

A STUDY ON THE PHYSICO-CHEMICAL CHARACTERISTICS OF KOTITIRTH LAKE WATER IN KOLHAPUR CITY, MS, INDIA

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Abstract

In the present work lake water samples are collected from four different stations of Kotitirth lake in Kolhapur city and water quality assessment is carried out from September 2016 to February 2017 on weekly basis in order to assess the environmental impact of disposal of domestic, industrial, household and religious waste into the lake. Then water quality index (WQI) study is carried out to assess the environmental impact on the water quality of the Kotitirth lake and to arrive at the level of pollution. From the study it is observed that station-1, 2, 3 & 4 are excessively polluted and are totally unfit for drinking purpose. This is mainly due to regular addition of domestic sewage, industrial wastes and other wastes that are let into the lake and it may lead to excessive pollution.

Keywords: Coefficient of variation, physico-chemical, water quality index.

1. INTRODUCTION

Lakes are inland depressions comprising of standing enclosed water bodies which are being strongly influenced by the local climate. Lakes have always been of great importance to mankind being the valuable natural resources. Lakes are used by humans for many commercial purposes, including fishing, transportation, irrigation, industrial water supplies and receiving waters for waste water effluents. Aside from their importance for human use, lakes have intrinsic ecological and environmental values. They moderate the temperatures and affect the climate of surrounding land; they store water, thereby helping to regulate stream flow, recharge ground waters aquifers, and moderate droughts.

In India, the lake systems are getting polluted day by day. As the water flows downstream, it picks up silt, minerals, and mineral salts from the soil. Many other pollutants enter lake water as it flows downstream, including animal waste, human sewage, agricultural runoff, urban runoff due to which unfortunately, most of the lakes are facing pollution problems. Hence, it is an unkeep interest to clean lake water.

Kolhapur city is a prominent city of South Western Maharashtra, is rapidly emerging as a leading industrial and commercial centre. Kolhapur city is blessed with a number of lakes which are quite useful for the irrigation and domestic purposes also. For the present study Kotitirth Lake (16°41'39"N 74°14'12"E) is selected for the collection of water samples for further analysis. Kotitirth Lake is located in the nearby area of Shivaji Udyam Nagar, Kolhapur & it covers nearly 5.77 Hectares area in the vicinity of Shivaji Udyam Nagar, Kolhapur. Due to merging of the runoff from the nearby areas, discharge of wastewater from the nearby industrial area of Udyam Nagar and due to bathing, cloth

washing, immersion of Ganesh idols, dumping of flowers, garlands and other waste matter, and use of the lake water for domestic purposes, the lake is highly contaminated now a days.

Thus, it is essential to assess the water quality of Kotitirth Lake and suggest suitable remedial measures for improving the same. The present study aims in an investigation in the physico-chemical parameter analysis of Kotitirth Lake, and to find the possible reasons of deteriorated water quality of this lake. Also the study aims at developing a statistical approach for mathematical modelling so as to predict the water quality parameters in future.

2. STUDY AREA

The geographical area of Kolhapur district is about 7685 Sq. km, and the population of the district is 35, 15,413 of which Kolhapur city's population is about 5, 00, 000. There are 12 Tahasils, 09 Municipal councils, one Municipal corporation and 1200 villages in Kolhapur district. Kolhapur City (16° 42' N; 74° 14' E, Height: 570 m), stands on rising ground on the south bank of the river Panchaganga, bounded on the north by the Panchaganga river, on the east by the boundaries of Uchgaon village, on the south by the boundaries of Kalamba and Pachgaon villages and on the west by the boundaries of Nave Balinge, Padali and Shingnapur villages and by the Panchaganga river.

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It is said that about 5 acres of land is covered by Kotitirth lake water. Though this lake is having historical value now it is abounded by cluster type of settlement particularly Panzer pole, part of Udyam nagar, Shahu mill etc. Residences of these settlements are performing all their day-to-day work e.g. bathing, cloth washing, immersion of Ganesh idols, dumping of flowers, garlands and other waste matter which finely increases pollution of lake water. A steam from the Shahu mill area supplies the water to this lake. Beside there are few natural infiltration source of water to this lake which create potential threats to the lake.

Sampling of water from Kotitirth lake at selected 4 stations is being done on a weekly basis. Manual method of sample collection is preferred considering all site conditions. Station-1 is located near the Shahu mill, Udyam Nagar. Station-2 is located about 100 meters downstream of Station 1. Station-3 is located near the Koteshwar Temple and Station-4 is located about 130 meters downstream of Station 3.

