Volume 7 Issue 2 2021
ISSN 2454-3055

INTERNATIONAL JOURNAL OF ZOOLOGICAL INVESTIGATIONS

Forum for Biological and Environmental Sciences

Published by Saran Publications, India

International Journal of Zoological Investigations Vol. 7, No. 2, 369-375 (2021)

International Journal of Zoological Investigations

ISSN: 2454-3055

Contents available at Journals Home Page: www.ijzi.net

Assessment of Quality Index of Water by Using Different Physico-Chemical Parameters in Rabale Waterbody, Navi-Mumbai, Maharashtra, India

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Received: 7th June, 2021; **Accepted:** 11th July, 2021; **Published online:** 15th July, 2021

https://doi.org/10.33745/ijzi.2021.v07i02.007

Abstract: Water is a must for all living things. Reservoir and lake water is used for a variety of purposes, including drinking water, agricultural, commercial, recreational, and aquaculture. However, due to rising population pressures, which has resulted in rapid urbanization, industrialization, and modern agricultural practices, water pollution has become a major issue in recent years. The water quality index is a single number that reflects overall water quality at a specific place and time. To compute, water quality index (WQI) we used Temperature, pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (B.O.D), Chemical Oxygen Demand (C.O.D), Alkalinity, Electrical Conductivity, Turbidity, and Chemical Oxygen Demand (C.O.D), Nitrite-Nitrogen, Nitrate-Nitrogen and Hardness were the physico-chemical parameters investigated in this study. The water quality index is to transform complicated water quality data into information that the general public can use. The Water Quality Index was calculated using the Weighted Arithmetic Water Quality Index (WQI). The measured WQI was then used to assess the water quality in Rabale water body. The water quality index (WQI) of the lake was 49.813, 53.483, and 53.045 during the pre-monsoon, monsoon, and post-monsoon periods, respectively. When comparing seasonal variations, WQI values show that water status is fairly good during the pre-monsoon but is low during the monsoon and post-monsoon seasons, thus water from Rabale water body may be used for a variety of industrial purposes.

Keywords: Water parameters, Water quality index, Weighted arithmetic, Sampling stations, Physico-chemical parameters

Citation: Singh Pooja and Jadhav Anita S. : Assessment of quality index of water by using different physico-chemical parameters in Rabale waterbody, Navi-Mumbai, Maharashtra, India. Intern. J. Zool. Invest. 7 (2): 369-375, 2021. https://doi.org/10.33745/ijzi.2021.v07i02.007

Introduction

Water is one of the most vital natural resources on the planet, as it is needed directly or indirectly by all humans, animals, and plants. Only 3% of the world's water is fresh and fit for human use, with lakes and wetlands accounting for 0.35 per cent and rivers and streams for less than 0.01 per cent (Dorlikar, 2019). Lakes are a significant source of water for irrigation, drinking, washing, agriculture, fishing, and industrial use. As a result of developmental activities, population growth, industrialization, and urbanization have dramatically increased water pollution, putting the ecosystem under tremendous stress (Seitzing *et al.,* 2005; Halpern *et al.,* 2008; Qu and Kroeze, 2010). Pollution has a negative impact not only on human health but also on the health of flora and wildlife. The water quality index is used to determine the purity of water. Water quality index is a single figure calculated to determine the overall quality of water for human and animal use. Water quality testing necessitates a number of chemical and physical characteristics. Eutrophication and environmental imbalance are caused by poor water quality. In this study, we determined the water quality status of Rabale waterbody by analyzing physico-chemical parameters and nutrient concentrations and calculating WQI.

Materials and Methods

Study Area :

The study was carried out at Rabale Lake located in Rabale, Navi-Mumbai, Maharashtra, India. The area of the lake is about 1,250 sq.km. The latitude and longitude of lake is 19.14390N, 73.00260E (Fig. 1).

Figure 1: Satellite view of Rabale Lake

Water Sample Collection:

Water samples from the lake were collected every month from June 2019- Feb. 2020. Water was collected from five different sampling stations (Figs. 2, 3) in plastic bottles. Physico-chemical parameters such as Temperature, pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (B.O.D) were analyzed using Winkler's method. Chemical Oxygen Demand (C.O.D), Alkalinity, Electrical Conductivity, Turbidity, and Chemical Oxygen Demand (C.O.D), Nitrite-Nitrogen, Nitrate-Nitrogen and Hardness were analyzed using photometrical method given by APHA (1998). Values obtained were considered to compute water quality index (WQI).

