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RESEARCH ARTICLE

PHYSICO-CHEMICAL PROPERTIES IN RELATION TO WATER QUALITY AT DIFFERENT LOCATIONS ALONG THE SHUTANGA RIVER, LIFE-LINE OF MATHABHANGA SUBDIVISION TOWN OF COOCHBEHAR DISTRICT, WEST BENGAL, INDIA.

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Abstract:
The physico chemical parameters such as water temperature, turbidity, pH, total dissolved solid, total suspended solid , total solid conductivity (µs/cm), dissolved oxygen, free CO_2,salinity , BOD, nitrate , phosphate ,silicate , chloride , total alkalinity were evaluated at selected three sites of Shutunga river, a tributary of Jaldhaka river traversing through Coochbehar district of West Bengal, India to study the seasonal alteration of physico-chemical factors .The study was carried out for a period of three seasons (Pre-monsoon, monsoon and Post-monsoon) from February,2012 to July, 2013. The river is subjected to rigorous domestic and sewage pollution. Agricultural land utilises the water source for plantation and drain off the used surplus water which carries different pesticides and fertilizers to the river .The fisherman make the most of the downstream of this river for fish capture. Slum-dwellers take advantage of the water resource for bathing, washing of cloths etc. Sewage from municipality, garbage from market and ash of cremation openly combine with this river. As a result the physical, chemical and biological characteristics of the river water are gradually changing and producing the harmful effect on aquatic biota and thereby human beings. The present studies indicate that increase water pollution levels in the river near urban environment due to discharge of various types of waste water, sewage and various effluents from the domestic sewage, garbage from market, leaching of fertilizers & pesticides from agriculture land, use of ichthyotoxic substances for fish capture and also ashes of cremation directly mix up with Shutunga river.

Keywords: Shutunga river , turbidity, pH, total dissolved solid, total suspended solid , total solid**,**conductivity (µs/cm), dissolved oxygen, free CO_2, salinity , BOD, nitrate ,phosphate ,silicate, chloride , total alkalinity.

Introduction

The Coochbehar district is situated in the northeastern part of West Bengal state of India. Coochbehar is a district under the Jalpaiguri division of the state of West Bengal. Coochbehar is bounded by the district of Jalpaiguri in the north, state of Assam in the east and by Bangladesh in the west as well as in the south. The district forms a part of the Himalayan Terai of West Bengal. The district has a high percentage of SC/OBC population.

Mathabhanga subdivision is a subdivision of the Coochbehar district in the state of West Bengal, India. It consists of Mathabhanga municipality and three community development blocks: Sitalkuchi, Mathabhanga–I and Mathabhanga–II. The three blocks contain 28 grampanchayets. The subdivision has its headquarters at Mathabhanga. The Mathabhanga sub division town lies on the bank of the Shutunga River which is tributary of Mansai river.

Mansai river which is actually Jaldhaka river. The tiny River Shutunga flows through the middle of the town bisecting the town into two halves.

The shutanga is a small stream which takes its rise in the Western Duars and enters the Coochbehar district from the north at the north-west corner of Changrabandha where it is joined by the Chebas from the north. It forms for about 4.8 km the western boundary of Changrabandha, until it turns east from the north of Panisala where the road fromChanrabandha to the frontiers crosses it and goes into the interior .Its course now lies through a tract of district rich in paddy,tobacco and jute,the western half of which belongs to Mekhligunj and the eastern half appertains to Mathabhanga. Before leaving the borders of Mekhligunj it receives on its left bank in Dhuliya Khalisa a small stream called the Jalshuya, which is a branch of the Jaldhaka flowing south from the north-west frontiers. The Jalsuya becomes almost dry during the hot weather months.The Shutanga then cuts the Patgram Moranga road below the Jamaldah.,which stands on its right bank.The river then continues eastward and after a course of about 11.2 km marks the boundary line between Mekhligunj and Mathabhanga,for 4 km ,along the east of Chongarkhata Khagribari.The course of the river lies now south-east,and after a flow of 12.8km ,crosses the Emigration Road below the Mathabhanga town.It then forms a curve by the west and south of Mathabhanga town and flows on to fall into the Manshai in the north-east of Manabari. Mansai river intersected Shutanga river below Chakiyarchhara the channels of the two lying almost parallel to each other for about 4.8 km with a narrow slip of land intervening between them.The western bank of the Manshai has of late been very largely diluviated and the shutanga is now cut through further up below Manabari. The section of its old bed between Manabari and Chakiyarchhara remains almost dry except during the rains,when a current of the Manshaiflows through it and feeds the main stream below Chakiyarchhara.

