

DOI No.: <http://doi.org/10.53550/EEC.2022.v28i07s.017>

Assessment of Water Quality in Safilguda Lake, Hyderabad using Water Quality Index

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(Received 5 February, 2022; Accepted 21 April, 2022)

ABSTRACT

In the present study, Water Quality Index (WQI) was used to assess the quality of water in Safilguda lake. Safilguda lake was the source of drinking for the Nawabs and British authorities and was also the source of irrigation to the farmers. But today the agricultural fields have turned into housing colonies and multi-storey complexes which led to the deterioration of lake water by direct entry of sewage into the lake. Three sampling stations were selected within the lake for the collection of surface water samples at monthly intervals for a period of one year. The water samples were analyzed for various physico-chemical parameters by following the standard procedures. For calculating WQI, ten physico-chemical parameters were considered such as pH, alkalinity, chlorides, total hardness, calcium, magnesium, nitrates, sulphates, total dissolved solids and dissolved oxygen. From the water quality index, the lake water quality was determined. On the basis of WQI classification, the water quality status ratings clearly indicates that the Safilguda lake has **poor** water quality due to the discharge of untreated domestic waste water from the surrounding residents and religious activities like immersion of Ganesh idols made up of plaster of paris and the lakewater is unsuitable for drinking, domestic and recreational purposes. The water quality rating study also exhibits eutrophic condition of the lake.

Keywords: Water quality, Water quality index, Surface water, Physico-chemical parameters, Sewage, Safilgudalake.

Introduction

Water quality assessment of waterbodies like lakes has become an important issue due to increased water pollution by human interference (Lingaswamy and Saxena, 2016). Lakes have been continuously contaminated by encroachment of lake area due to human settlements, release of industrial waste, sewage, dumping of garbage etc. By assessing the water quality of lakes, pollution load caused by human activities can be monitored regularly and water pollution can be controlled.

Water quality index tells the water quality status

of a water source and has been applied for both surface and ground water quality assessment (Yadav *et al.*, 2015, Krishnan *et al.*, 2016). WQI reduces the large amount of water quality data into easily understandable information to the public and also to the concerned authorities and policy makers (Padma Priya *et al.*, 2015). WQI detects and evaluates the level of contamination of any water body and helps in water quality management (Srinivas *et al.*, 2017).

The present work is to assess the water quality of Safilguda lake by using WQI as it under threat by human activities. There is no such study done previously on Water quality index of Safilguda lake.

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Study area

Safilguda lake also known as Nadimicheruvu is selected for the present investigation. Safilguda lake is a naturally formed lake situated in Hyderabad, the capital city of Telangana, the newly formed state at a latitude 17°27'N with longitude 78°32'E. The Nizams and British military authorities used to quench their thirst from Safilguda lake and the lake water was also used for agriculture. Slowly, as years passed, the lake bed was encroached due to urbanization and was polluted by dumping of domestic waste and discharge of untreated sewage from nearby residential colonies. However, in 2001, Safilguda lake was restored by HUDA (Hyderabad urban development authority). HUDA constructed a bund to prevent encroachment of lake bed area and a Sewage treatment plant was provided to treat sewage before letting into the lake. At present, Safilguda lake condition has worsened by the direct release of waste water as the Sewage treatment plant provided by the government is non-functional. Immersion of ganesh idols made up of plaster of paris in the lake is also one of the reason for the lake to be in deteriorating condition. Even the ground water near Safilguda lake is contaminated due to the seepage and infiltration of untreated sewage from the lake.

Materials and Methods

Collection of water samples

Three sampling stations were selected for collection of surface water samples within the Safilguda lake. Station I is located at the right side of the lake which is the lake entrance for the immersion of Ganesh idols, station II is situated near KattaMaisamma temple and station III is near the apartment Krupa complex. Water samples were collected in sterilized two litre capacity polythene containers at monthly intervals for a period of one year from May 2017 to April 2018.

