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Study on Physicochemical Properties of Water of Bamgaon Village, Assam

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Abstract

Water resources are most important part of the natural ecosystem and potentially influence agriculture, industry and life. The modernization, industrialization and necessity to ease life has affected the water resources polluting it to high extent. Thus, continuous evaluation of physicochemical parameters of water bodies is utmost necessary to check on water quality for drinking and other purposes. The study on physicochemical characteristics of different water sources in the Bamgaon region has been studied to understand the quality of drinking water; specifically focusing on Bamgaon PWSS raw and filtered water, as well as hand tube-well water. By analyzing key water quality parameters such as pH, turbidity, hardness, fluoride, calcium, iron, arsenic, sulfur, magnesium, and alkalinity, the study aims to determine the suitability of these water sources for various domestic purposes. This analysis helps in identifying any potential health risks associated with water consumption and provides a scientific basis for recommending appropriate treatment or intervention measures.

Keywords: Water quality, hardness, alkalinity, PWSS, Bamgaon

Introduction

Water is one of the most essential natural resources for all forms of life. The quality of water directly influences human health, aquatic ecosystems, and the socio-economic development of a region. However, with the rapid pace of industrialization, urbanization, and intensive agricultural activities, water bodies are increasingly becoming contaminated with various chemical and biological pollutants. This necessitates continuous monitoring and scientific analysis of water sources to ensure their safety and sustainability. The physicochemical study of water quality is a critical aspect of environmental chemistry. It involves the analysis of various parameters such as pH, turbidity, hardness, fluoride, calcium, iron, arsenic, sulphate, magnesium (Mg) and alkalinity among others. These parameters help determine whether the water is suitable for drinking and other uses. Water quality standards have been established by various organizations such as the World Health Organization (WHO), Bureau of Indian Standards (BIS), and Central Pollution Control Board (CPCB), which serve as benchmarks to evaluate the safety of water sources. Globally, groundwater is the most significant source of drinking water, even though surface water also contributes notably. Groundwater supplies only 0.9% of the Earth's total water, yet it meets around 80% of the drinking water needs and 50% of the agricultural demands in rural India.

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Drinking water should be free of harmful microorganisms and toxic substances while still containing essential minerals. Unfortunately, clarity, lack of colour, and absence of taste or odor do not necessarily indicate water safety. Chemical contamination whether from natural sources or human activity is a growing concern, as many toxic substances do not produce immediate effects but act as cumulative poisons, causing serious health problems after prolonged exposure. India continues to struggle with high rates of water-borne diseases, with a significant portion of the population lacking access to safe drinking water. Around 30% of urban households and 90% of rural households rely entirely on untreated surface or groundwater. The health and well-being of communities are closely linked to water quality. In fact, per capita water consumption is often considered a reflection of a population's overall quality of life and socio-economic conditions.

Among the various concerns related to groundwater quality, fluoride contamination stands out as a major geo-environmental issue. The fluoride level exceeding the permissible limit of 1.5 mg/L are harmful and chronic consumption of high fluoride concentrations can lead to fluorosis, a condition affecting bones and teeth. In India, fluoride levels in groundwater vary dramatically from 0.01 ppm to 48 ppm with over 15 states reporting dangerously high concentrations. In Assam, severe fluoride contamination has been identified particularly in the Karbi Anglong and Nagaon districts, where cases of fluorosis have been increasingly reported. First documented in India by Short et al. in 1937, fluorosis can affect the nervous system, thyroid gland, and even fetal development. High fluoride levels can also result in serious health issues such as muscular weakness, gastrointestinal disorders, excessive thirst, and in extreme cases, permanent disability. Alongside fluoride, arsenic (As) contamination in groundwater is another pressing issue in Assam. The presence of arsenic in Assam’s groundwater was first reported in 2004. Between 2004 and 2005, the Public Health Engineering Department (PHED), with support from UNICEF, conducted a large-scale water quality survey. A total of 5,729 water samples from 192 blocks across 22 districts were analysed. The results revealed arsenic contamination in 72 blocks from 18 districts, with 6.3% of the samples exceeding the safety limit of 0.05 ppm. The Golaghat district, located in the Brahmaputra River basin, was identified as one of the most severely affected regions. Arsenic exposure, even in trace amounts over time, can lead to severe health problems including skin lesions, cancer, and cardiovascular issues.

