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Water Quality Assessment of Tapti River Using Water Quality Index (WQI), at Multai City, District - Betul (M.P.)

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Abstract: ***The present study was aimed to assess the water quality index (WQI) of Tapti River at Multai city, District-Betul, (M.P.). Water Quality Index serves as the basis for environment assessment of water in relation to pollution load. The water samples were collected from six (06) different pollution prone sampling stations located at Tapti River and analyzed for seven (07) important physico-chemical parameters as pH, Electrical Conductance (EC), Turbidity, Total Hardness (TH), Total Dissolve solids (TDS), Calcium and Magnesium. The data so obtained was also used to calculate the Water Quality Index to get better understanding of overall water quality. The standards for drinking water suggested by Word Health Organization (WHO) and Bureau of Indian Standard (BIS) were also compared with the calculated values of WQI. The values of WQI were found ranged from 47.12 to 56.28 which indicates that at almost all locations of sampling stations at Tapti River in Multai, the water quality was found under the category of "Good" and "Fair" and it may be used for domestic and irrigation purpose after some proper and necessary treatment. It is also suggested that the public awareness would be helpful to maintain and improve the quality of river water.***

Keywords: Water Quality Index (WQI), Physico-Chemical Parameters, Water Quality Standards, Word Health Organization (WHO), Bureau of Indian Standard (BIS).

1. Introduction

Water is vital for sustaining life on earth. Among all the matters present on the earth none is more basic than water. It is said that "water is more precious that gold and more explosive than dynamite". Though 80% of earth's surface is covered by water, the fresh water supply has increasingly become a limiting factor because of various reasons. The expansion of industrialization and exploding population are the major once. Acute short fall of heavy rains, poor water shed management, abundant use of water for household and agricultural purposes have led to the overexploitation of the surface water sources especially from the river bodies. Many rivers become short-lived and even dried up perpetually. Water should be safe and wholesome for drinking purpose. Various national and international agencies have prescribed standards for various beneficial uses in term of water quality Index (WQI). Water Quality Index presents integrated effect of various parameters considering due to weightage to concentration of parameters and to significance by a single number for particular use of water. This provides meaningful information about water quality to generate public and policy makers also. The present study was carried out to assess the Tapti River water quality at study sites during study period.

2. Study Area

To assess the quality of Tapti River, Multai city, the origin place of Tapti River was selected. The original name of the city 'Multai' was 'Multapi', named after the river Tapti that originates from here. The Multai city is comes in District Betul and in the Southern part of Indian state of Madhya Pradesh. It lies on the Northern bank of the Tapti. The city Multai is located at 21.770N to 78.250E and has an average elevation of 749 meters. Multai is the holy place and origin for river Tapti "The daughter of the Sun God" called as "Surya". Multai is bounded on the North by town Amla, on the South by Amravati District of Maharashtra, on the East by Chhindwara District and on the West by District Betul. The Multai municipality has a population of 29,976 of which 15,356 are males while 14,620 are females as per the report of census India 2011. The literacy rate of Multai city is 88.10% and the sex ratio is 912 females per 1000 males. The river 'Tapti' also spelled as 'Tapi' is one of the major rivers in India. The total length of the Tapti River is approximately 724 km. It flows in the central parts of India. The states through which the Tapti River flows include Maharashtra, Gujrat and Madhya Pradesh. Apart from Narmada River, Tapti is the only river which flows in the Westward direction and merges into the Arabian Sea.

3. Material and Methods

The Tapti River water samples were collected from six (06) main sampling stations located at Multai named as S1, S2, S3, S4, S5 and S6 in between the months of Jun 2022 to Nov. 2022 on monthly basis. The sampling points were chosen considering the location of nearby villages, bathing zone area, domestic and industrial wastes, agricultural runoff which joins the river water and are responsible for pollution load in the river water. Samples were collected in acid clean one liter (01) polyethylene bottles in the morning hours in between 6.00 AM to 10.00 AM. Some of the studied parameters were analyzed at the sampling stations whereas the analysis of other physico-chemical parameters was done in the laboratory, followed by the methods prescribed by APHA (1995).

Determination of WQI Value

Water quality index (WQI) is defined as the reflection of composite influence of different quality parameters on the

overall quality of water. For WQI calculation, all studied seven (07) physico- chemical quality parameters have been selected. The weighed arithmetic WQI method was used for the calculation of water quality index of the Tapti River water. Quality rating was calculated as follows:

$Q_n = 100 * (V_n - V_{I0}) / (S_n - V_{I0})$,

Where, Q_n = Quality Rating for the nth water quality parameter

V_n = Estimated value of nth water quality parameters of collected samples

S_n = Standard permissible value of nth water quality parameter

V_{I0} = Ideal value of nth water quality parameter in pure water (V_{I0} value is 0 for all other parameters except pH and dissolved oxygen which are 7 and 14 respectively).

