dump site (Noa river)	10.5	11.3	0.8	16.8
S3	Gorubandha Ghat (Noa river)	12	12.4	0.4	8.4
S4	Singrimari (Ground water)	12.9	13.9	1	21
S5	Rakh mela Field (Ground Water)	14	14.9	0.9	18.9
S6	Garubandha mandir (Ground Water)	15	16	1.2	25.2

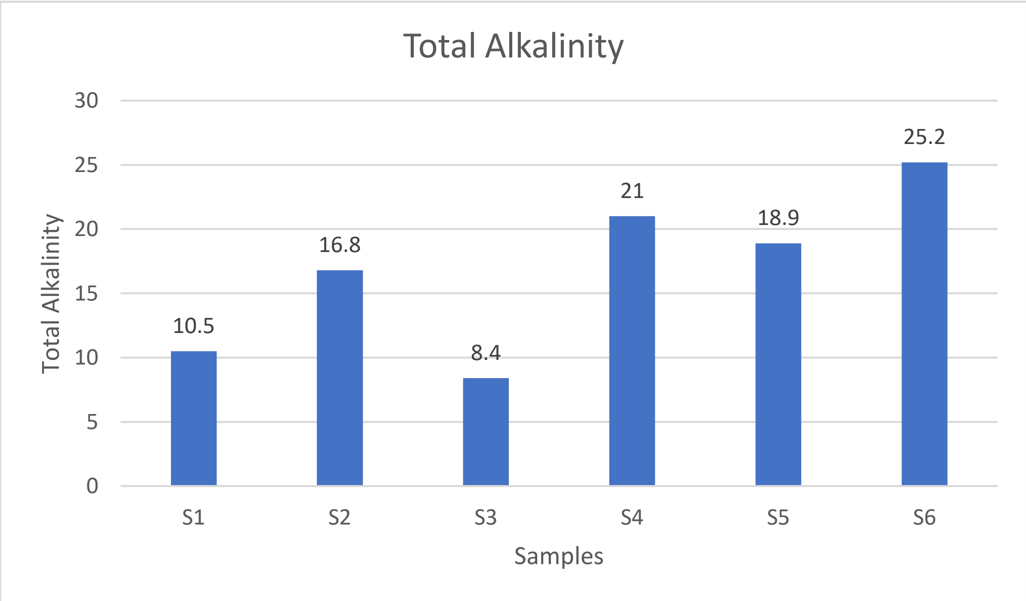


Fig 5.6 : Graph showing Total alkalinity value of all samples

5.1.7 SULPHATE

Table 5.7 : Values of Sulphate of all samples

Sample number	Location	Sulphate
S1	Kalaigaon rakh mela field ghat (NOA river)	9.39
S2	Kalaigaon town bridge dump site (NOA river)	16.2
S3	GorubandhaGhat (NOA river)	11.4
S4	Singrimari (Ground water)	20.43
S5	Rakh mela Field (Ground Water)	30.43
S6	Garubandha mandir (Ground Water)	32.59