Physico-chemical analysis

Water quality depends on many physico-chemical parameters and their concentrations. For the assessment of surface water quality, sixteen physico-chemical parameters were selected and analyzed using standard methods of American Public Health Association (APHA, 2005). pH, carbonates, bicar-

bonates, dissolved oxygen, chemical oxygen demand, chlorides, calcium, magnesium, total dissolved solids, organic matter, total hardness, nitrites, phosphates and sulphates were estimated in the water samples.

Calculation of Water Quality Index

Water quality index is calculated to reduce the large amount of water quality data to a single numerical value (Ravindranath *et al.*, 2015). In the present study, ten physico-chemical parameters namely pH, alkalinity, chlorides, total hardness, calcium, magnesium, nitrates, sulphates, total dissolved solids and dissolved oxygen were considered for computation of WQI. These parameters were chosen as they have much importance in water quality assessment. Five steps are followed in the calculation of WQI.

In the first step, the parameters selected for WQI computing have been assigned a weight (w_i) based on their effects on primary health and relative importance in the overall quality of water for drinking purposes ranging from 1 to 5 depending on the collective expert opinions taken from previous studies (Ravindranath *et al.*, 2015). The maximum weight of 5 has been assigned to the parameters nitrates, dissolved oxygen and total dissolved solids due to their major effect on water quality. The parameters having less harmful effect on water quality were assigned a weight of 2.

In the second step, the relative weight (W_i) is calculated by using the following equation

$$\text{Relative weight, } W_i = w_i / \sum w_i$$

Weight (w_i) and calculated relative weight (W_i) values for each parameter are presented in Table 1.

In the third step, a quality rating scale (q_i) for each parameter is assigned by dividing its concentration in each water sample by its respective standard according to the drinking water guidelines recommended by BIS and then multiplied by 100 using the following equation.

$$q_i = (C_i / S_i) \times 100$$

q_i = quality rating

C_i = concentration of parameter in mg/l

S_i = Indian drinking water standard (BIS 1998) of parameter in mg/l

In the fourth step, the water quality sub-index (SI) for each parameter is determined using the equation

$$SI = W_i q_i$$

Finally, in the fifth step, the overall Water Qual-

ity Index (WQI) is calculated by adding together each sub-index (SI) values of each parameter as per the equation.

$$WQI = \sum (Wi qi)$$

Or

$$WQI = \sum SI$$

Results and Discussion

The Surface water samples were collected and assessed from Safilguda lake from three sampling stations at monthly intervals for a period of one year from May 2017 to April 2018. The average, maximum and minimum values of physico-chemical parameters are shown in Table 2.

The range of pH is 8.0 to 8.8 at all the three stations in the lake. The pH values indicate alkaline nature of water. The average values of carbonates are 17.5 mg/l, 23.3 mg/l and 24.5 mg/l at station I, station II and station III respectively. The average values of total hardness were 422.2 mg/l at station I, 354.6 mg/l at station II and 295.7 mg/l at station III. The concentration of calcium is 43.3 mg/l at station I, 9.5 mg/l at station II and 26.12 mg/l at station III. The average values of magnesium are 20.2 mg/l, 39.29 mg/l and 13.8 mg/l at station I, station II and station III respectively. The average values of chlorides were 201.25 mg/l at station I, 238.62 mg/l at station II and 233.11 mg/l at station III. The concentration of total dissolved solids is 645 mg/l at station

Table 1. The weight and relative weight of each of the physico-chemical parameters used for WQI estimation

S.No.	Parameters	BIS desirable limit	Weight (wi)	Relative weight (Wi)
1	pH	8.5	3	0.083
2	Alkalinity	200	2	0.055
3	Chlorides	250	3	0.083
4	Total hardness	300	3	0.083
5	Calcium	75	2	0.055
6	Magnesium	30	2	0.055
7	Nitrate	45	5	0.138
8	Sulphate	200	3	0.083
9	Total dissolved solids	1000	5	0.138
10	Dissolved oxygen	6	5	0.138

Table 2. Ranges and average values of Physico-chemical parameters of Safilguda Lake (All values are expressed in mg/L except pH and Temp.)

