ANALYSIS OF WATER QUALITY PARAMETERS OF GROUND WATER IN BEKAJAN AND RAIDANGJURI PANCHAYAT VILLAGES, TITABOR SUB-DIVISION,JORHAT DISTRICT

A DISSERTATION SUBMITTED

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CERTIFICATE

This is to certify that the dissertation entitled "Analysis of Water Quality Parameter of Ground Water in Bekajan and Raidangjuri Panchayat Villages under Titabar Sub-Division of Jorhat District" is submitted by Gautam Gogoi, a B.Sc. 6th semester student of the Department of Chemistry, N. N. Saikia College, Titabar for the partial fulfillment of B.Sc. degree in Chemistry (Paper: DSE-603), is a record of original research work carried out by her under the supervision of Dr. Bhaskar Jyoti Saikia. He has fulfilled all the requirements for submitting the dissertation for the B.Sc. degree. The results embodied with this dissertation have not been submitted to any other college or institute for any other degree or diploma to the best of my knowledge.

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With regards

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Abstract

The study investigates the water quality of groundwater in **Bekajan and Raidangjuri Panchayat villages**, located in the **Titabor sub-division of Jorhat district, during the year 2024-25.** A total of 10 water quality parameters, including pH, turbidity, Total Dissolved Solids (TDS), Arsenic, and iron, were analyzed to assess the potability and safety of the groundwater sources. The results highlight variations in these parameters across the villages, providing insights into the factors affecting water quality in the region. The study aims to create awareness about groundwater quality and its implications for public health and environmental sustainability.

Keywords: Groundwater, Water Quality, pH, Turbidity, TDS, Arsenic, Iron, Bekajan, Raidangjuri, Titabor

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1.INTRODUCTION

1.1 INTRODUCTION

Groundwater is used for a variety of purposes, including irrigation, drinking and Manufacturing. Groundwater is also the source of a large percentage of surface water. To Verify that groundwater is suited for its purpose, its quality can be evaluated (i.e.,Monitored) by collecting samples and analyzing them. In simplest terms, the purpose of Groundwater monitoring is to define the physical, chemical, and biological characteristics of Ground water. Accurate and reliable groundwater resource information (including quality) investment in the areas of groundwater exploration,Development and management at state and national levels aims to meet the groundwater Requirement for drinking and irrigation and generates enormous amount of data. We need to Focus on improved data management, precise analysis and effective dissemination of data.Numerical models are capable of solving large and complex groundwater problems varying Widely in size, nature and real life situations. With the advent of high speed computers, Spatial heterogeneities, anisotropy and uncertainties can be tackled easily. However, the Success of any modelling study, to a large measure depends upon the availability and Accuracy of measured/recorded data required for that study. Therefore, identifying the data Needs of a particular modelling study and collection/monitoring of required data form anIntegral part of any groundwater modelling exercise.

1.2 The Four Essential Uses of Water in Daily Life

Domestic Use: Water is essential for household activities like drinking, cooking, bathing, cleaning and sanitation.

Agricultural Use: Water is a critical resource for irrigation and livestock farming, ensuring the product of food and other crops.

Industrial Use: Many industries use water in manufacturing, cooling, processing, and cleaning. Processes.

Environmental Use: Water supports ecosystems, helps maintain biodiversity, and is crucial for hydrological cycles and natural habitats.

Water covers 71 percent of the earth's surface, but most of it is salt water. Fresh water is only 3 percent. Of total water on earth's surface and much of it lies frozen in the Antarctica and Greenland polar ice. Freshwater available for human consumption constitutes only 1 percent of all water on the earth that comes from rivers, lakes, underground sources and aquifer.

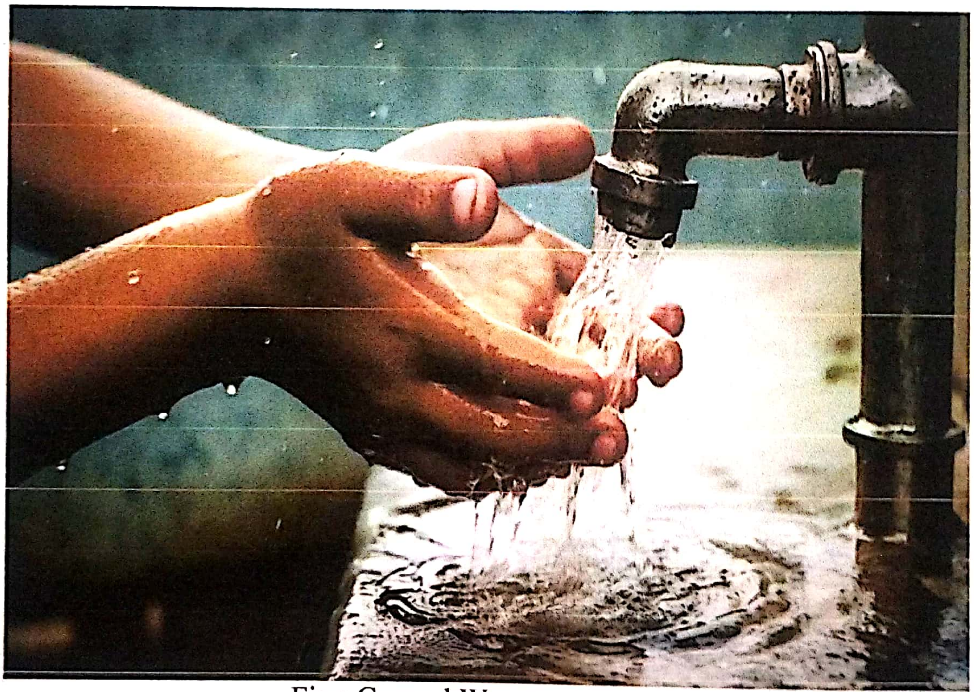

Fig1: Ground Water

1.3**Drinking water:** Fluids and hydration are crucial for the bodily functions of humans, especially when it comes To drinking water. As you probably remember, 60-80 percent of the human body is water.However the amount of fluid in our bodies varies, depending on certain factors, such as age, condition of internal organs, and health

1.4 Role of Drinking Water in the Human Body

Improved Skin, Nails, and Hair : Proper hydration enhances the condition of nails Skin, and hair, keeping them healthy and preventing dryness. Dehydrated skin can appear dull, contribute to acne, and accelerate aging.