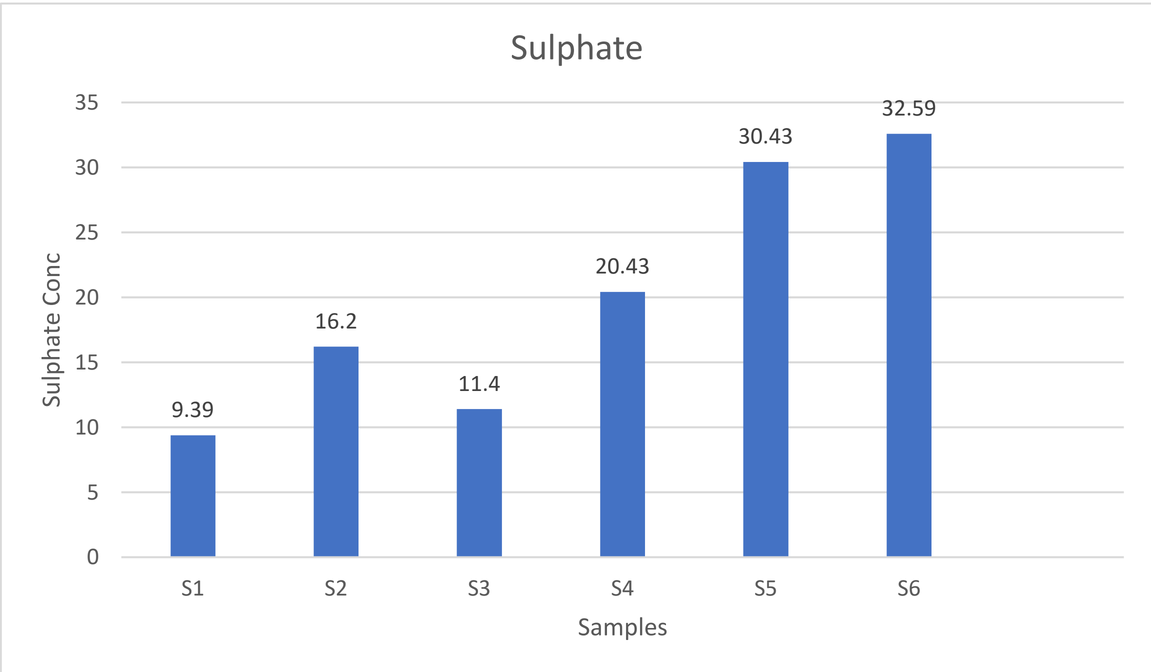


Fig 5.7 : Graph showing Sulphate value of all samples

5.1.8 TOTAL HARDNESS

Table 5.8 : Values of Total Hardness of all samples

Sample number	Location	Initial burette Reading	Final burette Reading	Difference between initial and final	Total Hardness
S1	Kalaigaon rakh mela field ghat (Noa river)	0	0.7	0.7	29.4
S2	Kalaigaon town bridge dump site (Noa river)	0.9	2.8	1.9	79.8
S3	Gorubandha Ghat (Noa river)	2	3.1	1.1	46.2
S4	Singrimari (Ground water)	3.5	6.6	3.1	130.2
S5	Rakh mela Field (Ground Water)	7	8.8	2.8	117.6
S6	Garubandha mandir (Ground Water)	9.1	13.1	4	168

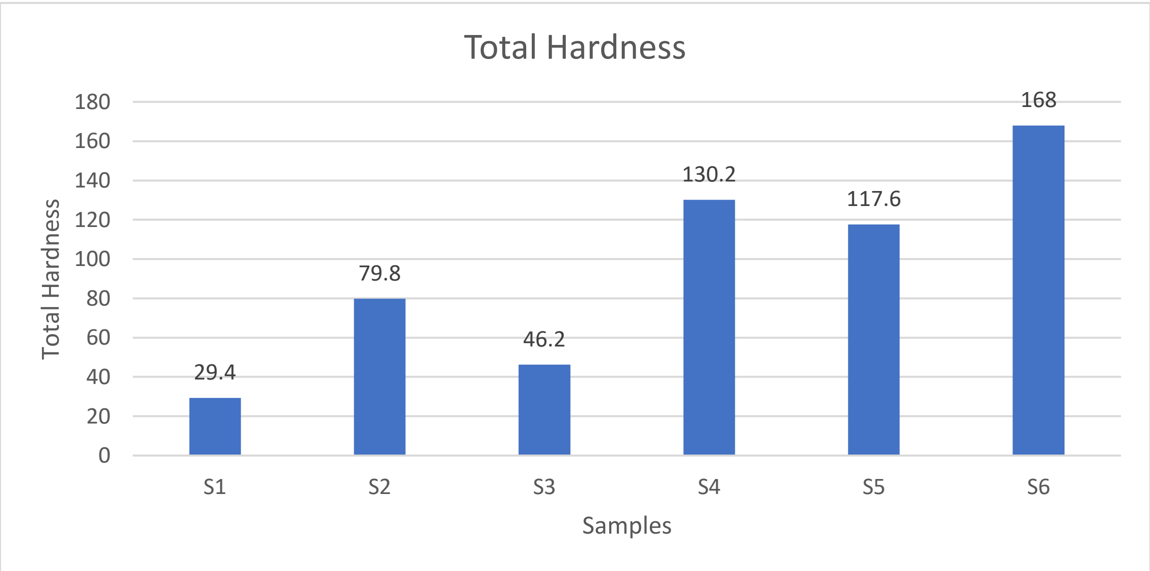


Fig 5.8 : Graph showing Total Hardness value of all samples

5.1.9 CALCIUM HARDNESS AND CALCIUM

Table 5.9 : Values of Calcium hardness and Calcium of all samples

Sample number	Location	Initial burette Reading	Final burette Reading	Difference between initial and final	Calcium	Calcium Hardness
S1	Kalaigaon rakh mela field ghat (Noa river)	5.3	5.8	0.5	8.41	21
S2	Kalaigaon town bridge dump site (Noa river)	5.8	6.7	0.9	15.15	37.8
S3	Gorubandha Ghat (Noa river)	6.8	7.5	0.7	11.78	29.4
S4	Singrimari (Ground water)	0.8	3.0	2.8	47.13	117.6
S5	Rakh mela Field (Ground Water)	3	4.9	1.9	31.98	79.8
S6	Garubandha mandir (Ground Water)	5	8.5	3.5	58.91	147

