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Monitoring Water quality and pollution status of Kaljani River at Alipurduar Municipality in Jalpaiguri District, West Bengal, India

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ABSTRACT

Pollution of water bodies is one of the areas of major concern to environmentalists. Water quality is an index of health and well being of a society. Industrialisation, urbanisation and modern agriculture practices have direct impact on water resources. These factors influence the water resources quantitatively and qualitatively. The study area selected were the Kaljani river basin of Alipurduar Municipality in Jalpaiguri district, West Bengal, India. The Kaljani river water is an important source of potable water supply for Alipurduar Municipality as well as adjointed areas of the district for various purposes. The physico-chemical parameters like temperature, pH, turbidity, total hardness, alkalinity, BOD, COD, chloride, nitrite and phosphate, sulphate, turbidity and coliform content in water of Kaljani River were studied to ascertain the drinking and domestic as well as irrigation water supply in municipality area. In this present study water quality of Kaljani River is taken into account and river water is found to be severely polluted with reference to these analyzed parameters.

Keywords: Kaljani river, Water quality parameters, Jalpaiguri district, Alipurduar municipality, Monitoring, Pollution status.

INTRODUCTION

Water is one of the most common yet the most precious resources on earth without which there would be no life on earth. Pollution is a serious problem as 70% of India's surface water resources and as growing number of its ground water reserves have been contaminated by biological, organic and inorganic pollutants. In India pollution of rivers is more severe and critical near urban stretches due to huge amounts of pollution load discharged by urban activities. The main cause of water pollution is human activities. Human's produce bodily wastes that enter the river and polluted water [1]. Industries discharge variety of pollutants in the waste water including heavy metals, organic toxins, oil nutrients and solids. Many of the substances are toxic or even carcinogenic. Pathogens can obviously produce water born diseases in either human or animal hosts. These wastes also increase the concentration of suspended solids (turbidity), bacteria and virus growth leading to potential health impacts. Increase in nutrient load may lead

to eutophication; organic wastes increases the oxygen demand in water leading to oxygen reduction in water with potentially severe impacts on whole ecosystems [1] .The river Kaljani is spread across Jalpaiguri district.

MATERIALS AND METHODS

Materials:-

All chemicals used in this study were of analytical grade. Deionized double distilled water was used for analysis and reagent preparation. Amber glass bottles with polypropelene cap were used for collection of water from each site.

Study area:-

The area under study is the basin of river Kaljani which pass through district Jalpaiguri, West Bengal. It is located at coordinate 26.30′N 89.31′E [2]. It covers 9,797 Km² areas. The people of this area work mainly in agriculture and small industries in nearest places. Due to rapid growth of population in the study area proper attention was not given towards the disposal of municipal sewage and drainage systems. Estimated total accumulation of municipal sewage and household garbage is approximately 20-30 metric tones per day [3].The Kaljani River water is used for agricultural, domestic use and as well as drinking purpose.

Water Sampling:-

A total of 15 water samples were collected from 3 locations which are situated in Kaljani river basin. Sample site “A” is below the river bridge ‘Birpara’, which connects Cooch Behar district with Alipurduar and is an up stream area. Sample site “B” is selected beneath the ‘Rail Bridge’, which crosses the river near Babupara and is a middle stream of our study site. Location “C” is chosen in down stream behind the NBSTC bus depot. where the river leaves the town. From each location five water samples were taken in different month through out a year for study to analyse the water quality. The samples are collected in clean polyethylene bottles and prior to collection, the samples are rinsed throughly with sample water [4]. The water samples are taken through pumping so the samples will be a representative and order to avoid only contamination from the surface of river basin [5].

Methods:-

1. Temperature, conductivity, pH, TDS and DO were measured at collection sites by using Water Analyser Kit, ELICO, India.
2. Turbidity was determined by Naphelo-turbidity meter [6].
3. TSS was measured using sintered G-4 Gooch Crucible.
4. Total hardness was determined tetrimetrically using EDTA method [7].
5. Total alkalinity was determined by pH-metric titration method.
6. BOD was determined as per standard method.
7. COD was determined by potassium dichromate open reflex method [8].
8. Chlorides were determined by Mohr’s argentometry method.
9. Nitrite and phosphate content is determined per standard method [9].
10. Spectrophotometric estimations were done by UV-160A, SHIMADZ.
11. Spectrophotometer. Coliforms are counted by Multiple-Tube method.