Figure 2: Photograph of Rabale Lake

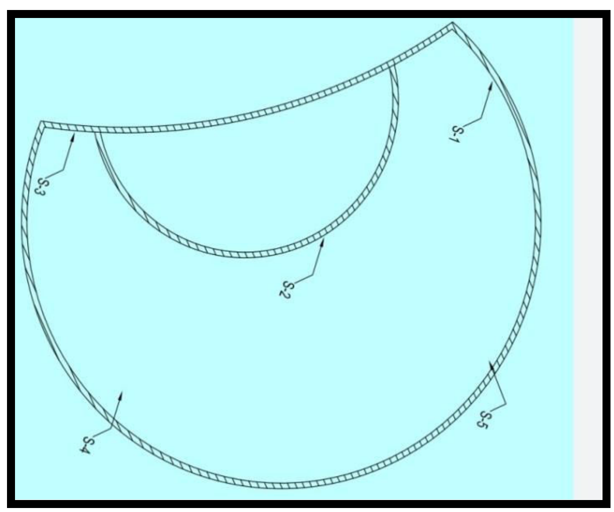


Figure 3: Sampling stations

Water quality index (WQI):

The major goal of any water quality monitoring study is to assess the water quality for special use, which is accomplished using a mathematically generated water quality index (WQI), which converts complex water chemistry data into a single value that represents water quality level.

The WQI was calculated by the following steps and finally to verify the derived indices.

Step I: To calculate the quality rating (Qn):

Weighted Arithmetic Index was calculated using Quality Rating (Qn) by using following expressions:

$$Qn = 100\,[Vn-Vio]/\,[Sn-Vio]$$

Where, n = Water quality parameter, Qn= Quality rating of n^{th} water quality parameter, Vn = Estimated value of n^{th} water quality parameter, Sn = Standard value of n^{th} water parameter, Vio = Ideal weight value of n^{th} parameter in pure water (Vio value is zero for all parameters except for pH and DO it is 7 and 14.6, respectively)

Step II: To find unit weight (Wn):

Unit weight was calculated for n^{th} water quality parameter by value inversely proportional to recommended standard value

$$Wn = K/Sn$$

Where, Wn= Unit weight for n^{th} water parameter, K = Constant of proportionality, Sn = Standard value of n^{th} water parameter,

WQI was calculated using following expression:

$$WQI = \sum QnWn/\sum Wn$$

Where, Qn= Quality rating of n^{th} water quality parameter, Wn = Unit weight for n^{th} parameter.

The Water Quality Index (WQI) is a rating that reflects the different quality metrics' combined influence on overall water quality characteristics. It is considered one of the most effective ways to communicate water quality (Behera *et al.*, 2004). In fact, generating WQI in a given area is a critical step in land use and water resource management planning (Saeedi *et al.*, 2010) since it aggregates water quality data in an easily expressed and comprehensible manner that is frequently used for comparison. Horton (1965) proposed that varied water quality data be combined into an overall index. Brown *et al.* (1970) established the general WQI (Wagh *et al.*, 2015). In the literature, various Water Quality Index have been calculated by using standard values of water recommended by ICMR, WHO, BIS, CCME (Chatterjee and Raziuddin, 2002; Saeedi *et al.*, 2010).

Results and Discussion

The primary focus of this research study was on water quality measures, including temperature, pH, EC, DO, BOD, COD, Alkalinity, turbidity, hardness, Nitrate, Nitrite and WQI, to determine the acceptability of surface water for human consumption (Atulegwu and Njoku, 2004). Table 1 summarizes the seasonal fluctuations in physico-chemical and nutrient parameter of the Rabale water body, as well as the results of water analysis with mean and standard deviation values for various parameters.

pH : The pH of the water body has been recorded to be 6.5 (Fig. 4a), which is within the (ICMR/BIS) recommended range. The pH range of 6.5 to 8.2 is ideal for long-term aquatic life (Yogendra and Puttaiah, 2008).

Temperature: The temperature in the present study was 30.5 C during the pre-monsoon and monsoon seasons, and 29 C during the post-monsoon season (Fig. 4b).

Electrical conductivity: In both the pre-monsoon and post-monsoon seasons, electrical conductivity (EC) was between 0.09 µS/cm and 0.08 µS/cm (Fig. 4 c), which is below the WHO/ ICMR permitted standard.

Dissolved oxygen: The distribution of vegetation and fauna is controlled by the concentration of dissolved oxygen in a water body. The depletion of oxygen could be attributed to intrusion of high organic load in the water which may disturb the water body ecosystem to a large extent. In the present study, the average value of the dissolved oxygen concentration was found as 1.92 mg/L during pre-monsoon (Misra, 2010) as compared to 2.24 mg/L in monsoon and 3.48 mg/L during post- monsoon (Fig. 4a) (Yogendra and Puttaiah, 2008; Rani *et al.*, 2013).