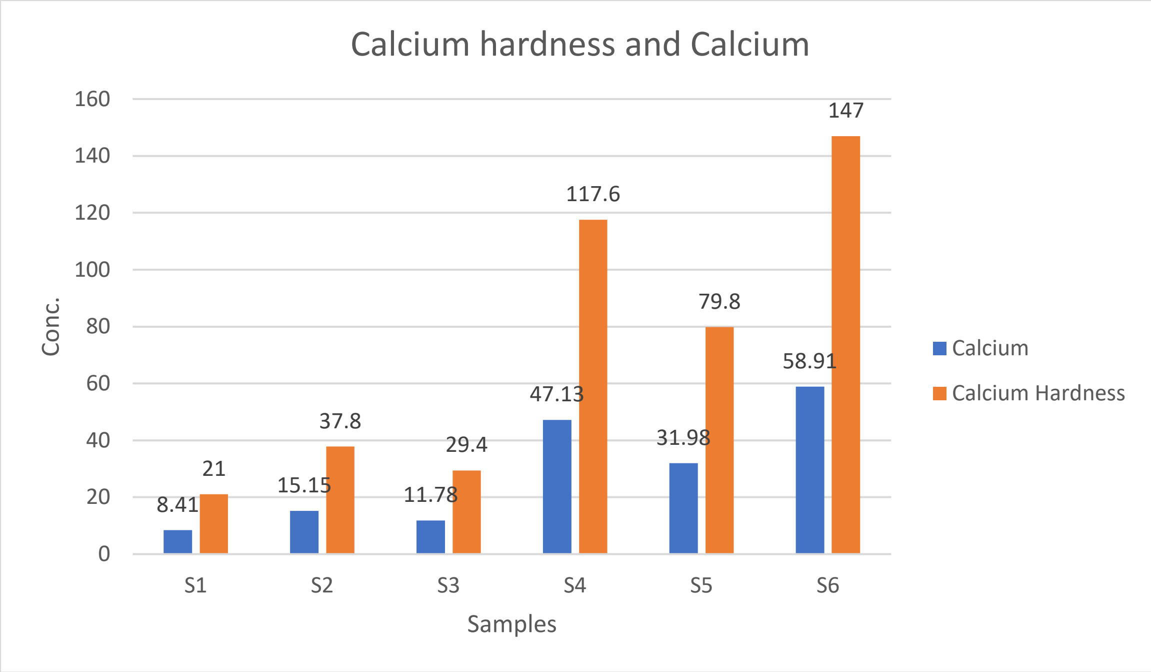


Fig 5.9 : Graph showing Calcium hardness and Calcium value of all samples

5.1.10 MAGNESIUM AND MAGNESIUM HARDNESS

Table 5.10 : Values of Magnesium and Magnesium Hardness of all samples

Sample number	Location	Magnesium Hardness	Magnesium
S1	Kalaigaon rakh mela field ghat (NOA river)	8.4	2.0412
S2	Kalaigaon town bridge damp site (NOA river)	15.15	10.206
S3	Gorubandha Ghat (NOA river)	11.78	4.0824
S4	Singrimari (Ground water)	47.13	3.0618
S5	Rakh mela Field (Ground Water)	31.98	9.1854
S6	Garubandha mandir (Ground Water)	58.91	5.103