The basin of this river sustains life and livelihoods of farmers, fishermen and slum dwellers. Farmers consume the water resource for agricultural land and drain off the utilized excess water which carries varieties of pesticides and fertilizers and other pollutants to the river Shutunga. The fisherman utilizes the downstream of this river for fish capture. Slum-dwellers exploit the water resource for bathing, washing and other domestic purposes. Sewage from municipality and hospital, garbage from market and ash of cremation directly disposes to this river. As a result the physical, chemical and biological characteristic of the river water is gradually changing and producing alarming harmful effect on aquatic biota and thereby the health of human beings. Water pollution is a major problem in all the major rivers of India [1, 1a.1b and 1c]. The excellence of river water as determined by its physical and chemical constituents is of great value in determining its fitness for a certain use such as public water supply, irrigation, industrial application etc [2]. The detailed inspection of river exposed that small areas as well as large areas which fall in the way of river, dump and toxic wastes in the river which has caused very acute pollution in the river to the level that its water is posturing danger to the survival of aquatic flora and fauna as well as human life. Human made activities like discharge of sewage effluents, waste waters from houses, toxic metals as well as metal chelates from different sources and also random use of heavy metal containing fertilizers and pesticides in agriculture resulted in worsening of water quality interpretation serious environmental hazards posing threat on human beings and sustaining biodiversity studied the result of the agricultural land effluents and domestic sewage on river Shutunga at three different stations of Mathabhanga subdivision and reported that all the pollution parameters are beyond the acceptable limits and unhealthy for human consumption [3-6]

About the river Shutunga

Northern part of West Bengal, sometimes mentioned as North Bengal is gifted with numerous fresh water rivers. River “Shutunga” (Fig-2) is one of them. Shutunga river which takes its rise in the western Duars and flows down to the river Mansai near Manabari at Mathabhanga subdivision town. The river bisects the Mathabhanga subdivision town in two halves and the basin of this river sustains life and livelihoods of farmers, fishermen and slum-dwellers. Slum-dwellers exploit the water resource for bathing, washing of cloths etc. Sewage from municipality, garbage from market and ash of cremation directly mix up with this river. The fisherman utilizes the downstream of this river for fish capture. As a result the physical, chemical and biological characteristics of the river water are gradually changing and producing the harmful effect on aquatic biota and thereby human beings. Research has been carried out on the physicochemical parameters of river water and their impact on aquatic biota in India [7-16a].

Experimental Section:

MATERIALS AND METHODS

Study area

Three different locations were chosen in that river for sampling of water The station-PI is near the Jamaldah, upperstream of the river. Its latitude, longitude, and elevation (from Mean Sea Level) are 26°26'15" N, 89°01'58" E, and 212 ft. correspondingly. The station-PII (Near College More, ward no-9) (Fig- 3) is situated in the heart of subdivision town. Its latitude, longitude, and elevation (from Mean Sea Level) are 26°20'27" N,

89°12'32" E, and 163 ft. respectively. The station-PIII (Near Manabari) is located at the intersection of Mansai and shutunga. Its latitude, longitude, and elevation (from Mean Sea Level) are 26°19'38"N, 89°13'47"E, and 159 ft. respectively [17]

Collection of Samples

Water samples were collected once in pre monsoon, monsoon & post monsoon seasons during, February, 2012 to july 2013 from three selected sites of the River Shutunga. Samples were collected from a three places of each sampling site, randomly and mixed thoroughly. Water samples were stored in the ice box. Collection of samples took place between the hours of 6.30 am to 8.30 am. The samples were analyzed as per standard methods mentioned in (APHA, 1995). The standards reagents used in analysis were prepared using double distilled water. Fortnightly the water samples were collected at the depth of 1 ft. All fifteen days samples were brought together as monthly average. All water sample were collected in duplicate form by two glass DO (Dissolved Oxygen) bottles with the capacity of 150 ml each and one large PVC (1 litter capacity) bottle. The water samples were transferred to the laboratory for all physicochemical studies except the water temperature, pH, conductivity and total dissolved solid (TDS).Physico- chemical parameters were analyzed in the laboratory in the same day as early as possible except BOD.

