WATER QUALITY ANALYSIS OF RIVER BHOGDOI FOR A STRETCH THROUGH JORHAT TOWN OF ASSAM

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SYNOPSIS

This study is focussed at analysing the water quality of river Bhogdoi, identifying causes of its deterioration due to pint and non-point source pollution and recommending a series of measures for restoration of the health of the river. There lies a considerable number of point-source as well as non-point-sources on both sides of the river, which have a typical impact on the water quality. Pollutants from these sources discharge into the river due to the lack of stringent rules and regulations. The city of Jorhat collects its water from the river and considerable size of the population depends upon the river directly or indirectly. Further, this polluted water reaches the downstream areas where farmers grow various crops. It is feared that many of the toxins carried by the water of Bhogdoi get deposited in the crop fields and have already become a part of the food chain. In light of these considerations, a scientific study was felt to be of necessity to analyse the gravity of the situation. Accordingly, major physical, chemical and biological indicators of the water of river Bhogdoi were tested.

1. Introduction

A river is a natural watercourse, usually freshwater, but with the passage of time and the increase of human population and their unscientific use, our rivers are not what they used to be before. This resource is getting polluted at an alarming rate and its quality has started depleting due to various reasons like effluents from industry, domestic wastes, runoff from agricultural fields and urban areas, urban and rural garbage being some of the major sources.

It has constantly been observed that the river banks have been the most populated spots on account of the availability of ample water resources for the maintenance of daily life along with farming and other climatic advantages. The cities and towns always have shown a rising trend of population because of the easy earning sources due to the various industries, which are set up to meet the increasing demand of the growing civilisation. Because of this, day by day the urban areas are being more densely populated and as a result, the surrounding areas of the cities are suffering from various kinds of pollutions like the air pollution, water pollution, soil pollution and many more due to the sewage, garbage, dumps and barnyard manures etc. This has resulted in the loss of habitats and spoiling whole river eco-systems in relation to physical, chemical, ecological and aesthetic features.

2. Need of the Study

Over the years, like most rivers of Assam flowing through urban centres, the river Bhogdoi also has been polluted by both point and non-point sources of pollution as it flows through the city of Jorhat. It is evident from physical observation itself that the nature of the river and the quality of water of the river at present is not what it used to be in the recent past. Thus, a need was felt to undertake a scientific study on the existing health of the river, especially focussing at its water quality.

3. Objective of Study

The study was planned and conducted with two objectives:

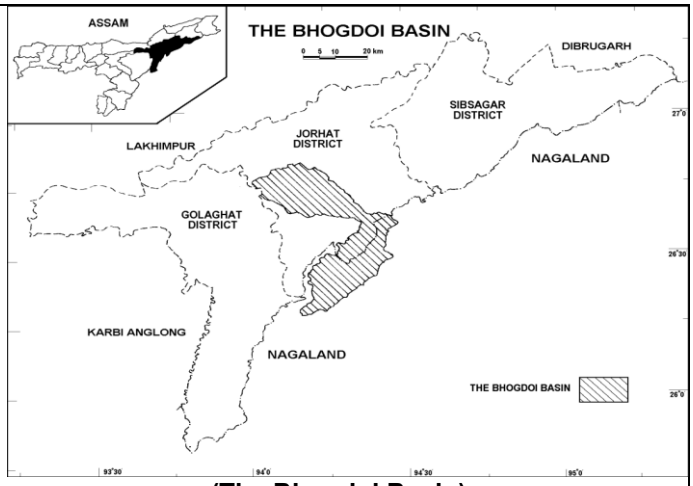
- To study the biological and chemical characteristics of the Bhogdoi river water
- Identifying the causes of river water degradation and suggest remedial measures

