International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 06 | June -2018 www.irjet.net p-ISSN: 2395-0072

Determination of Water quality of Vengaihnakere Lake and Varthur lake, Bangalore.

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Abstract - *Water is a natural resource which is decisive for the survival of living organisms. One such source is surface water, in other words lakes and rivers. This work is focused on the quality of water of lakes in Bangalore. The lake under study is Vengaihnakere Lake or better known as K.R Lake and Varthur lake. The method adopted for determining the water quality is weighted arithmetic index method.*

***Key Words*: K.R kere, Varthur kere, WQI, Physicochemical parameters, Vengaihnakere.**

1. INTRODUCTION

We are well aware that most of the globe is covered with water, which is roughly 71% of the earth's surface, among which 97% of the water is spread out in the oceans. So the water which can be used for the needs of life on earth results to only 3 percent of which two third is frozen in glaciers and polar ice caps which further leaves us with only 1% of usable fresh water. Which is why this work focuses on the importance of wetlands. Bangalore was known as a city of a thousand lakes, due to rapid urbanization and the needs of humans these lakes have been constantly declining. According to the BWSSB's records Bangalore generates 1400 Million litres of sewage per day but the treatment capacity in Bangalore is only of about 721 MLD of which 520 MLD get treated on average, therefore majority of the remaining sewage and the industrial waste get dumped into the lakes which leads to the lake water pollution and degradation of water bodies. There is a need to study the quality of water in order to specify the level of treatment required and also know the status of the respective lakes. The method adopted in this study is the Weighted arithmetic index method. By determining the water quality index thereby classifying the water into classes of Excellent to poor.

1.1 Study Area.

Bengaluru urban, the district headquarter is located approximately at mid-south-eastern part of Karnataka with the latitude of Bangalore, Karnataka, India is 12.97, and the longitude is 77.58. Bangalore, Karnataka, GPS coordinates of 12° 58' 20.79'' N and 77° 34' 50.315'' E. Bangalore, Karnataka India elevation is 924 meters height.

The waterbodies taken for study is K.r Lake and Varthur lake. The location of the K.R Lake is at 13°01'00.7"N 77°41'52.0"E (DMS) with an area of 40 acres, whereas the location of Varthur Lake is at 12°56'55.2"N 77°44'20.5"E (DMS), with an area of 445.8 acres.

2. METHODOLOGY

The methodology adopted in this case study is the Weighted arithmetic index method. A total of 15 parameters are considered in this work they are namely pH, Turbidity, Electrical conductivity Total hardness, Chlorides, Sulphate Total alkalinity, DO, BOD, Magnesium, Calcium, Iron, TSS, Nitrates, TDS.

Water Quality Index (WQI): It indicates a single number which represents the overall quality of water by evaluating the individual parameters.

For calculating the WQI, Relative weight(W_n) is determined by assigning each parameter a unit weight based on the significance on the quality of water and computed with the formula below.

$$W_n = {}^{w_i}/_{\sum_{i=1}^{n} w_i}$$

Where,
W_n = Relative weight
n = Number of parameters
w_i = Weightage of each parameter

Once W_n is computed next A quality rating (Q_n) is computed. C_i is the concentration of each physicochemical parameter in each water sample in mg/L, and S_i is the Indian drinking water standard for each chemical parameter in mg/L according to the guidelines of the Bureau of India Standards 10500, 2012. The equation is as follows,

$$Q_n = {}^{C_i}/_{S_i} \times 100$$

Where,

Q_n = Quality rating.
C_i = Concentration of each parameter.
S_i = Indian drinking water standards.

Finally after determining Q_n, Subindex is determined for the nth parameter(SI_n).

$$SI_n = W_n \times Q_n$$

With the computation all the required values the WQI is determined from the equation below,

$$WQI = \sum SI_n$$

3. RESULT AND DISCUSSION.

The below mentioned physicochemical parameter study is most essential to determine to get literal idea of water quality index or quality of water. Quality of water is determined based on characteristics such as physical (temperature, color, taste, odor) chemical, biological characteristics and compare with standard value for drinking water which is recommended by WHO(world health organization) and BIS(bureau of Indian standards). The quality of water is also determined based on Chemical parameters. 15 Chemical parameters are pH, turbidity, total dissolved solids, total suspended solids, nitrates, sulphates, iron, total hardness, Calcium carbonate, magnesium, Dissolved Oxygen, Biochemical Oxygen Demand, total alkinity, electrical conductivity, chlorides. These test conducted on two water bodies are K.R lake and Vartur lake. The water collected for two different season such as winter and summer season. By using the grab sampling method. The water quality index calculation is done for two seasons as shown in table 1 and 2. The obtained value of each lake is compared.

