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ORIGINAL RESEARCH PAPER

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FLOOD EVENTS IN HOJAI DISTRICT AND ITS IMPACT ON DRINKING WATER:

KEY WORDS: Groundwater contamination, contaminant, waterborne diseases.

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ABSTRACT

Assam is a land of mighty river Brahmaputra along with many other major rivers and it's tributaries. So Assam is highly vulnerable and most of its geographical area is prone to annual flooding. The floods in Assam and other North-Eastern states have caused devastation of life and property , which is an annual problem in the region. Hojai District is one of such area. The geographical area of Hojai district in Assam is 1,685 square kilometers. It is located in the Central Assam division, south of Nagaon, and is bordered by Karbi-Anglong to the east and west. The Kapili and Jamuna rivers flow through the district. Kopili and Jamuna rivers.Every year Hojai district suffer from flood event, two severe flood situation in 2022 and 2024 are mentioned here. In 2022, the floods in Assam, India affected many villages, including Hojai, and caused widespread damage, The 2022 floods were caused by the monsoon season, which led to the overflow of major rivers like the Brahmaputra and Barak. The floods caused extensive erosion of river banks and houses, and landslides in several districts. The floods also affected railway lines. Again on 31 May 2024 , the flood situation of Hojai district damaged many villages.These major rivers cause annual floods and riverbank erosion, especially in the char areas. Sediment carried in flood water can then settle at the bottom, clogging riverbeds and changing habitats for the worst. It's important to note that sometimes, natural flooding carries vital nutrients and helps renew ecosystems. Six water samples were analyzed for six parameters, namely turbidity, total hardness, total dissolved solids, chlorides, nitrates, total bacterial count. Every sample had varying levels of pollution, and the majority were unfit for drinking water due to concentrations of multiple parameters were higher than the advised standard.

INTRODUCTION

Assam has more than 120 rivers, several of which originate from the hills and mountains of extreme rainfall hotspots in Arunachal Pradesh and Meghalaya as well as in China and Bhutan. The Brahmaputra and Barak River with more than 50 numbers of tributaries feeding them, causes the flood devastation in the monsoon period each year. Assam is one of the most flood-prone states in India and it experiences up to three to four waves of flooding every year. In all, 31,050 square kilometers (3,105,000 hectares) or 39.58% of its total land area is vulnerable to flooding each year.[3] Assam's vulnerability to flood stems from a complex web of climatic, hydrological and social factors. Hojai, Nagaon, Kamrup, Dhubri, Dhemaji, Charaideo, Kamrup(M), Morigaon, Barpeta are among the flood affected districts in Assam. The Hojai district of Assam is prone to flooding due to various reasons . The reasons are (i)The Kopili and Jamuna rivers are major rivers that flow through the district and cause annual floods. Other minor rivers that contribute to flooding include the Khringkhring, Lumding, Dimoru, and Nikhari rivers. (ii) The soil in the region is clay loamy, (iii) The district receives relatively high annual rainfall. (iv) Encroachments into flood plains over the years have made the flood problem worse. Incessant rain over the past few days has disrupted life in Hojai district, leading to a grim situation in several villages including Raikata, Kumrakata, Nabhanga, Dakhin Kenduguri, Theplaguri, Jugijaan, and others. The water level of the Kapili river has risen, causing many village roads to be submerged. In the year **2022**, : In the first wave of flood (6th April to 12th June 2022) 33 districts were affected inthe State viz. Bajali, Baksa, Barpeta, Biswanath, Bongaigaon, Cachar, Charaideo, Darrang, Dhemaji, Dhubri, Dibrugarh, Dima-Hasao, Goalpara, Golaghat, Hailakandi, Hojai, Jorhat, Kamrup, Kamrup (M), Karbi Anglong West, Karimganj, Kokrajhar, Lakhimpur, Majuli. In the second wave (13th June to 16th September 2022) 34 districts were affected viz. Bajali, Baksa, Barpeta, Biswanath, Bongaigaon, Cachar, Charaideo, Chirang, Darrang, Dhemaji, Dhubri, Dibrugarh, Dima-Hasao, Goalpara, Golaghat, Hailakandi, Hojai, Jorhat, Kamrup, Kamrup (M), Karbi Anglong West, Karimganj, Kokrajhar, Lakhimpur, Mauli, Morigaon, Nagaon, Nalbari, Sivasagar, Sonitpur, South Salmara, Tamulpur, Tinsukia, Udalguri Third wave of Flood: In the third wave (7th October to 28th October 2022) 15 districts were affected viz. Darrang, Dhemaji, Dhubri, Dibrugarh, Golaghat, Jorhat, Karbi Anglong , Kokrajhar, Lakhimpur, Morigaon, Nagaon, South Salmara, Tinsukia, Kamrup . Nearly 373 relief camps have been opened to provide shelter to over one lakh flood-hit people.

