

Assessment of the Water Quality of Hussain Sagar, Fox Sagar and Kattamysamma Lakes of Hyderabad, Telangana State, India: Using Water Quality Index (WQI)

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ABSTRACT

The present study was carried out to assess the water quality of three lakes of Hyderabad, Telangana State, India viz., Hussain Sagar, Fox Sagar and Kattamysamma Lake by using water quality index (WQI). For this study systematic sampling has been carried out by collecting sixteen samples from each lake. The collected samples were analyzed for physico-chemical parameters like pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Total Hardness (TH), Total Alkalinity (TA), Sodium (Na⁺), Potassium (K⁺), Calcium (Ca²⁺), Magnesium (Mg²⁺), Nitrates (NO₃²⁻), Sulphates (SO₄²⁻), Fluoride (F⁻) and Chloride (Cl⁻) according to Standard Methods for the Examination of Water and Wastewater (APHA 2005) and Central Pollution Control Board (CPCB) guide manual: Water and Waste water analysis. The results were compared with water quality guidelines for drinking purpose (BIS 2012). The mean values of most water quality parameters were significantly higher than the accept limits in all three lakes. Ten important water variables were chosen to calculate Water Quality Index (WQI). All the three lakes fall under unsuitable for drinking purpose (>100) according to WQI scale.

Keywords: Water Quality, Water Quality Index (WQI), Physico-chemical parameters, Systematic sampling, Municipal sewage, Industrial effluents.

INTRODUCTION

Water - the main source of life and one of the most important natural resource of the ecosystem¹. Lakes are the major sources of drinking and domestic usage for rural and urban population of India. A lake is a watershed area in which its quality depends upon every component of that ecosystem. The health of lakes and their biological diversity are directly related to health of almost every component of the ecosystem². Topography of the surrounding area, soil, geology and vegetation determine the kind of materials entering into lake which indicates the water quality³. In present scenario, the contamination and degradation of lake ecosystems has increased

manifold due to various anthropogenic activities like urbanization, industrialization, discharge of domestic sewage, untreated industrial effluents, idol immersion and encroachment of Lake Watershed area. The effects of water pollution are not only devastating to people but also to animals, fish and birds⁴ and causing serious disturbance to the biodiversity of the lake environment.

Water quality assessment has become a critical issue in the last decades^{5,6,7,8,9,10,11,12}. Therefore regular monitoring of the lake water in terms of quality assessment is mandatory to control the pollution to earliest either experimentally or through mathematical modeling. Water quality index

is one of the most effective tools to communicate information on the quality of any water body¹³. It is basically a dimensionless number that combines multiple water-quality factors into a single number by normalizing values to subjective rating curves. It is a widely used communication tool which summarizes water quality data in an effective and understandable way for to the general public¹⁴.

The present study was undertaken to enumerate water quality of the three lakes viz., Hussain Sagar, Fox Sagar and Kattamysamma lake of Hyderabad city using mathematical aggregation of water quality index (WQI) as an indicator of the environmental quality and to classify based on the Indian standards. There is no previous classification study based on the WQI scores on these Lakes.

MATERIALS AND METHODOLOGY

Sample Collection

Three different lakes such as Hussain Sagar Lake, Fox Sagar Lake and Kattamysamma

Lake in Hyderabad, Telangana State, India were selected for study (Figure.1). Hussain Sagar Lake is located $17^{\circ}25'22''\text{N}$, $78^{\circ}28'28''\text{E}$ at an elevation 510 m in the heart of twin cities of Hyderabad and Secunderabad. It is, built during 1550-1580 AD¹⁵. It is 3.2 km long and 2.8 km wide; its depth ranging from 2.5 to 12.5 m with a surface area of 446 hectares. Fox Sagar Lake local name is Jeedimetla cheruvu or Kolla Cheruvu is the fifth largest lake in India spreading about 2 km². Situated ($17^{\circ}30'-17^{\circ}20'\text{N}$ and $78^{\circ}30'-78^{\circ}20'\text{E}$) 1 km west of Hyderabad-Nizamabad road at Jeedimetla near Kompally in Hyderabad^{1, 16}. Kattamysamma Lake is also known as Gandimysamma Lake is situated between $17^{\circ}33'-17^{\circ}42'\text{N}$ and $78^{\circ}26'-78^{\circ}20'\text{E}$ near Medak highway in Sooraram, Hyderabad. Systematic sampling (sixteen samples from each lake which covers entire lake) was carried during monsoon season (September-October) in the year 2014.

