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Research Article

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Comparative Study of Pollution Status of Two Main Rivers: Karola and Tista of Jalpaiguri, West Bengal, India

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ABSTRACT

The comparative study of two main rivers Tista and Karola of Jalpaiguri take attention to some special aspects of this area. River Karola is passing through the main town but Tista is passing through outside the town. The measured values of some physico-chemical parameters show almost same ranges for the two rivers. It indicates that the sources of pollution are almost same type for two rivers. The parameters also prove that at the Karola - Tista meeting point contamination of water takes place. The agriculture of this area is directly and indirectly linked with the rivers. So pollution of water has a great impact on both the quality of growing crops and as well as aquatic life of this area. The continuing pollution from 2004 to 2014 of Karola was proved previously by same author. The present study also proves that river Tista follows the same trend from 2004 to 2014. pH, DO, EC, Alkalinity, BOD, Chloride, Fluoride, Phosphate, Hardness etc. were chosen as physico-chemical parameters for the comparison.

Keywords: Physico-chemical parameters; Pollution status; River Karola; River Tista; Agriculture; Aquatic life; Comparative study; Contamination

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INTRODUCTION

A change in the chemical, physical, biological and radiological quality of water which is injurious to its existing, intended, or potential uses is termed as Water Pollution. The term generally refers to human induced changes to water quality. Water pollution can threaten human health when pollutants enter the body via skin exposure or through the direct consumption contaminated food. DDT and PCBs persists in the natural environment and bio accumulates in the tissues of aquatic organisms. These persistent organic pollutants are transferred up the food chain in a process called biomagnifications and they can reach levels of concern in fish species that are eaten by humans. Finally, bacterial and viral pathogens can pose a public health risk for those who drink contaminated water or eat raw shellfish from polluted water bodies [1]. The soil is also polluted by the surface water. Aquifers are often in hydraulic connection with bodies of surface water. Under certain condition, polluted surface water from lakes or streams can percolate into a water-table aquifer, thereby degrading the quality of the ground water. Also groundwater development near a body of surface water may draw contaminated water into the aquifer [1]. In recent years there have been numerous studies of the accumulation or uptake, of heavy metals by crop plants growing in sludge treated soils [2].

The district of Jalpaiguri lies between 26°0' and 27°0' North latitude, and between 88°20' and 89°53' East longitude. It is the 'Capital of Green Colony', the tea plants, the highest tobacco producing district of India, the most lucrative centre of forest wealth, the cultural hub of North Bengal and the land of the first anti-colonial upsurge in North Bengal. The other crops are rice, jute and mustard. Geographically it is surrounded by the Majestic Himalayan Hills. The two main river of Jalpaiguri is Tista and Karola. Jalpaiguri is called by the local historians as Tista Banga. It is worshipped as Ganga by local people. The role of Karola river is also interesting [3].

The Tista is the largest river in the district. It rises from the Himalayas and passes through Sikkim; Darjeeling Terain then enters the Jalpaiguri district at its north-west corner. With a view to search the sources of probable

contamination of the water of the river it is observed that it carries only the sewage of the capital Gantok, Sikkim and only a few people staying in the riverbank along the Sikkim and Darjeeling catchments area uses the river in some domestic purpose. The river Karola is mainly a rain fed river and a tributary of Tista. It originated at the Terrain slopes of the Tista catchment area in Baikunthapur forest and meets to Tista at Jalpaiguri town (Near Old Ferry Ghat). After the great flood in 1968, a barrage is constructed on the river so that the water of Karola can be drained to Tista at downstream. This was necessary because after the flood the riverbed of Tista was elevated above the elevation of the soil level of Jalpaiguri town areas and in consequence in each rainy season the water from Tista back flowed along the Karola and flooded the town. The river carries direct sewages from the cremation ghat, Maskalai Bari, from Jalpaiguri District Hospital and from Dinbazar area. The river Karola divides the town Jalpaiguri into two halves and collected the swages from town area and drained them to the Tista at its downstream. Both the rivers are passing through tea gardens and other agricultural field. So on the basis of contamination of water in their downstream and flowing pathway, it is expected to have same type of pollution in river Tista and Karola.
The two threats - On December 11, 2012, hundreds of dead fish were recovered from the Tista River, on November 29, 2011, dead fish were found floating on the Karala River. Continuous pollution of Karola River has been proved. The cause is mainly man made activity and garbage of the Jalpaiguri town which is disposed in Karola River. The over use of fertilizer in tea gardens and agriculture also a vital cause of deterioration of water quality [4]. The central Inland Fisheries Research Institute Calcutta tested the Karala sample after the mishap and concluded that over use of insecticide and heavy metals are the cause of above incident. The incident also proves that river Tista is not out of danger. It also needs an examination of some physico-chemical parameters as the two rivers have direct impact on environment through water pollution, it may affect the aquatic life, agriculture etc. of this area. Recent study compares the water of two rivers in 2004 and 2014 by two different assessments taking an average of 6 months period. Comparison of parameters of two river water has been taken as two different observation systems in almost same environmental condition.