Recently, the water quality in different parts of Biswanath district, Assam, has been assessed for groundwater contamination due to agricultural and domestic activities. One notable study was carried out by Dr. Joydev Dutta in the Gohpur Sub-Division of Biswanath district. In his 2020 research titled "Ground Water Contamination in Tea Gardens Area: A Case Study in Gohpur Sub-Division, Biswanath (Assam), India", he collected 60 water samples from hand tube wells, deep tube wells, ponds, and open wells located in tea garden areas. The results revealed elevated levels of heavy metals such as arsenic and iron, indicating significant contamination, likely due to agrochemical usage in tea cultivation. His work emphasized the urgent need for monitoring and managing groundwater resources in such high-risk zones to protect public health. Another important study was conducted by Ritusmita Goswami et al. in 2022, focusing on groundwater quality in Biswanath Chariali and Sonitpur districts. This research analysed 56 water samples and evaluated both general physicochemical parameters and the concentration of heavy metals like arsenic and iron. Alarmingly, 95% of the samples exceeded the WHO permissible limit for iron, and 25% showed elevated arsenic levels, posing serious health risks. These findings further underscore the regional vulnerability to groundwater contamination. In addition, the Pollution Control Board of Assam (PCBA) monitors water quality in various districts under the National Water Quality Monitoring Programme (NWMP), including parts of Biswanath. Their periodic assessments provide valuable data on surface and groundwater sources.

Despite these studies, there is a noticeable lack of localized research focused specifically on the Bamgaon area within Biswanath district. This gap highlights the importance of the present study, which investigates the physicochemical properties of water in Bamgaon, particularly in Bamgaon PWSS raw and filtered water, and hand tube-well water. By conducting detailed tests on key parameters such as pH, turbidity, hardness, fluoride, calcium, iron, arsenic, sulfur, magnesium, alkalinity, and dissolved oxygen (DO), this study contributes original data from an under-explored region. The findings will help in identifying potential health risks, assessing the effectiveness of local filtration systems, and raising awareness among residents. Moreover, the study can serve as a baseline for future scientific investigations and support local authorities in designing targeted water management strategies tailored to the needs of Bamgaon.

Experimental

Study area:

The present study was conducted in Bamgaon, a village situated in the Biswanath subdivision of Biswanath district, Assam, India. Geographically, Bamgaon is located at approximately 26°44'2" North latitude and 93°9'26" East longitude, placing it in close proximity to the town of Biswanath Chariali, which lies about 3 kilometres away (Figure 1). The village encompasses a total area of 214.73 hectares and, according to the 2011 Census, has a population of 664 individuals residing in 153 households. The literacy rate in Bamgaon is notably high at 87.65%, with male literacy at 89.24% and female literacy at 85.94%.