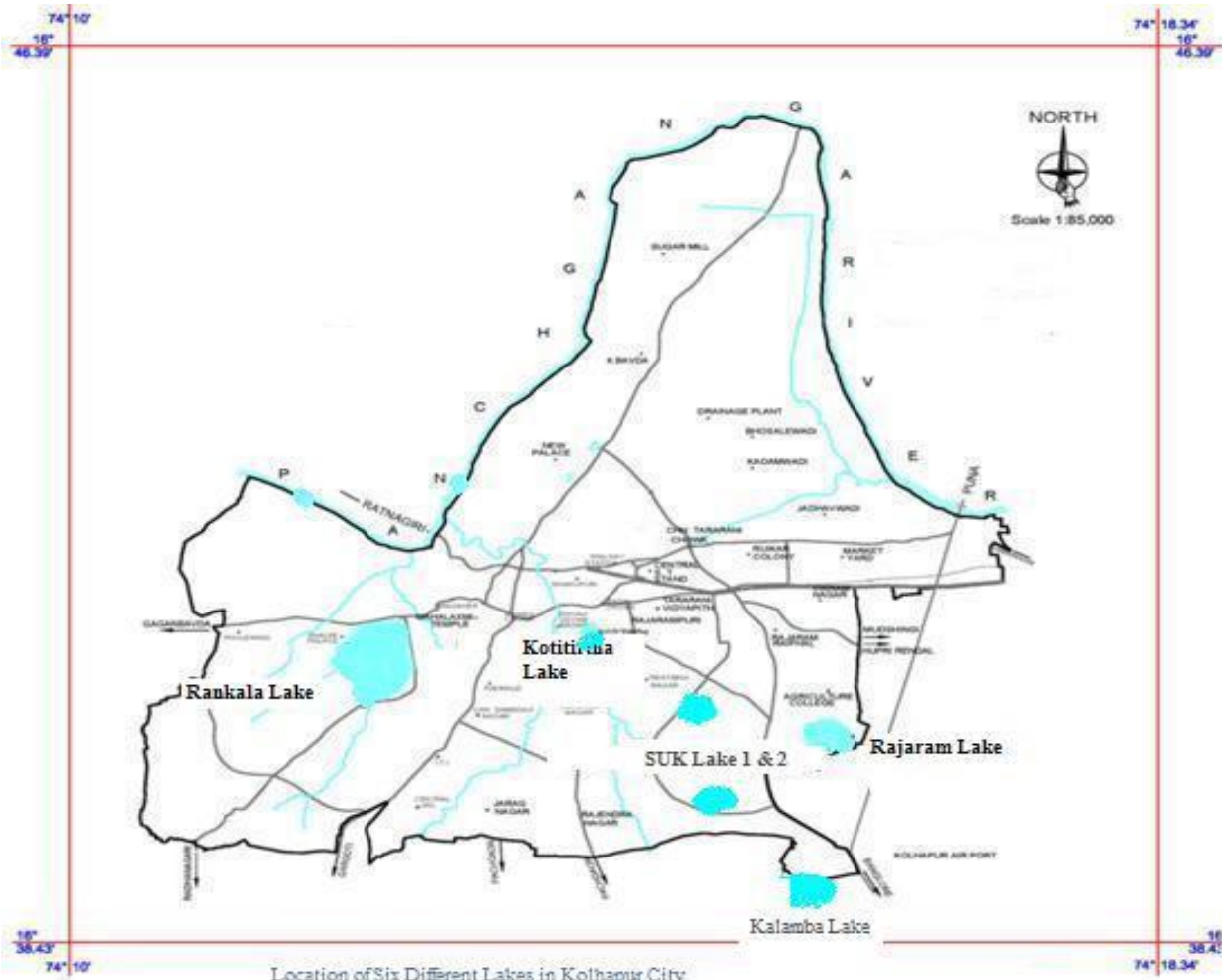


Fig 1: Location of kotitirth lake in kolhapur city, Maharashtra state (India)

3. MATERIALS AND METHODS

It is said that about 5 acres of land is covered by Kotitirth lake water. Though this lake is having historical value now it is abounded by cluster type of settlement particularly Panzer pole, part of Udyam nagar, Shahu mill etc. Residences of these settlements are performing all their day-to-day work e.g. bathing, cloth washing, immersion of Ganesh idols, dumping of religious waste, garlands and other waste matter which finely increases pollution of lake water. Besides, there are few natural infiltration source of water to this lake which creates potential threats to the lake.

