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Assessment of Water Quality Index of Bilawali Tank, Indore

Renu Jain
Assistant Professor,
Department of Zoology,
Govt.Holkar Science College,
Indore, M.P.

Preeti Chaudhary
Professor and Head,
Department of Zoology,
Govt. P.G. College,
Dhar, M.P.

N.K. Dhakad
Additional Director,
Higher Education,
Indore- Division,
Indore, M.P.

Abstract

This paper deals with the study on the seasonal variations of the physico-chemical parameters on the water quality of Bilawali tank, Indore. The present study focused on calculating Water Quality Index (WQI) of water body in order to access the suitability of it for human uses. Water quality index, indicating the quality of water in terms of index number, offers a useful demonstration of overall quality of water for public. It was determined on the basis of various parameters like pH, Conductivity, Total Dissolved Solids, Alkalinity, Total Hardness, Calcium, Magnesium, Chloride and Nitrate.

Keywords: Bilawali Tank, Physico-Chemical Parameters, Seasonal Variation, Water Quality Index.

Introduction

Water is used in day to day activities like drinking, bathing, washing, recreation, irrigation and industrial purposes. It is an incredibly important aspect of our daily life and essential for the survival of all the organisms.

Water quality also varies significantly due to different environmental conditions, ecosystems and intended human use. Toxic substances and high population of certain micro-organisms can also be a great hazard to non-drinking purposes of water such as fishing and boating. These conditions may also adversely affect the life which uses the water for drinking purpose.

Therefore, the suitability of water sources for human consumption had been described in term of Water Quality Index (WQI), which is one of the most effective tools to describe the quality of water. It gives the numerical value that express overall water quality at the particular location and time, dependent on several water quality parameters. For the water quality assessment, WQI was applied to different water resources by various researchers like Thakor *etal*., (2011), Kankal *etal.,* (2012), Mishra *etal.,* (2012), Shrivastava *etal.,* (2013), Tyagi *etal.,* (2013), Bhadja and Vaghela (2013), Sinha *etal.,* (2014).

Present study deals with the necessity of restoring the water quality of the tank and is aimed at calculation of water quality index in order to access the suitability of it for human uses.

Study Area

Indore is the largest city of Madhya Pradesh in central India. Its latitude and longitude are $22^0$20" N to $23^0$05" N and $75^0$25" E to $75^0$15" E respectively. Bilawali Tank is situated in the south-west direction of Indore at Khandwa road near Asaram Bapu Ashram. It is located at a distance of 6 km from Indore, Madhya Pradesh. The catchment area of tank is 117 ha. and the water area is 69 ha. The tank was completed in 1914 by Maharaja Tukoji Rao Holkar under the supervision of Sri Geddes. After its completion, the tank was connected to Pipliya Pala Talab by means of a canal near the Limbodi village. It is based on the plan of the contemporary resident Shri Bhojket in 1905. The tank caters to the need of the particular area for its various uses i.e. drinking, fish culture etc.

Method

Water samples were collected seasonally and analyzed for nine physico-chemical parameters. The analysis of water was done as per the standard method of APHA (1998). In this study for the calculation of WQI nine important parameters were chosen. The calculation of WQI was made using a weight arithmetic index method given below (Brown *etal.,* (1972)) and the calculation of WQI was made by using the following equation:

$$\text{WQI} = \sum_{n=1}^{n} qnWn \,/\, \sum_{n=1}^{n} Wn \qquad (1)$$

Further quality rating or sub index (qn) was calculated using the following expression

$$qn = 100\,[(Vn - Vio)/\,(Sn - Vio)] \qquad (2)$$

Where
qn = quality rating for the n^{th} water quality parameter
Vn = estimated value of the n^{th} parameter at a given sampling site
Sn = Standard permissible value of n^{th} parameter
Vio = ideal value of n^{th} parameter in pure water

Ideal value in most cases Vio = 0 except in certain parameters like pH and Dissolved oxygen.

Calculation of quality rating for pH and DO (Vio ≠ 0) is 7.0mg/l and 14.6 mg/l respectively.

Unit weight (Wn) was calculated by a value inversely proportional to the recommended standard values Sn of the corresponding parameters.

$$Wn = K/Sn \quad (3)$$

Where
K = proportionality constant
Wn = unit weight for n^{th} parameter
Sn = Standard permissible value of n^{th} parameter

Values of K were calculated as:

$$K = \frac{1}{\sum(1/Sn)} \quad (4)$$

Result and Discussion

Water quality index of the present tank is analyzed from the various important physico-chemical parameters like pH, Conductivity, Total Dissolved Solids, Alkalinity, Total Hardness, Calcium, Magnesium, Chloride, Nitrate etc. in different seasons. The values of the various parameters for calculation of Water Quality Index are presented in table 1. Season wise water quality index calculations are depicted in table 2, 3, 4 and status of WQI values in table 5.

In the present study samples of Water Quality Index were taken in Winter, summer and rainy season taking into consideration the parameters like pH, Conductivity, Total Dissolved Solids, Alkalinity, Total Hardness, Calcium, Magnesium, Chloride, Nitrate etc. The calculation of WQI was made using arithmetic index method of Brown *etal.,* (1972).

