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Research Article

WATER QUALITY AND POLLUTION STATUS OF TAPI RIVER, GUJARAT, INDIA

Monika Dubey* and N.C. Ujjania

Department of Aquatic Biology, Veer Narmad South Gujarat University,
Surat, Gujarat-395 007, India

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ABSTRACT

In the present paper an attempt has been made to study water quality parameters and pollution status of Tapi River (Gujarat). This is river situated 72º 38' to 78º 17' E longitudes and 20º 5' to 22º 3' N latitudes. For this study the water samples were collected from pre-selected sampling stations during January to June 2011 and important physico-chemical parameters such as temperature, turbidity, conductivity, pH, total alkalinity, DO, BOD, COD, chloride, total hardness, phosphate, Nitrate-N, Nitrite-N, ammonia, sodium and potassium were analyzed. Present study revealed that temperature (20-28^{o}C), conductivity (0.08-2.71 µmhos /cum), total alkalinity (72-170 mgl^{-1}), chloride (29.90-194.94 mgl^{-1}) total hardness (20-192 mgl^{-1}), Nitrate-N (0.05-0.90 mgl^{-1}), Nitrite-N (0.02-0.82 mgl^{-1}) and sodium (50-178 mgl^{-1}) were within the permissible limits of WHO and BIS while pH (7.9-8.6), Turbidity (20.0-33.3 NTU), dissolved oxygen (4.40-8.50 mgl^{-1}),biological oxygen demand (0.40-8.40 mgl^{-1}), chemical oxygen demand (24-152 mgl^{-1}), phosphate (0.10-0.73 mgl^{-1}), ammonia (0.03-1.04 mgl^{-1}) and potassium (50.5-178.0 mg1^{-1}) were observed beyond the permissible limits. On the basis of this study it was concluded that water of Tapi River is moderately polluted due to discharges of industrial waste, domestic sewage and agricultural run-off in river water, which require more efficient management to conserve this river.

Key words: Tapi River, water quality, permissible limit, pollution status.

INTRODUCTION

The water of rivers plays an important role in development of the country. The rivers serve as a source of water supply to meet our domestic, industrial, agricultural, fisheries and power generation needs. It is agonizing to see that the same water resources are also utilized for the disposal of domestic and industrial wastes which ultimately leads to water pollution (Kumar, 2002).

In India almost 70% of the surface waters have become polluted due to the discharge of domestic sewage and industrial effluents into natural water sources, such as rivers, streams as well as lake (Sangu and Sharma, 1978). Akuskar *et al.,* (2006) reported bad water quality of Manjara River, Dhanegaon. Gupta and Pankaj (2006) reported organic pollution in River Gomati due to anthropogenic activities. Begum and Harikrishna (2008) reported increased pollution load due to the movement of fertilizers, agricultural ashes, industrial effluents and anthropogenic wastes at river Cauvery. Ujjania and Mistry (2012) observed that the pollution and nutrient load were increased in Tapi River due to religious activities.

Tapi is the major river of West Coast river system of India with total length of 720 Km. It originates from Satpura hills of Betul district (Madhya Pradesh). This river drains into Gulf of Khambhat (Arabian Sea) after flowing through Madhya Pradesh, Maharashtra and Gujarat.

Surat is known as industrial city of Gujarat and situated in the southern part of state on the bank of Tapi River where the several industries such as ONGC, ESSAR, KRIBHCO, Reliance, Hazira welt, textiles mills, fertilizers industries, chemical plants, diamond processing units etc. are located. Thus, various industrial wastes and domestic sewage are the main causes of pollution in this river.

*****Corresponding author e-mail: monika_aqua12@yahoo.co.in

MATERIALS AND METHODS

(a) Sample collection

Water samples were collected from preselected sites at monthly intervals in the morning hours during January to June 2011. These samples were collected in clean and rinsed plastic bottles.