The main road connecting Hojai and West Karbi Anglong at Tumpreng is also underwater due to flash floods. Additionally, the bridge connecting Warigading to Nepalikuthi was washed away On May,**2024**, Incessant rain over the few days has disrupted life in Hojai district, leading to a grim situation in several villages including Raikata, Kumrakata, Nabhanga, Dakhin Kenduguri, Theplaguri, Jugijaan, and others. Three people went missing after a boat carrying 24 flood-affected people capsized at Raikata in Assam's Hojai district . The water level of the Kapili river has risen, causing many village roads to be submerged. The main road connecting Hojai and West Karbi Anglong at Tumpreng is also underwater due to flash floods. Additionally, the bridge connecting Warigading to Nepalikuthi was washed away Floodwater can reach wells and springs, contaminating them with bacteria, microorganisms, and other pollutants. Floodwater can be contaminated with pollutants such as agricultural pesticides, industrial chemicals, debris, and sewage. Effect of flood on drinking water is investigated by studying some important parameters which are turbidity, total hardness, total dissolved solids, chlorides, nitrates and total bacterial count in some area which are badly affected by flood . The areas which are selected for present study are Raikata, Kumrakata, Nabhanga, Dakhin Kenduguri, Theplaguri, Jugijaan, and others. The main road connecting Hojai and West Karbi Anglong at Tumpreng is also remain underwater every year due to flash floods. The bridge connecting Warigading to Nepalikuthi was washed away on flood in the flood which occurred in last May,2024. Chemicals and waste from agriculture and industry can contaminate floodwater. During and after flooding, private wells and springs can become contaminated with bacteria, microorganisms and other pollutants from sewage, heating oil, agricultural or industrial waste, chemicals, and other substances that can cause serious illness. As a result, chemicals, fuel, animal waste, bacteria, and other harmful substances are often present in floodwater as it accumulates. This water then makes its way into water wells or community drinking systems if the infrastructure isn't equipped to manage floods. The district is known as the Rice Bowl of Assam because of the large area of paddy grown there. Other crops grown in the district include rabi and kharif vegetables, turmeric, and sugarcane. Hojai is also known for its many forest-based small-scale industries, including agar wood distillation units, saw mills, and bamboo and cane furniture manufacturing units. This study was carried out to investigate the amount of contaminants present in drinking water after the period of flood by using standard methodology.

Study Area:

Sl. no.	Location of station	Sample number	Nature of source
1	Raikata,	TW1,RW1	Tube well, ring well
2	Kumrakata	TW2,RW2	Tube well, ring well
3	Nabhanga	TW3, PW1	Tube well
4	Dakhin Kenduguri	TW4	Tube well
5	Theplaguri	TW5, River Water	Tube well
6	Jugijan	TW6,RW3,PW2	Tube well, ring well

Sources of water sample:

Tube well-TW
Ring well-RW
Pond water-PW
TW1,RW1-Tube well of sample no.1 and ring well of sample no.1 .
TW2,RW2-Tube well of sample no.1 and ring well of sample no.1 .
TW3-Tube well of sample no.3
TW4-Tube well of sample no.4
TW5-Tube well of sample no.5
TW6,RW3- Tube well of sample no.6 and ring well of sample no.
PW1,PW2-Pond Water of sample 3 and 6 rw-River Water

Methodology:

The water samples from tube well and ring well are collected from above mentioned locations in precleaned polythene containers of 5 litres capacity. Time and date of collection was also recorded. A turbidity meter known as nephelometer is used to measure turbidity.

Total hardness was measured by titration method in the Chemistry laboratory in Rabindranath Tagore University by using standard EDTA solution.

Total dissolved solid was measured by using gravimetric analysis which involve evaporating the liquid solvent and measuring the mass of residues left. TDS is often measured in parts per million or milligrams per litre of water.

Mohr's method (Precipitation titration method) is used for the determination of chloride ions in water sample. This method determines the chloride ion concentration of a solution by titration with o.o2 N silver nitrate and the indicator used is 5% potassium chromate solution.