Study of Physico-Chemical parameters

The physico-chemical parameters were analyzed as per the Standard Methods for

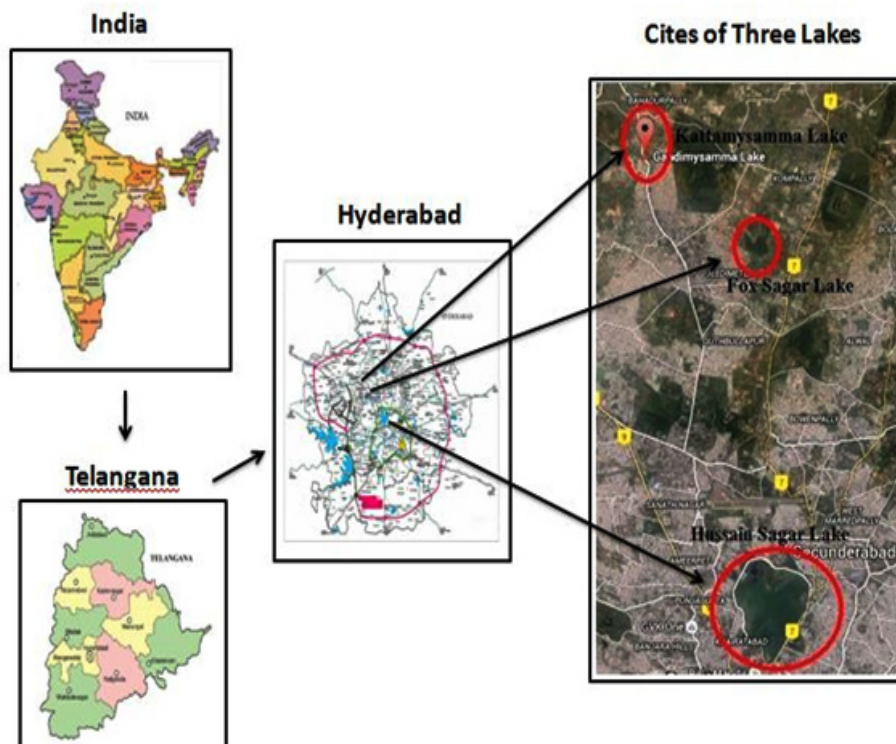


Fig.1: Location Map of the study area

Examination of Water and Wastewater¹⁷ and Guide manual: Water and Waste water analysis¹⁸. In situ measures such as pH, EC of the water samples were determined on the spot using pH meter and conductivity meter respectively. The laboratory analyses such as cations Calcium (Ca²⁺) and Magnesium (Mg²⁺) were analyzed by complexometric titration method using ethylene diamine tetra acetic acid (EDTA). Sodium (Na⁺) and Potassium (K⁺) were analyzed using flame photometry. The anions Carbonate (CO₃²⁻) and Bicarbonate (HCO₃⁻) were analyzed by acid-base volumetric titration using sulfuric acid (H₂SO₄) and the chloride ions (Cl⁻) were analyzed by argent-metric titration using silver nitrate (AgNO₃). Nitrates (NO₃²⁻) and Fluoride (F⁻) were analyzed by using nitrate and fluoride ion selective electrodes respectively. Sulphates (SO₄²⁻) analyzed by using UV-Visible spectrophotometer.

Calculation of Water Quality Index (WQI)

In the present study, for the calculation of WQI, ten physico-chemical parameters viz., pH, TDS, TH, TA, Ca²⁺, Mg²⁺, NO₃²⁻, SO₄²⁻, F⁻ and Cl⁻ were chosen. The WQI has been calculated by using water quality guidelines for drinking purpose¹⁹. The Weight Arithmetic Water Quality Index method has been used for calculation WQI of three lakes.