Table1. Shows the values of different parameters at three sample sites in five months
(All the values are in ppm unit except conductivity in Mho/cm, turbidity in NTU and pH.):-

Parameters	Sample Sites	February	March	April	May	June	Avg.	Min.	Max.
	A	26.5	22	28.5	35	31.5	28.7	22	35
Temp.	**B**	27	22.5	29	34	32.5	29	22.5	34
Air	**C**	27	21.5	29	35	33	29.1	21.5	35
	A	21.5	24	25	32	29	26.3	21.5	32
Temp.	**B**	21.5	24	25	31	29.5	26.2	21.5	31
Water	**C**	23	23.5	25	32	29.5	26.6	23	32
	A	7.86	7.8	8.11	7.76	8.1	7.926	7.76	8.11
pH	**B**	7.96	7.87	8.12	7.83	7.92	7.94	7.83	8.12
	C	7.97	7.98	8.16	7.88	7.72	7.942	7.72	8.16
	A	166.8	147.8	156.2	155.7	176.57	160.614	147.8	176.57
Conductivity	**B**	165.7	146.7	157	156.4	160.53	157.266	146.7	165.7
	C	166.9	146.8	158.6	156.1	157.3	157.14	146.8	166.9
	A	75.03	73.94	76.81	85.64	94.35	81.154	73.94	94.35
TDS	**B**	74.57	73.37	77.09	87.77	85.23	79.606	73.37	87.77
	C	75.11	73.4	77.83	85.91	84.19	79.288	73.4	85.91
	A	26	39	60	8	30	32.6	8	60
TSS	**B**	21	54	57	16	142	58	16	142
	C	51	64	78	19	434	129.2	19	434
Alkalinity	**A**	72.87	68.48	80.96	58.37	78.16	71.768	58.37	80.96
	B	74.29	69.22	81.58	58.29	68.29	70.334	58.29	81.58
	C	76.29	69.91	82.52	58.53	68.38	71.126	58.53	82.52
Hardness	**A**	70	72	76.7	74	72.7	73.08	70	76.7
Total	**B**	71	74.3	82	74.5	76.3	75.62	71	82
	C	72.3	73	80.7	74	75.3	75.06	72.3	80.7
Hardness	**A**	38	40	42.3	44.5	46	42.16	38	46
Ca	**B**	39	41	43	45	46.3	42.86	39	46.3
	C	40	42	42.5	44.3	46.3	43.02	40	46.3
Hardness	**A**	33	33	34.2	44.5	46.3	38.2	33	46.3
Mg	**B**	32	42	38.3	44.3	46.3	40.58	32	46.3
	C	32	43	38	45	46	40.8	32	46
DO	**A**	7.8	8.5	5.9	8.1	6.3	7.32	5.9	8.5
	B	7.8	7.8	5.3	7.1	5.6	6.72	5.3	7.8
	C	7.6	7.8	4.5	7.2	3.9	6.2	3.9	7.8
BOD	**A**	1.3	0.7	1.2	1.1	0.8	1.02	0.7	1.3
	B	2.9	1.4	1.4	1.2	1	1.58	1	2.9
	C	3.4	1.3	1.4	1.2	1.1	1.68	1.1	3.4
COD	**A**	23.35	17.64	8.2	8	6.79	12.796	6.79	23.35
	B	30.2	26.1	10.97	14	8.03	17.86	8.03	30.2
	C	38.96	31.57	10.96	16.04	12.96	22.098	10.96	38.96
Total	**A**	1.548	3.532	1.865	1.7	0.481	1.8252	0.481	3.532