For NO3–N analysis, a cadmium foil pack from the nitrate test kit was added to a reaction tube containing 15 mL of sample. The mixture was shaken vigorously for 3 minutes, followed by allowing it to sit undistributed for 2 minutes. The treated solution was then poured into a sample cup without transferring any cadmium particles. Subsequently, the tip of the Vacu-vial ampoule was immersed into the sample cup and snapped by pressing against the sample cup. The ampoule was inverted several times to ensure homogenous mixing, followed by wiping it dry. It was then left to stand for 10 minutes before measurement was taken. A background correction was performed using the sealed blank ampoule provided with the test kit before sample measurement. For NO2–N analysis, the sample cup was first filled with 25 mL of sample. This is followed by immersing the t tip of the Vacu-vial ampoule into the sample cup and snapping the tip. The ampoule was then inverted several times and wiped dry. It was left to stand for 10 minutes before measurement was performed. To obtain the concentration of NO3–N and NO2–N, equations (1) and (2) from the test kit was used for calculation as shown below:

$$NO3\text{–}N\ (ppm) = 0.02 + 1.66\ (A_{520}) - 0.39\ (A_{520})^2 \quad \ldots\ldots(1)$$

$$NO2\text{–}N\ (ppm) = 1.17\ (A_{520}) - 0.67\ (A_{520})^2 + 0.24\ (A_{520})^3 \quad \ldots\ldots(2)$$

where A_{520} is the absorbance of the solution measured at 520 nm. In the photometric function of LabSolutions UV-Vis, these calculations based on equation (1) and (2) can be performed directly from measured absorbance values by setting the calculation formula in the Formula window.

To calculate total bacterial count in contaminated water, we can use viable plate count method, which involves the following steps. Spread a small amount of the water sample on an agar plate Incubate the plate for 24-36 hours, Count the number of colonies that grow on the plate . Calculate the number of bacteria per milliliter or gram of the sample using the following formula:

Number of bacteria (CFU) per milliliter or gram = Number of colonies / (Dilution factor x Amount of sample added to liquefied agar)

The total number of viable cells is usually reported as the number of colony-forming units (CFUs).

The TBC determines the total number of cells in a sample, including both dead and alive cells. In contrast, the total viable count (TVC) estimates the number of live cells that are capable of growing into colonies. The TVC test can indicate the general level of contamination in a water sample and its overall quality.

RESULT AND DISCUSSION:

Turbidity:

Turbidity of different water samples were measured and compared with WHO limit. River water exhibited the highest turbidity at 65 NTU, reflecting substantial sediment and particulate matter, likely due to natural sediment load and runoff. Pond water showed moderate turbidity, with values of 41 NTU and 30 NTU, indicating a higher concentration of organic matter and suspended particles typical of stagnant water bodies. The turbidity range of ringwell water samples are RW1=18 NTU, RW2=10.5 NTU and RW3=11 NTU respectively. All the samples has higher value of turbidity than WHO guideline value. TW1=4 NTU, TW2=6 NTU, TW3=5.5 NTU, TW4=6 NTU, TW5=8 NTU and TW6=8.2 NTU. Overall, the data highlights the influence of water source and treatment processes on turbidity levels, emphasizing the need for regular monitoring to ensure water quality to different sources.

High turbidity levels can cause hypoxic conditions by displacing oxygen, absorbing heat, and reducing sunlight penetration, this can lead to the death of underwater vegetation, disruption of the food chain, and harmful algae blooms. WHO recommends that drinking water should have a turbidity of less than 5 NTU and ideally less than 1 NTU.

Total Hardness:

Hardness in water is due to the presence of dissolved salts of calcium and magnesium. The present study had revealed that out of six places, the two places had shown high level of hardness . River water exhibits moderate hardness, reflecting the influence of natural mineral content and surrounding geology, In Kumrakata, out of 10 water samples collected, almost all the samples were moderately hard (42.5%) .In Jugijan, more number of samples had shown hardness between 150-300mg/l of $CaCO_3$ (67.5%) i.e hardwater. Some of the samples had shown moderate hardness(30%) and very few of them have shown extreme hardness(2.5%). Similar type of results were found in the study of samples of Raikata village also. The results were hard water-70%, moderately hard water - 25% and very hardwater - 5%. Finally no soft water sample was found in all the places.

Hard drinking water is generally not harmful to one's health, (WHO, 2003) but can pose serious problems in industrial settings. Most of the people especially housewives dislike hardwater because it does not lather well or does not taste good. Calcium, one of the components of hard water, can be protective because it makes water less corrosive and less likely to leach toxic trace minerals, such as cadmium and lead, out of metal pipes .

Sl no.	Sample number	Total hardness in mg/lt
1	TW1,RW1	260,300
2	TW2,RW2	370,400
3	RW3,PW1	320, 410
4	TW4	250
5	TW5, rw	310, 400
6	TW6,RW3,PW2	320,280,370

Total Dissolved Solid:

Total dissolved solids (TDS) indicate the general nature of water quality or salinity. Water containing more than 500 mg/l of TDS is not considered desirable for drinking water supplies, but in unavoidable cases 1500 mg/l is also allowed. In the present investigation, TDS values varied from490 to 670 mg/l. It shows that samples have higher values than the prescribed limit (WHO=300ppm). The highest TDS value in Jugijan may be due to sewage along with a pond near the sampling point.