4. The river and the Study Area

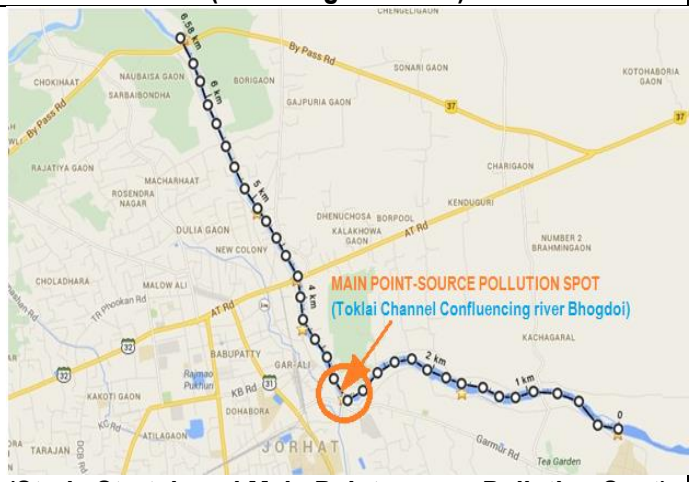
The river Bhogdoi is a small but perennial river coming down from the foothills of Assam-Nagaland border into the plains of Assam and finally pours into the Brahmaputra. It has its source in the Mokokchung district of Nagaland. Its source has an elevation of about 1400 m above msl. Its source is the point where 94°27′23″ east meridian and 26°29′6″ north parallel meet each other.

The historical documents of Assam describe the river as Disoi. The river flows through *Malow Pathar*, an extensive paddy field in the southern plain of Brahmaputra, noted for its bumper rice production since time immemorial.

The course of the river has undergone changes due to physical and anthropogenic factors during the last two centuries.

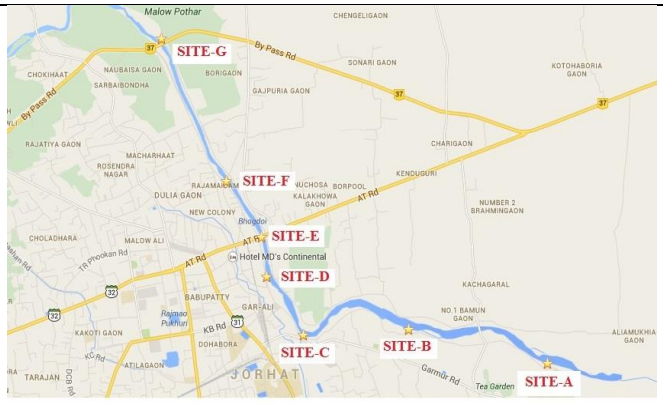


(The Bhogdoi Basin)



(Study Stretch and Main Point-source Pollution Spot)

SITE	CO-ORDINATE
A	26°45'03.6"N 94°15'06.4"E
B	26°45'15.1"N 94°14'10.1"E
C	26°45'13.2"N 94°13'27.6"E
D	26°45'33.0"N 94°13'12.9"E
E	26°45'46.8"N 94°13'10.4"E
F	26°46'05.6"N 94°12'56.2"E
G	26°46'54.3"N 94°12'30.2"E



(Identified Study Sites)

5. Sampling Procedure

Standard sampling procedures were used for collection of water samples required for carrying out the Chemical as well as the Bacteriological Tests

6. Experimental Analysis

After the samples were preserved and brought to the laboratory, various experimental analyses were carried out on them in order to determine the water quality. The basic purpose of conducting the analysis is to compare the results for various parameters of the given water sample with the results obtained few years back and with the drinking water standard.

7. Physical and Chemical Analysis of Water

Chemical analyses are used in conjunction with biological and physical parameters to characterize the quality of river water. As such the following parameters were analysed.

SN	Parameter	Significance
1	Turbidity	Turbidity is the measure of relative clarity of a liquid that is important when producing drinking water for human consumption and in many other uses. Controlling turbidity is a safeguard against pathogens in drinking water.
2	Total solids	A high concentration makes water unpalatable. Too high or too low can also reduce the efficiency of wastewater treatment plants. Higher solids decrease the passage of light through water, slowing photosynthesis by aquatic plants.
3	pH	Acidity/alkalinity of water. The pH of most inland waters that support fish range from 6.7-8.6 with extremes of 6.3 and 9.0.
4	Hardness	Undesirable because they lead to greater soap consumption.
5	Iron content	Iron is important for a healthy body and deficiency of iron results in anaemia. Higher concentration of it can cause staining.
6	Chloride content	Reasonable amount of chlorides are not harmful though they cause a threat if the concentration surpasses 250mg/lt.
7	Magnesium	Responsible for hardness of water
8	Calcium	Responsible for hardness of water
9	Sulphate	Responsible for algal growth
10	Arsenic	Heavy metal. Hazardous for human health
11	Phenolphthalein alkalinity	One of the best measures of sensitivity of a stream to acid inputs. Used to determine a stream's ability to neutralize acidic pollution e.g. wastewater.
12	Methyl orange alkalinity	Measures total alkalinity

8. Biological Analysis of Water

This was conducted for analysing water to estimate the numbers of bacteria present and to find out what sort of bacteria they are. The following parameters were analysed.

