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Assessment of Water Quality Index of Tapi River in Surat

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Abstract— The present study describes the quality of Tapi river of Surat city, Gujarat. The water samples will be collected from five sites. This study will be aimed at using the assessment of Water Quality Index (WQI) in evaluating the quality of Tapi river for public usage. The water samples will be analyzed for various physic-chemical parameters namely pH, temperature, conductivity, DO, BOD, total dissolve solids, total hardness, nitrate, fluoride, chloride. The calculate Water Quality Index (WQI) and the determine physical and chemical parameters of surface water to provide safe drinking water.

Keywords— Water Quality, Water Quality Index, Tapi river, Physic-chemical parameters, Pollution

I. INTRODUCTION

Water quality Index (WQI) is defined as a technique of rating that provides the composite influence of individual water quality parameters on the overall quality of water. It reduces the large amount of water quality data to a single numerical value. It is calculated from the point of view of human consumption. Water quality and its suitability for drinking purpose have been considered for calculation of WQI. In this method the weightage for various water quality parameters is assigned to be inversely proportional to the recommended standards for the corresponding parameters.

Surface water is required for most human activities like – drinking, cooking bathing, washing, agriculture, industry, recreation, navigation and fisheries etc. About 75% of the world's surface area is covered with water. Out of which 97% of the earth's water is in the ocean, not fit for human use due to its high salt content. Remaining 2% is locked in polar ice caps and only 1% is available as fresh water in rivers, lakes, streams reservoirs and ground water, suitable for human consumption.

The physic-chemical contaminants that adversely affected the quality of surface water is likely to arise from a variety of sources, including land application of agricultural chemicals and organic wastes, infiltration of irrigation water, septic tanks, and infiltration of effluent from sewage treatment plants, pits, lagoons and ponds used for storage is the groups of prominent chemist importantly contributed to assessed the quality of surface water.

In this study, physic-chemical assessment of surface water samples are determined by using standard analytical methods. The objective of the study is to analyze the 10 parameters of water along five sites in Surat city for monsoon (During 2017). The aim of this study was to determine the physic-chemical analysis of surface water sources of village area and to compare with levels obtained with the BIS and IS:10500 drinking water directive..

II. METHODOLOGY

A. Study area

Surat is one of the largest cities in northwestern India, the state of Gujarat, with the 350,000 people and the population of the metropolitan area close to 4.5 million people. The area of Surat is 326.515 km2 (126.068 sq. mi). Surat pin code is 395008. The study area has been selected for collection of samples on the bases of certain characteristic features. The samples were collected for pre-monsoon and monsoon season (2017) from five sites reasonably representing the water quality of the river system. The selected sampling sites and observed pollution sources at each site are as follows: Causeway, Dabholi, Nanpura, Varachha and Amroli. The Sampling sites along with their Latitude and Longitude is shown in table-I

Table-I Sampling sites along with their Latitude and Longitude

code	Locations	Latitude	Longitude
S1	Causeway	21.2179	72.8022
S2	Dabholi	21.2339	72.8116
S3	Nanpura	21.1901	72.8139
S4	Varachha	21.2096	72.8692
S5	Amroli	20.9910	73.0624

Fig-1:Satellite view of study area

B. Sample collection

The present study deals with few physical and chemical parameters of the water to check the present status of water quality for the monsoon season. Samples are collected from five different sites. After collection of samples, these bottles are labeled and possible efforts are made to transport them to the laboratory as earlier as possible.

The water sample analyzed for 10 Physic-chemical parameters namely pH, temperature, conductivity, DO, BOD, total dissolve solids, total hardness, nitrate, fluoride and chloride in the laboratory as per the standard procedures of Indian Standard for Drinking Water - Specification IS 10500 : 1991 of surface water are shown in Table-II National River water quality standards and Bureau of Indian Standards (BIS) for river water quality has been considered for comparison of surface water quality of Tapi River.