Prevents Urinary Infections : While water doesn't directly improve kidney function, it aids in flushing out toxins. This prevents toxin build-up, which can corrode the mucous membrane, leading to inflammation and discomfort.

Aids Digestion : Adequate water levels ensure the stomach produces the necessary amount of gastric juice for proper digestion.

Relieves Joint Pain : Water helps keep cartilage healthy, reducing wear and tear and supporting joint health.

Reduces Headaches : Dehydration often triggers headaches, making hydration essential for relief and prevention Staying hydrated is vital for maintaining optimal physical and mental health.

1.5 water – related diseases

Water-related diseases are typically associated with inaccessibility of clean drinking water. They are transmitted by insect vector, especially mosquitoes that breed or feed near contaminated water: They include malaria, sleeping sickness, encephalitis, dengue, yellow fever, and filari

1.6 Water – based diseases

Water-based diseases are caused by the parasites found in mermediate organisms living in contaminated water. They include schistosomiasis(snail-diseases),drarunculiasis(guinea worm), In India, a large portion of the population depends on surface water, such as dams, for drinking water supply, while groundwater is considered cleaner and free from pollution. However, prolonged discharges of industrial effluents, domestic sewage, and solid waste have polluted groundwater sources, leading to health problems. The rapid urbanization has exacerbated this issue through the over-exploitation of groundwater and improper waste disposal. Heavy metals are identified as priority toxic pollutants, and in some places, water quality is further compromised due to excessive turbidity and hardness beyond permissible limits. Several physicochemical parameters are responsible for waterborne diseases, particularly in villages, with consequences like crippled health. The lakes in the area, with their fragile ecosystems, lack self-cleaning capabilities and accumulate pollutants, which severely restrict their use for domestic and industrial applications.

Indian Standard: Drinking Water – Specification (BIS, 2012)

Radha Kund, a water body linked with Shyam Kund, holds significant mythological importance and attracts a large number of pilgrims and tourists throughout the year. The water for these kunds primarily comes from rainfall and groundwater. However, the religious rituals and constant visitor activity worsen the condition of the kunds and their surroundings. The surrounding community suffers from the lack of a sewerage and drainage system, which places the kunds at further risk of contamination.The combination of high human activity, inadequate sanitation, and the fragile nature of the ecosystem makes it difficult to maintain the water quality in these important cultural and religious sites.

Drinking Water Quality in Kamrup District, Assam (Chakrabarty and Sharma 2010)

Chakrabarty and Sharma analyzed the quality of drinking water in Kamrup district of Assam, India, by examining several parameters, including Temperature, pH, Electrical Conductivity, Total Solids (TS), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Turbidity, Dissolved Oxygen (DO), Total Hardness (TH), Calcium Hardness (CH), Magnesium Hardness (MH), Chloride (Cl), Sulphate (SO_4), Sodium (Na), and Potassium (K). The study utilized 46 different sampling stations across the district to assess water quality. Statistical analysis was conducted to determine the distribution pattern of the data, which showed non-uniform distribution with a long asymmetric tail either to the right or left of the median. Descriptive statistics, including mean, variance (V), standard deviation (SD), standard error (SE), median, range of variation, and percentiles at 95%, 75%, and 25% (P95%, P75%, P25%) were calculated and summarized to provide detailed insights into the variation and localization of these

parameters. The study highlights the variability in drinking water quality across the district and emphasizes the need for targeted monitoring

3.Aim and Objective of Study

To analyze the water quality parameters of **groundwater in 10 village, Bekajan and Raidangjuri** Panchayat in Titabor sub-division, Jorhat district Assam and evaluate its suitability for drinking, agricultural, and other domestic purposes.

1.1 Objectives

1.1 Assessment of Groundwater Quality

1.2 To determine the physical parameters like turbidity and TDS

1.3 To determine the chemical parameters like pH, iron, Arsenic, fluoride and nitrate etc.

1.2 Identification of Contamination Sources

To identify potential sources of groundwater contamination, such as agricultural runoff, industrial discharges, domestic waste, and natural processes.

1.3 Comparison with Standards

To compare the obtained results with national and international water quality standards (**e.g., BIS and WHO guidelines).**

1.3 Spatial and Temporal Variation

To study the spatial distribution of water quality parameters across Bekajan and Raidangjuri Panchayats.To investigate seasonal variations in water quality

1.4 Impact Assessment

To evaluate the impact of groundwater quality on human health, agriculture, and the local ecosystem

4.Ground water quality Parameter

4.1 pH

pH of a solution is the negative common logarithm of the hydrogen ion activity : pH = -log (H) The pH of water is a measure of the acid-base equilibrium and, in mostnatural waters, is controlled by the carbon dioxide bicarbonate-carbonate equilibrium system An increased carbon dioxide The ide concentration will therefore lower pH, whereas a decrease will cause it to rise. Temperature will also affect the equilibria and the pH. In pure water, a the range decrease in pH of about 0:45 occurs as the temperature is raised by 25 °C. The pH of most raw water lies within 6.5-8.5

Health Effect on Human: Exposure to extreme pH values results in irritation to the eyes, skin, and mucous membranes. Eye irritation and exacerbation of skin disorders have been associated with pH values greater than 11. In addition, solutions of pH 10-12.5 have been reported to cause hair fibres to swell. In sensitive individuals, gastrointestinal irritation may also occur.