Sl no.	Sample no	Total dissolved solid in ppm
1	TW1,RW1	490,512
2	TW2,RW2	420,480
3	RW3,PW1	520.500
4	TW4	540
5	TW5, rw	500,590
6	TW6,RW3,PW2	580, 590,670

Chloride:.

In this study, chloride ion concentration was determined in all of 30 samples of drinking water of Al Hawash area. Chloride ion concentration was found to be between 40 mg/L and 80 mg/L with 33.638 mg/L as an average and 9.219 as a standard deviation. Results are presented in table 2 and table 3. It is found that chloride ion concentration in all of drinking water sample was within internationally accepted limit which is less than 250 mg/L.

Sl. No.	Sample no	Chloride in mg/lt
1	TW1,RW1	40
2	TW2,RW2	57.9
3	RW3,PW1	69
4	TW4	79
5	TW5, rw	86.9
6	TW6,RW3,PW2	80

Nitrate:

Nitrate contamination in groundwater is a growing concern globally, especially for children. Consuming water with high levels of nitrate can increase the risk of cancer and cause methemoglobinemia, which can lead to asphyxia. The World Health Organization's limit for nitrate nitrogen is 11 mg/L.The study used the World Health Organization's 2011 Drinking Water Hygiene Standard (Nitrate Nitrogen: 11 mg/L) for health risk assessment.

Sl.no.	Sample no	Nitrate in mg/lt
1	TW1,RW1	2.22, 3.0
2	TW2,RW2	2.88,3.0
3	RW3,PW1	3.62,2.99
4	TW4	3.01
5	TW5, rw	3.02, 2.98
6	TW6,RW3,PW2	3.62,2.98,3.88

Total E.Coli bacterial count:

E. coli is a type of faecal coliform bacteria commonly found in the intestines of animals and humans. E. coli is short for Escherichia coli. The presence of E. coli in water is a strong indication of recent sewage or animal waste contamination. Sewage may contain many types of disease-causing organisms. These bacteria can be removed by UV filtration or chlorine addition to water. There should be zero presence of E-Coli in water. E-Coli can be harmful to humans if found in water. Infection often causes severe bloody diarrhea and abdominal cramps including non-bloody diarrhea. Frequently, no fever is present. If your water has 1 or more E.coli present the water is not suitable for drinking. Limit of E.Coli per 100 ml of drinking water is zero, but a count of 1-10 MPN/100 ml is regarded as low risk.

Sl.no	Sample no	E.Coli count(MPN/100ml)in water
1	TW1,RW1	2.9,2,98
2	TW2,RW2	3.1,3.3
3	RW3,PW1	4, 5.7
4	Tw4	2.02,2.9
5	TW5, rw	1.9,1.0
6	TW6,RW3,PW2	3.1, 2.7,3.7

A summary of comparative analysis between E. coli counts measured in MPN/100 ml in samples from the water sources is presented in the above table. The highest counts for E. coli were identified in water samples collected from the Nabhanga(PW1) sources after the flood in last may,2024. On the other hand, the lowest counts were identified from samples sourced from the river in Theplaguri(rw).

CONCLUSION:

This study gives idea about a water pollution due to flood in some places in Hojai district. Extreme flood events can significantly disturb hydro-sediment dynamics and effect turbidity maximum zone. Suspended solids in a body of water are often due to natural causes These natural solids include organic materials such as algae and inorganic materials such as silt and sediment mostly during flood .TDS less than 50mg/lt should raise a concern for a potential corrosion problem. When the flooding frequency increased , TDS declined insignificantly, while the TDS was significantly higher than other flooding grades when the duration of flood is more.Consuming water containing chloride and/or sodium alone is typically not harmful to your health.The total hardness of water is significant because it is used to estimate the concentration of metal ions in it; the higher the concentration, the greater the risk to aquatic life and other creatures' health. The concentration and the flux of pollutants such as nitrates and pesticides is higher during flood events . Incidents such as heavy rains, flooding,chemical spills or failed sewage systems can cause nitrate to enter soil near tube well,ring well etc. Generic E.Coli is normally found in all streams, lakes and canals. When there is flooding, the water may contain faecal material from overflowing sewage system, agricultural and industrial wastes. So,we should be very much careful during flood. We should consume water by proper filtration and also by boiling.

Objectives:

To identify the parameters like turbidity, total hardness, total dissolved solids, chlorides, nitrates, total bacterial count during and after flood in certain selected places in Hojai district and compare their values with the World Health Organization (WHO).

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