(b) Analysis of sample

Water quality parameters like pH, temperature, and dissolved oxygen were analyzed *in situ* while the turbidity, electrical conductivity, total alkalinity, total hardness, chloride, nitrate-nitrogen, nitrite-nitrogen, phosphate, biochemical oxygen demand, chemical oxygen demand, ammonia, sodium and potassium were analyzed at research laboratory department of aquatic biology, VNSGU (Surat). Preservation and analysis of the water samples were done as per standard methods of Trivedy and Goel (1984) and APHA (1995).

RESULTS AND DISCUSSION

The result of the present study is depicted in Table 1 and Figures 1 to 6. Temperature is the important factor for determining rate of chemical processes in the aquatic ecosystems. It also influences population fluctuation in the water body. In this study, temperature varied between 20^{o}C to 28^{o}C with the average value of 23.72±0.57 (Table 1). The temperature was high (28^{o}C) during June and low (20^{o}C) during January month (Figure 1). The observation shows the optimum range of temperature for growth of aquatic fauna and flora. Similar results were obtained by Singh *et al.*, (2010) in river Imphal.

The Turbidity reflects the transparency in water and it is caused by the presence of substances in water. It was observed 20.00 NTU - 33.30 NTU with average of 27.19±1.01 during the January and June, respectively (Figure 1). Akuskar and Gaikwad (2006) observed high turbidity during summer and low during winter in Manjara River Dhanegoan, Maharashtra.

Chloride is one of the important indicators of pollution. These are present in sewage, effluents and farm drainage. The monthly variation in chloride ranged from 29.00 to 194.94 mgl^{-1} (Figure 2). The minimum value (29.00 mgl^{-1}) was recorded in June and maximum (194.94 mgl^{-1}) in the month of February with the average value of 97.42±11.04. Further, chloride was within the prescribed limit (250 mgl^{-1}) of BIS and showing no significant variations.

Total hardness of water is an important consideration in determining the suitability of water for domestic and industrial uses. Hardness is caused by multivalent metallic cations and with certain anions present in the water. In the study period, it fluctuated from 20.00 to 192.00 mgl^{-1} with the average value of 98.56±9.37. Total hardness was maximum during June (192.00 mgl^{-1}) and minimum during January (20.00 mgl^{-1}) month (Figure 2). The earlier studies also revealed that maximum hardness was in summer due to reduced inflow and hardness was minimum in monsoon due to increasing inflow and dilution in Cauvery River at Karnataka (Venkatesharaju *et al.,* 2010).

Total alkalinity refers to the quantity and kind of dissolved compound that collectively shift the pH neutrality to alkaline. The range of total alkalinity was between 72.00 and 170.00 mgl^{-1} with the average value of 99.11±6.77. It was maximum during May (170.00 mgl^{-1}) and minimum (72.00 mgl^{-1}) in January month (Figure 2). Kumar and Dua (2009) observed alkalinity to range between 18-172 mgl^{-1} minimum and maximum respectively in Ravi River at Madhopur (India).

Biological Oxygen Demand (BOD) represents the quantity of dissolved oxygen required for the oxidation of decomposable organic matter in the aerobic biochemical actions. In the study period, it was observed to oscillate between 0.4 to 8.4 mgl^{1} with the average value of 3.42±0.57. The BOD was maximum (8.40 mgl^{1}) in May and minimum (0.40 mgl^{1}) in January month (Figure 3). These were due to higher rate of decomposition of organic matter at higher temperature, turbidity and less water current in Godavari River, Nasik (Sanap *et al.*, 2006).

Dissolved oxygen may play a very crucial role for the survival of aquatic organism (Yakub and Ugwvmba, 2009). In the present investigation, it fluctuated from 4.40 to 8.50 mgl^{1} with the average value of 6.33±0.59. The DO was maximum (8.05 mgl^{1}) during May and minimum (4.40 mgl^{1}) during June month (Figure 3). DO was beyond of permissible limits of WHO (1993).