EXPERIMENTAL SECTION

Water samples were collected separately from each of three sampling stations of the river. Temperature, conductivity, pH, TDS and DO were measured at the collection sites by Water Analyzer Kit, ELICO, India. Total harness, Calcium hardness, Chloride and alkalinity measured by titration. Indicator tablets were used for the estimation of Total hardness and Ca-hardness. Orthophosphate as phosphate 'P' was calculated from stannous chloride method using Double beam UV-VIS Spectrophotometer model SL-210 (Elico, India). The samples were preserved and analyzed for other parameters in accordance with the Standard Methods [5,6].

Sampling Sites

Three points of two rivers was chosen. They are A (Karola-at Gouriohat before entering Jalpaiguri town, Tista-at Gazoledoba barrage, entering the district), B (Karola- near Jalpaiguri Sadar Hospital, middle of the town, Tista-Bridge near Paharpur-Jalpaiguri, middle point), C (Karola- just before meeting to Tista, end of the town, Tista- After Tista – Karola meeting point, leaving Jalpaiguri town).

RESULTS AND DISCUSSION

Water of river Karola and river Tista assessed in year 2004 and 2014. The data recorded in Tables 1 and 2 represents the 6 months average of analysis of two rivers in respective years.

pH

The water of the rivers became alkaline day by day (Tables 1 and 2). The reduced rate of photosynthetic activity, the assimilation of carbon dioxide and bicarbonates which are ultimately responsible for increase in pH. The higher pH values observed suggests that carbon dioxide, carbonate-bicarbonate equilibrium is affected more due to change in physicochemical condition [7]. Hydrogen ion concentration represented by pH is also an index upon which irrigation water is quickly assessed for its suitability. Normally, the pH of irrigation water ranges from 6.5 to 8.4. The pH outside of the normal range might be suitable for irrigating, but has the potential to cause an imbalance of nutrients or contain poisonous ions [8]. The pH was below 8 upto year 2004 but in yea 2014 it rises to 8.5.

Electrical Conductivity

Conductivity shows significant correlation with ten parameters such as temperature, pH value, alkalinity, total hardness, calcium, total solids, total dissolved solids, chemical oxygen demand, chloride and iron concentration of water [9]. Electrical conductivity determines the dissolved salts in water. Both the rivers have increasing tendency of EC but the amount is in tolerable range (Tables 1 and 2). The TDS trend in two rivers has been changed though the values are close enough. In previous time River Tista had leading role but recent years the trend becomes reverse.

Salinity has been deemed as the most important factor of agricultural water quality because high salinity in soil can create a hostile environment for the crop to absorb nutrients and provoke specific ion toxicity [10-12]. Salinity is usually described in electric conductivity (EC). The effect that salinity gives to crop growth differs by crop type. Generally, if the EC of irrigation water is below 700 µs/cm, it does not affect crop growth; when above 3000 µs/cm, it can cause severe damage [8]

Total Suspended Solid

Slit bearing surface runoff can inhibit the penetration of sunlight through the water column, hampering Photosynthesis in aquatic plants. Excessive levels of sediments and minerals in water can inhibit the penetration of sunlight, which reduces the production of photosynthetic organisms. So, total suspended solid have an important role for water body. It is high for Tista river although turbidity is greater for Tista in previous time but recent studies show that the increase in turbidity factor higher for Karola river (Tables 1 and 2). The maximum limit 100 mg/l. Suspended solid very objectionable in rivers. Suspended solids containing much organic matter may cause putrefaction and consequently the stream may be devoid of DO [5].