Methodology

The aim of this study is to describe the trend and variations of the selected water quality parameters of the river. The study also aims to ascertain the levels of the quality parameters and in the absence of any detectable impact from any source, may serve as baseline values [17a] The water quality test methods are shown in Table 1.

The range values of the River Shutunga water quality parameters of the present study are presented in Table 2, 3, 4 and discussed on the basis of pre monsoon, monsoon and post monsoon seasons inbrief. The odour was unobjectionable and taste agreeable at the selected sites except the PII station where odour of the water is objectionable specially at pre-monsoon and post monsoon period.

RESULTS AND DISCUSSION

Temparature

The air temperature was measured with the help of ordinary mercury thermometer at 1.5 ft. above surface water and the water temperature was measured with the same thermometer by placing it inside the water at the depth of 1.5 ft. on the sampling stations at PI, PII and PIII. Temperature is one of the most important physical parameters that control the physiological activities. The water temperature at PI and PII found in the range 29-29.5°C during pre-monsoon which was greater than the air temperature but at PIII it was 25°C and was lower than the air temperature. The reason behind the observation is the thermal properties, depth and mixing of cold water from the hills. Throughout the monsoon at PI the water temperature was 27.2°C, at PII 28.5°C and at PIII 28.2°C. For the period of post-monsoon it was 16.9 °C at PI, 18.4°C at PII and 17.6°C at PIII.

Turbidity

For the entire period of study, monsoon showed the maximum turbidity range but the pre and post monsoon showed the least range. At the convergence of Mansai and shutunga the water was more turbid than other two sampling sites. As the turbidity depends upon the TSS, it may be due to the soil erosion. Turbidity is the optical property of a water sample that causes light to be scattered and absorbed rather than transmitted in straight lines through the sample. Light's ability to pass through water depends on the amount of suspended material present. Turbidity may be caused when light is blocked by large amounts of silt, microorganisms, plant fibers, wood ashes, chemicals. Any substance which makes water cloudy will cause turbidity.

pH

One of the important factors that serve as an indicator of pollution of water body is pH. The fluctuation of pH in the present system may be due to the buffering capacity. The pH is one of the most important factor which influences aquatic life of any water body .The pH of natural water can provide important information about many chemical and biological processes and provides indirect correlations to a number of different impairments. At the period of study, the average pH on PI and PIII during pre and post monsoon was acidic. During early monsoon it was neutral to alkaline. The PII which is located at the centre of the district town showed acidic pH during all the seasons. The acidic pH may be due to the high organic load and decomposition. The rain water is responsible for neutralization and finally make it to alkaline.

Total solid (TS), TDS and TSS

Total solid (TS) of water is mathematically represented by the sum total of TDS and TSS. The TSS values of water ranged from 0.03-0.08 ppt at PI, 0.08-0.2 ppt at PII and 0.12-0.64 ppt at PIII. Comparatively PIII station showed maximum TSS. The solid substances present in the water stay either in dissolved or suspended forms. The dissolved forms are smaller and lighter than the suspended ones. The TDS values of water ranged from 0.02 to 0.03 ppt at PI, 0.04 to 0.08 ppt at PII and 0.04 to 0.05 ppt at PIII. Comparatively PII station showed maximum TDS concentration. The TDS and TSS were

irreversibly related. This may be due to the addition of solids from runoff water.

***Electrical conductivity* (EC)**

The electrical conductivity is represents the total concentration of soluble salts/mineral salts inwater (Trivedy and Goyal, 1986), so making it sour and unsuitable for drinking. In the present study the EC values of water samples ranged from 31 to 39 (µs/cm) at PI, 65 to 79 (µs/cm) at PII and 43 to 51(µs/cm) at PIII. It was observed that PII showed maximum EC. The EC depends upon the concentrate of ions and nutrients and variation of dissolved solids. Dilution water during rain depletes the EC value of water. The variation of conductivity shows the uneven happening of un-ionized chemical substances and due to poor irrigation supervision, minerals from rain water runoff, or other discharges.