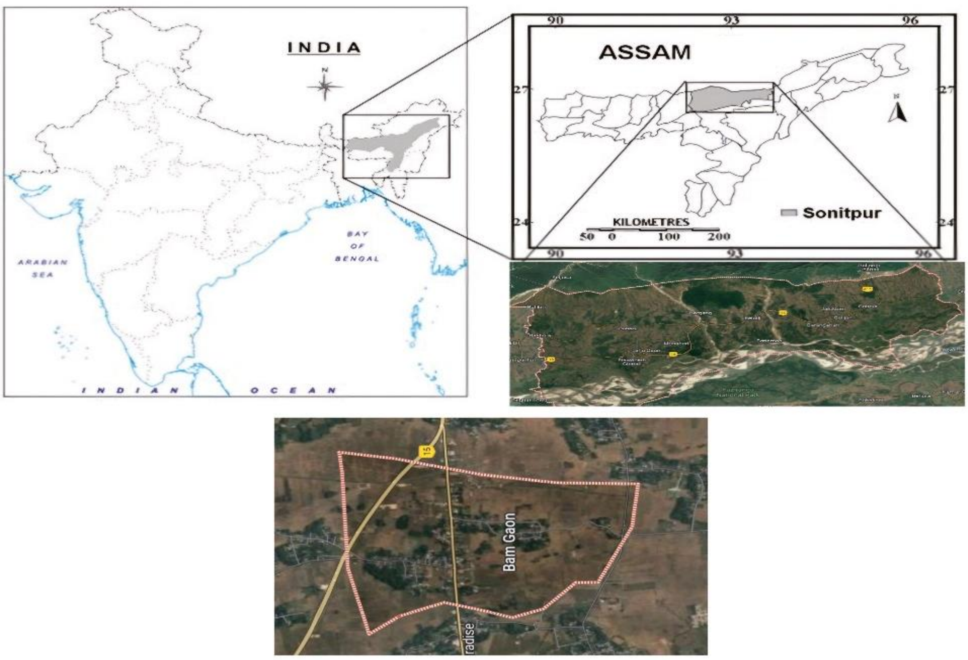


Figure 1: Study area (Bamgaon, Biswanath District, assam)

For this study, three water samples were collected from different sources within Bamgaon to assess the physicochemical properties of the water. The first two samples were obtained from the Public Water Supply Scheme (PWSS) of Bamgaon, specifically from the raw water source and the filtered water output. The third sample was collected from a local hand tube-well. These sources were selected to provide a comprehensive understanding of the water quality available to the residents of Bamgaon, considering both treated and untreated water supplies. The analysis of these samples aimed to evaluate parameters such as pH, turbidity, hardness, fluoride, calcium, iron, arsenic, sulfur, magnesium, alkalinity, and dissolved oxygen (DO), thereby offering insights into the suitability of the water for domestic consumption and potential health implications.

Methodology:

To analyse the physicochemical characteristics of various water sources in the Bamgaon region, three types of water sources: Bamgaon PWSS (Piped Water Supply Scheme) raw water and filtered water, and hand tube-well water were taken. These sources were selected based on their common usage in the area for domestic purposes, including drinking, cooking, and bathing. The parameters tested in the laboratory include:

pH – to assess the acidic or basic nature of water.

Turbidity – to measure the cloudiness or haziness caused by suspended particles.

Hardness – to determine the concentration of calcium and magnesium ions.

Fluoride (F^-) – to check for its concentration as both deficiency and excess can cause health issues.

Calcium (Ca^{2+}) – a major contributor to water hardness.

Iron (Fe^{2+}/Fe^{3+}) – excess of which can affect taste, stain clothing, and have health impacts.

Arsenic (As) – a toxic element often found in groundwater, known for its severe health risks.

Sulfur (as sulfate SO_4^{2-}) – high levels can give water an unpleasant taste and laxative effect.

Magnesium (Mg^{2+}) – another contributor to water hardness.

Alkalinity – to measure the water's capacity to neutralize acids, primarily from bicarbonates and carbonates.

Each of these parameters was measured using standard analytical techniques, following protocols suggested by BIS and WHO. The results of the analysis provide an overall assessment of the water quality in the Bamgaon region and help identify any deviations from permissible limits.

Now let's look out the procedure along with the different types of tests done-

(A) Total hardness:

50 ml of sample was taken in a 250 ml conical flask and 1-2 ml ammonia buffer solution was added to it to maintain a pH between 10 - 10.1. Then 1-2 drops of EBT (Eriochrome Black-T) indicator were added to get a wine-red colour followed by titration with 0.02N EDTA solution (Colour changes from wine red to blue). The end point from the burette was noted.