Table-II Indian Standard for Drinking Water - Specification IS 10500: 1991 of surface water

Sr No.	Name of the Water Quality Parameter	Bureau of Indian Standard(IS-10500:1991)
1	pH	6.5 - 8.5
2	Total Alkalinity (mg/l)	200-600
3	Electrical conductivity(μ mhos/cm)	700-3000
4	Total Dissolved Solids(mg/l)	500-2000
5	Total Hardness (mg/l)	300-600
6	Calcium Hardness (mg/l)	75-200
7	Magnesium Hardness (mg/l)	30-100
8	Nitrites (mg/l)	0.05-5
9	Nitrates (mg/l)	45-100
10	Sulphate (mg/l)	200-400
11	Chlorides (mg/l)	250-1000
12	Fluorides (mg/l)	1.0-1.5

E. The Calculation Involves the Following Steps

Step 1: Collect data of various physic-chemical water quality parameters.

Step-2: Calculate quality rating for i^{th} parameter (Qi) where there are i parameters. This is calculated using formula Qi=100(Vi/Si) where, Vi=Observed value, Si= Standard value

Step-3: Calculate unit weight for the i^{th} parameters. Wi= (k/Si). Where, k=1(Proportionality constant), Si= Standard value.

Step 4: Calculate Water Quality Index (WQI) using formula, WQI = ((∑WiQi)/∑Wi).

III. RESULTS AND DISCUSSION

The results regarding the mean values of various physic-chemical parameters of surface water collected during the period 2017 at pre-monsoon and monsoon are shown below in tables and figure. pH is the measure of acidity and alkalinity of water. The mean values are recorded within the range of 7.3-9.5 and 7.3-8.3 for surface water samples in both seasons respectively (**Table III and Table IV**).The most of the pH values are found to be within the permissible limit of BIS (6.5-8.5ppm). The pH value is an important factor in maintaining the carbonate and bicarbonate levels in

water. The low pH does not cause any harmful effect. The variations in pH are relatively in small. Some of the samples have been found acceptable for usage and the ranges are between 7.3 and 9.5 meeting with WHO guidelines.

Table-III :Variation of mean values of physic-chemical parameters collected from different stations during January 2017 (Pre-monsoon)

Location of station	pH	EC	TDS	DO	BOD	Al	TH	NO_3^-	Cl^-
S_1	9.1	2700	216	1.5	8	86	89	4.7	205.7
S_2	7.3	3576	1049.1	2.6	11.6	443	1008	25.8	198
S_3	8.9	4500	4810	4	13.92	1880	2057	31.9	198
S_4	7.03	1760	600	3.3	10.58	1502	1643	16.89	135
S_5	7.03	3400	1110.3	3.9	10.56	1690	1407	17.2	180

Table-IV: Variation of mean values of physic-chemical parameters collected from different stations during January 2017 (monsoon)

Location of station	pH	EC	TDS	DO	BOD	Al	TH	NO_3^-	Cl^-
S_1	8.2	2363	290	2.8	8.9	104	102	5.6	104
S_2	7.6	3786.5	1062	2.9	13.4	463	780	26.5	193
S_3	9.22	4686	4631	3.9	14.5	1837	1790	29.9	306
S_4	8.96	1799	1851.9	3.4	10.37	1691	1501	24	256
S_5	7.9	2999.9	998.6	4.5	10.70	1637	1543	19.8	167

Electrical conductivity is about the conducting capacity of water which in turn is determined by the presence of dissolved ions and solids. Higher the ionizable solids, greater will be the EC. The mean EC values are 3187.2(µmho/cm) and 3126.8(µmho/cm) for the surface water samples in pre-monsoon and monsoon seasons respectively (**Table III and Table IV**). The EC values are the permissible limit of WHO (1400 µmho/cm) for surface water samples.

The mean TDS values are 1557.08mg/L and 1766.7mg/L for surface water samples in both seasons respectively. Most of the surface water samples show the TDS values are within the permissible limit of WHO(500ppm). The maximum TDS values are observed at stations 2 and 3 in monsoon. High levels of TDS may aesthetically be unsatisfactory for bathing and washing.

DO is a measure of the degree of pollution by organic matter. It is the destructive powers of organic substance as well as the self-purification capacity of the wastewater body. The mean values of DO are recorded with the 3.06mg/L and 3.5mg/L for all the surface water samples in pre-monsoon and monsoon seasons respectively (**Table III and Table IV**). DO reflect the physical and biological process prevailing in the water indicates the degree of pollution in the water bodies. The quality of water enhanced if it contains more oxygen.