SN	Parameter	Significance
1	Total Count	To detect all viable microorganisms. The TBC tests reflect the general hygiene condition of a sample.
2	Most Probable Number of Coliform and E. coli	

9. Results and Discussion

9.1 Findings of Chemical and Biological Analysis

The results obtained for different parameters from the timely sampling and subsequent tests are presented in the following tables and graphs.

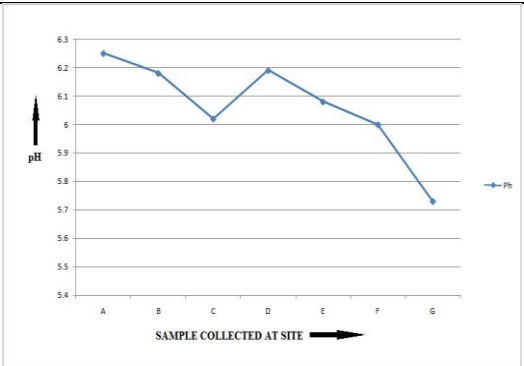
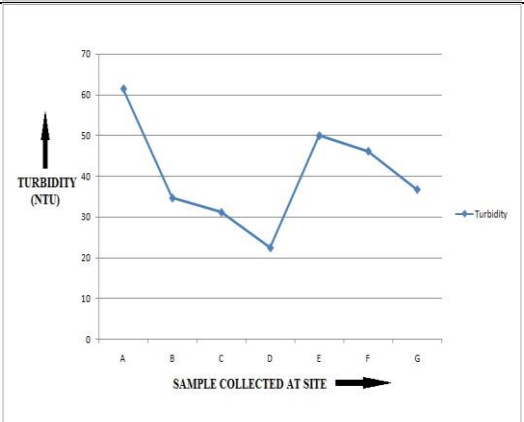
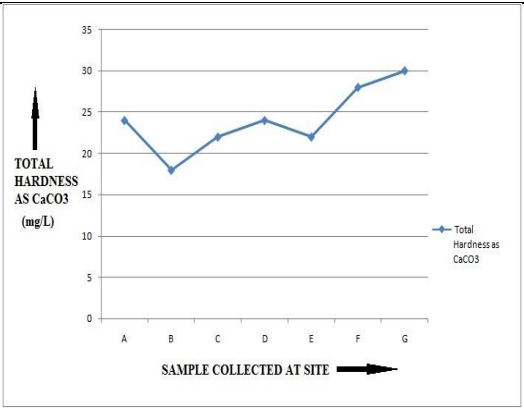
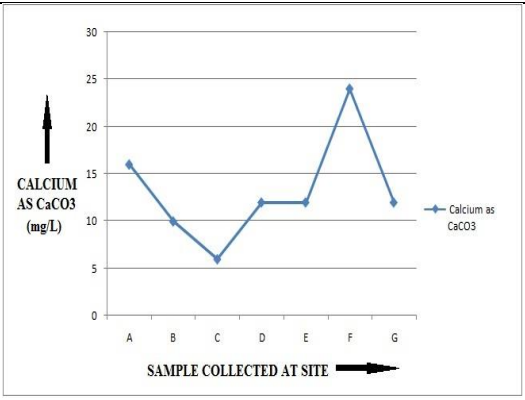
TEST RESULTS ON CHEMICAL PARAMETERS (River: Bhogdoi, Jorhat, Assam)									
PARAMETERS	**SITE**							**Avg.**	**Limit**
	A	**B**	**C**	**D**	**E**	**F**	**G**		
1. pH	6.25	6.18	6.02	6.19	6.08	6	5.73	**6.06**	6-9
2. Turbidity (NTU*)	61.5	34.7	31.2	22.5	50	46.2	36.8	**40.41**	10-25
3. Total Hardness, $CaCO_3$ (mg/lit)	24	18	22	24	22	28	30	**24**	15-375
4. Calcium, $CaCO_3$ (mg/lit)	16	10	6	12	12	24	12	**13.14**	10-250
5. Magnesium, $CaCO_3$ (mg/lit)	8	8	16	12	10	4	8	**9.43**	5-125
6. Iron as *Fe* (mg/lit)	0.5	3.5	3.6	0.5	0.6	3	2.8	**2.07**	0.70 (Median)
7. Sulphate as SO_4 (mg/lit)	Trace	Trace	Trace	Trace	Trace	Trace	Trace	**Trace**	50
8. Chloride as Cl (mg/lit)	4.8	4.8	9.8	4.8	3.8	4.8	2.8	**5.09**	1-100
9.Phenolpthelain Alkalinity	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	15 ppm + 0.4 x total alkalinity
10. Methyl Orange Alkalinity (i.e. Total Alkalinity) (mg/lit)	2	4	4	2	2	2	4	2.86	10-500
11. Residual chlorine	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	0.2 mg/lit
12. Total Solids (mg/lit)	340	210	200	188	274	250	230	241.7	20-500
13. Arsenic as As (µg /lit)	2	<1	2	1	2	2	2	1.69	10