Exposure to low pH values can also result in similar effects. Below pH 4, redness and irritation of the eyes have been reported, the severity of which increases with decreasing pH. Below pH 2.5, damage to the epithelium is irreversible and extensive. In addition, because pH can affect the degree of corrosion of metals as well as disinfection efficiency, it may have an indirect effect on health.

4.2 Turbidity

Turbidity is a critical parameter in water quality assessment, reflecting the cloudiness or haziness of water caused by the presence of suspended particles. These particles can be inorganic, such as clays, silts, or sands, or organic, such as algae and decaying plant material.Turbidity is particularly problematic in surface water sources, as it can have significant implications for both health and aesthetics. One of the main health concerns related to turbidity is that it may protect harmful microorganisms, such as bacteria, from disinfection processes. The suspended particles can shield the bacteria from chemical disinfectants like chlorine, preventing them from effectively killing the pathogens. Additionally, organic materials responsible for turbidity, when combined with chlorine, can lead to the formation of potentially harmful disinfection by-products, such as tri halomethanes, which are associated with various health risks from an aesthetic standpoint, turbid water is often considered unappealing due to its cloudy appearance This can lead to consumer complaints, especially when bubbles or cloudiness are observed, often caused by aeration in faucets rather than turbidity itself. Consequently, accurate measurement and management of turbidity are essential in ensuring safe, clean, and aesthetically pleasing drinking water

Health effects on Human

The presence of turbidity in drinking water can have significant health consequences. When water is turbid, the suspended particles can harbor bacteria, viruses, and protozoa, which are harmful to human health. These microorganisms can cause a wide range of diseases, including gastrointestinal disorders, Dysentery, cholera, and giardiasis. The cloudiness caused by turbidity can also protect these pathogens From the effects of disinfectants such as chlorine, which means the water may still contain harmful Microorganisms, even after treatment Another critical health concern is related to the organic particles in turbid water. When organic matter, such as algae and decaying vegetation, combines with chlorine during water treatment, harmful chemical known as trihalomethanes (THMs) can form. THMs are classified as carcinogenic substances, and long-term exposure to these compounds can significantly increase the risk of cancer and

other chronic health issues, such as liver and kidney damage. Furthermore, these disinfection by-products can contribute to reproductive and developmental health problems.

Turbidity can also be indicative of the presence of heavy metals and toxic chemicals that may be attached to the suspended particles. These substances, such as lead, mercury, and arsenic, are toxic to the human body and can lead to neurological damage, kidney failure, and long-term health complications therefore, the presence of turbidity is not only a visual concern but also an important indicator of potential chemical contamination in drinking water

4.3 Total dissolved solids (TDS)

Total dissolved solid (TDS) is the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. The principal constituents are usually calcium, magnesium, sodium, and potassium cations and carbonate, hydrogen carbonate, chloride, sulphate, and nitrate anions. The presence of dissolved solids in water may affect its taste. TDS in water supplies originate from natural sources, sewage, urban and agricultural run- off, and industrial wastewater. Concentrations of TDS from natural sources have been found to vary from less than 30 mg/litre to as much as 6000 mg/litre, depending on the solubilities of minerals in different geological regions

4.4 Iron (Fe)

Iron can be a troublesome chemical in water supplies, despite being one of the earth's most abundant resources, Making up at least 5 percent of the earth's crust. Rainwater, as it infiltrates the soil and underlying geological formations, dissolves iron, allowing it to seep into aquifers that serve as sources of groundwater for wells. Although Iron is commonly found in drinking water, its concentrations rarely exceed 10 milligrams per liter (mg/L) or 10 Parts per million. However, even as little as 0.3 mg/L can cause water to turn a reddish-brown color Iron is primarily present in water in two forms: soluble ferrous iron and insoluble ferric iron. Water containing Ferrous iron is clear and colorless because the iron is fully dissolved. When exposed to air in the pressure tank or Atmosphere, the water becomes cloudy, and a reddish-brown substance starts to form. This sediment is the Oxidized, or ferric, form of iron, which is not soluble in water

Health Effects on Human

Iron is a vital nutrient for human health, playing a crucial role in oxygen transport, energy production, and. Overall cellular function. The recommended daily intake of iron varies based on factors such as age, sex, and physiological status, with values ranging from 10 to 50 mg/day.For adults, iron toxicity can be harmful. The average lethal dose of iron is estimated at 200-250 mg per kg of body weight, although fatal cases have been reported with doses as low as 40 mg/kg. Autopsies of individuals who have died from iron overdose typically reveal hemorrhagic necrosis and sloughing of stomach mucosa, extending into the submucosa.Chronic iron overload, on the other hand, often stems from a genetic disorder known as haemochromatosis, which leads to excessive iron absorption, or from diseases requiring frequent blood transfusions. Despite this, adults who take iron supplements for extended periods generally experience no adverse effects, provided the dosage is within safe limits. A daily intake of 0.4-1 mg of iron per kg of body weight is unlikely to cause harm in healthy individuals.

