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Selected Hydrological Parameters and Water Quality Index Analysis of Ambica River, Gujarat (India)

Kinjal Sangani, N. C. Ujjania, Ranjana Bengani, Shriya Patel

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ABSTRACT

Present study dealt with water quality parameters and water quality index of Ambica River from Gandevitaluka of Navsari District (Gujarat) during August-2019 to February-2020. The selected hydrological parameters including temperature, pH, DO, BOD, COD, hardness, free CO_2 and total calcium were analyzed. The results were compared with water quality standard prescribed by the national and international authorities and found thatp H (7.369) was slightly alkaline, temperature (25.323 ^oC) was moderate, DO (7.362 mg/L), BOD (6.862 mg/L), COD (18.707 mg/L), hardness (158.154 mg/L)were within the limits while, free CO_2(22.000 mg/L) and total calcium (120.000 mg/L) were high which indicate that water quality of Ambica River was poor. The findings of present study was verified by the determination of water quality index (194.782) which also shows that water quality of Ambica River was poor and could not be used for human consumption without application of appropriate treatment method. The poor water quality of Ambica River might be impaired with anthropogenic and agricultural activities in catchment area.

Keywords Water quality, WQI, Ambica River, Navsari.

INTRODUCTION

Surface water resources are the major and important sources to survivethe living components on the earth. The water quality of these resources is not onlysignificant for the human health but also it is essential for health of ecosystem and aquatic life. The quality of river water reflects influences of different factors including atmospheric, climatic, anthropogenic, population density (Nouri *et al.* 2008). Therefore, analysis of physico-chemical and microbiological properties of river waters are important to assess the impact of these influencing factors because deteriorated water quality poses health risk to several people who rely on the river water (Oke and Sangodoyin 2015). The water quality parameters were studied in Cauvery River (Venkatesharaju *et al*. 2010), Devahariver (Chandra and Saxena 2011), Chambal River (Gupta *et al*. 2011), Arasalar River (Annalakshmi *et al.* 2012), Kolong river (Khan and Hazarika 2012), Satluj River (Chauhan and Sagar 2013), Yamuna River (Gupta *et*

[1]Kinjal Sangani, [2]N. C. Ujjania, [3]Ranjana Bengani* [4]Shriya Patel
[1, 2, 3, 4] Department of Aquatic Biology, Veer Narmad South Gujarat University, Surat, Gujarat 395007, India.
Email : [1]kksangani@vnsgu.ac.in,[2]ncujjania@vnsgu.ac.in, [3]ranjanajain27@yahoo.com, [4]patelshreya427@gmail.com
*Corresponding author

al. 2013) and in Tapi River (Dubey and Ujjania 2013, 2014, 2015, 2020 Sangani and Manoj 2015, 2018, 2020) of India and reported the pollution status of the river water.

The conclusion of such kind of study is very problematic and complicate because huge number of water quality parameters is required to analyze and monitor which is time consuming process and large data set is difficult to interpret (Hernández-Romero *et al.* 2004). Therefore, such problems can be resolved and overcome by the analysis of various indices values such as weight arithmetic water quality index (Kumar and Alappat 2009), Canadian council of ministers of the environment water quality index (CCME 2001), Oregon water quality index (Cude 2001) which helpto classify the water resources on the basis of the water quality from pure to pollute (Tyagi *et al.* 2013, Dubey and Ujjania 2014, Naubi *et al*. 2016, Abazi *et al.* 2020). The weighted arithmetic water quality index method was applied in many of the resources to water quality studies (Ujjania and Dubey 2016; Shah and Joshi 2017, Lkr *et al.* 2020, Sangani and Manoj 2020) in which the water quality parameters were multiplied by weighting factor and then aggregated simple arithmetic mean.The main aim of the present study is to determine the water quality parameters and to assess the pollution status of the Ambica River, Navsari (Gujarat) which is helpful to decide the judicious usage of river water.

MATERIALS AND METHODS

Study area

The Ambica River originated from the Saputara Hills of the Nasik District (Maharashtra) and river basin is extended from Maharashtra to Gujarat covering about 2715 m^2 catchment area and flowing through the length of 164 km. The major part of the river flows in Gujarat about length of 136 km and passing through the districts of Valsad, Dang, Navsari and Surat joined by many tributaries along the way e.g. Khapri, Kaveri, Wallan and Kharera before empting to Arabian Sea.