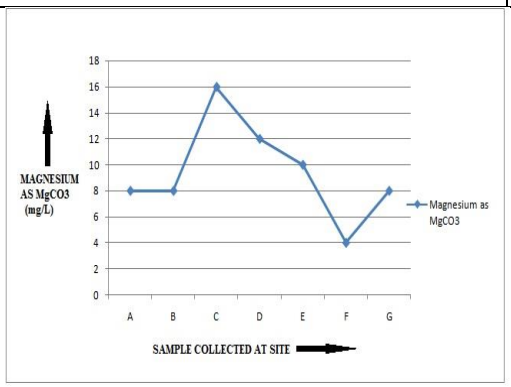
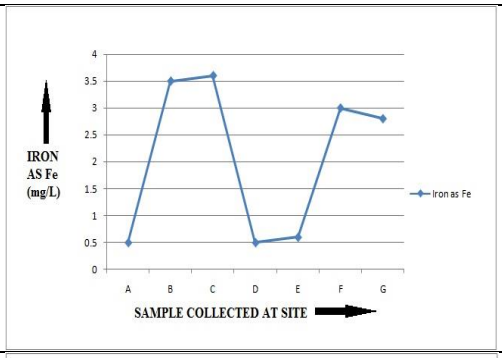
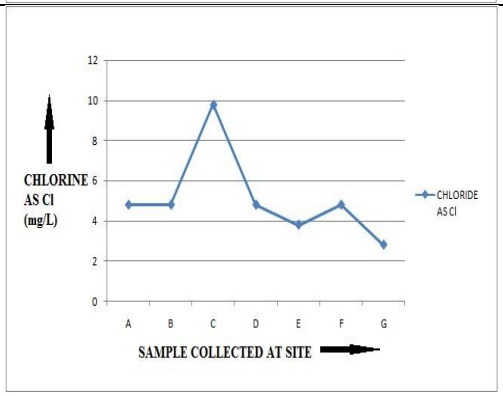
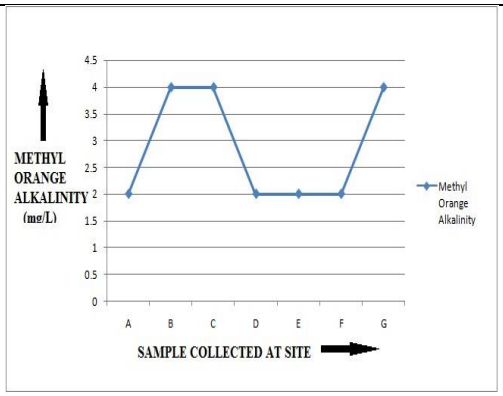
Note:

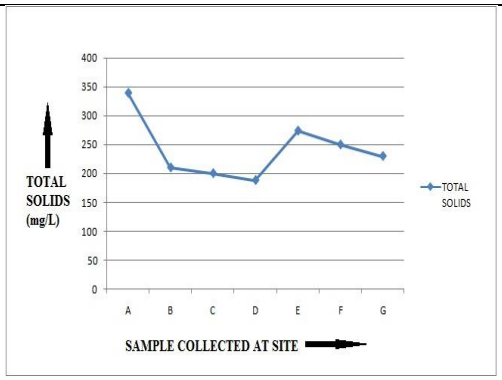
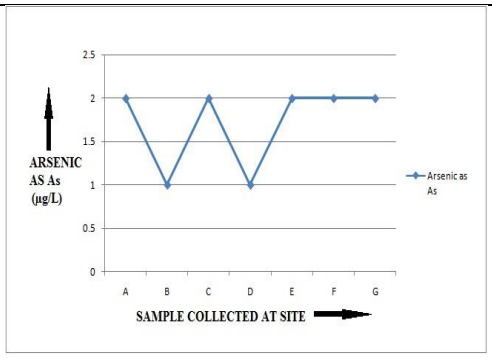
mg/lit	Milligramme per Litre (one part per million)
µg/lit	Microgramme per Litre (one part per billion)
NTU	The units of turbidity from a calibrated Nephelometer are called Nephelometric Turbidity Units (NTU)