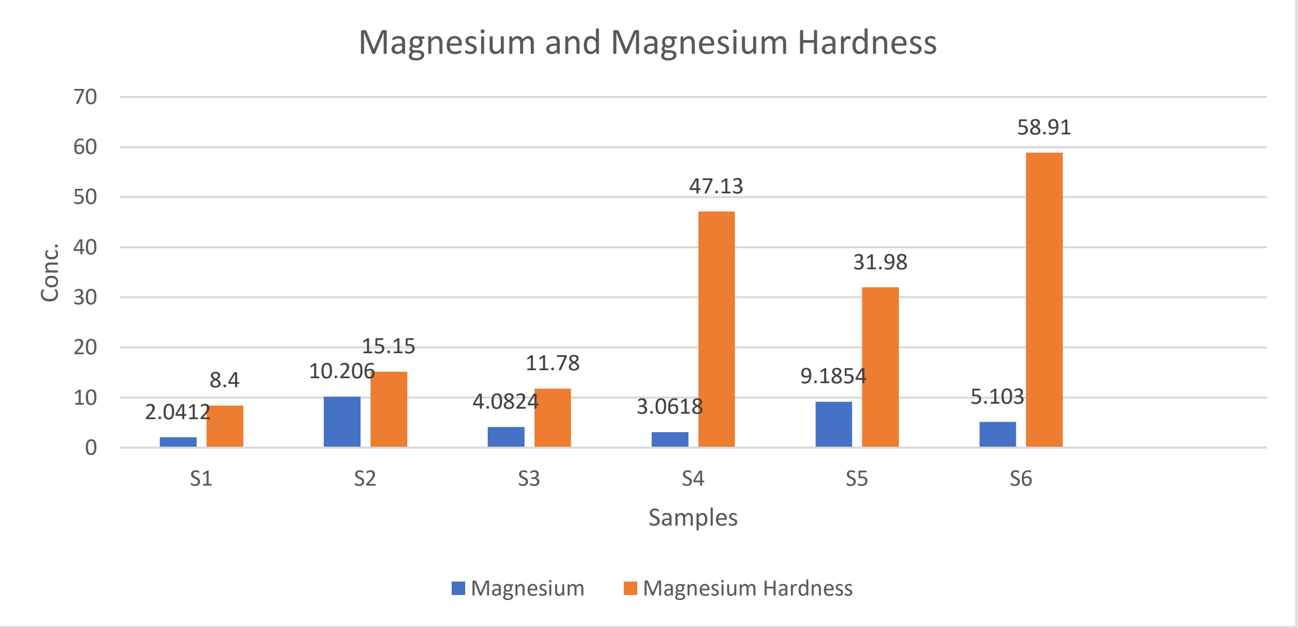


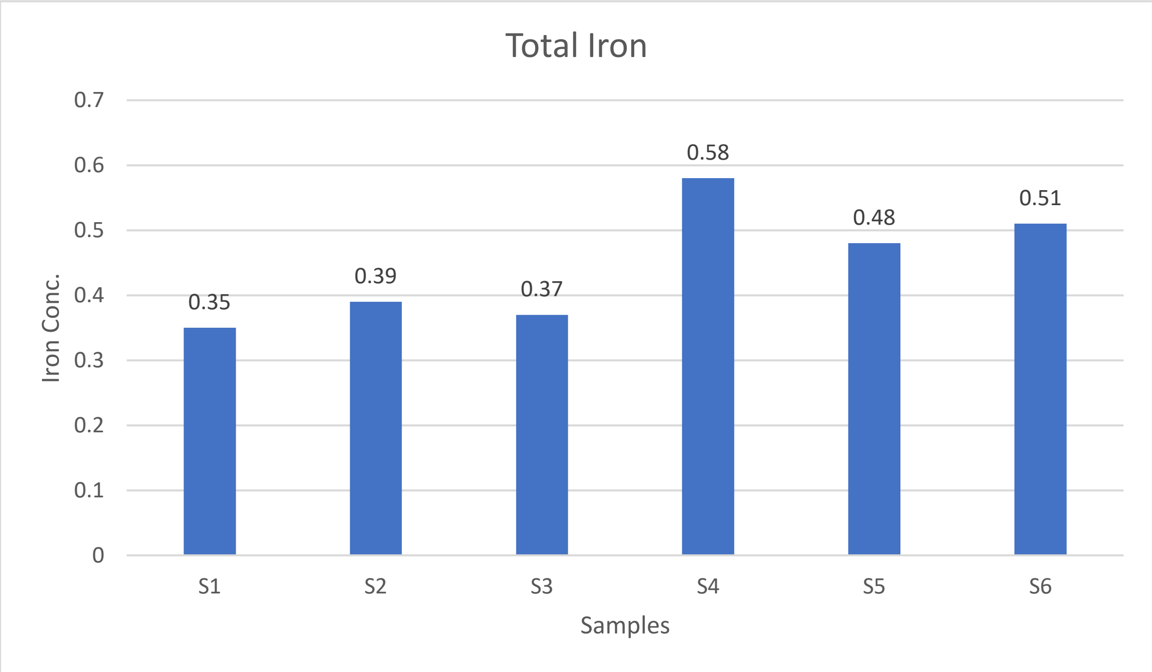
Fig 5.10 : Graph showing Magnesium and Magnesium Hardness value of all samples

5.1.11 TOTAL IRON

Table 5.11 : Values of Total Iron of all samples

Sample number	Location	Total Iron
S1	Kalaigaon rakh mela field ghat (NOA river)	0.35
S2	Kalaigaon town bridge damp site (NOA river)	0.39
S3	Gorubandha Ghat (NOA river)	0.37
S4	Singrimari (Ground water)	0.58
S5	Rakh mela Field (Ground Water)	0.48
S6	Garubandha mandir (Ground Water	0.51

Fig



5.11 : Graph showing Total Iron value of all samples

5.1.12 FLUORIDE

Table 5.12 : Values of Fluoride of all samples

Sample number	Location	Fluoride
S1	Kalaigaon rakh mela field ghat (NOA river)	0.38
S2	Kalaigaon town bridge dump site (NOA river)	0.39
S3	Gorubandha Ghat (NOA river)	0.41
S4	Singrimari (Ground water)	0.147
S5	Rakh mela Field (Ground Water)	0.21
S6	Garubandha mandir (Ground Water	0.312