4.5 Aresnic (As)

Arsenic is introduced into water through the dissolution of rocks, minerals and ores, from industrial effluents, including mining wastes, and via atmospheric deposition. In well oxygenated surface waters, arsenic (V) is generally the most common arsenic species present, under reducing conditions, such as those often found in deep lake sediments or groundwater, the predominant form is arsenic(III). An increase in pH may increase the concentration of dissolved arsenic in water. Except for individuals who are occupationally exposed to arsenic, the most important route of exposure is through the consumption of food and drinking-water, including beverages made from drinking-water. Ingested elemental arsenic is poorly absorbed and largely eliminated unchanged. Soluble arsenic compounds are rapidly absorbed from the gastrointestinal tract: arsenic(V) and organic arsenic are rapidly and almost completely eliminated via the kidneys. Inorganic arsenic may accumulate in skin, bone, liver, kidney and muscle: its half-life in humans is between 2 and 40 days.

Health Effect on Humans

The acute toxicity of arsenic compounds in humans is predominantly a function of their rate of removal from the body. Arsine is considered to be the most toxic form, followed by the arsenites (arsenic (III)), the arsenates (arsenic(V)) and organic arsenic compounds. Lethal doses in humans range from 1.5 mg/kg of body weight (diarsenic trioxide) to 500 mg/kg of body weight. Early clinical symptoms of acute intoxication include abdominal pain, vomiting, diarrhoea, muscular pain and weakness, with flushing of the skin. Signs of chronic arsenicism, including dermal lesions such as hyperpigmentation and,hypopigmentation, peripheral neuropathy, skin cancer, bladder and lung cancers and peripheral vascular disease, have been observed in populations ingesting arsenic contaminated drinking-water.

4.6 Nitrate (NO_3^-)

Nitrate (NO_3^-) is a naturally occurring ions that are ubiquitous in the environment It is a product of the oxidation of nitrogen, as part of the cycle required by all living systems for the production of complex organic molecules, such as enzymes and other proteins. Nitrate is the more stable form of oxidized nitrogen. However, under anaerobic conditions and in the presence of a carbon source, nitrate can be reduced by microbial action to nitrite, which is relatively unstable and moderately reactive. The most common sources of both nitrate and nitrite in water include agricultural activities (inorganic fertilizers and manure), wastewater treatment, nitrogenous waste products from humans and discharges from industrial processes and motor vehicles Vitrite can also be formed chemically in distribution pipes by Nitrosomonas bacteria during stagnation of nitrate-containing and oxygen-poor drinking- water in galvanized steel pipes or if chlorination is used to provide a residual disinfectant and the process is not sufficiently well controlled In soil, fertilizers containing inorganic nitrogen and wastes containing organic nitrogen are first decomposed to give ammonia, which is then oxidized to nitrate and nitrite. The nitrate is taken up by plants during their growth and used in the synthesis of organic nitrogenous compounds. Surplus nitrate readily moves with the groundwater as it is not absorbed by the soil and is very mobile. Using an isotopically labelled nitrogen fertilizer, a scientific study in 2013 found that 61 65% of the applied fertilizer's. Nitrogen was taken up by plants, Whereas 12-15% was still residing in the soil organic matter more than 25 years after tracer application. Between 8% and 12% of the applied fertilizer had leaked towards the hydrosphere during the 30-year observation period. The authors predicted that additional exports of nitrogen-labelled nitrate from the tracer to the hydrosphere would continue for at least another 50 years. Concentrations of nitrate in rainwater of up to 5 mg/l. Have been observed in industrial areas.The nitrate concentration in surface water is normally low (0-18 mg/L; up to 4 mg/L as nitrate-nitrogen), But can reach high levels as a result of agricultural runoff, refuse dump runoff or contamination with

Human or animal wastes. Generally, nitrate concentrations in well water are higher than those in surface water supplies as plants (phytoplankton) in surface area take up the nitrate. The natural nitrate concentration in groundwater under aerobic conditions is a few milligrams per litre and depends strongly on soil type and on the geological situation. The increasing use of artificial fertilizers, the disposal of wastes (particularly from animal farming) and changes in land use are the main factors responsible for the progressive increase in nitrate levels in groundwater supplies over the last 20 years. As a result of these activities,

Effect on Human Health

The oral lethal doses for humans range from 67 to 833 mg/kg body weight for nitrate. Methaemoglobinaemia is the main acute effect, whereas effects on the thyroid have been reported after longer-term exposure. Young children do not appear to be as sensitive as infants In the USA, methaemoglob in levels were not significantly different in 64 children aged 1-8 years who consumed well water containing nitrate at concentrations of 22-111 mg/L as nitrate-nitrogen (97-491 mg/L. As nitrate), when compared with 38 children consuming well water containing less than 10 mg/L as nitrate-nitrogen. Current evidence suggests that exposure to nitrate in drinking-water may alter human thyroid gland function by competitively inhibiting thyroidal iodide uptake, leading to altered thyroid hormone concentrations and functions. Earlier it was thought Nitrate will impact adverse reproductive and developmental effects. However, recent studies do not provide strong evidence for a causal association between nitrate in drinking-water and birth defects or growth restriction.

4.7 Fluoride (F^{-})

Fluoride is an essential trace element for human health, primarily for maintaining dental health. However Excessive fluoride intake can lead to dental and skeletal fluorosis. The permissible limit for fluoride in Drinking water, as set by BIS and WHO, is 1.0–1.5 mg/L. This study was conducted to evaluate the Fluoride content in different water samples to ensure public health safety

Health effects on human :

Health effects Fluoride has been found to have a significant mitigating effect against dental caries and it is Accepted that some fluoride presence in drinking water is beneficial. Optimal concentrations are around 1 Mg/l. However, chronic ingestion of concentrations much greater than 1.5 mg/l (the WHO guideline Value) is linked with development of dental fluorosis and, in extreme cases, skeletal fluorosis. High doses Have also been linked to cancer.