Alkalinity

It is the quantitative capacity of water sample to neutralize a strong acid to a pH. Alkalinity is not a pollutant. It is a total measure of the substances in water that have "acid-neutralizing" ability. pH measures the strength of an acid or base. Alkalinity is an indicator for a solution's capacity to react with acid and "buffer" its pH. In the present study, total alkalinity (TA) represents to bicarbonate alkalinity only. Increase dilution of river water may be responsible for lower values of alkalinity in rainy seasons [18].

Dissolved oxygen

Dissolved oxygen in water is an indicator for water quality and diversity of living things. The concentrations ranged from 4.3 to 5.6 ppm at PI, 3.3 to 5.0 ppm at PII and 3.4 to 5.5 ppm at PIII. The highest values of DO were observed from the end of pre monsoon to mid monsoon at all the three poins. The reason behind the fact is the turbulence and oxygenation resulting from rain falls and mixing up of gleaming aerated water. Addition of domestic sewage, municipalities wastes, waste from market and hospital etc. encourage the growth of micro organisms which use the dissolved oxygen for decomposition. So the concentration gradually decreases. [19]. The values recorded at the three stations in the pre monsoon, monsoon and post-monsoon was irreversibly correlated and supports the observations of Ray & David, 1966 and Barat & Jha, 2002 [20.21].

The biological oxygen demand (BOD)

The biological oxygen demand (BOD) gives an thought of the quantity of biodegradable organic matter present in an aquatic system that is subjected to aerobic decomposition by microbes which provides a direct dimension of the state of pollution. The concentration of BOD ranged from 0.46 to 1.4 ppm at PI, 0.94 to 2.7 at PII and 0.84-1.7 at PIII. The BOD level indicates that PII is more polluted than other two stations.

Free carbon dioxide

The presence of carbonic acid in water may be good or bad depending on the water's pH and alkalinity. In the present work, the free carbon dioxide concentration varies from 5.97-6.65 ppm at PI, 5.13-7.57 ppm at PII and 5.3-9.1 ppm at PIII respectively. It is inversely correlated with pH at both the stations. The result of carbon dioxide indicates high organic load in two down stream locations i.e., PII and PIII.

Chloride concentration

Chloride concentration is one of the indicators of water pollution [22]. It is also related with the concentration of salinity. In the present work, the average chloride concentration showed an increase from PI to PII and subsequently decreased at PIII at pre-monsoon, monsoon and postmonsoon seasons.Minimum concentrations were observed during monsoon and maximum were observed during pre-monsoon at both the stations due to the organic waste load particularly sewage pollution.

salinity

If salinity concentration is more than 1 ppt, it is marked as saline water. In the present work, the salinity of water was very poor and always less than 1 ppt. It ranged from 0.035-0.040 ppt at PI, 0.042-0.053 ppt at PII and 0.040-0.050 ppt at PIII. Organic wastes openly mixed with water body increasing the chloride concentration which finally increases the salinity during pre-monsoon. During monsoon rain fall dilutes the concentration of chloride and ultimately the decrease of salinity.

Nitrate (NO3-)

To study water quality of Shutunga River, three nutrient factors were selected. Nitrate (NO_3 -) is one of the important nutrients in water body which is the common form of nitrogen in natural water. In the present study, the nitrate concentration ranged from 0.14 to 0.45 ppm at PI, 0.21 to 0.58 ppm at PII and 0.27 to 0.33 ppm at PIII. Maximum concentration was observed during premonsoon at all the three stations. The average values were low at PI in comparison to PII and PIII. The possible reason behind the fact is the mixing of nitrogenous fertilizer from tea gardens, sewage, etc.

Phosphate (orthophosphate or total reactive phosphorus [TRP])

In general, phosphorous is an essential nutrient to living organisms. Inorganic phosphate, another ingredient of cultural eutrophication in water body, ranged from 0.072-0.1924 ppm at PI, 0.07- 0.283 ppm at PII and 0.067-0.156 ppm at PIII. At all the three defined locations, TRP concentration was maximum during pre-monsoon and the least during rainy season.