In order to assess the environmental impact on the Kotitirth lake water quality four stations are selected and 4 lake water samples are collected for the laboratory analysis and physico-chemical water quality analysis is carried out. The Temperature, pH, Electrical Conductivity (EC), Turbidity, Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Alkalinity, Acidity, Hardness & Chlorides are measured in the laboratory. Because the preservatives interferes the chemical processes, no preservatives are used. Only in case of samples for DO tests, the DO is fixed at site and temperature is recorded on site only. In order to check the level of the pollution at each station the drinking water quality standards (desirable limits) as prescribed by IS-

10500, (1991) are selected for the determination of water quality index (WQI) in the present study. To calculate WQI, the product of rating scale (Vr) and unit weights (Wi) are summated.

$$WQI = \sum W_i \times V_r$$

Water quality index is calculated in this way for each station. WQI falling within the range 0-39.99 stood for severely polluted water; between 40-59.99 for excessively polluted water; between 60-79.99 for moderately polluted water; between 80-99.99 for slightly polluted, and 100 for absolutely clean water.

Table 1: Rating scale (Vr) and unit weights (Wi) for the physico-chemical parameters

PARAMETER	CLASS-I	CLASS-II	CLASS-III	CLASS-IV	CLASS-V	WEIGHTING (Wi)
pH	6.5-8.5	>8.5-8.7	>8.7-8.9	>8.9-9.1	>9.1	0.1447
		6.3- <6.5	6.1- <6.3	5.9- <6.1	<5.9	
TDS	0-250	>250-500	>500-750	>750-1000	>1000	0.00246
TURBIDITY	0-10	>10-20	>20-30	>30-40	>40	0.0492
DO	>5.0	4.6-5.0	4.1->4.5	3.0-4.0	<3.0	0.246
BOD	0-3.0	3.1-4.0	4.1-5.0	5.1-6.0	>6.0	0.410
COD	0-10	11-15	16-20	21-25	>25	0.123
HARDNESS	0-100	101-200	201-300	301-400	>400	5.040×10^{-3}
ALKALINITY	0-200	201-300	301-400	401-500	>500	7.561×10^{-3}
RATING SCALE (Vr)	100	80	60	40	0	

Table 2: Range of rating scale (Vr) and significance for the physico-chemical parameters

Range of Rating Scale (Vr)	Significance
100	Clean
80-99.99	Slightly Polluted
60-79.99	Moderately Polluted
40-59.99	Excessively Polluted
Excessively Polluted	Severely Polluted

Table 3: Water quality index (WQI) for the lake water sampling stations

STATION NAME	WQI= $\sum W_i \times V_r$	DESIGNATION (WATER QUALITY)
STATION 1	45.40	Excessively Polluted
STATION 2	42.50	Excessively Polluted
STATION 3	45.40	Excessively Polluted
STATION 4	42.50	Excessively Polluted

4. RESULTS AND DISCUSSION

The water quality analysis of Kotitirth lake water has been carried out from the month of September, 2016 to February 2017 for the predefined four sampling stations. It is observed that the Physico-chemical and biological characteristic features of this lake have been significantly altered by human activities as well as natural dynamics which consequently affect the water quality and quantity, biodiversity and ecological imbalance. The mean values of the water quality parameters at four different stations with their desirable limits as per IS 10500, (1991) and coefficient of variation (CV %) obtained in the statistical analysis is shown in table no.4. Temperature values are ranging from 19°C to 29°C. It is observed that the water temperature is within the desirable limit and the CV is very low and there is a very small variation in the temperature. The pH values

vary from 7.7 to 9.4. Here it is observed that in the month of November & December pH values for all Stations fall within the desirable limit. The CV for pH indicates that the range of variation is narrow. Electrical conductivity (EC) values fluctuated in the range 2630.040 to 3569.340 $\mu\text{mhos/cm}$. The CV for EC is narrow and the variation is also less. Turbidity values fluctuated in the range of 7.800 to 9.870 NTU. It is observed that the turbidity values are within the desirable limit and CV is also less which shows there is narrow range of variation. The TDS values are ranging from 105 to 395 mg/l and these values fall within the desirable limit. The CV for TDS indicates that the variation is high. The dissolved oxygen values fluctuated from 7.400 to 13.700 mg/l and fall within the desirable limit. The CV for DO indicates that the variation is high. The biochemical oxygen demand values are fluctuating from

station to station and are ranging from 32.000 to 82.000 mg/l. It is observed that the BOD values are more than the desirable limit and the CV reveals that the variation in BOD is slightly higher. The chemical oxygen demand values are ranging from 30.000 to 72.340 mg/l and it is observed that the COD values are more than the desirable limit and the CV obtained is slightly higher and there is a slight variation in COD values. The Alkalinity values fluctuated from 85.2 to 195.50 mg/l and fall within the desirable limit. The CV for Alkalinity indicates that the variation is high. The Acidity values are ranging from 20.600 to 50.100 mg/l and CV obtained is slightly higher and there is a slight variation in acidity values. The Hardness values are ranging from 82.000 to 135.000 mg/l. It is observed that the hardness values are within the desirable limit and the CV reveals that the variation in hardness is higher. The Chlorides values are ranging from 40.000 to 63.200 mg/l and these values fall

within the desirable limit. The CV obtained for chlorides slightly higher.