Table 1 Seasonal variations in Water Quality Index Of Rabale Lake

S.no.	Parameters	Standard values (Sn)	Unit weight (Wn)	PRE-MONSOON			MONSOON			POST-MONSOON		
				Observed value	Quality rating (qn)	Wnqn	Observed value	Quality rating (qn)	Wnqn	Observed value	Quality rating (qn)	Wnqn
1	Temperature	15 (CCME) (WHO)	0.123	30.5	203.33	25.139	30.5	203.33	25.137	29	193.33	23.901
2	pH	6.5-8.5 (ICMR/BIS)	0.219	6.5	100	21.9	6.5	100	21.9	6.5	100	21.9
3	Dissolved Oxygen mg/L	5.00 (ICMR/BIS)	0.372	1.92	132.08	49.173	2.24	128.75	47.933	3.48	115.83	43.123
4	B.O.D mg/L	5.00 (ICMR/BIS)	0.372	0.26	5.2	1.935	0.89	17.8	6.626	0.7	14	5.212
5	C.O.D mg/L	10 (WHO)	0.025	4.68	46.8	1.173	7.04	70.4	1.764	9.15	91.5	2.293
6	Total Alkalinity mg/L	120 (ICMR)	0.015	201.7	168.08	2.605	167	139.16	2.156	274.9	229.08	3.55
7	Turbidity	5 NTU (BIS)	0.370	0.04	0.8	0.296	0.1	2	0.74	0.13	2.6	0.964
8	Total Hardness mg/L	300 (ICMR/BIS)	0.006	19.2	6.4	0.039	15.7	5.2	0.032	17.8	5.9	0.036
9	Conductivity µS/cm	300 (ICMR)	0.006	0.09	0.03	0.0001	0.08	0.02	0.0001	0.08	0.02	0.0001
10	Nitrite Nitrogen µg/l	3 (BIS)	0.616	0.28	9.33	5.75	0.47	15.66	9.655	0.68	22.66	13.972
11	Nitrate Nitrogen µg/l	45 (ICMR/BIS)	0.041	0.32	0.711	0.02	0.44	0.977	0.04	0.89	1.977	0.081
Total			**∑Wn=2.1685**			**∑Wnqn=108.02**			**∑Wnqn=115.98**			**∑Wnqn=115.03**
Water Quality Index				**49.813**			**53.483**			**53.045**		

Table 2: Water quality index and water quality status

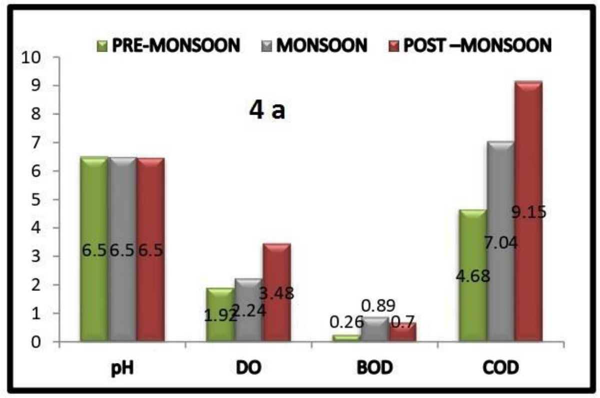
S. No.	Water Quality Index Range	Status	Category
1	0-25	Excellent	A
2	26-50	Good	B
3	51-75	Poor	C
4	76-100	Very Poor	D
5	100 and above	Unsustainable for drinking	E

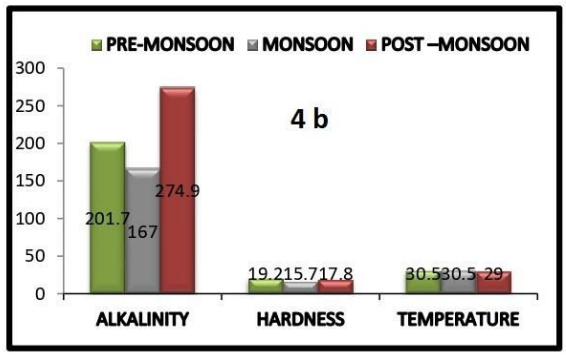
BOD: The organic load in a water body is measured using biochemical oxygen demand. BOD concentrations in the present study was 0.26 mg/L during the pre-monsoon period, 0.89 mg/L during the monsoon period, and 0.70 mg/L during the post-monsoon period (Fig. 4a). Unpolluted natural waters contain BOD levels of 5 mg/L or less (Yogendra and Puttaiah 2008; Satone *et al.,* 2011).

COD: COD values for pre-monsoon are 4.68 mg/L, monsoon values are 7.04 mg/L, and post-monsoon values are 9.15 mg/L (Fig. 44a). The amount of dissolved oxidizable organic matter, including non-biodegradable stuff, was represented by COD values (Satone *et al.,* 2011).