Fig-2: A simple view of Shutunga at PII Site

Fig-3: A Simple view of Shutunga where it meets River Mansai (above)

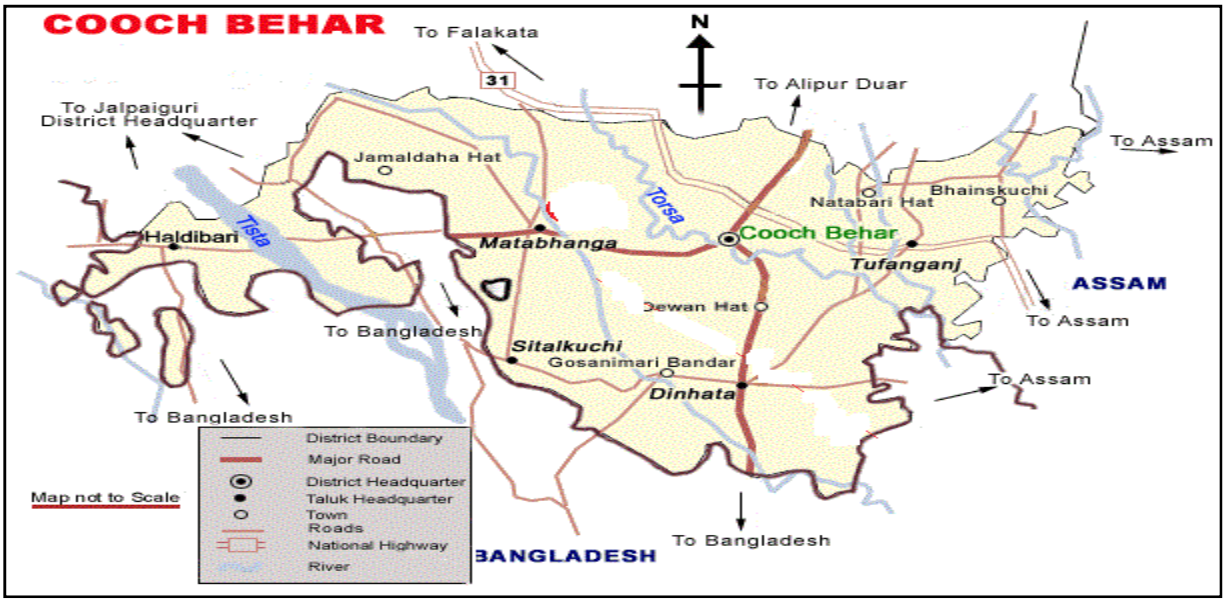

Fig.1.Map of Coochbehar District.