TEST RESULTS ON BIOLOGICAL PARAMETERS								
PARAMETER	**SITE-A**	**SITE-B**	**SITE-C**	**SITE-D**	**SITE-E**	**SITE-F**	**SITE-G**	**Average**
1. MPN coliform	1800+	1800+	1800+	1800+	1800+	1800+	1800+	1800+
2. MPN E. coli	14	20	9	17	15	16	15	15.15
3. Total count	200+	200+	200+	200+	200+	200+	200+	200+

Graphical Representation of Results and Remarks

Para-meter	Trend	Remark
pH		➢ Permissible limit for natural water is 6 to 9 ➢ Bhogdoi river water is fairly acidic ➢ As pH decreases, the concentration of metal may increase as higher acidity increases its ability to be dissolved from sediments into the water.
TURBIDITY		➢ The permissible limit is 10-25. ➢ It is observed that all the values of turbidity for all the sampling sites exceed this range with Site A showing the maximum deviation. This is mainly due to the agricultural site on both bank of Site-A leading to high sediment load entering the river due to storm water runoff. ➢ High turbidity levels reduce the amount of light reaching lower depths, which can inhibit growth of submerged aquatic plants and consequently affect species which are dependent on them, such as fish.
TOTAL HARDNESS		➢ Permissible limit for natural water is 15-375 ➢ From the above graph it is observed that all the values of total hardness for all the sampling sites are from 18-30 mg/L ➢ Ideal quality water should not contain more than 80 mg/L of total hardness as $CaCO_3$. ➢ Calcium is an important component of cell walls of aquatic plants and of the bones or shells of aquatic organisms.
CALCIUM		➢ Permissible limit of calcium as $CaCO_3$ for natural unpolluted water is 10-250 ➢ It is observed that all the values of calcium as $CaCO_3$ for all the sampling sites lie in this range with the exception of Site-C which is the point of confluence of the Toklai channel. ➢ Calcium serves an important role in the health of bodies of water. In natural water it is known to reduce the toxicity of many chemical compounds on fish and other aquatic life.

Para-meter	Trend	Remark
MAGNESIUM		➢ Permissible limit as $MgCO_3$ is 5-125 ➢ It is observed that values of magnesium as $MgCO_3$ for all the sampling sites lie within this range except for Site F. ➢ Magnesium is a dietary mineral for humans, responsible for membrane function, nerve stimulant transmission, muscle contraction, also protein construction and DNA replication. ➢ There is no scientific information of magnesium toxicity. If water has magnesium components making water hard we can remove
IRON		➢ For Site A, D & E values of iron are lower than mean value (0.7), but for Site B, C, F and G, their values lie above the mean value. ➢ The total amount of iron in the human body is approximately 4 g, of which 70% is present in red blood colouring agents. ➢ Iron is a dietary requirement for humans, just as it is for many other organisms.
CHLORIDE		➢ Permissible limit is 1-100. ➢ It is observed that all the values of chloride for all the sampling sites lie within this range. ➢ Site C shows maximum chloride concentration as it is the confluence point of Toklai channel. ➢ Chloride toxicity has not been observed in humans except in the special case of impaired sodium chloride metabolism, e.g. in congestive heart failure. Healthy individuals can tolerate large quantities of chloride provided there is intake of fresh water.
METHYL ORANGE ALKALINITY		➢ The permissible limit is 10-500. ➢ It is observed that values of MO alkalinity for all the sampling sites lie below this range. ➢ Alkalinity is not a primary or a secondary drinking water contaminant. A ➢ Alkalinity is important for fish and aquatic life because it protects or buffers against rapid pH changes and makes water less vulnerable to acid rain, protecting an important resource.