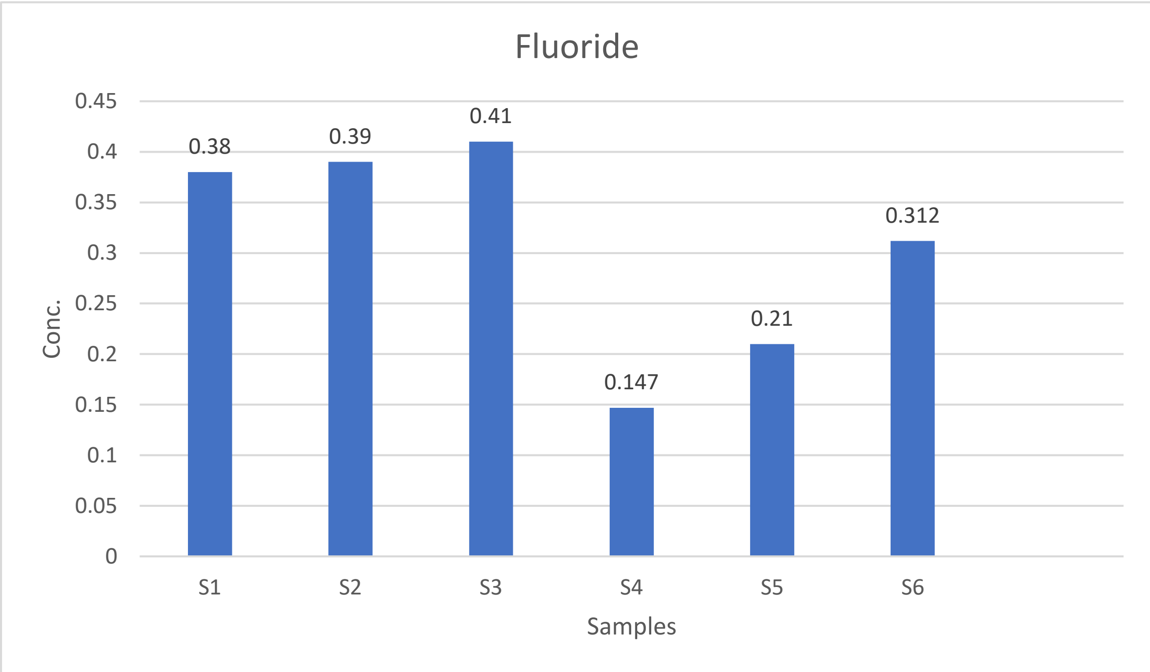


Fig 5.12 : Graph showing Fluoride value of all samples

5.1.13 NITRATE

Table 5.13 : Values of Nitrate of all samples

Sample number	Location	Nitrate
S1	Kalaigaon rakh mela field ghat (NOA river)	3.368
S2	Kalaigaon town bridge dump site (Noa river)	4.51
S3	Gorubandha Ghat (NOA river)	3.79
S4	Singrimari (Ground water)	2.631
S5	Rakh mela Field (Ground Water)	1.957
S6	Garubandha mandir (Ground Water	1.548

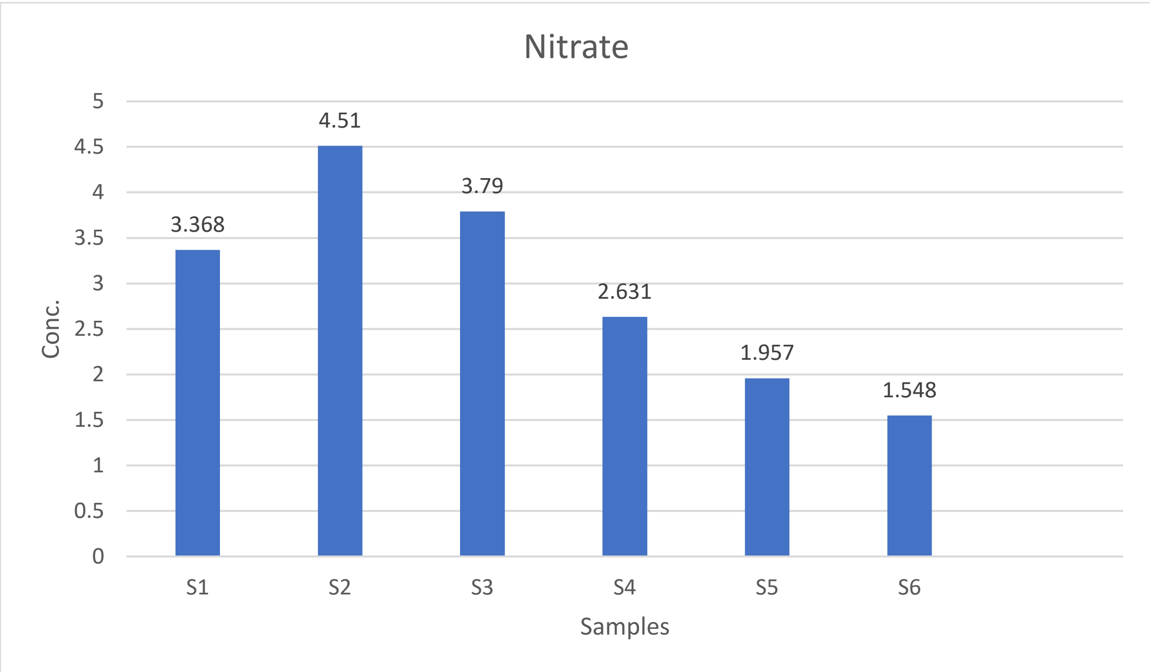


Fig 5.13 : Graph showing Nitrate value of all samples

5.2 DETERMINATION OF WATER QUALITY INDEX

Table 5.14 Table for determining WQI of Sample 1

Parameters	BIS standard (Sn)	1/Sn	∑1/Sn	K=1/(∑1/Sn)	Wi=K/Sn	Ideal value (Vo)	Mean concentration value(Vn)	Vn/Sn	Qn=Vn/Sn*100	WnSn
Electronic Conductivity (µScm-1)	500	0.002	4.367369	0.228970791	0.0004579	0	120.4	0.2408	24.08	0.011027
Iron, Fe (mg/l)	0.3	3.333333	4.367369	0.228970791	0.763236	0	0.35	1.166666667	116.6666667	89.0442
Nitrate NO_3 (mg/l)	45	0.022222	4.367369	0.228970791	0.0050882	0	4.51	0.100222222	10.02222222	0.050995
Flouride F (mg/l)	1.5	0.666667	4.367369	0.228970791	0.1526472	0	0.39	0.26	26	3.968827
p^H	8.5	0.117647	4.367369	0.228970791	0.0269377	7	8	0.941176471	94.11764706	2.535317
Turbidity	5	0.2	4.367369	0.228970791	0.0457942	0	1.5	0.58	58	2.656061
Total alkalinity (mg/l)	200	0.005	4.367369	0.228970791	0.0011449	0	16.8	0.084	8.4	0.009617
Total Hardness (mg/l)	300	0.003333	4.367369	0.228970791	0.0007632	0	79.8	0.266	26.6	0.020302
TDS (mg/l)	500	0.002	4.367369	0.228970791	0.0004579	0	120	0.24	24	0.010991
Calcium,Ca^{2+} (mg/l)	200	0.005	4.367369	0.228970791	0.0011449	0	15.15	0.07575	7.575	0.008672
Magnesium, Mg^{2+} (mg/l)	150	0.006667	4.367369	0.228970791	0.0015265	0	10.21	0.06804	6.804	0.010386
Sulphate SO_4 (mg/l)	400	0.0025	4.367369	0.228970791	0.0005724	0	16.2	0.0405	4.05	0.002318
Chloride, Cl (mg/l)	1000	0.001	4.367369	0.228970791	0.000229	0	60.67	0.06067	6.067	0.001389
		4.367369			1					97.04786