Blank titration (Titrated in a similar way)

B_1 = Volume of 0.02N EDTA solution used in the titration for blank

V_1 = Volume (ml) of sample taken

X_1 = Volume of EDTA solution used in the titration for sample

B_2 = Volume of 0.02N EDTA solution used in the titration for blank sample

X_2 = Volume of EDTA solution used in the titration for sample

S_1 = Volume (ml) of standard solution taken for standardization

S_2 = Volume (ml) of sample solution used in the titration

Correction Factor (CF) = $S_1 \times V_1 / S_2 \times V_2$

(B) Total alkalinity:

50 ml sample added in a 100 ml conical flask, if the pH of the sample is less than 8.3, then 2-3 drops of methyl orange indicator is added. The solution is titrated with standard 0.02 N Sulphuric acid (H_2SO_4) solution. The colour of sample changes from yellow to red. The end point from the burette is carefully noted.

If the pH of the sample is greater than 8.3, then 2-3 drops of phenolphthalein indicator (Bromo cresol green: methyl red indicators) is added. The solution is titrated with standard 0.02 N Sulphuric acid (H_2SO_4) solution. The colour of sample changes to blue. The end point from the burette is noted.

Total Alkalinity (as $CaCO_3$) in mg/L = $A \times N \times 50000 / V$

A = ml of Sulphuric acid used to titrate to pH 8.3

N = Normality of standard acid

V = Volume in ml of sample taken for test

(C) Calcium by EDTA titration method:

50 ml sample is taken in a 250 ml conical flask. The pH is adjusted in between 12-13; followed by addition of Sodium Chloride (2 pinch). The solution is titrated with 0.01 M EDTA solution (Colour changes from pink to purple), on adding add Murexide indicator (1 pinch, Colour changes to pink), the end point from the burette is noted.

($CaCO_3$) mg/L = $[A \times C \times 400008] / V$

Calcium ($CaCO_3$) mg/L = $[A \times C \times CF \times 400008] / V$

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

CF = M_2 / M_1 (Correction factor of standardization of EDTA solution)

C = 0.01M EDTA solution (concentration)

M_2 = Volume of EDTA solution used for standardization

M_1 = Volume of std $CaCO_3$ solution taken for standardization

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

V = Volume in ml of sample taken for the test

(D) Magnesium hardness: Procedure for Magnesium (Mg) in Water Analysis

Determine Total Hardness:

Use EDTA titration method.
Indicator: Eriochrome Black T.
Buffer: Ammonia-ammonium chloride buffer (pH 10).
Titrate with 0.01M EDTA until color changes from wine red to blue.
Recorded volume of EDTA used.

2. Determine Calcium Hardness: Same sample can be used.

Indicator: Murexide (ammonium purpurate).
Buffer: 1 N NaOH to maintain pH ~12.
Titrate with 0.01M EDTA until pink to purple transition.
Recorded volume of EDTA used.

3. Calculate Magnesium Hardness:

Formula:

$$\text{Mg Hardness (mg/L as } Mg^{2+}) = (\text{Total Hardness - Calcium Hardness}) \times 0.243$$

Figure 2: Tests performed in District level laboratory, Biswanath Chariali, Public Health Engineering Department, Assam

Results & Statistical Analysis:

In the present study, physicochemical parameters of water from three different sources in