S. No.	Parameters	Station I			Station II			Station III		
		Average	Range		Average	Range		Average	Range	
			Min	Max		Min	Max		Min	Max
1	Temperature	21.4	16.5	23.4	21.3	16	23.2	21.4	16	23.6
2	pH	8.3	8.0	8.6	8.4	8.0	8.6	8.4	8.2	8.8
3	Carbonates	17.5	6.0	36.0	23.3	6.0	36.0	24.5	12.0	48.0
4	Bicarbonates	185.6	132	281	215.14	138.11	286.12	247.23	208.5	295.67
5	Chlorides	201.25	140	297	238.62	200.24	298.73	233.11	207.2	265.8
6	DO	3.5	2.4	5.0	2.9	2.2	3.5	3.3	1.6	4.2
7	OM	4.1	2.0	7.5	3.1	1.9	5.2	4.3	1.5	6.7
8	COD	350.8	100	560	355.6	240	560	274.5	120	480
9	Total hardness	422.2	360	500	354.6	290	488	395.7	210	426
10	Calcium	43.3	20.32	64.33	35.9	16.2	64.33	26.12	13.0	48.3
11	Magnesium	20.2	10.0	32.0	9.5	6.9	12.5	13.8	6.0	26.0
12	Phosphates	10.2	8.98	11.77	10.9	8.67	12.98	10.98	9.72	13.89
13	Sulphates	30	23.0	38.0	14.4	11.45	18.34	24.9	22.37	28.89
14	Silicates	0.91	0.53	1.37	0.94	0.45	1.89	0.91	0.53	1.56
15	Nitrites	0.003	0.002	0.006	0.0037	0.002	0.006	0.003	0.002	0.006
16	TDS	645	600	680	634	600	670	670	610	740

I, 634 mg/l at station II and 670 mg/l at station III respectively. The concentration of dissolved oxygen is 3.5 mg/l at station I, 2.9 mg/l at station II and 3.3 mg/l at station III.

In the present study, based on the results obtained, the physico-chemical parameters alkalinity, total hardness and total dissolved solids are in

higher concentration at all stations and dissolved oxygen is lower than BIS permissible limits (BIS 2012) which is shown in Table 3.

Water quality index was calculated for all the three stations of Safilgudalake and the results are summarized in Table 4, 5 and 6.

Water quality index of the lake was found to be

Table 3. Comparison of Physico-chemical parameters of Safilguda Lake with BIS standards (All values are expressed in mg/l except pH)

S.No.	Parameter	Station I	Station II	Station III	BIS
1	pH	8.3	8.4	8.4	6.5 to 8.5
2	Alkalinity	203.1	238.44	271.73	200
3	Chlorides	201.25	238.62	233.11	250
4	DO	3.5	3.1	3.3	6
5	Total hardness	422.2	354.6	395.7	300
6	Calcium	43.3	35.9	26.12	75
7	Magnesium	20.2	9.5	13.8	30
8	TDS	645	634	670	500

Table 4. Water Quality Index (WQI) calculation at Station I
Water Quality Index=WQI = Δ SI = 62.9

S.No.	Parameters	Concentration of each parameter (Ci)	BIS desirable limit (Si)	Weight (wi)	Relative weight (Wi)	qi	SI(Wiqi)
1	pH	8.3	8.5	3	0.090909	100	9.0909
2	Alkalinity	203.1	200	2	0.060606	101.55	6.155
3	Chlorides	201.25	250	3	0.090909	80.5	7.32
4	Total hardness	422.2	300	3	0.090909	140.74	12.8
5	Calcium	43.3	75	2	0.060606	57.73	3.5
6	Magnesium	20.2	30	2	0.060606	67.34	4.081
7	Nitrate	0.003	45	5	0.151515	0.0067	0.00101
8	Sulphate	30	200	3	0.090909	15	1.3636
9	Total dissolved solids	645	1000	5	0.151515	64.5	9.772
10	Dissolved oxygen	3.5	6	5	0.151515	58.3	8.833
				$\Sigma w_i=33$	$\Sigma W_i=1$		$\Sigma SI=62.9$