Water sample collection and analysis

The water samples were collected and preserved from the northern bank of river at Patel Ovara, Ichhapur, Gandevitaluka of Navsari District (Fig. 1) during august-2019 to January-2020 and transported to Department of Aquatic Biology (VNSGU), Surat to analyze the various physio-chemical parameters including temperature, pH, free CO^2, total Hardness, Biological Oxygen demand (BOD), Chemical

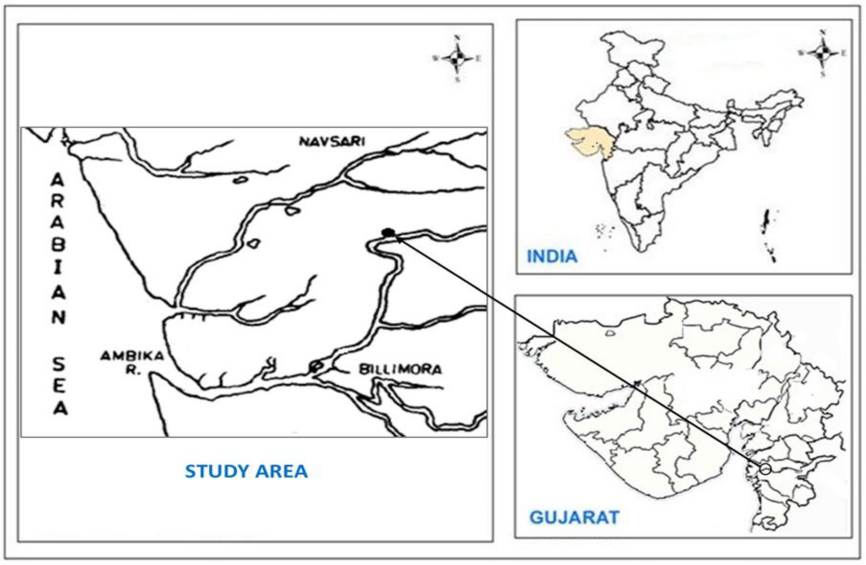

Fig. 1. Location of study site (Ambica River).

oxygen demand (COD) and total calciumto follow the standard methods of APHA (2005). rivedi and Goel (1986).

Calculation of WQI

Generally, water quality index (WQI) is discussed for a specific and intended use of water. The values of water quality parameters were used to calculate WQI using by using following equation of weighted arithmetic index method (Srinivasa *et al.* 2012).

$$WQI = \Sigma Qi*Wi / \Sigma Wi$$

The quality rating (Qi) of each parameter were calculated by following formulae:

$$Qi = 100 [(Vn–Vi) / (Vs–Vi)]$$

Where,
Vn : Actual amount of nth parameter (Table 2),
Vi : Idealvalue of this parameter (Table 2),
Vs: Recommended standard values of parameter (Table 2).

Relative weight (Wi) is a value inversely proportional to the recommended standard (Si) of the corresponding parameter and it was calculated using the following expression :

$$Wi = 1/Si$$

The statistical analysis of the data was done by SPSS 15.

RESULTS AND DISCUSSION

Water quality parameters

Water chemistry of the resources and aquatic organisms influenced by functions in amount of dissolved oxygen, sensitivity to toxic wastes and physiological activities are affected by temperature. In present study it was observed 18.00 °C minimum and 28.20°C maximum with mean 25.32±1.000 °C (Table 1). The temperature of river ecosystem depends on the season, geographic location and entry of effluents (Dubey and Ujjania 2013). Similar findings were also reported in Tapi River by Dubey and Ujjania (2015), Sangani and Manoj (2020).

The pH play imperative role in bio-chemical reactions in organisms which are necessary for survival and growth (Jalal and Kumar 2012, Gupta *et al.* 2017). The pH was ranged from 6.2 to 8.05 with mean value 7.4±0.153 during study period (Table 1). Salam *et al.* (2012) reported the similar findings in Aliyar River (Tamil Nadu) whereas, Sangani and Manoj (2020) also reported 7.6-7.9 pH range in Tapi River.

Dissolved oxygen is an important water parameter and river ecosystem is adversely impacted by its fluctuations (Dubey and Ujjania 2015). According to APHA (2005) 6.5 mg/L values of dissolved oxygen indicate the moderate water quality and in present study DO was 5.65 to 9.29 mg/Lwith mean value of 7.362±0.301mg/L (Table 1) which is more than prescribed value of APHA (2005). Jitendra *et al*. (2008) reported similar findings in Yamuna River and Dubey and Ujjania (2016) reported 3.733 mg/L to 7.200 mg/L and Sangani and Manoj (2020) reported 6.52 mg/L to 7.55 mg/L DO in Tapi River which were very close to findings of the present study.

Concentration of CO_2 was found higher than the standard permissible limits throughout the study period. It was ranged between 13.20 mg/L to 35.20 mg/L with average value 22.00±1.726 mg/L (Table 1). Similar results were also reported by Ujjania and Mistry (2012).

Biological oxygen demand (BOD) shows the amount of oxygen required for microbial activities to decompose the organic matter in water and its high concentration causes stress, suffocation and eventual death of aquatic organisms (Dhinamala *et al*. 2015). During study period, BOD values were ranged from 6.00 mg/L to 7.60 mg/L with average concentration of 6.862±0.169 mg/L (Table 1). The result of the present study is advocated by Joshi *et al.* (2009) in Ganga River at Haridwar (UP), Yahya *et al*. (2012) in Indus River, Sindh (Pakistan) and Dubey and Ujjania (2015) in Tapi River (Gujarat).