Dissolve Oxygen

DO is one of the most important parameter. Its correlation with water body gives direct and indirect information e.g. bacterial activity, photosynthesis, availability of nutrients, stratification etc. [13]. The organic material which requires oxygen for its oxidation is called oxygen demanding waste. Micro-organisms use organic compounds as food, by which large complex molecule of fats, lipids, nucleic acid etc. breakdown into simple organic compounds and inorganic compounds. Both aerobic and anaerobic decomposition occur in water bodies. When the organic compounds are oxidized by micro-organisms the amount of dissolved oxygen decreases, because of consumption of oxygen [1]. DO values decrease for both the rivers with time, the amount of decrease higher for Tista (Tables 1 and 2). Generally, biochemical oxygen demand (BOD) is used as an index for organic matter. In a high BOD environment, oxygen in water is consumed for decomposing organic matters to create an anaerobic state, and during the process of decomposition, oxides in the soil such as $Fe^{3+,}$ $Mn^{5+,}$ and $SO4^{2-}$ consume oxygen to lower the oxidation-reduction potential [14]. In the end, the generated iron, manganese, and sulfide along with organic acids can disrupt the paddy rice to absorb nutrients [15]. According to previous report river Karola had greater BOD values than river Tista.

Alkalinity

Alkalinity of water is its acid-neutralizing capacity. It is the sum of all the titrable basae. This is really an expression of buffering capacity. There are small changes in these parameters of the two rivers in two years (Tables 1 and 2).

Chloride

Chloride ion is the common anion found in water and sewage. The amounts of chloride in a water sample can give an indication of the amount of sewage effluent in river water [13]. There is higher concentration of chloride ion in the hill streams of North Bengal. The higher concentration of chloride ion in the hill streams of North Bengal may be due to sewages, pesticide, leaching etc. Sewage water contains higher chloride ion concentration because sodium chloride is a common article of diet and passes unchanged through the digestive system. High chloride content may harm metallic pipes and structures as well as the aquatic plants, which naturally grows in the marshy lands of North Bengal. There is hike in amount of two rivers; river Karola has the leading role (Tables 1 and 2).

Fluoride

The values of fluoride indicate that the contamination of water in river Karola and Tista take place. Fluoride content of Tista in site A and B less than 0.05 mg/l but elevated in site C whereas Karola has greater fluoride content (Tables 1 and 2). The permissible limit is 1 to 1.5 mg/l [5].

Hardness

Hardness in water is due to the natural accumulation of salts from contact with soil and geological formation or it may enter from direct pollution by industrial effluents. The Hardness as Ca $(CO_3)_2$ in mg/litre, 0-75 soft, 75-100 moderately hard, 150-300 hard, above 300 very hard. In the present case total hardness of water samples are increased but they are below 75 (Tables 1 and 2). So water of river Karola and Tista are soft.

Phosphate and Nitrogen

Any substance assimilated by living organism that promotes growth (generally Nitrogen and Phosphorus) is called nutrient. Several cations and anions also fall in this category and are generally called as essential salts. The nutrients support the growth of algae and other plants forming the lower levels of food chain. However, excessive levels of nutrients from sources such as fertilizer can cause eutrophication, which is the overgrowth of aquatic vegetation. This overgrowth clouds the water and smothers some vegetation [1]. River Karola has greater phosphate content but Tista has greater TKN. Nitrogen (N) and phosphorus (P) are also the primary nutrients for crop growth but when applied excessively can give a negative effect. Especially for paddy rice, excessive N and P can cause the crop to over-grow which leads to lodging [16]. Excessive nutrients in water can also cause groundwater contamination as well as eutrophication [17,18]. Leaving organisms require various kinds of chemical constituents for their metabolic and biosynthetic process. Their recycling and regeneration back into the environment compensate the absorption and utilization of such constituents. Hence, any aquatic environment requires a definite amount of these nutrients and salts, excess or inadequate amount of these cause deterioration in environmental quality now the water plant has been destroyed simultaneously owing to the growth of population and amount of sewage has increased. The introduction of organic waste leads to the microbial growth. The natural water is contaminated, contains mainly parasites, fungi, bacteria etc. The sources of these organisms in the river water are sewage; animal carcasses, run-off from Terrain land etc. They are the main cause of increasing water pollution.

Waste water containing biodegradable organic matter is discharged into stream with inadequate dissolved oxygen; the water downstream of the point of discharge will become anaerobic and will be turbid and dark. Settleable solids, if present, will be deposited on the stream bed, anaerobic decomposition will occur. Over the reach of stream where DO concentration is zero, a zone of putrefaction will occur with the production of hydrogen sulphide, ammonia and other odorous gases. Because many fish species require a minimum 4-5 gms of DO per litre of water, they will be unable to survive in this portion of the stream [1].