Unit weight (W_n) for nth water quality parameter is a value inversely proportional to the recommended standard value S_n of the corresponding parameter-

$W_n = K/S_n$, Where, W_n = Unit weight for nth water quality parameter

S_n = Standard permissible value of nth water quality parameter,

K = Constant of Proportionality

The standards recommended by Indian Standards Institution (ISI) are considered for quality rating (Q_n) and Unit Weight (W_n). The overall WQI was calculated by aggregating the quality rating with the unit weight linearly and can be given by the following expression.

$WQI = \Sigma Q_n.W_n / \Sigma W_n$,

Where, Q_n = Quality Rating for the nth water quality parameter,

W_n = Unit weight for nth water quality parameter

4. Results and Discussion

The observed values of studied seven (07) physico-chemical parameters of all the samples and their corresponding WQI values are presented in tabular form. The summary of observations of physico-chemical parameters and WQI values of the water samples from all six (06) water sampling stations are presented in table 1, 2, 3,4 and 5.

pH: pH is an important parameter in evaluating the acid-base balance of water. The intensity of an acidic or basic feature in a solution at a specific temperature is known as pH and is the negative logarithm of hydrogen ion concentration. The pH of water is vital for biotic communities since most plant and animal species can only survive in a small pH range, from slightly acidic to slightly alkaline conditions. Since most biological life only survives in a very limited and important pH range, hence it is a sign of biological life. The pH of water is a crucial factor in determining whether it is suitable for use in various processes like drinking, bathing, cooking, and cleaning. In this present study, the average value of pH was found as 7.9.

Electrical Conductivity (EC): The high or low value of Electrical Conductivity (EC) in water is a result of an elevated reduced level of dissolved ions. Water capability to transmit electric current is known as electrical conductivity and serves as tool to assess the purity of water. This ability depends on the presence of ions, their total concentration, mobility, valence, relative concentrations and temperature of measurement. The average value of electrical conductivity was found 410.0µmhos/cm.

Turbidity: The turbidity in water is mainly due to the presence of sand, clay, microorganisms and organic materials suspended in it and indicates the extent of pollution in water body. In present study,the average value of turbidity was found as 2.6 NTU.

Total Hardness (TH): Hardness implies the lather forming capacity of a water sample and the two cations mainly responsible for hardness of water are calcium and magnesium. Total Hardness might be due to the dissolution of land acquired carbonates and bicarbonates in water. In the present study, the average value of total hardness was observed as 120.6 mg/l.

Total Dissolved Solids (TDS): Freshwater, usually has a TDS level of 10 to 500 mg/l. The concentration of cations and anions together make up the total dissolved solids (TDS). High solids content increases the density of water, decreases the solubility of gases like oxygen and diminishes the amount of water that may be used for irrigation, drinking, and other uses. For drinking water, 500 mg/l of TDS is the upper allowed limit. The average value of TDS was found 242 mg/l was during the rainy season.

Calcium Hardness (Ca-H): Calcium is an important micronutrient in an aquatic environment. Hardness of the river water is of considerable significance in connection with the discharge of sewage and industrial effluent containing pollution, as indicated by variation in the concentration of hardness of the water. The average concentration value of the Ca hardness recorded in the present study was 41.6 mg/l.

Magnesium Hardness (Mg-H): Magnesium is a co-factor for various enzymatic transformation within the cell especially in the trans-phosphorylation in algal, fungal and bacterial cell. The average value of Magnesium Hardness of Tapti River was found 17.28 mg/l during study period.

Table 1: Average Values of studied Physico-Chemical Parameters of River Tapti during Study period Jun 2022-Nov. 2022

S.No.	Parameters	Unit	Average Values Obtained
1	pH	-	7.79
2	EC	µmhos/cm	410.0
3	Turbidity	NTU	2.6
4	TH	mg/l	120.6
5	TDS	mg/l	242.0
6	Ca-H	mg/l	41.6
7	Mg-H	mg/l	17.28

Table 2: Statistical Analysis of Monthly Variation in Physico Chemical Parameters of Tapti River from Jun 2022 To Nov.2022