Potential of hydrogen (pH) is negative logarithm of the hydrogen ion concentration and shows the intensity of acidity or alkalinity of water. During the investigation water of Tapi river water was observed alkaline (7.50 to 8.60).

It was maximum (8.60) in February and minimum in April (7.50) month (Figure 3) with the average value 8.12±0.08 .The similar result were found by Rajiv *et al.* (2012) in Aliyar river in Tamil Nadu.

Chemical oxygen demand (COD) is the amount of oxygen required for a sample to oxidize its organic and inorganic matters and quite useful in finding out the pollution load of industrial waste and sewage. In the present study, it fluctuated from 24.00 to 152.00 mgl^1 with the average value of 59.44±9.15. The COD was maximum in May (152.00 mgl^1) and minimum in June (24.00 mgl^1) month (Figure 4). Similar results were obtained by Pande and Sharma (1998) in Ramganga River at Moradabad.

Potassium and sodium are the mainly arising from the weathering of rocks, sewage, etc. Potassium was found to range from 50.50 mgl^{-1} to 178.00 mgl^{-1} during the study period. The minimum (50.50 mgl^{-1}) was observed in February and maximum (178.00 mgl^{-1}) was in June month (Figure 4) with the average value of 84.17±5.87. These results also find support from Zafar and Sultana (2008) for water quality of Ganga River. Similarly, the sodium content in water samples ranged from 50.00 to 178.00 mgl^{-1}. The minimum value of sodium in the river was (50.00 mgl^{-1}) in the month of April and maximum (178.00 mgl^{-1}) in June with the average value of 96.53±7.94. Sodium was found within the recommended limits of WHO (1993).

Nitrate-N concentration depends on the activity of nitrifying bacteria which in turn get influenced by the presence of dissolved oxygen. In the study period, this fluctuated from 0.05 to 0.90 mgl^{-1} while the average value was 0.47±0.08. The nitrate-nitrogen was maximum (0.90 mgl^{-1}) in April and minimum (0.05 mgl^{-1}) in May month (Figure 5). This corroborates to the observations of Royer *et al. (*2004) at agricultural stream in Illinois.

The electrical conductivity is a measure of mineral contents present in water. In present investigation, variations in conductivity were observed to vary from 0.08 m mhos to 2.71 m mhos. The conductivity was maximum (2.71 m mhos) in June and minimum (0.08 m mhos) in March (Figure 5) with the average value 0.56±0.14. The conductivity values were fairly lower than the recommended values of WHO (1993) and hence the water can be considered suitable from this point of view.

Phosphates in water mainly come from the rocks, agricultural runoff, industrial wastes, municipal sewage and synthetic detergents. The high concentration of phosphate is always indicating eutrophic condition of water. In the present investigation, it ranged between 0.10 and 0.73 mgl^{-1}. It was maximum in April (0.73 mgl^{-1}) and minimum in January (0.10 mgl^{-1}) month (Figure 5) with the average value 0.36±0.06. Bhandari and Nayal (2008) reported similar findings on Kosi River in Uttarakhand.

Fluoride concentration is an aspect of hydrogeochemistry, because of its impact on human health. In the present investigation, it ranged from 0.00 to 0.42 mgl^{-1}. It was maximum in January (0.42 mgl^{-1}) and minimum in June (0.00 mgl^{-1}) month (Figure 6) with the average value of 0.09±0.03. Fluoride concentration was found within the permissible limit between 1.0 and 1.5 mgl^{-1} of BIS (1991).

Nitrites are formed in water due to bacterial action and oxidation of ammonia which is readily oxidized to nitrates. They are seldom present in significant concentration in surface or other natural waters. The high nitrites in water are indicative of organic pollution. Biological decomposition of all nitrogenous organic matters 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 indicating of pollution in the River. In the present investigation, it varied from 0.02 to 0.82 mgl^{-1} with the average value of 0.18±0.05. It was maximum in April (0.02 mgl^{-1}) and minimum (0.82 mgl^{-1}) in May month (Figure 6). These results are comparable with the observations made by Kumar *et al.* (2006) who recorded low levels of nitrite and suggested stability of Tunga River in Karnataka.