5. Study area

The present study has been carried out in Bekajan and Raidangjuri Panchayat located in the Jorhat district. Assam, under the Titabor sub-division. These two panchayat total 10 village Study.Primarily on groundwater for various essential needs, including drinking water, domestic consumption, and agricultural activities. The local population's dependence on groundwater makes it crucial to assess the water quality in this region makes it crucial to assess the water quality in this region.

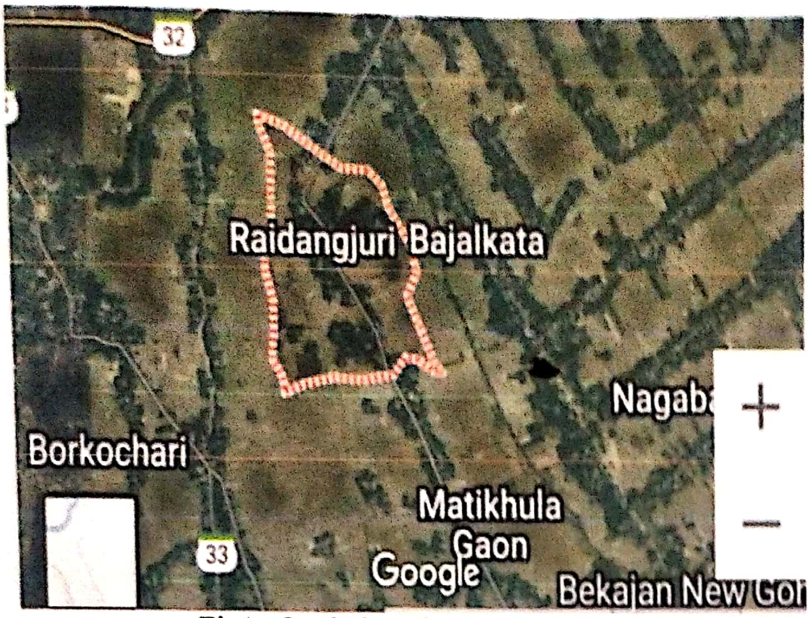

Fig1 : Study location

5.1 Water Sources

Groundwater sources include hand pumps, water wells, and river which are critical for drinking and irrigation.

5.2Geographical Coordinates Raidangjuri Panchayat: Latitude 26.5873 Bekajan Panchayat: Latitude 26.6132° N, Longitude 94.2058° E N.Longitude 94.1986° E

5.3 Climate and Rainfall Climate:

The region experiences a humid subtropical climate characterized by high humidity and temperature variations. Summers are warm and humid, while winters are mild and dry.

Rainfall: The area receives heavy rainfall, predominantly during the monsoon season (June to September), with an annual average rainfall of 788 mm to 1392 mm

Table: 1 Water sampling source and village table

SL	Panchayat Name	Source	Village Name
1	Kakodunga Bekajan	Hand pump	No2 Block

2	Kakodunga Bekajan	Water well	No3 Block
3	Kakodunga Bekajan	Hand pump	No4 Block
4	Kakodunga Bekajan	Hand pump	No5 Block
5	Kakodunga Bekajan	Water well	Half mile belt
6	Raidangjuri	Hand pump	Annapurna
7	Raidangjuri	Water well	Torani
8	Raidangjuri	Hand pump	Sukanjan
9	Raidangjuri	River	Bojalkata
10	Raidangjuri	Hand pump	Matikhula

Water samples were collected during December 2024 in composite form. The samples were taken in pre-cleaned, high-density polyethylene (HDPE) bottles with a capacity of 500 ml from designated sampling locations. Key parameters such as pH, temperature, and conductivity were measured immediately after collection to maintain accuracy. • To preserve the chemical stability of the samples, hydrochloric acid (HCl) was used for acidification as needed. After collection,

the samples were quickly transported to the laboratory and stored in a refrigerator at 4°C until further analysis. These procedures were followed diligently to ensure the quality and reliability

6.DETERMINATION OF SAMPLE PARAMETERS

Water samples are collected from Bekajan and Raidangjuri panchayats in Titabor sub-division, Jorhat. These samples are tested to determine their suitability for drinking purposes by analyzing various physical and chemical parameters. The study aims to evaluate water quality in accordance with prescribed safety standards for human consumption.

1. pH of water

2. Turbidity

3. Total dissolved solids (TDS)

4. Iron (Fe)

5. Arsenic (As)

6. Fluoride (F^-)

7. Nitrate (NO_3^-)

Table 1.2 Standard for drinking water quality BIS (Bureau of Indian Standards) and WHO (World health organization)

SL No	Parameter	Unit	BIS standard (Acceptable and permissible limit)	WHO standard
1	pH	-	6.5-8.5	6.5-8.5
2	Turbidity	NTU	1-5	5
3	TDS	Mg/L	500-2000	1000
4	Iron (Fe)	Mg/L	0.3 – 1.0	0.3
5	Arsenic	Mg/L	0.01-0.05	0.01
6	Fluoride	Mg/L	1.0-1.5	1.5
7	Nitrate	Mg/L	45	50

Table 2.1 pH Results of All Village Water Samples and Comparison with BIS & WHO Standards