Ammonia	**B**	1.316	7.829	1.206	1.815	0.545	2.5422	0.545	7.829
	C	4.86	6.695	2.813	2.273	1.403	3.6088	1.403	6.695
Total	**A**	856.64	835.84	813.06	770.46	730.86	801.372	730.86	856.64
Phospate	**B**	1776.65	1012.12	882.38	801.17	594.2	1013.304	594.2	1776.65
	C	1976.65	923	882.39	957.65	3113.6	1570.658	882.39	3113.6
Chloride	**A**	0.774	0.387	0.387	0.387	0.387	0.4644	0.387	0.774
	B	0.774	0.774	0.387	1.161	0.774	0.774	0.387	1.161
	C	0.774	0.774	0.387	1.161	0.774	0.774	0.387	1.161
	A	900	2200	3900	45400	14600	13400	900	45400
Fecal	**B**	1800	1300	5700	38200	26000	14600	1300	38200
Coliform	**C**	4000	4100	11800	54000	47700	24320	4000	54000
	A	2900	3600	9700	39000	23000	15640	2900	39000
Total	**B**	2300	7100	7800	12100	57000	17260	2300	57000
Coliform	**C**	18500	26400	16700	74900	81000	43500	16700	81000
Turbidity	**A**	1.7	1	2.3	0.5	7.5	2.6	0.5	7.5
	B	1.6	1	2.2	0.8	19.4	5	0.8	19.4
	C	1.6	1.1	3.7	0.7	19.2	5.26	0.7	19.2
Sulphate	**A**	3.9	2.6	4.8	3.2	4.9	3.88	2.6	4.9
	B	4.2	3.3	4.4	3.7	7.6	4.64	3.3	7.6
	C	4.4	3.1	4.5	3.3	8.6	4.78	3.1	8.6
Nitrite	**A**	11.5		16		14	13.8333	11.5	16
	B	21.5		13		37	23.8333	13	37
	C	16		24.5		32	24.1666	16	32

RESULTS AND DISCUSSION

Temperature: - The maximum water temperature (32^0C) was obtained at station “C” in May and minimum water temperature (21.5^0C) was obtained at station “A” in the month of February. The variation in water temperature may be due to different timing of collection. Temperature controls behavioural characteristics of organisms, solubility of gases and salts in water. No other factor has so much influence on temperature [10]. Where as the air temperature varied in between 21.5^0C to 35^0C.

PH: - The maximum value of pH of the water samples was recorded as 8.16 at station “C” in April and minimum value of pH was recorded as 7.76 at station “C” in May. In general pH was within the limits of standard value. For drinking water, a pH range of 6.0-8.5 is recommended [11].

Turbidity:-The present study shows the turbidity in the range of 0.5 -19.4 NTU. World Health Organization prescribed the highest desirable limit 5.0 NTU and maximum permissible limit 25.0 NTU [12]. In all the stations the value of turbidity present is in permissible limits.

Total Alkalinity: - The alkalinity of water is its capacity to neutralize acids. The alkalinity of water is due to the salt of carbonates, bicarbonates, borates, silicates and phosphates along with hydroxyl ions in the free State. The high value of alkalinity could be due to cattle bathing and laundering of clothes. Since most of the soaps have water softening agents such as washing soda and sodium carbonate, the use of these soaps might have increased the concentration of

carbonates and hence alkalinity [13]. The maximum alkalinity was recorded as 82.52 ppm at station "C" and minimum value is recorded as 58.29 at station "B". BIS has set a desirable level of alkalinity in drinking water to be 200 ppm where as its value has been prescribed to be 600 ppm in the absence of alternative source. So in all stations value of total alkalinity present in water is in range.

Total hardness: - In the present study water samples of different locations was observed in the range of 70-82 ppm. The hardness of water is not a pollution parameter but indicates water quality.

Total Dissolved Solids:- TDS are solids in water that can pass through a filter (usually with a pore size of 0.45 micrometers). TDS is a measure of the amount of material dissolved in water. This material can include carbonate, bicarbonate, chloride, sulphate, phosphate, nitrate, calcium, magnesium, sodium, organic ions, and other ions. A certain level of these ions in water is necessary for aquatic life. Similar to TSS, high concentrations of TDS may also reduce water clarity, contribute to a decrease in photosynthesis, combine with toxic compounds and heavy metals, and lead to an increase in water temperature. TDS is used to estimate the quality of drinking water, because it represents the amount of ions in the water. Water with high TDS often has a bad taste and/or high water hardness, and could result in a laxative effect. In present study TDS varied in the range 73.37 – 94.35 ppm.

TSS:-The suspended solids determination is particularly useful in the analysis of sewage and other waste waters and is as significant as BOD determination. It is used to evaluate the strength of domestic wastewaters and efficiency of treatment units. Suspended solids are objectionable in river for many reasons. Suspended Solids containing much organic matter may cause putrefaction and consequently the stream may be devoid of dissolved oxygen. In the present study, the total suspended solids ranged between 8-434 ppm; maximum at Station "C" in the month of June and minimum in the month of May at Station "A".

BOD: - Biochemical oxygen demand is usually defined as the amount of oxygen required by bacteria in stabilizing the decomposable organic matter. BOD gives an idea about the extent of pollution. In present study water samples, sampling stations BOD was found in the range of 0.7-3.4 ppm, it indicates that the pollution affects the water quality.