Ammonia generally arises from aerobic and anaerobic decomposition of nitrogenous organic matter. Urine of human and animals yields large quantities of ammonium carbonate and hence sewage is rich in free ammonia. In the present investigation, it varied from 0.03 to 1.047 mgl^{-1} with the average value of 0.24±0.09. The ammonia was maximum during June (1.047 mgl^{-1}) and minimum (0.03 mgl^{-1}) in January month (Figure 6). Ammonia was beyond the permissible limits of WHO (1993).

Table1. Physico-chemical parameters variations in Tapi River.

Parameters	Units	Min.	Max.	Mean	SE	Standard value
Temperature	^{0}C	20.00	28.00	23.72	0.57	30-35[1]
Turbidity	NTU	20.00	33.30	27.19	1.01	5-10[1]
pH		7.50	8.60	8.12	0.08	6.5-8.5[1]
Conductivity	m mhos	0.08	2.71	0.56	0.14	0.750-1[1]
Dissolved oxygen	mgl^{-1}	4.40	8.50	6.33	0.59	5-7[1]
Biological oxygen demand	mgl^{-1}	0.40	8.40	3.42	0.57	6.0[1]
Chemical oxygen demand	mgl^{-1}	24.00	152.00	59.44	9.15	10[1]
Nitrate-n	mgl^{-1}	0.05	0.90	0.47	0.08	45[2]
Nitrite-n	mgl^{-1}	0.02	0.82	0.18	0.05	3[1]
Ammonia	mgl^{-1}	0.03	1.04	0.24	0.09	0.1[1]
Total Hardness	mgl^{-1}	20.00	192.00	98.56	9.37	300-600[2]
Fluoride	mgl^{-1}	0.00	0.42	0.09	0.03	1.0-1.5[2]
Chloride	mgl^{-1}	29.90	194.94	97.42	11.04	250-1000[1]
Total Alkalinity	mgl^{-1}	72.00	170.00	99.11	6.77	200-600[2]
Phosphate	mgl^{-1}	0.10	0.73	0.36	0.06	0.1[1]
Sodium	mgl^{-1}	50.00	178.00	96.53	7.94	200[1]
Potassium	mgl^{-1}	50.50	148.00	84.17	5.87	50[1]

1=WHO (1993), 2=BIS (IS10500: 1991).

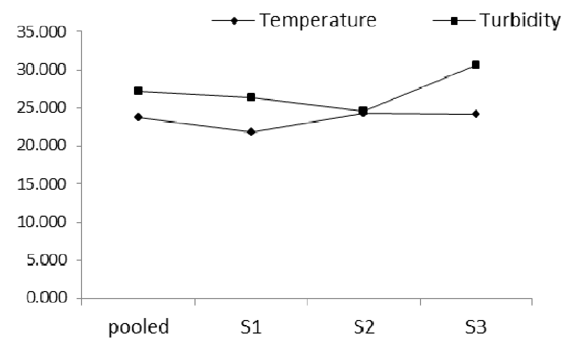

Figure 1. Temperature and Turbidity levels in Tapi River (S1, S2 and S3-Sampling Stations).

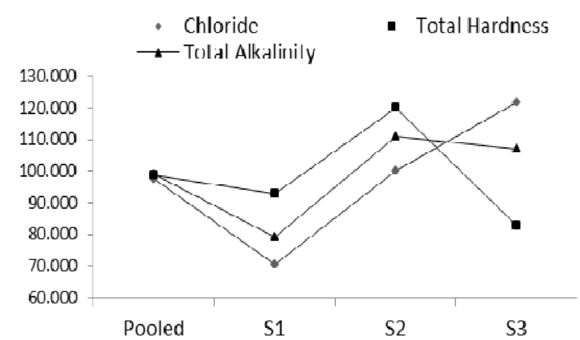

Figure 2. Chloride, Total Hardness and Total Alkalinity levels in Tapi river.