The water quality index (WQI) of the collected water samples is calculated to arrive at the level of pollution. However, the WQI depends on the intended use of the water. Rating scale (Vr) and unit weights (Wi) are shown in table no.1. Then the range of rating scale (Vr) and its significance for the physico-chemical parameters of lake water is tabulated in table no. 2 and the WQI of lake water samples at 4 stations of Kotitirth Lake are presented in table no. 3. From the study it is observed that station-1 (WQI = 45.40), station-2 (WQI = 42.50), station-3 (WQI = 45.40) and station-4 (WQI = 42.50) are found to be excessively polluted and are totally unfit for drinking purpose. This is mainly due to regular addition of domestic sewage, religious wastes and other wastes that are let into the lake and it may lead to excessive pollution.

Table 4: Coefficient of Variation (CV %) for the lake water samples

Sr. No.	Parameters	Desirable limits as per IS 10500:1991	Station 1			Station 2			Station 3			Station 4		
			Mean	S. D.	CV %	Mean	S. D.	CV %	Mean	S. D.	CV %	Mean	S. D.	CV %
1	Temperature °C	40°C	22.909	3.624	15.820	22.705	2.802	12.339	22.750	2.802	12.316	22.705	2.856	12.580
2	pH	6.5-8.5	8.463	0.366	4.327	8.542	0.423	4.957	8.496	0.337	3.967	8.562	0.322	3.766
3	EC µmhos/cm	-	3072.735	303.86	9.889	3075.320	208.84	6.791	3069.431	232.59	7.578	3065.450	262.50	8.563
4	TDS mg/l	Max 500 mg/lit.	216.364	77.892	36.000	210.409	73.859	35.103	213.727	75.380	35.269	209.955	79.544	37.886
5	Turbidity NTU	25 NTU	8.895	0.463	5.200	8.945	0.409	4.571	8.868	0.471	5.314	8.848	0.378	4.271
6	DO mg/l	Min. 5.0 mg/lit.	9.430	1.419	15.051	9.330	1.318	14.131	9.451	1.422	15.043	9.486	1.444	15.217
7	BOD mg/l	Max. 3.0mg/lit.	57.501	11.394	19.816	58.016	11.230	19.356	57.991	10.377	17.895	58.306	10.836	18.584
8	COD mg/l	Max. 10 mg/lit	48.873	10.041	20.545	49.347	9.445	19.141	50.425	9.266	18.376	48.330	8.613	17.822
9	Alkalinity mg/l	Max 200 mg/lit.	140.736	30.052	21.354	140.945	30.923	21.939	140.714	30.033	21.344	139.650	29.792	21.333
10	Acidity mg/l	-	30.774	6.527	21.210	29.706	5.652	19.026	30.894	5.736	18.566	31.427	7.084	22.541
11	Hardness mg/l	Max 300 mg/lit.	109.682	14.039	12.799	109.545	12.719	11.611	111.124	13.026	11.722	111.625	12.528	11.223
12	Chlorides mg/l	Max 200 mg/lit.	49.707	6.699	13.476	50.066	6.378	12.739	49.375	6.908	13.991	49.549	6.498	13.114

(Source: S. K. Maithi; "Handbook on Water and Wastewater Analysis", Maharashtra Pollution Control Board)

5. CONCLUSION

The present study is aimed to assess the environmental impacts on the Kotitirth lake water quality and to check the level of pollution at the located stations. From the results of present investigation it is concluded that due to merging of the runoff from the nearby areas, discharge of wastewater from the nearby industrial area of Udyam Nagar and due to

bathing, cloth washing, immersion of Ganesh idols, dumping of religious waste, garlands and other waste matter, and use of the lake water for domestic purposes, the lake is highly contaminated now a days. Despite of all these facts, anthropogenic activities are depleting quality and aesthetic value of this lake. The coefficient of variation (CV %) on water quality parameters revealed that the variation in most of the parameters is high and which do not fall within

the desirable limit range. As per table no.4, the water quality index study revealed that the water quality index (WQI) for station-1 & 3 is 45.40 and for station-2 & 4, it is 42.50 which indicates that water is excessively polluted and are totally unfit for drinking purpose.

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