Table 1: Data of K.R puram lake water quality.

SI no	Chemical parameters	Unit	Season	
			Pre-monsoon	Post-monsoon
1	pH	-	6.79	8.04
2	Electrical conductivity	Mmhos	1.9	1.4
3	Total dissolved solids	mg/L	333	411
4	Total alkalinity	mg/L	125	87.5
5	Total hardness	mg/L	320	261.1
6	Total suspended solids	mg/L	317	541
7	Calcium carbonate	mg/L	220	211.1
8	Magnesium	mg/L	100	50
9	Chloride	mg/L	219.99	185
10	Nitrates	mg/L	21	25.5
11	Sulphates	mg/L	20.5	32.5
12	Dissolved oxygen	mg/L	1.7	2.58
13	Bod	mg/L	4	4.5
14	Iron	mg/L	0.2	0.1
15	Turbidity	NTU	31.9	9.7

Table 2: Data of Vartur lake water quality.

Sl.no	Chemical parameters	Unit	Season	
			Pre-monsoon	Post-monsoon
1	pH	-	7.54	88.71
2	EC	Mmhos	1.4	1.87
3	TDS	mg/L	1393	278.60
4	TA	mg/L	150	125.00
5	TH	mg/L	440	146.67
6	TSS	mg/L	251	50.20
7	CaCO3	mg/L	400	533.33
8	Mg	mg/L	40	133.33
9	Cl	mg/L	115.00	46.00
10	Nitrate	mg/L	52	115.56
11	Sulphate	mg/L	45.1	30.07
12	DO	mg/L	2.38	0.476
13	BOD	mg/L	13.3	266
14	IRON	mg/L	0.3	100.00
15	Turbidity	NTU	7.6	76

For calculating water quality index weighted arithmetic index. There are 3 steps. First step is calculating relative weight using following formula

$$W_n = {}^{w_i}/_{\sum_{i=1}^{n} w_i}$$

Table 3: Calculation of relative weight (W_i).

Sl no	Chemical parameters	Unit	Indian standard	Weigh t	Relative weight (W_i)
1	pH	-	6.5-8.5	4	0.091
2	Electrical conductivity	Mmhos	75	1	0.023
3	Total dissolved solids	mg/L	500-200	4	0.091
4	Total alkalinity	mg/L	120	2	0.046
5	Total hardness	mg/L	300-600	2	0.046
6	Total suspended solids	mg/L	500	1	0.023
7	Calcium carbonate	mg/L	75	2	0.046
8	Magnesium	mg/L	30-100	2	0.046
9	Chloride	mg/L	250-100	3	0.068
10	Nitrates	mg/L	45	5	0.161
11	Sulphates	mg/L	150	4	0.091
12	Dissolved oxygen	mg/L	5	3	0.068
13	Bod	mg/L	5	4	0.091
14	Iron	mg/L	0.3-1	4	0.091
15	Turbidity	mg/L	10	3	0.068
Total = Σw_1 =44					

After computing W_n next A quality rating (Q_n) is computed as folowslows.

$$Q_n = {}^{C_i}/_{S_i} \times 100$$

Where,

Q_n = Quality rating.
C_i = Concentration of each parameter.
S_i = Indian drinking water standards.

Finally after determining Q_n, Subindex is determined for the nth parameter(SI_n).

$$SI_n = W_n \times Q_n$$

With the computation all the required values the WQI is determined from the equation below,

$$WQI = \sum SI_n$$

Table 4: Water quality calculation for K.R Puram Lake for summer season

SI no	Chemical parameters	S_i	W_i	C_i	Q_i	SI_i
1	Ph	6.5-8.5	0.091	7	79.88	7.27
2	Electrical conductivity	75	0.023	1.9	2.53	0.06
3	Total dissolved solids	500-200	0.091	333	66.60	6.06
4	Total alkalinity	120	0.046	125	104.17	4.79
5	Total hardness	300-600	0.046	320	106.67	4.91
6	Total suspended solids	500	0.023	317	63.40	1.46
7	Calcium carbonate	75	0.046	220	293.33	13.49
8	Magnesium	30-100	0.046	100	333.33	15.33
9	Chloride	250-100	0.068	219.99	88.00	5.98
10	Nitrates	45	0.161	21	46.67	7.51
11	Sulphates	150	0.091	20.5	13.67	1.24
12	DO	5	0.068	1.7	34	2.312
13	BOD	5	0.091	4	80.00	7.28
14	Iron	0.3-1	0.091	0.2	66.67	6.07
15	Turbidity	10	0.068	31.9	319	6.596
Water quality index = ΣSIi = 90.37						