Table 5.15 Table for determining WQI of Sample 2

Parameters	BIS standard (Sn)	1/Sn	∑1/Sn	K=1/(∑1/Sn)	Wi=K/Sn	Ideal value (Vo)	Mean concentration value(Vn)	Vn/Sn	Qn=Vn/Sn*100	WnSn
Electronic Conductivity (μScm-1)	500	0.002	4.367369	0.228970791	0.000458	0	120.4	0.2408	24.08	0.011027
Iron, Fe (mg/l)	0.3	3.333333	4.367369	0.228970791	0.763236	0	0.39	1.3	130	99.22068
Nitrate NO_3 (mg/l)	45	0.022222	4.367369	0.228970791	0.005088	0	4.51	0.100222	10.02222222	0.050995
Flouride F (mg/l)	1.5	0.666667	4.367369	0.228970791	0.152647	0	0.39	0.26	26	3.968827
p^H	8.5	0.117647	4.367369	0.228970791	0.026938	7	8	0.941176	94.11764706	2.535317
Turbidity	5	0.2	4.367369	0.228970791	0.045794	0	2.9	0.58	58	2.656061
Total alkalinity (mg/l)	200	0.005	4.367369	0.228970791	0.001145	0	16.8	0.084	8.4	0.009617
Total Hardness (mg/l)	300	0.003333	4.367369	0.228970791	0.000763	0	79.8	0.266	26.6	0.020302
TDS (mg/l)	500	0.002	4.367369	0.228970791	0.000458	0	120	0.24	24	0.010991
Calcium,Ca^{2+} (mg/l)	200	0.005	4.367369	0.228970791	0.001145	0	15.15	0.07575	7.575	0.008672
Magnesium, Mg^{2+} (mg/l)	150	0.006667	4.367369	0.228970791	0.001526	0	2.04	0.013608	1.3608	0.002077
Sulphate SO_4 (mg/l)	400	0.0025	4.367369	0.228970791	0.000572	0	16.2	0.0405	4.05	0.002318
Chloride, Cl (mg/l)	1000	0.001	4.367369	0.228970791	0.000229	0	61	0.06067	6.067	0.001389
		4.367369			1					108.4983

Table 5.16 Table for determining WQI of Sample 3

Parameters	BIS standard (Sn)	1/Sn	∑1/Sn	K=1/(∑1/Sn)	Wi=K/Sn	Ideal value (Vo)	Mean concentration value(Vn)	Vn/Sn	Qn=Vn/Sn*100	WnSn
Electronic Conductivity (µScm-1)	500	0.002	4.367369	0.228970791	0.000458	0	149.5	0.299	29.9	0.013692
Iron, Fe (mg/l)	0.3	3.333333	4.367369	0.228970791	0.763236	0	0.37	1.233333	123.3333333	94.13244
Nitrate NO_3 (mg/l)	45	0.022222	4.367369	0.228970791	0.005088	0	3.79	0.084222	8.422222222	0.042854
Flouride F (mg/l)	1.5	0.666667	4.367369	0.228970791	0.152647	0	0.41	0.273333	27.33333333	4.172357
p^H	8.5	0.117647	4.367369	0.228970791	0.026938	7	7.6	0.894118	89.41176471	2.408551
Turbidity	5	0.2	4.367369	0.228970791	0.045794	0	2.8	0.56	56	2.564473
Total alkalinity (mg/l)	200	0.005	4.367369	0.228970791	0.001145	0	8.4	0.042	4.2	0.004808
Total Hardness (mg/l)	300	0.003333	4.367369	0.228970791	0.000763	0	130.2	0.434	43.4	0.033124
TDS (mg/l)	500	0.002	4.367369	0.228970791	0.000458	0	91	0.182	18.2	0.008335
Calcium,Ca^{2+} (mg/l)	200	0.005	4.367369	0.228970791	0.001145	0	11.78	0.0589	5.89	0.006743
Magnesium, Mg^{2+} (mg/l)	150	0.006667	4.367369	0.228970791	0.001526	0	4.08	0.027216	2.7216	0.004154
Sulphate SO_4 (mg/l)	400	0.0025	4.367369	0.228970791	0.000572	0	11.4	0.0285	2.85	0.001631
Chloride, Cl (mg/l)	1000	0.001	4.367369	0.228970791	0.000229	0	79.45	0.07945	7.945	0.001819
		4.367369			1					103.395