COD: - The chemical oxygen demand is a measure of oxygen equivalent to the requirement of oxidizing organic matter contents by a strong chemical agent. The COD test is helpful in indicating toxic conditions and the presence of biologically resistant organic substances. The maximum COD value was recorded 38.96 ppm at station "C" and the minimum values was recorded as 6.79 ppm at station "A". The high value of COD due to high level of pollutants present in water samples.

Chlorides: - Chloride is an important quality parameter that affects the aesthetic property of water including taste and renders it unsuitable for drinking purpose if present in high concentration [14].Chlorides occurs in all natural waters in widely varying concentrations. The chloride contents normally increases as the mineral content increases [15]. In present study the chloride concentration were found in the range of 0.387-1.161 ppm. The chloride contents were due to addition of natural contaminants and pollutants in the river.

Nitrite- Nitrogen: - Generally, nitrites are formed in water due to bacterial action oxidation of ammonia and are readily oxidized to nitrates. Though they are seldom present in significant concentration in surface or other natural water. The nitrites in water are indicative of organic pollution. Biological decomposition of all nitrogenous organic matter such as sewage and animal wastes contribute nitrite values in water. Their presence indicates that the nitrogenous organic matter is undergoing oxidation or nitrification and that the process is not complete. The presence of little higher value in water is indication of pollution in the River. In Kaljani River water nitrite were observed 11.5 ppm at station "A" and 37 ppm at station "B", the polluted middle stream.

Phosphates: - The phosphate content of water bodies was found in the range of 594.2-3113.6 ppm. The highest value was recorded at station "C" while minimum value at station "B". The United State Public Health standards limit for phosphates in drinking water is 0.1 ppm, so it is not within the acceptable limits. This greater deviation is due to the use of fertilisers in the catchments areas.

Sulphate:-The mean concentration of sulphate was found in the range of 2.6 to 8.6 ppm which is within the range of prescribed drinking water standards (200 ppm) [16, 17]. The lower values of sulphate recorded could be because sulphate easily precipitates and settles to the bottom sediment of the river [18].

Fecal coliform: - Fecal colifrom test is one of the most important biological parameter in drinking water quality. The microbiological quality of river is controlled by human activities. In urban areas fecal micro-organisms are mainly brought to aquatic environments through the discharge of domestic waste water and some industrial waste waters [19]. According to WHO the number of Fecal coliform in 100 ml of water should be zero. In present study the values of FC/100 ml varied between 900 at site "A" to 54000 at site "C" which makes water of inferior quality. The fecal contamination of water by slums located along the river bed might be the reason of higher values in the present study. The high coliform counts in the water body may also be as a result of contributions from the tributaries [20].

Conductivity: - The conductivity of water is a measure of capacity of a solution to conduct electrical current through it and depends on the concentration of ions and load of nutrients. As most of the salts in water are present in ionic forms, they make water capable for conducting current. The conductivity, thus serves as a good and rapid measure of the total dissolved solids in water. In the present study, lowest value of conductivity was found 146.7 and highest 176.57 at the stations.

Ammonical Nitrogen: - Ammonia generally arises from aerobic and anaerobic decomposition of nitrogenous organic matter. Urine of men and animals yields large quantities of ammonium carbonate and hence sewage is rich in free ammonia. Free ammonia is an indicator of aquatic pollution and in the present study, the concentration of ammonical- nitrogen was found 7.829 ppm at "B" due to lots of municipal sewage discharge in to the river by the drains. The lower concentration of ammonical nitrogen was found 0.781 ppm at station "A", up stream of the river.

National Sanitation Foundation Water quality Index (NSF WQI)

A water quality index is defined as a rating reflecting the composite influence of different water quality parameters on the overall quality of water. NSF WQI is an excellent management and general administrative tool in communicating water quality information. This index has been widely tested and applied to data from a number of different geographical areas all over the world in order to calculate Water Quality Index [21, 22].

NSF WQI has taken into consideration nine parameters and a weight was given to each factor according to its importance in water quality (Table 2).