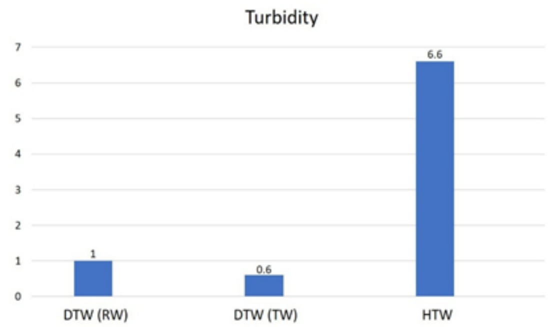
Bamgaon namely PWSS raw water, PWSS treated water (deep tube well filtered), and a local hand tube well were analysed to evaluate the quality and safety for domestic use. Key parameters measured include pH, turbidity, iron, fluoride, sulphate, arsenic, chloride, total hardness, total alkalinity, calcium, and magnesium. The pH levels across all sources ranged from 5.54 to 6.18, indicating slightly acidic to neutral water, which generally falls within the acceptable range prescribed by BIS (6.5–8.5). Turbidity was found to be highest in the hand tube well water (6.6), suggesting the presence of suspended particles, while both the raw and filter water recorded turbidity values of 1.0 and 0.6 respectively, indicating effective filtration.

The iron content in raw water and filter water was below detection level but iron content in hand tube well was 0.5mg/L fluoride content across all sources ranged from 0.50 mg/L to 0.65 mg/L both within permissible limits set by WHO. However, other elements like arsenic and sulphate were below detectable levels (BDL) in all three samples, which is a positive indicator for safety.

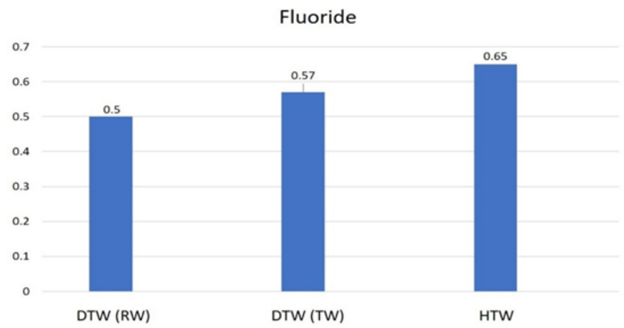
Table 1: Physiochemical parameters of water sample from Bamgaon

Sl No	**Pinpoint location**	**Type of source**	**PH**	**Turbidity**	**Iron**	**Fluorine**	**Sulphate**	**Arsenic**	**Total hardness**	**Total alkalinity**	**Calcium**	**Magnesium**
1	Bamgaon PWSS	Deep tube well (raw water)	6.18	1.0	BDL	0.50	BDL	BDL	67.58	64.00	12.31	8.95
2	Bamgaon PWSS	Deep tube well (treated water)	6.17	0.6	BDL	0.57	BDL	BDL	49.15	56.00	16.41	1.99
3	Barnali Phukan Vill- Bamgaon, Biswanath	Hand tube well	5.54	6.6	0.50	0.65	BDL	BDL	81.92	52.00	27.08	3.48

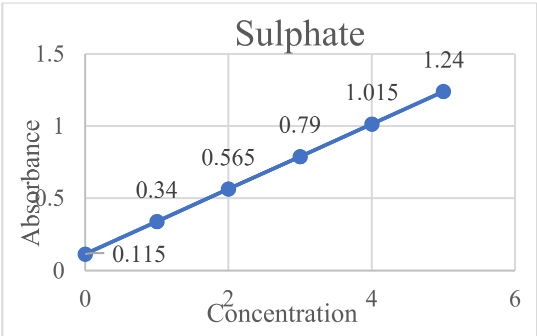
Total hardness showed variation, with the highest value of 81.92 mg/L observed in hand tube well water, while raw water and filter or treated water recorded 49.15 mg/L and 67.58 mg/L respectively, all of which fall under the "soft water" category. Calcium and magnesium values were also within safe limits, with the highest calcium concentration of 27.08 mg/L found in the hand tube well sample. The magnesium levels ranged from 1.99 to 8.95 mg/L across the samples. These results suggest that while the water quality in Bamgaon is generally safe for consumption, minor variations in parameters such as turbidity and hardness between treated and untreated water highlight the importance of regular monitoring.