Alkalinity: Alkalinity is dependent on the presence of carbonates, bicarbonates and hydroxides (Satone *et al.*, 2011, Phadatare and Gawande, 2016 ; Behailu *et al.*, 2017; Shrivastava and. Thakur, 2018). The lowest alkalinity value was 167 mg/L during the monsoon season, and the maximum was 274.9 mg/L during the post-monsoon season (Fig. 4b). It is within the acceptable alkalinity range.

Hardness: The water hardness is due to the presence of soluble chlorides, bicarbonates and sulphates of calcium and magnesium. It is an important metric for detecting water quality (Satone *et al.*, 2011; Behailu *et al.,* 2017). In the present study, pre-monsoon, monsoon, and post-monsoon hardness values were 19.2 mg/L, 15.7 mg/L and 17.8 mg/L, respectively (Fig. 4b).





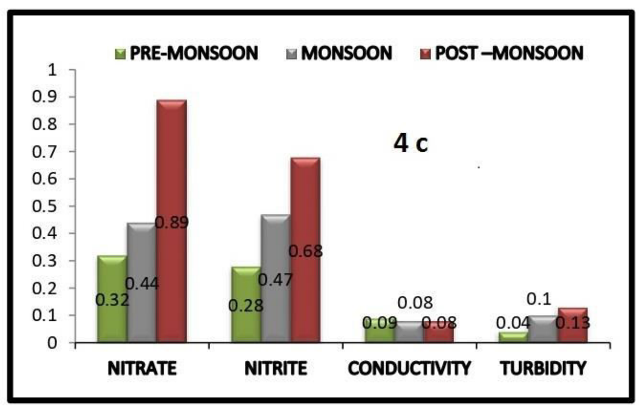


Fig. 4 a, 4 b and 4 c showing seasonal variation in physico-chemical parameters of Rabale lake.

Turbidity: It was 0.04 NTU in pre-monsoon and 0.1 NTU and 0.13 NTU in monsoon and post-monsoon, respectively (Fig. 4c). Turbidity can be caused by solid suspended matter such as finely divided organic and inorganic matter, clay, slit etc. (Bhardwaj and Verma, 2017).

Nitrate and Nitrite: During the pre-monsoon the concentration of nitrate and nitrite was 0.32 µg/L and 0.28 µg/L, respectively in the water samples of Rabale waterbody. Similar observations were reported by Paliwal *et al.* (2007), Sharma *et al.* (2009), Phadatare and Gawande (2016) and Sharma *et al.* (2017). During the monsoon nitrate and nitrite concentrations recorded were 0.44 µg/L and 0.47 µg/L, and during post-monsoon it was 0.89 µg/L and 0.68 µg/L, respectively (Fig. 4c).

In this study WQI was computed in three seasons utilizing various physicochemical and nutrient factors. The WQI for the lde water body was found to be less than 100, which is considered to be of acceptable quality, and interestingly, WQI values for the Rabale waterbody from Navi Mumbai area for all three segments were found to be less than 100, indicating that the water body, while not highly polluted, had WQI values that were lower than 100. WQI values are fairly good during the pre-monsoon period, with a value of 49.81 in category B (Tables 1, 2). The marginally high readings of 53.48 in monsoon and 53.04 in post-monsoon may be owing to an influx of fresh water from the surroundings, which certainly might be related to input from lithogenic and anthropogenic sources, suggesting marginally poor category (Tables 1, 2). Despite the fact that the WQI values are below 100, the allowed limit is unfit for human consumption, but it can be utilized for industrial purposes (Wagh *et al.,* 2015; Udeshani *et al.,* 2020). This demonstrates its inadequacy for human use (Bahera *et al.,* 2004, Paliwal *et al.,* 2007). Increased nutrient loading produces significant local, regional, and global eutophication problems which leads to anoxic conditions by depleting oxygen from the water body (Billen and Garnier, 2007). The concentration of DO revealed to be at its lowest, which could be owing to high organic loading from residential sewage waste intake, which causes oxygen depletion in the water body and the mortality of aquatic creatures, indicating a eutrophication problem in the Rabale water body. The addition of a large quantity of wastewater generated is a key cause of water body degradation and water quality degradation.

Conclusion

WQI is used to monitor, measure, and study the influence of various water bodies in various places throughout the world. It assists various decision makers in taking appropriate action or determining treatments. It will be beneficial for detecting water quality degradation caused by water quality management activities. Due to low dissolved oxygen and biochemical oxygen demand, the water quality in the Rabale water body is eutrophicated, according to the current study. It is unfit for humans use but can be used for industrial use. As a result, the water quality index methodology, when combined with the nutrient elemental ratio, is a useful tool for determining water quality.

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