Table 5: Water quality calculation for K.R Puram Lake for Winter season

SI no	Chemical parameters	S_i	W_i	C_i	Q_i	SI_i
1	Ph	6.5-8.5	0.091	8.04	94.59	8.61
2	Electrical conductivity	75	0.023	1.4	1.87	0.04
3	Total dissolved solids	500-200	0.091	411	82.20	7.48
4	Total alkalinity	120	0.046	87.5	72.92	3.35
5	Total hardness	300-600	0.046	261.1	87.03	4.00
6	Total suspended solids	500	0.023	541	108.20	2.49
7	Calcium carbonate	75	0.046	211.1	281.47	12.95
8	Magnesium	30-100	0.046	50	166.67	7.67
9	Chloride	250-100	0.068	185	74.00	5.03
10	Nitrates	45	0.161	25.5	56.67	9.12
11	Sulphates	150	0.091	32.5	21.67	1.97
12	DO	5	0.068	2.58	51.6	3.51
13	BOD	5	0.091	4.5	90	8.19
14	Iron	0.3-1	0.091	0.1	33.33	3.03
15	Turbidity	10	0.068	9.7	97	6.60
Water quality index = ΣSIi = 84.05						

Table 6: Water quality calculation for Varthur Lake for Summer season.

SI no	Chemical parameters	S_i	W_i	C_i	Q_i	SI_i
1	Ph	6.5-8.5	0.091	7.54	88.71	8.07
2	Electrical conductivity	75	0.023	1.4	1.87	0.04
3	Total dissolved solids	500-200	0.091	1393	278.60	25.35
4	Total alkalinity	120	0.046	150	125.00	5.75
5	Total hardness	300-600	0.046	440	146.67	6.75
`6	Total suspended solids	500	0.023	251	50.20	1.15
7	Calcium carbonate	75	0.046	400	533.33	24.53
8	Magnesium	30-100	0.046	40	133.33	6.13
9	Chloride	250-100	0.068	115.00	46.00	3.13
10	Nitrates	45	0.161	52	115.56	18.60
11	Sulphates	150	0.091	45.1	30.07	2.74
12	DO	5	0.068	2.38	0.476	0.03
13	BOD	5	0.091	13.3	266	24.21
14	Iron	0.3-1	0.091	0.3	100.00	9.10
15	Turbidity	10	0.068	7.6	76	5.17
Water quality index = ΣSIi = 140.76						

Table 7: Water quality calculation for Varthur Lake for Winter season

Sl no	Chemical parameters	S_i	W_i	C_i	Q_i	SI_i
1	Ph	6.5-8.5	0.091	6.99	82.23529	7.483412
2	Electrical conductivity	75	0.023	1	1.333333	0.030667
3	Total dissolved solids	500-200	0.091	987.12	197.424	17.96558
4	Total alkalinity	120	0.046	111.11	92.59167	4.259217
5	Total hardness	300-600	0.046	440	146.6667	6.746667
6	Total suspended solids	500	0.023	340	68	1.564
7	Calcium carbonate	75	0.046	350	466.6667	21.46667
8	Magnesium	30-100	0.046	40	133.3333	6.133333
9	Chloride	250-100	0.068	100.3	40.12	2.72816
10	Nitrates	45	0.161	48	106.6667	17.17333
11	Sulphates	150	0.091	35.5	23.66667	2.153667
12	DO	5	0.068	3.5	70	4.76
13	BOD	5	0.091	15.01	300.2	27.3182
14	Iron	0.3-1	0.091	0.35	116.6667	10.61667
15	Turbidity	10	0.068	7.2	72	4.896
Water quality index = ΣSIi = 135.3						