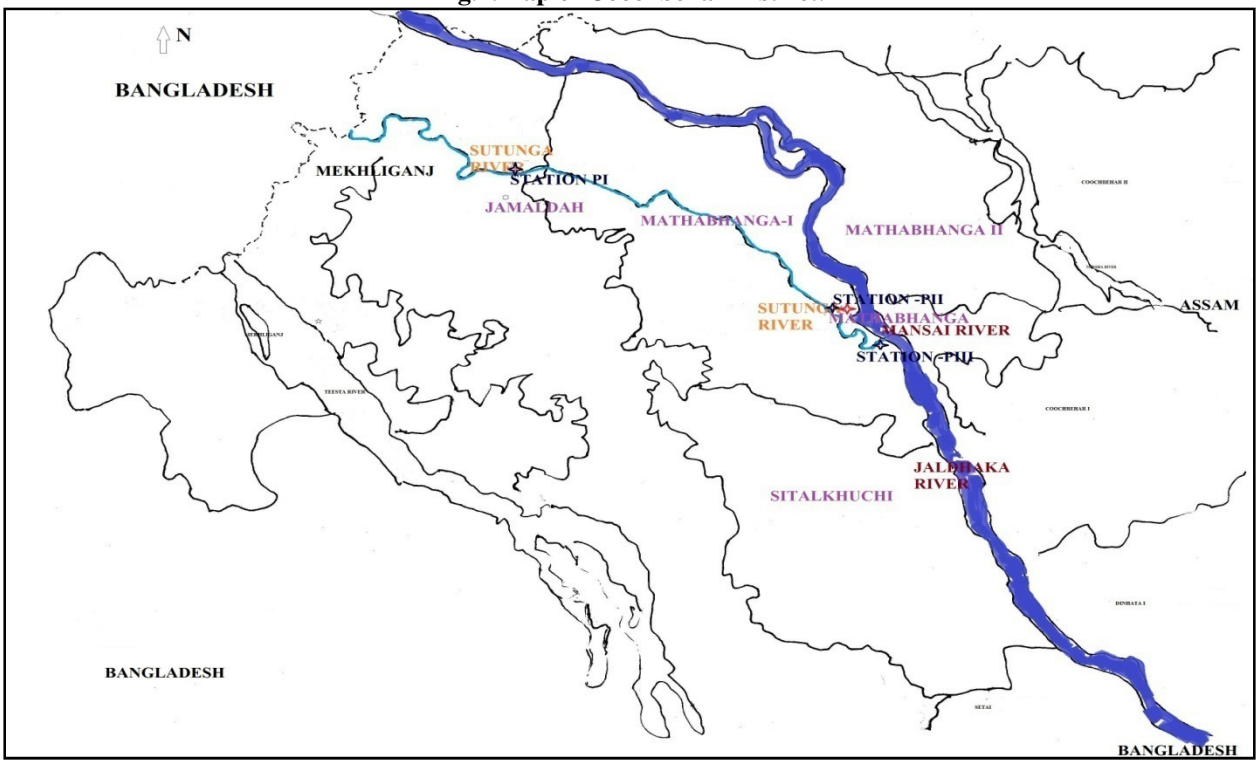

Fig.1a. Location of sampling sites in River Shutunga (Blue star Marked)

Table 1: Water Quality Test Methods

S. No	Parameters	Units	Test Method
1	pH	-	Deluxe water and soil analysis kit (Model-171 of Electronics India).
2	Electrical Conductivity	µs/cm	Deluxe water and soil analysis kit (Model-171 of Electronics India).
3	Total dissoved Solids	ppt	Deluxe water and soil analysis kit (Model-171 of Electronics India).
4	Alkalinity	mg/l	Titration and Electrometric
5	Chloride	ppm	Titration
6	Dissolved Oxygen	ppm	Winkler method with Azide Modification
7	Biological Oxygen Demand	ppm	5 days incubation
8	Turbidity	Nephelometric Turbidity Units (NTUs)	Turbidity meter
9	Total suspended Solids	ppt	evaporation method
10	Air and water emparature	^{0}C	ordinary mercury thermometer
11	Total solid	ppt	Sum of TDS and TSS values.
12	Free CO_2	ppm	In accordance with APHA (1995)
13	Salinity	ppt	In accordance with APHA (1995)
14	Nitrate	ppm	In accordance with APHA (1995)
15	Phosphate	ppm	In accordance with APHA (1995)
16	Silicate	ppm	In accordance with APHA (1995)
17	Total alkalinity	ppm	In accordance with APHA (1995)

Table 2.Physico-chemical parameters of water at PI of Shutunga river.

Water quality (Physico-chemical) Water quality	Seasons		
	Pre-monsoon Mean value	Monsoon Mean value	Post-monsoon Mean value
Air temperature (°C)	26.0	27.2	13.4
Water temperature (°C)	29.5	27.6	16.9
Dissolved oxygen (ppm)	5.6	6.7	4.3
Free CO2 (ppm)	6.65	5.97	6.67
TDS (ppt)	0.030	0.023	0.032
TSS (ppt)	0.0624	0.0873	0.0373
Total solid (ppt)	0.1023	0.1124	0.06
Turbidity (NTU)	19.74	32	8.74
pH	6.9	7.14	6.82
Conductivity (µs/cm)	39.23	31.23	34
Nitrate (ppm)	0.45	0.14	0.18
Phosphate (ppm)	0.1924	0.072	0.074
Silicate (ppm)	0.543	0.15	0.237
Chloride (ppm)	3.2	4.43	6.023
Total alkalinity (ppm)	30.34	28.66	29.92
Salinity (ppt)	0.040	0.037	0.035
BOD (ppm)	1.37	0.46	0.94

Table 3.Physico-chemical parameters of water at PII of Shutunga river.