S.No.	Month	Parameters	Unit	Sampling Stations						Range	AV±SD
				S1	S2	S3	S4	S5	S6		
1	Jun	pH		7.2	7.3	7.3	7.4	7.5	7.4	7.2-7.5	7.4±0.1
		EC	µmhos/cm	181.3	181.7	182.4	182.3	183.1	182.7	181.3-183.1	182.3±0.7
		Tur.	NTU	5.1	5.2	5.3	5.2	5.3	5.2	5.1-5.3	5.2±0.1
		TH	mg/l	123.4	123.8	123.6	124.2	124.7	124.1	123.4-124.7	124±0.5
		TDS	mg/l	188.2	189.8	189.2	189.3	190.2	189.4	188.2-190.2	189.4±0.7
		Ca^{++}	mg/l	88.2	88.9	89.1	89.4	89	88.7	88.2-89.4	88.9±0.4
		Mg^{++}	mg/l	27.5	28.3	28.1	28.5	27.4	27.1	27.1-28.5	27.8±0.6
1	Jul.	pH		7.4	7.5	7.3	7.4	7.5	7.6	7.3-7.6	7.4±0.10
		EC	µmhos/cm	185.4	188.1	191.3	190.7	192.5	191.2	185.4-192.5	189.9±2.63
		Tur.	NTU	5.5	5.4	5.5	5.6	5.6	5.7	5.4-5.7	5.6±0.10
		TH	mg/l	125.1	126.2	126.9	127.2	126.8	127.1	125.1-127.2	126.6±0.79
		TDS	mg/l	191.1	191.7	192.3	191.7	190.9	191.4	190.9-192.3	191.5±0.50
		Ca^{++}	mg/l	91.4	91.8	92.5	93.1	92.6	92.8	91.4-93.1	92.4±0.64
		Mg^{++}	mg/l	28.5	30.3	30.8	31.4	30.6	30.7	28.5-31.4	30.4±0.99
2	Aug.	pH		7.5	7.6	7.6	7.7	7.7	7.8	7.5-7.8	7.7±0.10
		EC	µmhos/cm	189.2	190.3	192.1	192.4	193.6	193.5	189.2-193.6	191.9±1.76
		Tur.	NTU	5.6	5.5	5.8	5.7	5.8	5.7	5.5-5.8	5.7±0.12
		TH	mg/l	126.7	127.8	128.1	128.8	129.5	128.3	126.7-129.5	128.2±0.95
		TDS	mg/l	192.3	193.5	194.2	194.1	193.6	193.8	192.3-194.2	193.6±0.69
		Ca^{++}	mg/l	93.5	93.2	94.2	94.1	93.3	93.5	93.2-94.2	93.6±0.42
		Mg^{++}	mg/l	29.9	31.8	32.5	33.6	33.7	32.8	29.9-33.7	32.4±1.41
3	Sep.	pH		7.6	7.8	7.9	7.8	7.8	7.9	7.6-7.9	7.8±0.11
		EC	µmhos/cm	191.5	192.4	193.5	195.3	194.2	193.4	191.5-195.3	193.4±1.33
		Tur.	NTU	5.7	5.7	5.9	5.8	5.9	5.8	5.7-5.9	5.8±0.09
		TH	mg/l	126.9	128.9	129.3	130.2	130.8	131.9	126.9-131.9	129.7±1.73
		TDS	mg/l	193.7	194.6	195.1	196.4	196.9	197	193.7-197	195.6±1.35
		Ca^{++}	mg/l	94.7	93.3	94.1	93.7	94.3	93.8	93.3-94.7	94.0±0.49
		Mg^{++}	mg/l	34.6	34.1	34.7	35	34.6	35.9	34.1-35.9	34.8±0.60
4	Oct.	pH		7.8	7.9	8	8.1	8.2	8.2	7.8-8.2	8.0±0.16
		EC	µmhos/cm	192.4	193.2	195.5	195.1	194.8	194.5	192.4-195.5	194.3±1.20
		Tur.	NTU	5.9	5.8	5.7	5.8	5.9	6	5.7-6.0	5.9±0.10
		TH	mg/l	130.6	131.4	132	132.7	133.1	132.6	130.6-133.1	132.1±0.93
		TDS	mg/l	198.3	197.8	197.9	196.5	196.7	196.8	196.5-198.3	197.3±0.76
		Ca^{++}	mg/l	95.2	95.7	95.8	96.5	96.1	96.7	95.2-96.7	96.0±0.55
		Mg^{++}	mg/l	35.6	35.9	37.2	36.1	36.8	35.9	35.6-37.2	36.3±0.62
5	Nov.	pH		7.7	7.7	7.8	7.8	7.9	7.9	7.7-7.9	7.8±0.09
		EC	µmhos/cm	189.4	190.6	191.7	192.1	191.6	191.3	189.4-192.1	191.1±0.98
		Tur.	NTU	5.6	5.5	5.4	5.5	5.6	5.7	5.4-5.7	5.6±0.10
		TH	mg/l	130.2	130.5	131.4	130.6	130.1	129.2	129.2-131.4	130.3±0.72
		TDS	mg/l	191.2	193.4	194.5	193.8	194.1	192.3	191.2-194.5	193.2±1.24
		Ca^{++}	mg/l	92.4	90.1	91.8	91.1	90.5	90.1	90.1-92.4	91.0±0.95
		Mg^{++}	mg/l	31.7	32.5	31.4	32.6	34.5	33.1	31.4-34.5	32.6±1.11