SL No	Village	Source	pH	BIS Standard	WHO standard	Result
1	No2 Block	Hand pump	6.77	Within limits	Within limits	Acceptable
2	No3 Block	Water well	6.85	Within limits	Within limits	Acceptable
3	No4 Block	Hand Pump	6.81	Within limits	Within limits	Acceptable
4	No5 Block	Hand pump	6.98	Within limits	Within limits	Acceptable
5	Half mile belt	Water well	6.78	Within limits	Within limits	Acceptable
6	Annapurna	Hand pump	7.12	Within limits	Within limits	Acceptable
7	Torani	Water well	6.72	Within limits	Within limits	Acceptable
8	Sukanjan	Hand pump	6.72	Within limits	Within limits	Acceptable
9	Bojalkata	River	6.72	Within limits	Within limits	Acceptable
10	Matikhula	Hand pump	6.91	Within limits	Within limits	Acceptable

6.1 TESTING OF SAMPLE

In a clean dry 100 ml beaker take the water sample and place it On a magnetic stirrer, insert the Teflon coated stirring bar and stir Well.

Now place the electrode in the beaker containing the water sample And check for the reading in the pH meter. Wait until you get a Stable reading.

Take the electrode from the water sample, wash it with distilled Water and then wipe gently with soft tissue.

Table 2.2 Turbidity Results of All Water Samples and Comparison with BIS & WHO Standards

SL No	Village	Source	Turbidity Result	BIS Standard (1-5NTU)	WHO (5NTU)	Result
1	No2 Block	Hand pump	33.9	Above limit	Above limit	~~Acceptable~~
2	No3 Block	Water well	0	Within limit	Within limit	Acceptable
3	No4 Block	Hand pump	28.1	Above limit	Above limit	Not acceptable
4	No5 Block	Hand pump	9.2	Above limit	Above limit	Not acceptable
5	Half mile belt	Water well	0	Within limit	Within limit	Acceptable
6	Annapurna	Hand pump	104.4	Above limit	Above	Not acceptable
7	Torani	Water well	0	Within limit	Within limit	Acceptable
8	Sukanjan	Hand pump	1.8	Within limit	Within limit	Acceptable
9	Bojalkata	River	0	Within limit	Within limit	Acceptable
10	Matikhula	Hand pump	21.4	Above limit	Above limit	Not acceptable

Table 2.3 Total Dissolved Solids (TDS) Results and Comparison with BIS & WHO Standards

SL No	Village	Source	TDS Result	BIS(500-2000mg/L)	WHO (500mg/L)	Result
1	No2 Block	Hand pump	228	Within limit	Within limit	Acceptable
2	No3 Block	Water well	175	Within limit	Within limit	Acceptable
3	No4 Block	Hand pump	243	Within limit	Within limit	Acceptable
4	No5 Block	Hand pump	215	Within limit	Within limit	Acceptable
5	Half mile belt	Water well	198	Within limit	Within limit	Acceptable
6	Annapurna	Hand pump	263	Within limit	Within limit	Acceptable
7	Torani	Water well	192	Within limit	Within limit	Acceptable
8	Sukanjan	Hand pump	218	Within limit	Within limit	Acceptable
9	Bojalkata	River	225	Within limit	Within limit	Acceptable
10	Matikhula	Hand pump	243	Within limit	Within limit	Acceptable

Table 2.4 Iron Content in Water Samples from All Villages Compared with BIS & WHO Standards

SL No	Village	Source	Iron (Fe)	BIS (1mg/L)	WHO(0.3mg/L)	Result
1	No2 Block	Hand pump	33.9	Above limit	Above limit	Not acceptable
2	No3 Block	Water well	0	Within limit	Within limit	Within limit
3	No4 Block	IHand pump	28.1	Above limit	Above limit	Not acceptable
4	No5 Block	Hand pump	9.2	Above limit	Above limit	Not acceptable
5	Half mile belt	Water well	0	Within limit	Within limit	Acceptable
6	Annapurna	Hand pump	104.4	Above limit	Above limit	Not acceptable
7	Torani	Water well	0	Within limit	Within limit	Acceptable
8	Sukanjan	Hand pump	1.8	Within limit	Within limit	Acceptable
9	Bojalkata	River	0	Within limit	Within limit	Acceptable
10	Matikhula	Hand pump	21.4	Above limit	Above limit	Not acceptable

Table 2.5 Arsenic Levels in Water Samples from All Villages Compared with BIS & WHO Standards

SL No	Village	Source	Arsenic	BIS (0.01Mg/L)	WHO (0.1Mg/L)	Result
1	No2 Block	Hand pump	0.057	Above limit	Above limit	
2	No3 Block	Water well	BDL	Within limit	Within limit	Safe
3	No4 Block	Hand pump	0.108	Above limit	Above limit	
4	No5 Block	Hand pump	0.097	Above limit	Above limit	
5	Half mile belt	Water well	BDL	Within limit	Within limit	Safe
6	Annapurna	Hand pump	0.106	Above limit	Above limit	
7	Torani	Water well	BDL	Within limit	Within limit	Safe
8	Sukanjan	Hand pump	0.077	Above limit	Above limit	
9	Bojalkata	River	BDL	Within limit	Within limit	Safe
10	Matikhula	Hand pump	0.109	Above limit	Above limit	

6.2 Materials and Methods

Arsenic Test Using the SDDC Method

❖ Preparation of the Sample

Take 35 mL of the sample in a 100 mL conical flask. Add 5 mL

Of concentrated hydrochloric acid (HCl). Add 2 mL of 15%

Potassium iodide (KI) solution.

Add 8 drops of 40% stannous chloride ($SnCl_2$) solution.