The overall WQI is determined by using Eq. (1)

$$WQI = \frac{\sum W_i Q_i}{\sum W_i}$$

The unit weight (W_i) for each water quality parameter is calculated by using the following expression:

$$W_i = K/S_i$$

Where, K is proportionality constant and is determined by using the following formula:

$$K = 1/\sum [1/S_i]$$

S_i is the standard permissible value of the i th parameter. The quality rating (Q_i) of Eq. (1) is calculated as under:

$$Q_i = 100[(V_i - V_0 / S_i - V_0)]$$

Where, V_i is estimated concentration of the i th parameter in the analyzed water and V_0 is the ideal value of this parameter in pure water. All ideal

Table 1: Physico-Chemical parameters of three lakes and comparison with standard values

S.No	Parameters	Hussain Sagar Lake	Fox Sagar Lake	Kattamy Samma Lake	BIS (2012)
1	pH	8.0	7.7	7.5	6.5-8.5
2	EC	1506	1313	1421	1500
3	TDS	964	840	1266	500
4	TH	214	281	402	200
5	TA	467	342	347	200
6	Na+	96	165	131	200
7	K+	18	13	15	-
8	Ca ²⁺	134	53	129	75
9	Mg ²⁺	20	36	20	30
10	NO ₃ ⁻	72	14	28	45
11	SO ₄ ²⁻	77	39	123	200
12	F ⁻	1.7	1.9	1.02	1
13	Cl ⁻	270	600	268	250

values are taken as zero for drinking water, except pH = 7.0.

RESULTS AND DISCUSSION

In this study, WQI for three lakes was evaluated to assess the water quality of these lakes. The results of various physicochemical parameters and their standard values (BIS 2012) were presented

in Table.1. WQI for Hussain Sagar, Fox Sagar and Kattamysamma Lakes were presented in Table.2, Table.3 and Table.4 respectively. WQI and status of Water quality were presented in Table.5. The graphical representation of WQI for three lakes is shown in Figure.2.

TDS, TH, TA, F, Cl⁻ values in all the three lakes, Ca²⁺ in Hussain Sagar and Kattamysamma

Table 2: Calculation of Water Quality Index (WQI) for Hussain Sagar lake

S. No	Parameters	Observed Value (V _i)	Standard Value (S _i)	Allocated Value (w _i)	Unit Weight (W _i)	Quality rating (Q _i)	W _i Q _i
1	pH	8	6.5-8.5	4	0.1212	66.67	8.08
2	TDS	964	500	4	0.1212	192.80	23.37
3	TA	467	200	3	0.0909	233.50	21.23
4	TH	214	200	2	0.0606	107.00	6.48
5	Ca ²⁺	134	75	2	0.0606	178.67	10.83
6	Mg ²⁺	20	30	2	0.0606	66.67	4.04
7	NO ₃ ⁻	72	45	5	0.1515	160.00	24.24
8	SO ₄ ²⁻	77	250	4	0.1212	30.80	3.73
9	F ⁻	1.7	1	4	0.1212	170.00	20.61
10	Cl ⁻	270	250	3	0.0909	108.00	9.82
				Σw _i =	ΣW _i	ΣQ _i =	ΣW _i Q _i =
				33	=1	1314.1	132.43

$$WQI = \frac{\sum W_i Q_i}{\sum W_i} = 132.43$$

Table 3: Calculation of Water Quality Index (WQI) for Fox Sagar Lake

S. No	Parameters	Observed Value (V _i)	Standard Value (S _i)	Allocated Value (w _i)	Unit Weight (W _i)	Quality rating (Q _i)	W _i Q _i
1	pH	7.7	6.5-8.5	4	0.1212	46.67	5.66
2	TDS	840	500	4	0.1212	168	20.36
3	TA	342	200	3	0.0909	171	15.55
4	TH	281	200	2	0.0606	140.5	8.52
5	Ca ²⁺	53	75	2	0.0606	70.67	4.28
6	Mg ²⁺	36	30	2	0.0606	120	7.27
7	NO ₃ ⁻	14	45	5	0.1515	31.11	4.71
8	SO ₄ ²⁻	39	250	4	0.1212	15.6	1.89
9	F ⁻	1.9	1	4	0.1212	190	23.03
10	Cl ⁻	600	250	3	0.0909	240	21.82
				Σw _i =	ΣW _i	ΣQ _i =	ΣW _i Q _i =
				33	=1	1193.54	113.09