Chemical oxygen demand (COD) is used as indicator of pollution in aquatic resources because it determines the load of organic and inorganic pollutants (Faith 2006). In Ambica River, COD was observed minimum 10.800 mg/Land maximum 22.000 mg/L

Table 1. Statistical summary of the physical and chemical parameters of the river water.

Parameters	Min	Max	Mean	SE
pH	6.210	8.050	7.396	0.153
Temperature (°C)	18.000	28.200	25.323	1.000
Dissolved Oxygen (mg/L)	5.650	9.290	7.362	0.301
Free CO_2 (mg/L)	13.200	35.200	22.000	1.726
Total Hardness (mg/L)	148.000	174.000	158.154	2.224
BOD (mg/L)	6.000	7.600	6.862	0.169
COD (mg/L)	10.800	22.000	18.707	0.932
Total Calcium (mg/L)	82.000	148.000	120.000	5.184

with an average value 18.707±0.932 mg/L (Table 1) which shows that water quality of river is good. The result of present investigation was evidenced by Khan and Hazarika (2012) in Kolong River (Assam), Shrivastava *et al*. (2012) in Machna River (MP) and Dubey and Ujjania (2020) in Tapi River (Gujarat).

Hardness of the water is the concentration of minerals, largely magnesium and calcium. Although it is not harmful for human but the presence of natural salts can be estimated by the determination of hardness (Gawas *et al.* 2006). The mean values of total hardness was observed 158.154±2.224 mg/Lwhile it was minimum 148.000mg/Land maximum 174.000 mg/L (Table 1) in Ambica river during present study. Similar results of the present study were reported by Dubey and Ujjania (2013, 2016, 2020) for Tapi River.

High temperature, low water levels, calcite path of river and domestic waste discharge in river water could be the reason of higher calcium concentration (Devi *et al.* 2015). The calcium concentration in AmbicaRivervaried from 82.00 mg/L to 148.00 mg/L with mean value 120.000±5.184 mg/L (Table 1) during the present study which was much higher than the standard values recommended by BIS (2002). The finding of the present study was agreed by (Mezgebe *et al.* 2015).

Water quality index

Determination of water quality index is to be more systematic procedure and resulted numerical value is useful to assess and verify the judgment on water quality of the aquatic resources. In this study, water quality index of Ambica River water was evaluated by applying weighted arithmetic index method and was noted 195.261 (Table 2) that comes under category III (Table 3) which consider that water of river is poor in water quality and presence of pollution. WQI based results were also concluded in Mahi River (Gujarat) by Gor and Shah (2014), in Tapi River (Gujarat) by Dubey and Ujjania (2015), Gamit *et al.* (2018).

CONCLUSION

The present study conclude that physico-chemical parameters pH was slightly alkaline, temperature was

Table 2. WQI of Ambica River (Gujarat). *BIS (2002).

Parameters	Observe value (Vi)	Ideal value (Vo)	Standard value* (Si)	1/Si	Wi	Qi	Wi* Qi
pH	7.396	7.000	8.500	0.118	0.209	26.410	5.524
Temperature	25.323	0.000	40.000	0.025	0.044	63.308	2.814
D.O.	7.362	14.600	6.000	0.167	0.296	84.168	24.942
CO_2	22.000	0.000	5.000	0.200	0.356	440.000	156.464
Hardness	158.154	0.000	300.000	0.003	0.006	52.718	0.312
B.O.D.	6.862	0.000	30.000	0.033	0.059	22.872	1.356
C.O.D.	18.707	0.000	250.000	0.004	0.007	7.483	0.053
Total calcium	120.000	0.000	80.000	0.013	0.022	150.000	3.334
				0.562	1.000		194.795
			K	1.778		WQI	194.782

Table 3. WQI based water quality classification (Shrivastava *et al*. 2012).

Class	WQI value	Water Quality Status
I	<50	Excellent
II	50-100	Good water
III	100-200	Poor water
IV	200-300	Very poor water
V	>300	Water unsuitable for drinking

moderate, DO, BOD, COD, hardness were within the limits while, free CO_2 and total calcium were beyond the permissible limits of state, national and international authorities like Gujarat Pollution Control Board, Central Pollution Control Board, World Health Organization and United States Environmental Protection Agency which indicate that water quality of Ambica River was poor. These findings were also verified by determination ofwater quality index (WQI). The possible causes of deterioration in water quality may be anthropogenic activities, unprotected river sites and runoff of the catchment area. It suggests that water of Ambica River is not suitable for domestic usage without application of proper treatments. For the betterment of the river it is recommended that domestic sewage or industrial dumping must be stopped, public awareness and participation may involve to cleaning and protection of river stretch and strict implementation of the legal action against culprits. Although such kind of study was not conducted till the date so this research task would be help to prepare the management policies to conserve the river ecosystem.

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