The mean values of BOD are 10.93mg/L and 11.45mg/L for the surface water samples in both seasons respectively (**Table III and Table IV**). In the present study, the values of BOD are found to exceed the permissible limit of WHO (5.0mg/L) for surface water samples in pre-monsoon and monsoon. It is known that at the surface dispersed oil may spread and increased biological oxygen demand near the mixing zone which have an adverse effect on aquatic life.

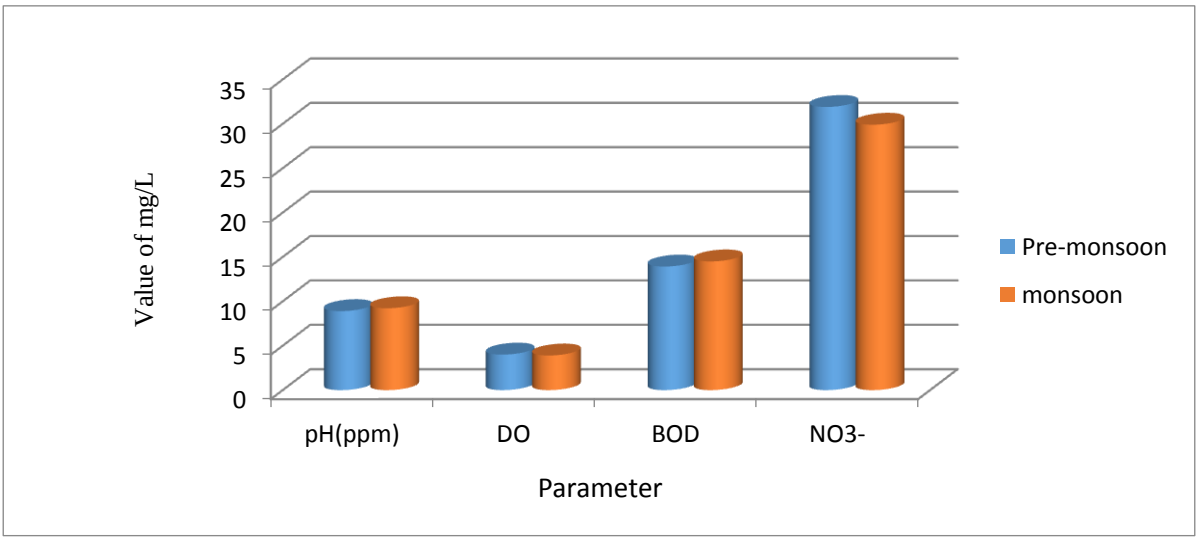

Fig-2 : Water quality of Tapi river of Nanpura site, Surat

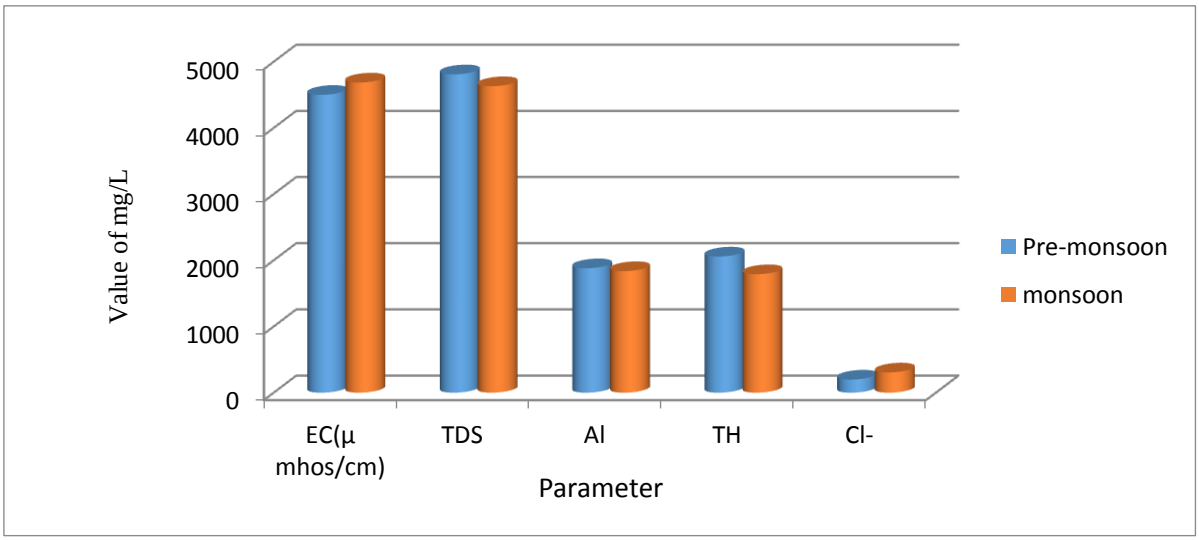

Fig-3 : Water quality of Tapi river of Nanpura site, Surat

The mean nitrate values were observed 19.298mg/L and 21.16mg/L for all surface water samples in pre-monsoon and monsoon respectively (**Table III and Table IV**). Nitrate values are within the permissible limit of WHO(50mg/L) of all the surface water samples. The low nitrate content encountered may be due to the less usage of nitrogen fertilizers and less disposal of wastes around these stations.

The Total Hardness (TH) is an important parameter of water quality whether it is used for domestic, industrial or agricultural purpose.TH is the property of water which prevents lather formation with soap. It is due to the presence of excess of Ca, Mg and Fe salts. The mean TH values are 1240.8mg/L and 1143.2mg/L for surface water samples in both pre-monsoon and monsoon respectively (**Table III and Table IV**). TH values were within the permissible limit of WHO (500mg/L) in all the stations for surface water samples in both seasons.

Table-V: Calculation of WQI values for surface water samples collected in pre-monsoon season

Parameters	**Observed Value(Vi)**	**Standard Value(Si)**	**Unit Weight(Wi)**	**Quality Rating Qi=100Vi/Si**	**WiQi**
pH	7.8	**8.5**	0.117	91.76	10.73
EC	3187.2	1400	0.0007	227.65	0.159
TDS	1557.08	500	0.002	311.41	0.622
DO	3.06	5	0.2	61.2	1.224
BOD	10.93	6	0.166	182.16	30.9
Al	980.2	120	0.0155	816.6	12.65
TH	1240.8	500	0.002	248.16	0.49
NO_3^-	19.298	50	0.02	7.719	0.154
Cl^-	183.34	250	0.004	73.33	0.29
			∑Wi=0.527		∑WiQi=57.21