Table 1: Comparison of parameters river Tista and Karola in year 2004 (sample site A, upstream), (sample site B, midstream), (sample site C, downstream)

Parameters	Sample Sites	Tista	Karola	Parameters	Sample Sites	Tista	Karola
pH	**A**	7.74	7.61	BOD in ppm	**A**	0.92	1.47
	B	7.84	7.35		**B**	1.2	1.5
	C	7.68	7.5		**C**	1.9	1.55
	A	61.94	76.25	TKN in mg/l as ammonia ‘N’	**A**	1.988	1.664
EC in µmho/cm	**B**	76.47	88.33		**B**	2.234	1.976
	C	92.17	84.96		**C**	3.268	1.442
TDS in ppm	**A**	31.37	38.73	TPP µg/l As phosphate ‘P’	**A**	376.58	918.9
	B	39.14	45.08		**B**	523.72	988.15
	C	46.79	43.28		**C**	656.44	917.05
TSS mg/l	**A**	39.8	30.67	Chloride in mg/l	**A**	0.736	0.967
	B	43.4	54.27		**B**	0.752	1.587
	C	78	38.27		**C**	1.684	1.742
Ca-H in mg/l	**A**	17	16.33	Sulphate in mg/l	**A**	5.288	0.541
	B	21.6	17.1		**B**	6.538	0.627
	C	24	16.97		**C**	8.4	0.752
Mg-H in mg/l	**A**	8.6	10.94	Turbidity NTU	**A**	3.14	1.81
	B	10	13.87		**B**	4.74	1.27
	C	12.4	13.13		**C**	6.08	1.78
Total-H as $CaCO_3$ mg/lit	**A**	25.6	27.77	Alkalinity mg/l	**A**	32.55	42.2
	B	33.6	30.97		**B**	37.26	38.53
	C	38.4	30.1		**C**	34.55	37.78
DO in ppm	**A**	9.93	6.97				
	B	8.74	5.51				
	C	7.9	5.04				

Table 2: Comparison of parameters river Tista and Karola in year 2014 (sample site A, upstream), (sample site B, midstream), (sample site C, downstream)

Parameters	Sample Sites	Tista	Karola	Parameters	Sample Sites	Tista	Karola
pH	**A**	7.56	8.073	Manganese in mg/l	A	>0.25	>0.25
	B	8.372	7.784		**B**	>0.25	>0.25
	C	8.377	8.52		**C**	>0.25	>0.25
EC in µmho/cm	**A**	87.32	81.83	Arsenic mg/lit	**A**	>0.01	>0.01
	B	103.75	101.6		**B**	> 0.01	>0.01
	C	115	104.83		**C**	>0.01	>0.01
TDS in ppm	**A**	51.32	39.3	Orthophosphate moles/Lit	**A**	105.03	149.07
	B	52.63	48.71		**B**	65.21	145.96
	C	56.21	49.44		**C**	99.37	90.03
Fluoride mg/lit	**A**	>0.05	0.9	Chloride in mg/l	**A**	3.67	6.2
	B	>0.05	>0.05		**B**	17.07	12.4
	C	0.77	1.3		**C**	28.39	13.2
Ca-H in mg/l	**A**	10.467	14.7	Turbidity NTU	**A**	6.24	4.42
	B	26.92	17.64		**B**	4.27	6.88
	C	31.64	20.58		**C**	2.23	2.6
Mg-H in mg/l	**A**	128.71	44.43	Alkalinity in mg/l	**A**	14	62
	B	42.27	49.01		**B**	58	47
	C	38.45	46.07		**C**	56	48
Total-H as $CaCO_3$ mg/lit	**A**	156	59.13	DO in ppm	**A**	5.1	7.2
	B	71.15	66.65		**B**	5.6	7.6
	C	74.88	66.65		**C**	3.5	4.2

CONCLUSION

All the parameters discussed above reveals that the pollution status of two rivers is more or less same and there is continuing degradation of water quality from 2004 to 2014. It proves that any measure to control the pollution has not been taken yet. Tista and Karola two main rivers of Jalpaiguri town move parallel upto some distance. Tista goes through the outerside of the town and Karola through the main town. The physico-chemical parameters prove that the man made pollution is more in Karola river. The comparison of parameters of two rivers shows that the values are within a comparable range which indicates that the sources of pollution are also same type as the two rivers passing through almost same environmental condition. Analysis of some parameters also indicate that contamination of water of two rivers enhance their pollution in downstream.

Along with the tea gardens, as far south as the Cooch Behar border, lie rich fertile plains growing splendid crops of rice, jute, tobacco and mustard. Artificial irrigation is not infrequent in Western Duars where the number of rivers and streams afford great facilities for it. There are almost 8.86 hect. River lifts irrigation in Jalpaiguri. The cultivators cut small irrigation channels, locally called jamnpios, from any stream. So the river pollution can affect to the quality of growing crops and as well as aquatic life, fish species of this area.

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