Sisodiya and Moundiotiya (2006) reported water quality of wetland Kalakho Lake, Rajasthan is under stress of severe pollution. Thakor *etal.,* (2011) reported water quality is poor and not totally safe for human consumption of Periyej Lake, Kheda district, Gujarat.

In the present study, among all the physico-chemical parameters selected for the Water Quality Index calculation, pH is an important parameter which determines the suitability of water for various purposes. In the present study, pH ranged between 7.15 to 7.95. Chloride is one of the most important parameters in assessing the water quality. In the present study the concentration of chloride was found to be high during summer season and low during winter season.

During the study period, all the parameters were in the permissible limits as prescribed by BIS. However, throughout the year no water samples were found in excellence rank (0-25). The WQI values were reported 27.53 in winter season, 63.51 in summer and 41.73 in rainy season and overall WQI value was 44.26.The values of winter and rainy season indicate that the water quality is under good ranking and can be utilized for fish culture and agriculture, but Water Quality Index in summer season indicate that it's not safe for human consumption unless being treated. All over Water Quality Index ranking was reported < 50 which indicates the good status of water (table 5)

Table 1
Seasonal Variations of the Physico-Chemical Parameters of Bilawali Tank

S. No.	Parameters	Winter Season	Summer Season	Rainy Season
1	pH	7.15	7.95	7.55
2	Conductivity	468.75	512	488.25
3	Total Dissolved Solids	292.25	323	305
4	Alkalinity	159	195.25	145
5	Total Hardness	152.25	185	137.25
6	Calcium	54.75	66.5	44.75
7	Magnesium	23.79	28.91	22.57
8	Chloride	24	54	38.5
9	Nitrate	0.59	0.23	1.16

Table 2
Calculation of Water Quality Index in Winter Season of Bilawali Tank

S. No.	Parameters	Estimated value (Vn)	Standard Values (Sn)/BIS	Unit Weight (Wn)	Quality Rating (qn)	Wnqn
1	pH	7.15	6.5-8.5	0.585	10	5.85
2	Conductivity	468.75	1000	0.00497	46.875	4.818
3	Total Dissolved Solids	292.25	500	0.0099	58.45	0.58
4	Alkalinity	159	200	0.025	79.5	13.16
5	Total Hardness	152.25	300	0.0166	50.75	0.145
6	Calcium	54.75	75	0.066	73	0.233
7	Magnesium	23.79	30	0.166	79.3	0.842
8	Chloride	24	250	0.01988	9.6	1.99
9	Nitrate	0.59	45	0.1104	1.31	0.019
	K= 4.97			**∑Wn= 1.00375**		**∑Wnqn= 27.637**

WQI=27.53

Table 3
Calculation of Water Quality Index in Summer Season of Bilawali Tank

Parameters	Estimated value (Vn)	Standard Values (Sn)/BIS	Unit Weight (Wn)	Quality Rating (qn)	Wnqn
pH	7.95	6.5-8.5	0.585	63.33	37.05
Conductivity	512	1000	0.00497	51.2	0.2544
Total Dissolved Solids	323	500	0.0099	64.6	0.64
Alkalinity	195.25	200	0.025	97.625	2.44
Total Hardness	185	300	0.0166	61.67	1.024
Calcium	66.5	75	0.066	88.67	5.85
Magnesium	28.91	30	0.166	96.37	16
Chloride	54	250	0.01988	21.6	0.43
Nitrate	0.23	45	0.1104	0.511	0.056
K= 4.97			**∑Wn= 1.00375**		**∑Wnqn= 63.7444**

WQI=63.51

Table 4
Calculation of Water Quality Index in Rainy Season of Bilawali Tank

Parameters	Estimated value(Vn)	Standard Values (Sn)/BIS	Unit Weight (Wn)	Quality Rating (qn)	Wnqn
pH	7.55	6.5-8.5	0.585	36.67	21.45
Conductivity	488.25	1000	0.00497	48.825	0.243
Total Dissolved Solids	305	500	0.0099	61	0.604
Alkalinity	145	200	0.025	72.5	1.8125
Total Hardness	137.25	300	0.0166	45.75	0.76
Calcium	44.75	75	0.066	59.67	3.94
Magnesium	22.57	30	0.166	75.23	12.49
Chloride	38.5	250	0.01988	15.4	0.306
Nitrate	1.16	45	0.1104	2.58	0.285
K= 4.97			**∑Wn= 1.00375**		**∑Wnqn= 41.8905**

WQI=41.73

Overall Water Quality Index = 44.26

Table 5
Water Quality Index (WQI) and status of water quality
(Brown *etal.* 1972)

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

Conclusion

Water Quality Index can be used as a tool to convey the information regarding the quality of water in an easy and understandable way to the public and policy makers. Application of WQI in this study has been found useful in assessing the overall quality of water and to get rid of judgment on quality of the water. Analysis reveals that the water of tank needs some more treatment before consumption. From the overall value of water quality index, the water of Bilawali tank is considered as good water.

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