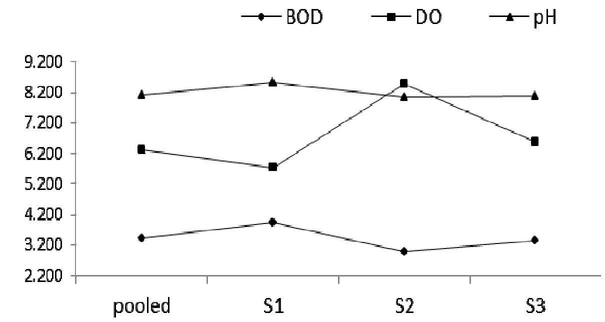

Figure 3. BOD, Dissolved oxygen and pH levels in Tapi River.

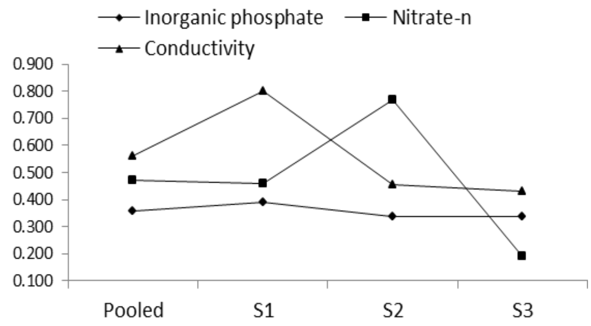

Figure 5. Inorganic phosphate, Nitrate-N and Conductivity levels in Tapi River.

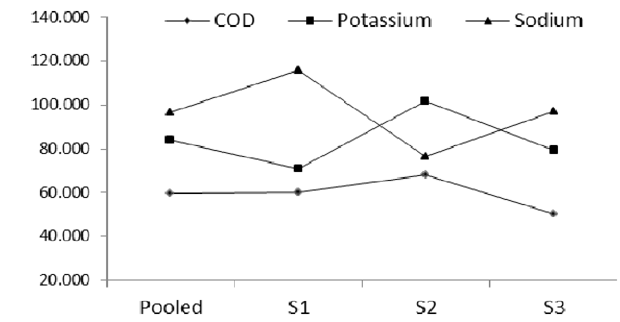

Figure 4. COD, Potassium and Sodium levels in Tapi river.

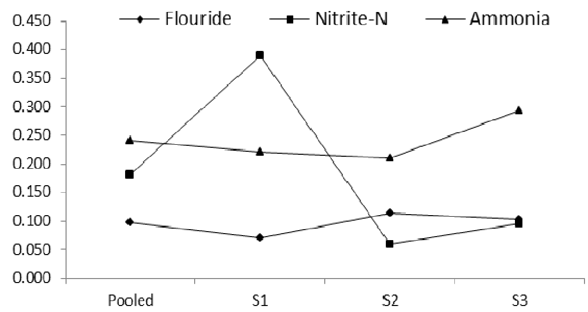

Figure 6. Fluoride, Nitrite-N and Ammonia levels in Tapi River.

CONCLUSIONS

The water quality parameters and pollution status of Tapi River studied during January to June 2011 revealed that due to anthropogenic activities, municipal waste, domestic sewage, washing clothes mostly by laundries and agricultural run-off, the water quality has been adversely affected. The results indicated that most of the physico-chemical parameters (pH, Turbidity, dissolved oxygen ,biological oxygen demand, chemical oxygen demand, phosphate, ammonia and potassium) from Tapi River were beyond the WHO and BIS limits for drinking water and even not suitable for domestic purposes. It was concluded that water of Tapi River is moderated polluted due to discharges of industrial waste, domestic sewage and agricultural run-off in river water, which require more efficient management to conserve the Tapi River in Gujarat.

CONFLICT OF INTERESTS

The author declares that there are no conflicts of interests associated with this article.

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