$$WQI = \frac{\sum W_i Q_i}{\sum W_i} = 113.09$$

Table 4: Calculation of Water Quality Index (WQI) for Kattamysamma Lake

S. No	Parameters	Observed Value (V _i)	Standard Value (S _i)	Allocated Value (w _i)	Unit Weight (W _i)	Quality rating (Q _i)	WiQi
1	pH	7.5	6.5-8.5	4	0.1212	33.33	4.04
2	TDS	910	500	4	0.1212	182	22.06
3	TA	347	200	3	0.0909	173.5	15.77
4	TH	345	200	2	0.0606	172.5	10.45
5	Ca ²⁺	129	75	2	0.0606	172	10.42
6	Mg ²⁺	20	30	2	0.0606	66.67	4.04
7	NO ₃ ²⁻	28	45	5	0.1515	62.22	9.43
8	SO ₄ ²⁻	123	250	4	0.1212	49.2	5.96
9	F ⁻	1.02	1	4	0.1212	102	12.36
10	Cl ⁻	268	250	3	0.0909	107.2	9.75
				Σw _i =	ΣW _i	ΣQ _i =	ΣW _i Q _i =
				33	=1	1120.62	104.29

$WQI = \frac{\sum W_i Q_i}{\sum W_i} = 104.29$

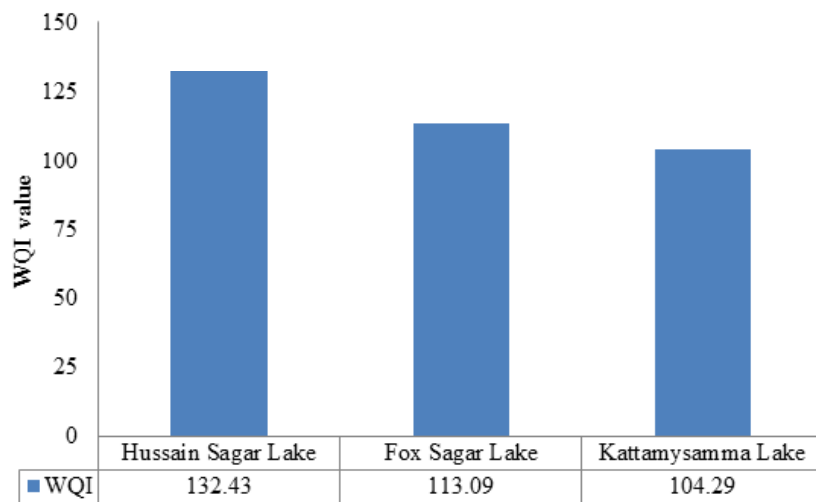


Fig. 2: Graphical representation of WQI of three lakes

Table 5: Water Quality Index (WQI) and status of Water quality

WQI scale	Grading	Water Quality status
0-25	A	Excellent water quality
26-50	B	Good water quality
51-75	C	Poor water quality
76-100	D	Very Poor water quality
>100	E	Unsuitable for drinking purpose

lakes, Mg²⁺ in Fox Sagar and Nitrates in the Hussain Sagar were found to be exceeding the acceptable limit¹⁹.

The WQI values of Hussain Sagar, Fox Sagar and Kattamysamma Lakes were 132.43, 113.09, and 104.29 respectively. The highest value of WQI was observed in Hussain Sagar while lowest value was observed in Kattamysamma Lake. WQI of all three lakes, falling under E grade and unsuitable for drinking purpose category (WQI > 100) (Table.5).

Discharge of untreated municipal sewage, industrial waste water into these lakes and religious activities like immersion of Gods and Goddess idols made by Plaster of Paris (POP) are responsible for the contamination of these three lakes.

CONCLUSION

Water quality index proposed in this work use ten parameters to evaluate the water quality of three lakes and this can be used as a useful tool for watershed management and aquatic body monitoring. On the basis of the above discussions,

it is concluded that the WQI for all the three lakes were found as unsuitable for drinking purpose.

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