(AV = Average Value, SD = Standard Deviation)

Table 3: Correlation-Coefficient between Various Physico-Chemical Parameters of Tapti River from Jun 2022 To Nov.2022

Parameter	pH	EC	Tur.	TH	TDS	Ca++	Mg++
pH	1						
EC	0.79	1					
Tur.	0.78	-0.89	1				
TH	0.92	0.87	0.78	1			
TDS	0.84	0.85	0.84	0.89	1		
Ca++	-0.69	0.84	0.88	0.73	0.84	1	
Mg++	0.88	0.9	0.87	0.9	0.94	0.83	1

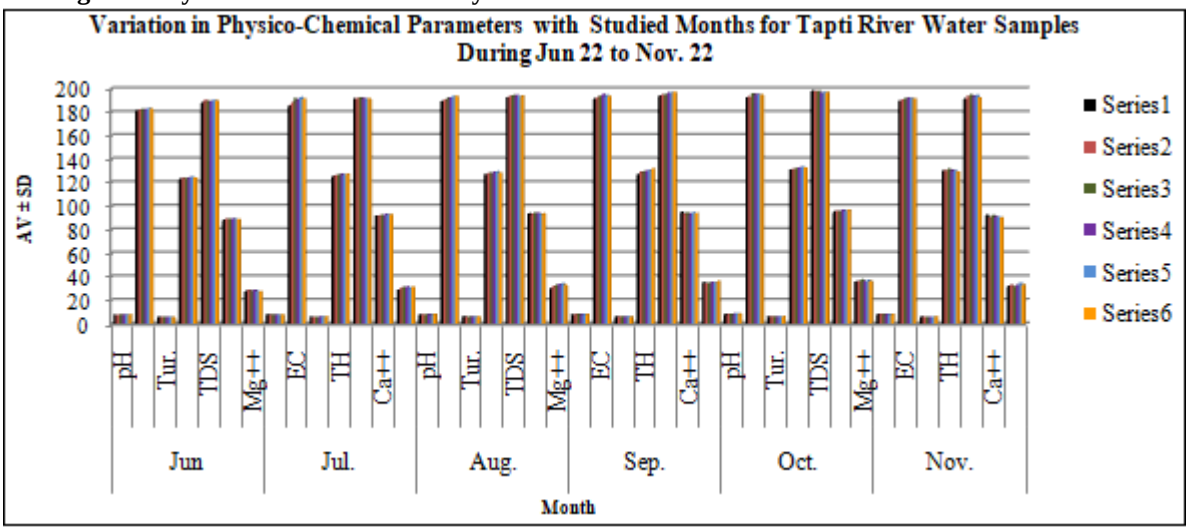
Table 4: Summary of Water Quality Index (WQI) and Corresponding Water Quality Status (WQS)

S.No.	WQI	WQS	Possible Uses
1	0 - 25	Excellent	Drinking, Irrigation and Industrial
2	26 - 50	Good	Domestic, Irrigation and Industrial
3	51 - 75	Fair	Irrigation and Industrial
4	76 - 100	Poor	Irrigation
5	101 - 150	Very Poor	Restricted use for Irrigation
6	> 150	Unfit for Consumption	Proper Treatment Essential before use

Table 5: Calculated Values of WQI and their Corresponding Categories for Tapti River Water Quality Status during Study Period (Jun 2022 to Nov. 2022)

S.No.	Month	WQI	Category
1.	Jun 22	48.32	Good
2.	Jul.22	53.54	Fair
3.	Aug.22	56.28	Fair
4.	Sep.22	52.94	Fair
5.	Oct.22	48.13	Good
6.	Nov.22	47.12	Good

Chart Showing Monthly Variation in Studied Physico-Chemical Parameters in Between Jun 22 to Nov. 22



5. Conclusion

Present investigation is helpful to create the awareness among people and Government authorities to maintain the Tapti river water at its highest quality and purity levels. However, it requires some proper treatment to minimize the contamination especially domestic wastes and agricultural runoff. On the basis of calculated WQI values and analysis of studied physico-chemical parameters, the results reveals that during the study period, the quality of Tapti River water falls under "Good" category and it is concluded that the Tapti River water is fit for domestic, irrigation and fish production purposes and it can be used for domestic and irrigation purposes after some proper and necessary treatment.

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