Table 5. Water Quality Index (WQI) calculation at Station II

S.No.	Parameters	Concentration of each parameter (Ci)	BIS desirable limit (Si)	Weight (wi)	Relative weight (Wi)	qi	SI(Wiqi)
1	pH	8.4	8.5	3	0.090909	101.2	9.12
2	Alkalinity	238.44	200	2	0.060606	119.22	7.225
3	Chlorides	228.62	250	3	0.090909	91.45	7.32
4	Total hardness	354.6	300	3	0.090909	118.2	10.75
5	Calcium	35.9	75	2	0.060606	47.87	3.5
6	Magnesium	9.5	30	2	0.060606	37.67	2.283
7	Nitrate	0.0037	45	5	0.151515	0.0082	0.0082
8	Sulphate	14.4	200	3	0.090909	7.2	0.655
9	Total dissolved solids	634	1000	5	0.151515	63.4	9.658
10	Dissolved oxygen	3.1	6	5	0.151515	51.67	7.828
				$\Sigma w_i=33$	$\Sigma W_i=1$		$\Sigma SI=58.35$

Water Quality Index=WQI = Σ SI = 58.35

Table 6. Water Quality Index (WQI) calculation at Station III

S.No.	Parameters	Concentration of each parameter (Ci)	BIS desirable limit (Si)	Weight (wi)	Relative weight (Wi)	qi	SI(Wiqi)
1	pH	8.4	8.5	3	0.090909	101.2	9.12
2	Alkalinity	480.34	200	2	0.060606	240.17	14.55
3	Chlorides	233.11	250	3	0.090909	93.25	8.48
4	Total hardness	395.7	300	3	0.090909	131.9	11.99
5	Calcium	26.12	75	2	0.060606	34.82	2.11
6	Magnesium	13.8	30	2	0.060606	46	2.78
7	Nitrate	0.003	45	5	0.151515	0.0066	0.00099
8	Sulphate	24.9	200	3	0.090909	12.45	1.132
9	Total dissolved solids	670	1000	5	0.151515	67	10.15
10	Dissolved oxygen	3.3	6	5	0.151515	55	8.33
				Σwi=33	ΣWi=1		ΣSI=68.65

Water Quality Index=WQI = ΣSI = 68.65

Table 7. Average Water Quality Index of the lake

Sample station	WQI
Station I	62.9
Station II	58.35
Station III	68.65

63.3 as shown in Table 7. Station III shows maximum Water Quality Index. At this station, chlorides, total hardness and total dissolved solids were the parameters which have high concentration than any other Water Quality Index values are 62.9, 58.35 and 68.65 at station I, II and III respectively. From these results, the average station.

Average WQI of the lake = Sum of WQI / No. of stations = 63.3

The status of water quality corresponding to the WQI is categorized into five types which are given in Table 8.

On the basis of WQI classification, the water quality status ratings clearly indicates that the Safilguda lake has **poor** water quality. Discharge of untreated municipal sewage, dumping of garbage and religious activities like immersion of Ganesh idols made of plaster of paris by the surrounding housing colo-

Table 8. Water Quality Index and status of water quality

S.No	Water quality index	Water quality status
1	0-25	Excellent
2	26-50	Good
3	51-75	Poor
4	76-100	Very Poor
5	Above 100	Unsuitable for drinking purpose

nies has led to the poor water quality of the lake. Hence, the water is not fit for drinking, domestic and recreational purposes. The high average Water Quality Index of lake proves that the lake water quality is deteriorated and exhibits eutrophic condition.

Conclusion

Water Quality Index can be used as an important tool in evaluating and assessing the level of contamination of any water body and helps in water resource management. To determine the water quality index in Safilguda lake, ten physico-chemical parameters were chosen. By the above discussions, it can be concluded that the WQI of Safilguda lake qualify in the 'Poor' category and found to be unsuitable for drinking, domestic and recreational purposes.

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