Para-meter	Trend	Remark
TOTAL SOLIDS		➢ Permissible limit is 20-500. It is observed that all the values of total solids for all the sampling sites lie in this range. ➢ The concentration of total dissolved solids affects the water balance in the cells of aquatic organisms (both too high and too low are bad). ➢ High concentrations of suspended solids serve as carriers of toxins (pesticide), clog irrigation devices and may become so high that irrigated plant roots will lose water rather than gain it.
ARSENIC		➢ The permissible limit is 10 µg /lit. ➢ It is observed that all the values of arsenic for all the sampling sites lie below this value. ➢ Arsenic (As) is now recognised as the most serious inorganic contaminants in water. ➢ Drinking water provides a potentially major source of arsenic in the diet and so its early detection is of great importance.

9.2 Causes of Deterioration of Water Quality

There are several sources of river water pollution, which work together to reduce overall quality of river water. The major causes of contamination of the water of river Bhogdoi are as follows:

9.2.1 Main point source pollution

Major cause of the Bhogdoi river water contamination is the Toklai channel. The Toklai, whose water level plummeted after a part of it merged with Bhogdoi during the 1987 floods has become an easy dumping zone for the people along the banks making it polluted and had also been encroached upon. The dumping of the municipality wastes collected from all over the city on both the side of the channel very near to the confluence contributes significantly to the contamination of the river Bhogdoi.

9.2.2 Growing population

Rapid growth of population in Jorhat town is responsible for the significant increase in the level of pollution of the river. The result of growing population is generation of huge wastes including waste water, which is disposed-off into the rivers. Bathing, defecating, washing clothes, animals washing and wallowing, disposal of solid waste, plastic bags etc in open and near the river contribute to river pollution. The detergents used for washing clothes, containing phosphorus stays in rivers for a long time where it takes up valuable oxygen. The practice of dumping human remains in the river also poses health threats because partially burnt bodies are dumped with potential to spread diseases.

9.2.3 Urbanization and Sewage Disposal

Growth of urban areas in last few decades, without infrastructure for proper collection, transportation, treatment and disposal of domestic waste water has led to increased pollution and health hazards. Fast urbanisation followed by increase in prosperity is resulting in steep increase in waste generation. Most of the Jorhat town's sewage is still disposed without treatment into the river posing a risk to health from sewage-borne pathogens (cholera bacterium, hepatitis viruses, salmonellae, and shigellas.

9.2.4 Agriculture

Agriculture fields can be found on both the side of the river Bhogdoi. Hence the agricultural waste produced from these areas also contributes to the contamination of the river. Agricultural wastes include wastes arising from production and processing of food and other crops and from the raising and slaughter of livestock. It include farm animals wastes, fertilizers and pesticides etc. farm animals waste consists of excreta, urine, slurry etc, which are organic in nature. Fertilizers and pesticides are harmful because they cause algae to grow. The algae then destroy water plants.

9.2.5 Religious and social practices

Burning of dead bodies on the bank of river, throwing of un-burnt or half-burnt bodies in the river, throwing of carcasses of animals, mass-bathing in river and idol immersion in the river during the festive seasons are some example of harmful religious and social practices prevailing in the city.

10. Remedial Measures and Conclusion

a) Upgrade sewerage facilities and set up regional sewerage treatment plants and install wastewater treatment plants at wet markets to decrease rubbish and pollutants.
b) Install gross pollutant traps at main drains to prevent litter, silt and grease from entering rivers.
c) Use retention ponds to remove pollutants from sewage and sullage.
d) Implement Drainage and Storm water Management Master Plan.
e) Prevent pollutants from restaurants, workshops and other commercials.
f) Generally all the parameters lie within the prescribed range though some of them are showing an increasing trend day by day viz. turbidity and iron, which is obviously a threat.
g) The quality of water in the river is degrading, due to the numerous point and diffuse discharge of liquids and solid wastes that occur in the rural and urban course of the river. If the present trend of effluent discharge goes on, the population of the town will be affected to a much greater extent as the river is the main water-supplying unit for the densely populated town.
h) So, the preventive measures must be taken and implemented from now on to get control over the situation. Awareness regarding the issue must be spread among the general public. The Municipality and the other NGO's must work hand in hand to solve this major issue.
i) In conclusion, we can say that, if the above objectives are achieved and the appropriate remedial measures are implemented in the right earnest, we can achieve our goal of a healthy river Bhogdoi in near future.

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