Water quality (Physico-chemical) Water quality	Seasons		
	Pre-monsoon Mean value	Monsoon Mean value	Post-monsoon Mean value
Air temperature (°C)	26.4	26.1	15.1
Water temperature (°C)	29.0	28.5	18.4
Dissolved oxygen (ppm)	4.95	5.01	3.37
Free CO2 (ppm)	7.57	5.13	6.14
TDS (ppt)	0.0874	0.044	0.0724
TSS (ppt)	0.08	0.2124	0.0424
Total solid (ppt)	0.1672	0.2574	0.114
Turbidity (NTU)	19.23	47	8.6
pH	6.42	6.8	6.4
Conductivity (µs/cm)	79.73	65.4	68.4
Nitrate (ppm)	0.582	0.21	0.274
Phosphate (ppm)	0.283	0.077	0.1074
Silicate (ppm)	0.534	0.15	0.2374
Chloride (ppm)	13.094	7.274	9.372
Total alkalinity (ppm)	33.24	31.37	32.6
Salinity (ppt)	0.053	0.042	0.045
BOD (ppm)	2.75	0.94	1.74

Table 4.Physico-chemical parameters of water at PIII of Shutunga river.

Water quality (Physico-chemical) Water quality	Seasons		
	Pre-monsoon Mean value	Monsoon Mean value	Post-monsoon Mean value
Air temperature (°C)	27.2	26.0	15
Water temperature (°C)	25.0	28.2	17.6
Dissolved oxygen (ppm)	4.8	5.5	3.4
Free CO2 (ppm)	9.1	5.3	6.82
TDS (ppt)	0.058	0.040	0.04
TSS (ppt)	0.37	0.64	0.1223
Total solid (ppt)	0.437	0.690	0.1724
Turbidity (NTU)	24.1	54	10.3
pH	6.6	7.02	6.53
Conductivity (µs/cm)	51.73	43	46.4
Nitrate (ppm)	0.334	0.287	0.273
Phosphate (ppm)	0.156	0.067	0.077
Silicate (ppm)	0.5574	0.15	0.2374
Chloride (ppm)	11.3	5.96	9.01
Total alkalinity (ppm)	29.3	27.4	28.5
Salinity (ppt)	0.050	0.040	0.045
BOD (ppm)	1.7	0.84	1.35

Silicate (soluble)

Silicate (soluble) is the other nutrient of fresh water body system. In the present observations the silicate concentration ranged from 0.15 to 0.55 ppm in the river and more or less uniformly distributed. Concentration was greater at pre-monsoon in comparison to other two seasons.

CONCLUSIONS

It may concluded that the general characteristics of water from the town area (PII) is alkaline in nature at rainy season. The parameters chlorides are well within the permissible limits of drinking water quality standards at PI and PII. Some selected parameters are slightly higher limits prescribed by (WHO,1993) at PII and not tolerable for household and commercial purposes mainly in premonsoon season. The PII appears to be more troubled by external influences compared to the PI and PIII. The domestic sewage, garbage from market, leaching of fertilizers & pesticides from agricultural land , use of ichthyotoxic substances for fish capture and also ashes of cremation directly mix up with Shutunga river and are clearly revealed in these results. The deterioration of water quality is related with above causes. The PI seems to be the least polluted. The results obtained from the present investigation shall be helpful in future management of the river Shutunga Slightly higher DO, BOD values in Shutunga river water is unfit for drinking purpose at PII mainly in premonsoon time. High pH, TS, Hardness, DO, BOD values recommend purification is necessary for domestic consumption. Firm legal action should be taken against those who pollute the Shutunga river by waste discharges of local effluents. Till date it is unfortunate that the Shutunga river, life line of Mathabhanga subdivision has not received any proper methodical attention from the authority. This report gains importance as the Shutunga river has been described as one of the most important tributary of Mansai.

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