4. Graph of results from K.R lake and Vartur lake

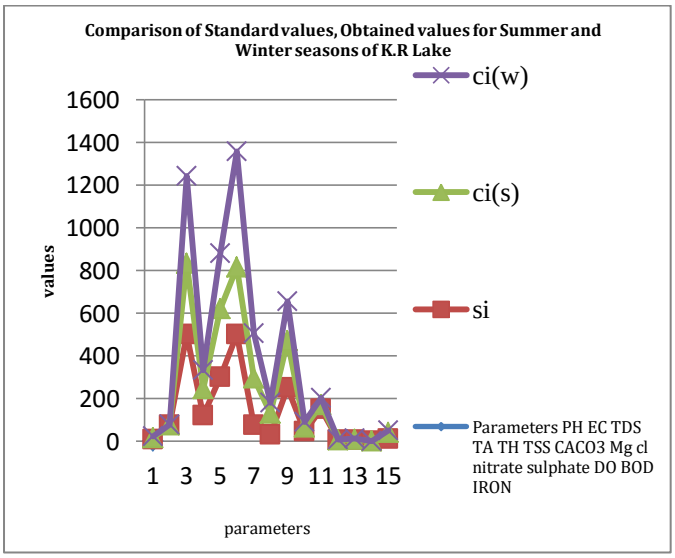

Chart 1: Graph plotted with the chemical parameter values of K.R. Lake.

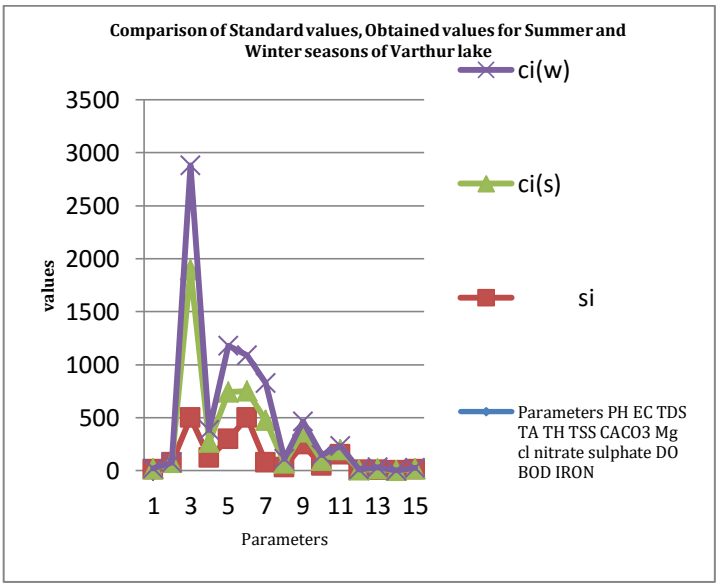

Chart 2: Graph plotted with the chemical parameter values of varthur lake.

Where,

$C_i(S)$ = Concentration of each chemical parameters in summer season.

$C_i(W)$ = Concentration of each chemical parameters in winter season.

S_i = Indian standard drinking water for each chemical parameter in mg/L according to guidelines of the BIS 10500.

TABLE 8: Final water quality rating and the applications.

Obtained water quality index of two different lakes of different seasons (summer and winter) are shown in following table and also it is representing the characteristics and applications of lake water.

Lake	Season	WQI Value	Quality rating	Applications
Vengaihnakere lake	Summer	90.37	Good water	Domestic, Irrigation and industrial uses.
	Winter	84.05	Good water	Domestic, Irrigation and industrial uses.
Varthur lake	Summer	140.76	Poor water	Irrigation
	Winter	135.30	Poor water	Irrigation

3. CONCLUSIONS

- Water quality index is helpful in assessment and management of water quality.
- The present investigation represents the water quality of KR lake and varthur lake, bangalore.
- The case study provides valuable insight into the status of overall suitability of the lake water based on WQI values.
- It highlights the salient features of various important physico-chemical parameters acting upon the general water quality of the river.
- Obtained water quality index of K.R puram lake (Summer) is 90.37 which is good water which can be used for domestic uses, irrigation and industrial purposes.
- Obtained water quality index of K.R puram lake (Winter) is 84.05 which is good water which can be used for domestic uses, irrigation and industrial purposes.
- Obtained water quality index of Varthur lake (Summer) is 140.76 which is poor water which can be used for irrigation and industrial purposes after secondary level treatment with trickling filter or activated sludge process and secondary sedimentation tank.
- Obtained water quality index of Varthur lake (Winter) is 135.30 which is poor water which can be used for irrigation and industrial purposes after secondary level treatment with trickling filter or activated sludge process and secondary sedimentation tank.

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