WQI = ((∑WiQi)/∑Wi)= 57.21/0.527=108.5

Table-VI: Calculation of WQI values for surface water samples collected in monsoon season

Parameters	**Observed Value(Vi)**	**Standard Value(Si)**	**Unit Weight(Wi)**	**Quality Rating Qi=100Vi/Si**	**WiQi**
pH	8.3	**8.5**	0.117	97.64	11.42
EC	3126.8	1400	0.0007	223.3	0.156
TDS	1766.7	500	0.002	353.37	0.706
DO	3.5	5	0.2	70	14
BOD	11.45	6	0.166	193.3	32.08
Al	1146.4	120	0.0155	955.3	14.8
TH	1143.2	500	0.002	228.64	0.457
NO_3^-	21.16	50	0.02	42.3	0.846
Cl^-	205.2	250	0.004	82.08	0.00328
			∑Wi=0.527		∑WiQi=74.47

WQI = ((∑WiQi)/∑Wi)= 74.47/0.527=141.2

The mean values of chloride are 183.34mg/L and 205.2mg/L for surface water samples in pre-monsoon and monsoon respectively (**Table III and Table IV**). The values of chloride exceed permissible limit of 250mg/L in most of the stations in monsoon. A chloride content of 600mg/L has been considered as the highest acceptable salinity level for human consumption. Based on the above equation the calculated water quality index for the surface water samples collected for pre-monsoon and monsoon were given in the (**Table V and Table VI)**. The pollution status of the channel water and surface water were identified by using the Table **VII.** The WQI calculated values ranged above 100 for all seasons, which shows that the water quality of the study area is very poor and not suitable for drinking purpose.

Table-VII: Status categories of WQI

WQI Level	Quality of water
0-25	Excellent Water Quality
26-50	Good Water Quality
51-75	Poor Water Quality
76-100	Very Poor Water Quality
>100	Unsuitable for drinking

IV. CONCUSSION

The calculate water quality index for post monsoon and monsoon season of the Tapi River is 108.5 and 141.2. It is clear from the research study that the overall water quality of the Tapi River falls under category above 100. Water Quality Index suggests that the water quality is not suitable for drinking and irrigation purposes. Generally, once a trend in pollution sets in, it accelerates day by day. So, there is a possible risk of water quality deterioration in near future.

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