(a)



(b)



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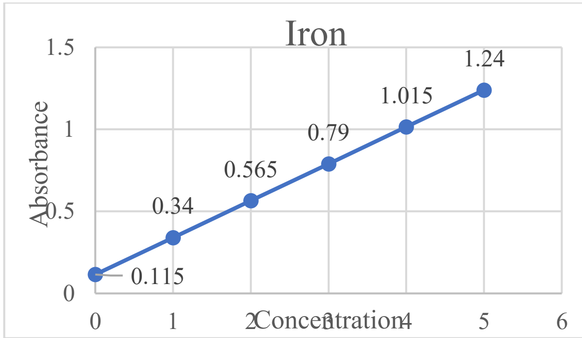

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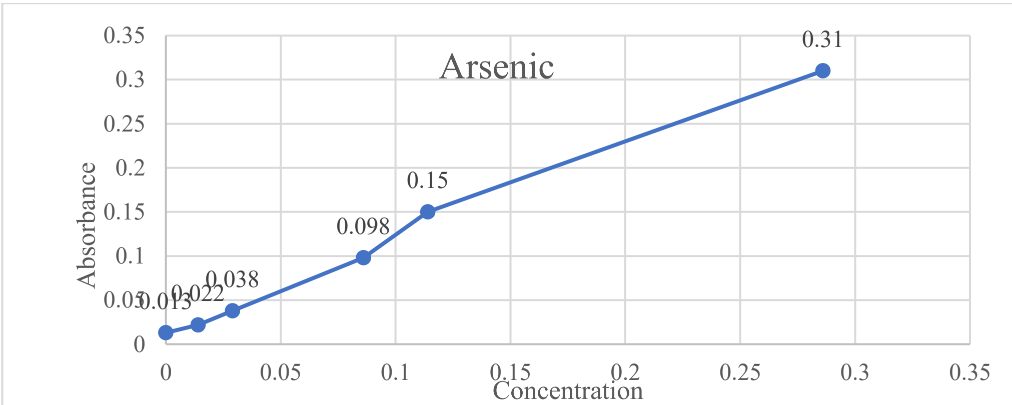

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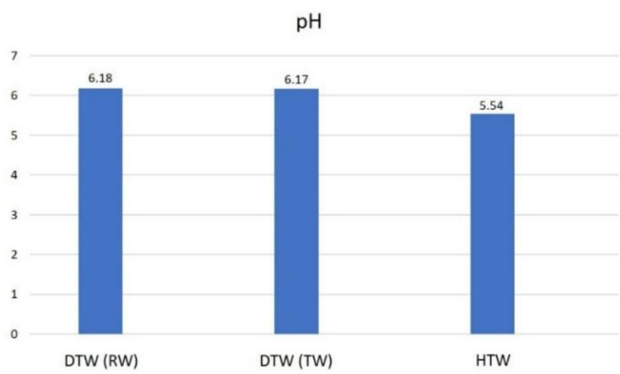

(f)

Figure 3: Graphical representation of different types of tests of water samples from Bamgaon.

Conclusion

The comprehensive analysis of water samples from Bamgaon village revealed that the overall physicochemical quality of the water from various sources namely PWSS raw water, PWSS treated water, and a local hand tube-well is generally within permissible limits prescribed by BIS and WHO standards. Key indicators such as pH, fluoride, iron, calcium, magnesium, and total hardness were found to be at safe levels, although the pH values were slightly acidic and marginally below the BIS minimum limit. Notably, turbidity was higher in the hand tube-well water compared to the treated sources, indicating the effectiveness of the filtration system in place under the PWSS. Importantly, the absence of toxic elements like arsenic and sulfate in detectable concentrations across all samples suggests minimal risk from these contaminants. Differences in total hardness and calcium content among the sources highlight the variability in water composition, further emphasizing the need for routine monitoring to ensure continued safety and suitability for domestic use. The findings underscore the effectiveness of the public water treatment system in Bamgaon and reinforce the importance of maintaining regular assessments to safeguard public health.

Data Availability Statement

Data are contained within the article.

Acknowledgments:

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Conflict of Interest

The authors declare no conflict of interest.

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