Table 2. Water Quality Factors and Weights [23]

Factor	Weight
Dissolved oxygen	0.17
Fecal coliform	0.16
pH	0.11
Biochemical oxygen demand	0.11
Temperature change	0.10
Total phosphate	0.10
Nitrates	0.10
Turbidity	0.08
Total solids	0.07

The mathematical expression for NSF WQI is given by

$$\text{NSF WQI} = \sum_{i=1}^{p} W_i I_i$$

Where,
I_i is the sub-index for ith water quality parameter
W_i is the weight associated with ith water quality parameter
P is the number of water quality parameters

The classification criteria standards based on NSF WQI are given in Table (Table 2.1)

Table 2.1 Range wise classification of water quality [23]

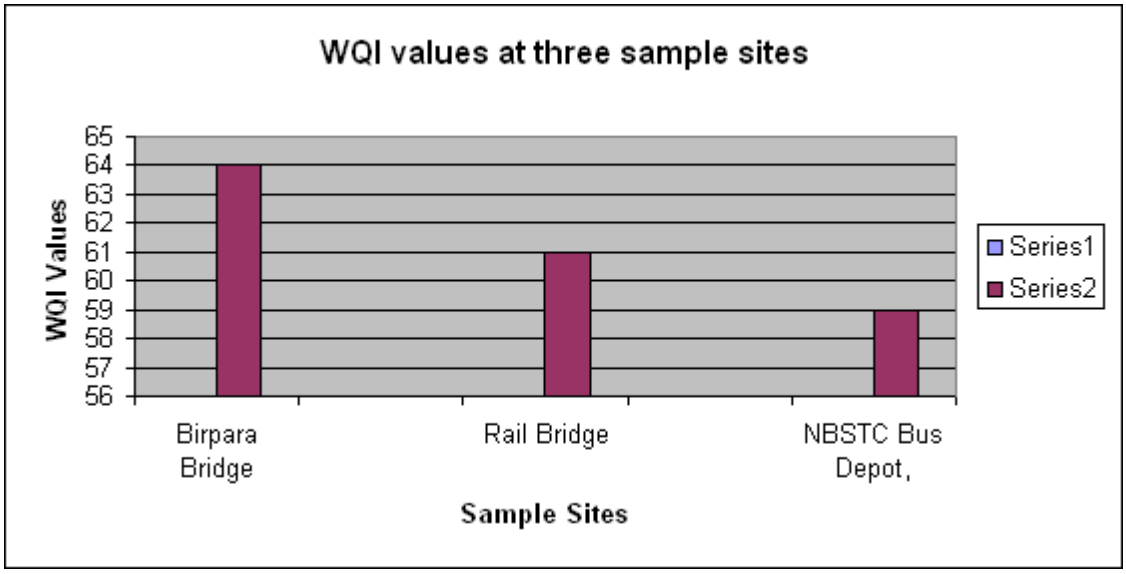
Range	Quality
90-100	Excellent
70-90	Good
50-70	Medium
25-50	Bad
0-25	Very bad

In the present study the water quality index was calculated based on seven parameters which include pH, total solids, DO, BOD, turbidity, total phosphate and fecal coliform. The values of WQI of three sampling stations are given in table 3.2. It has been observed that the quality of water at S-“A” was medium. S-“B” and S-“C” also represent medium water quality with lower values of WQI. From these results it can be said that the water of river Kaljani at Alipurduar get deteriorated due to anthropogenic pressure.

Table2.2. NSF WQI values at three sampling sites [24]

Sr. No.	Sampling site	WQI value	Description
1	Birpara bridge	64	Medium
2	Rail bridge	61	Medium
3	Near NBSTC bus depot.	59	Medium

Fig.1: Graphical representation of WQI values at three different sample sites



CONCLUSION

The results of the present study showed that the levels of nutrient parameters of water in downstream of river were elevated than the corresponding levels at upstream which shows that the quality of Kaljani River at Alipurduar is being adversely affected by discharge of domestic, agricultural and municipal sewage as a result of extended urbanization. The value of dissolved oxygen was highest at S-"A" but fell sharply at S-"B" and S-"C", it might be due to dredging of river that obstructs the flow of water. The values of chloride and hardness are higher at S-"B" and S-"C" of river body than at S-"A" that gives unpleasant smell and salty taste to water. The river gets polluted as it traverses downstream in the main city area. The higher values of COD exceed the water quality criteria given by WHO so it should be used only after proper primary treatment. The river water needs to be treated completely as some of the parameters are not within the range of standard values prescribed by various agencies, before its use for any human intended purpose. The water quality index values at different sites also revealed high pollution load at study area. The water of Kaljani River is highly contaminated at all the stations during the course of study and it is unfit for consumption, domestic and irrigation purposes.

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