Let the mixture react for 15–20 minutes to reduce arsenic from As(V) to As(III)

❖ Preparation of the Scrubber and Absorber Tubes

Take a scrubber tube and impregnate glass wool with 3–4 drops of 10% lead acetate

Solution. Add 4 mL of SDDC solution into the absorber tube in the Gutzeit apparatus.

❖ Generation of Arsine Gas

Place 3 grams of zinc (Zn) granules in the generator.

Immediately connect the generator to the scrubber-absorber assembly to prevent the escape of

gas

Figure:2 Arsenic test

❖ Absorption of Arsine Gas :Allow arsine gas to pass through the glass wool impregnated with lead acetate in the scrubber Tube. The SDDC solution in the absorber tube absorbs the arsine gas, forming a reddish coloration.

❖ Completion of the Reaction

Let the reaction proceed for 30 minutes at room temperature.

❖ Measurement of Arsenic Concentration

Slightly warm the generator on a hot plate to ensure all arsine gas is released. Transfer the solution from the absorber to a cuvette.

Measure the concentration of arsenic at 535 nm using a spectrophotometer, with a blank solution as the reference

Table 2.6 Nitrate (NO_3^-) Concentration in Water Samples and Comparison with BIS and WHO standard

SL No	Village	Source	Nitrate (NO_3^-)	BIS (45mg/L)	WHO (50mg/L)	Result
1	No2 Block	Hand pump	1.2	Within limit	Within limit	Acceptable
2	No3 Block	Water well	1.5	Within limit	Within limit	Acceptable
3	No4 Block	Hand Pump	0.9	Within limit	Within limit	Acceptable
4	No5 Block	Hand Pump	1.1	Within limit	Within limit	Acceptable
5	Half mile belt	Water well	1.7	Within limit	Within limit	Acceptable
6	Annapurna	Hand Pump	0.9	Within limit	Within limit	Acceptable
7	Torani	Water well	1.2	Within limit	Within limit	Acceptable
8	Sukanjan	Hand Pump	1.8	Within limit	Within limit	Acceptable
9	Bojalkata	River	2.5	Within limit	Within limit	Acceptable
10	Matikhula	Hand Pump	1.3	Within limit	Within limit	Acceptable

6.3 Materials and Methods

- Sample Preparation:

Take a clean, dry 10 ml volumetric flask.

Add 2 ml of the water sample to the flask.

- Add Sulphite-Urea Reagent:

Add 1 drop of sulphite-urea reagent to eliminate nitrite interference.

- Cooling Step :Place the flask in a cold water bath maintained at 10–20°C.

❖ Add Antimony Reagent:

While in the cold bath, add 2 ml of antimony reagent.

Let it stand for 4 minutes.

❖ Add Chromotropic Acid Reagent

Add 1 ml of chromotropic acid reagent.

Allow the reaction to proceed for 3 minutes in the cold bath.

❖ Dilution with Concentrated Sulphuric Acid:

Carefully add concentrated H_2SO_4 until the volume is near The 10 ml

Allow to stand at room temperature for 45 minutes.

❖ Final Volume Adjustment:

Adjust the volume exactly to 10 ml with concentrated H_2SO_4.

Mix thoroughly.

❖ Spectrophotometric Reading:

Allow the solution to stand for 15 minutes.

Measure absorbance at the wavelength specific for nitrate (around 4 10 nm).

Table 2.7Fluoride Results in Village Water Samples and Comparison with BIS & WHO Standards

SL No	Village	Source	Result
1	No2 Block	Hand Pump	Below Detectable Limit
2	No3 Block	Hand Pump	BDL
3	No4 Block	Water well	BDL
4	No5 Block	Hand Pump	BDL
5	Half mile belt	Hand Pump	BDL
6	Annapurna	Water well	BDL
7	Torani	Hand Pump	BDL
8	Sukanjan	Water well	BDL
9	Bojalkata	River	BDL
10	Matikhula	Hand Pump	BDL

Table 3.1 : Assessment of Physico-Chemical Parameters of Drinking Water Samples with BIS And WHO Standards and Remark

Parameter	Observed range	BIS limit	WHO limit	Remark
pH	6.72-7.12	6.5 -8.5	6.5 -8.5	All sample within range
Turbidity	0.5-104.4	1-5 NTU	Up to 5 NTU	5 samples exceeded limit
TDS	175-263	500 Mg/L	500 Mg/L	Allsamples within permissible limit
Iron	0.09-3.7	1.0 Mg/L	0.3 Mg/L	50% exceeded BIS,70% WHO
Arsenic	BDL ->0.01	0.01 Mg/L	0.01 Mg/L	5 sample exceeded the permissible limit
Nitrate	0.5-2.5	45 Mg/L	50 Mg/L	All samples within limits
Fluoride	BDL	1.0 -1.5 Mg/L	1.5 Mg/L	Allsamples within limit

Table 4.1 Parameters and methods employed in the physicochemical examination of water samples

SL No	Parameter	Unit	Method employed
1	pH	-	Digital pH meter
2	Turbidity	NTU (Nephelometric unit meter)	Turbidity Meter
3	TDS	Mg/L	TDS Meter
4	Iron	Mg/L	Spectrophotometer
5	Aresnic	Mg/L	Spectrophotometer
6	Nitrate	Mg/L	Spectrophotometer
7	Fluoride	Mg/L	Spectrophotometer

7.Result and Discussion

Groundwater quality in Bekajan and Raidangjuri Panchayat villages in Titabor Sub-Division was tested for most Important physic -chemical properties such as pH, Turbidity, Total Dissolved Solids (TDS), Iron, Arsenic, Nitrate, and Fluoride .The values are compared to the BIS (Bureau of Indian Standards) And WHO (World Health Organization guideline)

❖ pH: The pH levels varied between 6.72 and 7.12, which is within the acceptable range (6.5 to 8.5) as Recommended by BIS and WHO.