Table 5.17 Table for determining WQI of Sample 4

Parameters	BIS standard (Sn)	1/Sn	∑1/Sn	K=1/(∑1/Sn)	Wi=K/Sn	Ideal value (Vo)	Mean concentration value(Vn)	Vn/Sn	Qn=Vn/Sn*100	WnSn
Electronic Conductivity (µScm-1)	500	0.002	4.367369	0.228970791	0.000458	0	350	0.7	70	0.032056
Iron, Fe (mg/l)	0.3	3.333333	4.367369	0.228970791	0.763236	0	0.58	1.933333	193.3333333	147.559
Nitrate NO_3 (mg/l)	45	0.022222	4.367369	0.228970791	0.005088	0	2.631	0.058467	5.846666667	0.029749
Flouride F (mg/l)	1.5	0.666667	4.367369	0.228970791	0.152647	0	0.147	0.098	9.8	1.495943
p^H	8.5	0.117647	4.367369	0.228970791	0.026938	7	7.46	0.877647	87.76470588	2.364183
Turbidity	5	0.2	4.367369	0.228970791	0.045794	0	31.2	6.24	624	28.57555
Total alkalinity (mg/l)	200	0.005	4.367369	0.228970791	0.001145	0	21	0.105	10.5	0.012021
Total Hardness (mg/l)	300	0.003333	4.367369	0.228970791	0.000763	0	130.2	0.434	43.4	0.033124
TDS (mg/l)	500	0.002	4.367369	0.228970791	0.000458	0	206	0.412	41.2	0.018867
Calcium,Ca^{2+} (mg/l)	200	0.005	4.367369	0.228970791	0.001145	0	11.78	0.0589	5.89	0.006743
Magnesium, Mg^{2+} (mg/l)	150	0.006667	4.367369	0.228970791	0.001526	0	3.06	0.020412	2.0412	0.003116
Sulphate SO_4 (mg/l)	400	0.0025	4.367369	0.228970791	0.000572	0	20.43	0.051075	5.1075	0.002924
Chloride, Cl (mg/l)	1000	0.001	4.367369	0.228970791	0.000229	0	26.51	0.02651	2.651	0.000607
		4.367369			1					180.1338

Table 5.18 Table for determining WQI of Sample 5

Parameters	BIS standard (Sn)	1/Sn	∑1/Sn	K=1/(∑1/Sn)	Wi=K/Sn	Ideal value (Vo)	Mean concentration value(Vn)	Vn/Sn	Qn=Vn/Sn*100	WnSn
Electronic Conductivity (µScm-1)	500	0.002	4.367369	0.228970791	0.000458	0	319	0.64	63.80	0.03
Iron, Fe (mg/l)	0.3	3.333333	4.367369	0.228970791	0.763236	0	0.48	1.60	160.00	122.12
Nitrate NO_3 (mg/l)	45	0.022222	4.367369	0.228970791	0.005088	0	1.957	0.04	4.35	0.02
Flouride F (mg/l)	1.5	0.666667	4.367369	0.228970791	0.152647	0	0.21	0.14	14.00	2.14
p^H	8.5	0.117647	4.367369	0.228970791	0.026938	7	7.68	0.90	90.35	2.43
Turbidity	5	0.2	4.367369	0.228970791	0.045794	0	25.8	5.16	516.00	23.63
Total alkalinity (mg/l)	200	0.005	4.367369	0.228970791	0.001145	0	18.9	0.09	9.45	0.01
Total Hardness (mg/l)	300	0.003333	4.367369	0.228970791	0.000763	0	117.6	0.39	39.20	0.03
TDS (mg/l)	500	0.002	4.367369	0.228970791	0.000458	0	195	0.39	39.00	0.02
Calcium,Ca^{2+} (mg/l)	200	0.005	4.367369	0.228970791	0.001145	0	31.98	0.16	15.99	0.02
Magnesium, Mg^{2+} (mg/l)	150	0.006667	4.367369	0.228970791	0.001526	0	9.19	0.06	6.12	0.01
Sulphate SO_4 (mg/l)	400	0.0025	4.367369	0.228970791	0.000572	0	30.43	0.08	7.61	0.004
Chloride, Cl (mg/l)	1000	0.001	4.367369	0.228970791	0.000229	0	20.59	0.02	2.06	0.00
		4.367369			1					150.4609