❖Turbidity: Some hand pump samples had turbidity higher than BIS/WHO limits (1-5 NTU), the highest being 104.4 NTU from Raidangjuri, reflecting contamination. Samples from No. 3 Block, Half Mile Belt, Torani, and Bojalkata River were within limits.

❖ TDS: All the samples contained TDS values ranging from 175 to 263 mg/L, which are less than the BIS/WHO Standard of 500 mg/L, suggesting low risk due to dissolved solids.

❖ Iron: 50% of the samples were above the BIS standard (1.0 mg/L), and 70% were above WHO's aesthetic Standard (0.3 mg/L). No. 2, 4, 5 Blocks, Annapurna, and Bojalkata were the highest. No. 3 Block and Mattikhula Were within safety limits.

❖ Arsenic: 5 samples contained arsenic beyond the allowed limit (0.01 mg/L), and 4 were below detectable limits. Contamination can be geological. Mitigation by alternative sources or filters is required.

❖ Nitrate: All were within WHO (50 mg/L) and BIS (45 mg/L) standards. Maximum was 2.5 mg/L at Bojalkata River. No health hazard is presently shown.

❖ Fluoride: Fluoride was below detectable limit (BDL) in all samples. No risk of fluorosis, But Essential minerals must still be monitored.

8. Conclusion

The analysis of groundwater samples from Kakodunga Bekajan and Raidangjuri villages highlights Significant contamination, making most water sources unsafe for direct consumption. While Parameters like pH, TDS, fluoride, and nitrate were within permissible limits in most samples, iron, Arsenic, and turbidity levels exceeded BIS and WHO standards in a majority of the sources, Particularly hand pumps.

High concentrations of iron were observed in 8 out of 10 samples, and arsenic contamination Exceeded permissible limits in 6 samples, posing serious risks to health. Turbidity was also a Concern, indicating the presence of suspended impurities in many sources. However, water from Certain water wells and rivers in Raidangjuri met the acceptable standards, making them safer Options for drinking.

To ensure the availability of safe drinking water, immediate interventions are required. These include Installing water treatment systems such as iron and arsenic removal units, improving source Protection, and raising community awareness. Regular monitoring of water quality is essential to Prevent long-term health impacts and to maintain the safety of groundwater sources. This study emphasizes the urgent need for remedial actions and sustainable water management Practices to improve the drinking water quality for the residents of these villages.

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Photo gallery

Photos of Major Instruments Used During the Experiment: Groundwater Quality Analysis

Fig1: sample collection

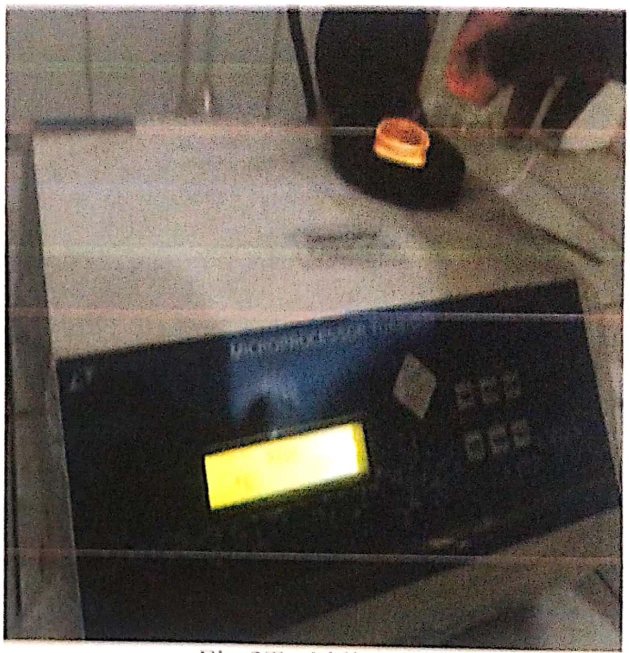

Fig:2Turbidity meter

Fig:3Digital pH meter

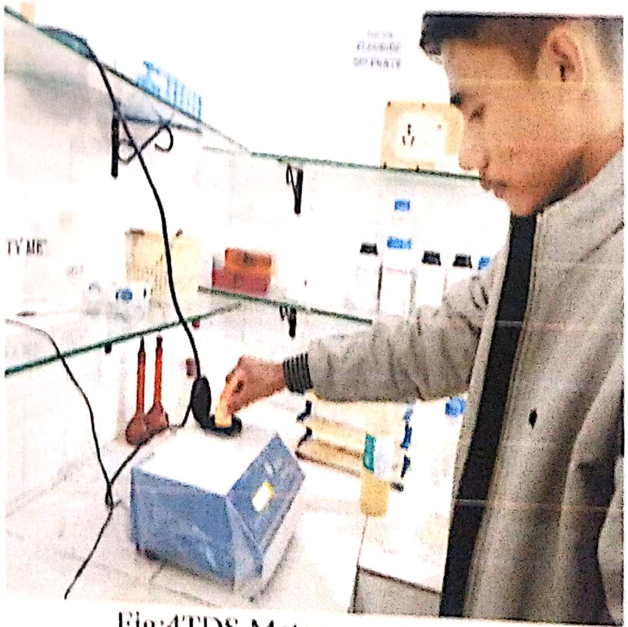

Fig:4TDS Meter