Table 5.19 Table for determining WQI of Sample 6

Parameters	BIS standard (Sn)	1/Sn	∑1/Sn	K=1/(∑1/Sn)	Wi=K/Sn	Ideal value (Vo)	Mean concentration value(Vn)	Vn/Sn	Qn=Vn/Sn*100	WnSn
Electronic Conductivity (µScm-1)	500	0.002	4.367369	0.228970791	0.000458	0	298	0.596	59.6	0.03
Iron, Fe (mg/l)	0.3	3.333333	4.367369	0.228970791	0.763236	0	0.51	1.7	170	129.75
Nitrate NO_3 (mg/l)	45	0.022222	4.367369	0.228970791	0.005088	0	1.548	0.034	3.44	0.02
Flouride F (mg/l)	1.5	0.666667	4.367369	0.228970791	0.152647	0	0.21	0.14	14.00	2.14
p^H	8.5	0.117647	4.367369	0.228970791	0.026938	7	7.5	0.88	88.24	2.38
Turbidity	5	0.2	4.367369	0.228970791	0.045794	0	20.9	4.18	418	19.14
Total alkalinity (mg/l)	200	0.005	4.367369	0.228970791	0.001145	0	25.2	0.126	12.6	0.01
Total Hardness (mg/l)	300	0.003333	4.367369	0.228970791	0.000763	0	168	0.56	56	0.04
TDS (mg/l)	500	0.002	4.367369	0.228970791	0.000458	0	305	0.61	61	0.03
Calcium,Ca^{2+} (mg/l)	200	0.005	4.367369	0.228970791	0.001145	0	58.91	0.29455	29.455	0.03
Magnesium, Mg^{2+} (mg/l)	150	0.006667	4.367369	0.228970791	0.001526	0	5.10	0.03402	3.402	0.01
Sulphate SO_4 (mg/l)	400	0.0025	4.367369	0.228970791	0.000572	0	32.59	0.081475	8.1475	0.00
Chloride, Cl (mg/l)	1000	0.001	4.367369	0.228970791	0.000229	0	21.58	0.02158	2.158	0.00
		4.367369			1					153.58

Table 5.20 Table for Observed values of WQI of all Samples

WQI	
Sample Site	**Observed values**
1	97.047
2	108.50
3	103.39
4	180.13
5	150.46
6	153.58

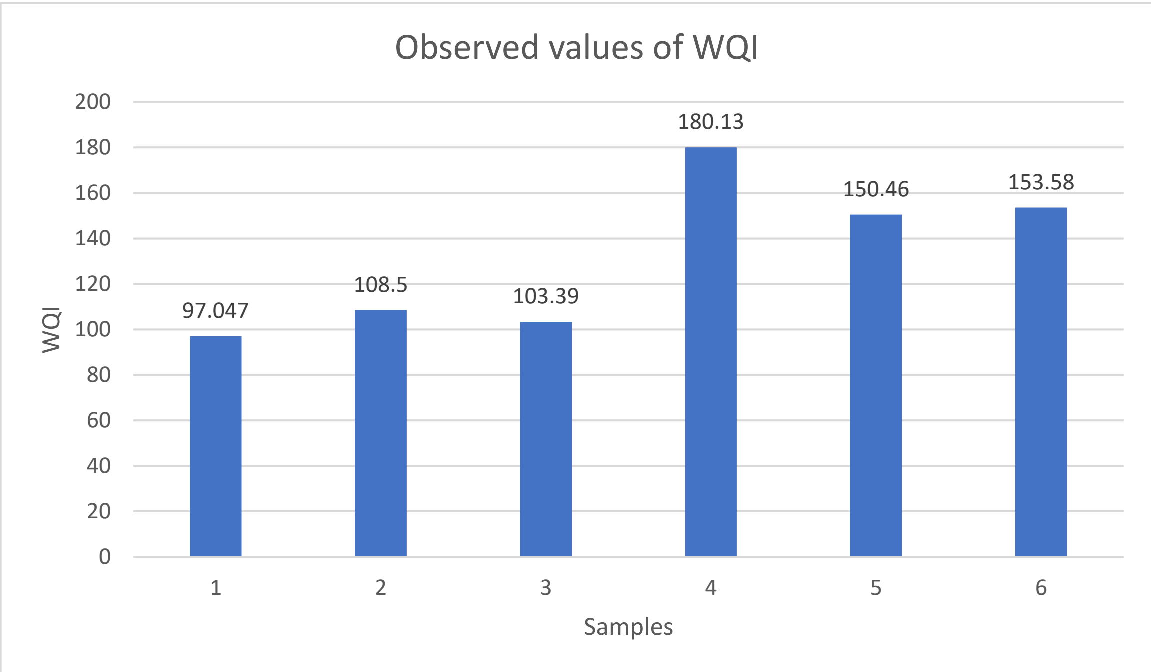


Fig 5.14 : Graph showing Observed values of WQI of all samples

CHAPTER 8

CONCLUSION

In conclusion, the water quality assessment conducted in the Kalaigaon area highlights significant differences between ground water and river water, with implications for public health and water usage practices. The study found that ground water in the region has elevated levels of iron, which results in a higher Water Quality Index (WQI). This high iron content can lead to a range of health concerns, such as staining of teeth and potentially affecting the liver over long-term consumption. Therefore, ground water in the Kalaigaon area is not considered ideal for direct consumption without proper filtration and treatment to reduce the iron levels to acceptable standards.

On the other hand, the river water in the region is comparatively of better quality, with lower levels of contaminants, making it suitable for domestic use. The river water could be further purified through filtration and appropriate treatment methods, enabling it to be used safely for drinking purposes as well. This suggests that river water, with proper management, could serve as a sustainable and accessible source of clean water for the community.

These findings underline the need for targeted interventions to improve the quality of ground water, particularly by addressing the high iron content through filtration technologies. Additionally, promoting the use of river water for drinking after proper treatment could offer a safer alternative for the local population. Future studies should focus on monitoring water quality trends over time and exploring cost-effective treatment methods, ensuring that both ground and surface water sources meet the required standards for health and safety. By implementing these measures, the Kalaigaon area can secure a more reliable and healthier water supply for its residents.

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