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Evaluation of Physico-Chemical Characteristics of Water Quality of Rajaram Lake in Kolhapur

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Abstract

In the present work lake water samples are collected from Rajaram lake in Kolhapur city and water quality assessment is carried out on weekly basis for the four different stations. The observed values of different water quality parameters are compared with the desirable limits as per IS-10500, (1991). Then the Water Quality Index (WQI) study is carried out to assess the environmental impact on the water quality of this lake and to arrive at the level of pollution. From the study it is observed that Station-1, Station-2, Station-3 and Station-4 are found to be excessively polluted and are totally unfit for drinking purpose. This is mainly due to regular addition of domestic sewage, runoff from the nearby areas, immersion of Ganesh idols, dumping of religious waste, garlands and other waste matter from nearby area in each station and it may lead to excessive pollution.

Keywords: Coefficient of Variation, Physico-Chemical, Rating Score, Unit Weight, Water Quality Index

Introduction

Water is known to contain large number of chemical elements. The interaction of both physical and chemical properties of water play a significant role in composition, distribution and abundance of aquatic community. Characteristics of water bodies influence the quality of water individually and in combination with various pollutants, thereby, influencing the biota therein. Lakes are the best „available fresh water source on the Earth"s surface." Lakes are used by humans for many purposes. 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. They provide habitat to aquatic and semi aquatic animals and plants which in turn provide food for many terrestrial animals; and they add to the diversity of landscape. Therefore, we can freely access only the water in lakes.

Kolhapur city is a prominent city of south-western Maharashtra, is rapidly emerging as a leading industrial and commercial centre. The development of city created directly or indirectly a number of water quality problems. The city once supposed to have 40 small and large lakes is presently left with only few. These lakes have potential to sustain variety of biota. As the water from these lakes is used for various purposes there is need to study the physico-chemical and biological parameters.

Rajaram lake was built in 1928 in memories of Shri Rajaram Chhatrapati Maharaja, covering 21.6 hectares of area in the vicinity of Shivaji University in Kolhapur city. This lake is facing a problem of pollution due to various activities viz. increasing settlements in the upstream side, idol immersions, bathing and washing of cloths, animals, vehicles. There are 12 sites in the city where the nirmalya and idols are immersed. Rajaram lake is one of the water body out of 12 sites where immersion of ganesh idols, durga idols and disposal of religious waste is at a higher level. Various Religious activities during festivals produce solid waste in the form of nirmalya and idols. The idols made up of plaster of paris changes the physico-chemical composition of water body. The idols once immersed in the water, the chemicals starts getting into the water. Heavy metals like copper, zinc, lead, chromium and iron get dissolved in the river water leading to water pollution. This also has negative impact on the biodiversity of the lake causing ecological imbalance. Hence it is worthwhile to assess the physico-chemical characteristics of Rajaram lake water to study its possible environmental impacts.

Study Area

Kolhapur city is located at 16° 42' N and 74° 14' E, having mean sea level of 570 m. Kolhapur city is blessed with a number of lakes, which are highly useful for various purposes. Rajaram lake is situated

at latitude 16º40‟48.25” N and longitude 74º15‟49.90” E, and near the National Highway No.4 (NH-04). The lake is designed to store 38 million cubic feet of water and covers 21.6 hectares in the vicinity of Shivaji University in Kolhapur city. The length of Rajaram lake is 1250 m and covers about 5400 acre area somewhat fan shaped with rocky shore line and depth of about 30 m. The lake water is basically used for irrigation, activities like bathing, washing of animals and idol immersion even though it is prohibited. Increasing idol immersions activities, bathing and washing of cloths, animals, vehicles in the lake are the potential threats to the lake and its biodiversity. For the present study along the stretch of the Rajaram lake four water sampling stations namely; Station-1, Station-2, Station-3 and Station-4 are selected and sampling of water is being done on a weekly basis to determine the lake water quality and to carry out a trend analysis in order to assess the impact on water quality. Manual method of sample collection is preferred considering all site conditions.

Materials and Methods

Due to fast change in land use and nature and magnitude of water quality problems, the existing methodologies may not be appropriate to cover enough water quality information for a given water body. It is utmost important that more attention towards quality assurance program in sampling, analysis and reporting of data is needed. Due to merging of the runoff from the nearby areas, due to 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. Thus, it is essential to assess the water quality and suggest suitable remedial measures for improving the water quality of Rajaram lake.

It is against this background that the present study aims in an investigation in the physico-chemical parameter analysis of this lake, and to find the possible reasons of deteriorated water quality. Also the study aims at the determination of Water Quality Index to check the level of pollution at selected stations.

In order to assess the environmental impact of such activities on Rajaram lake water quality, four points are selected and water samples are collected for the laboratory analysis and water quality assessment is carried out for the parameters such as, pH, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Total Solids (TS), Electrical Conductivity (EC), Hardness, Acidity, Alkalinity, Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD). 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 in the present study. To calculate WQI, the product of rating scale (Vr) and unit weights (Wi) are summated.

$$WQI = \sum Wi\ X\ Vr$$

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.

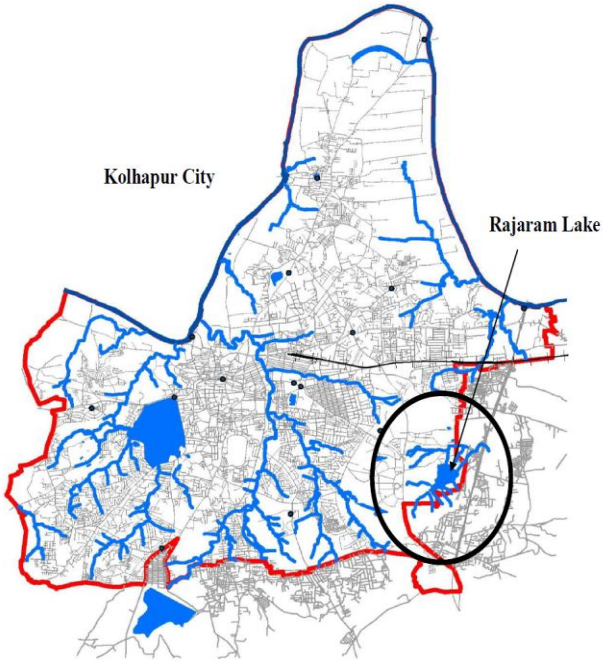

Figure 1: Location map of Rajaram lake

Table 1(a): Coefficient of variation of the lake water

Parameter	Station-1		Station-2	
	Mean	CV %	Mean	CV %
pH	8.484	3.66	8.427	3.50
EC	2985.362	10.94	2909.956	6.61
Hardness	73.091	11.29	82.273	18.12
Alkalinity	150.927	20.81	154.418	13.35
Acidity	32.227	27.90	30.955	25.49
TS	264.545	27.53	305.455	20.76
TDS	159.091	28.14	175.000	14.82
TSS	153.636	21.10	173.182	15.99
DO	16.283	16.89	16.873	13.90
BOD	50.709	26.20	42.064	18.26

(All parameters are expressed in mg/l except EC in µmhos/cm and pH)

Table 1(b): Coefficient of variation of the lake water

Parameter	Station-3		Station-4	
	Mean	CV%	Mean	CV%
pH	8.565	3.76	8.585	2.87
EC	2964.031	7.49	3050.886	6.22
Hardness	76.909	3.99	82.545	15.24
Alkalinity	157.409	9.58	152.073	17.66
Acidity	31.500	21.50	31.364	18.35
TS	255.455	18.78	276.818	10.77
TDS	170.000	15.54	178.636	10.61
TSS	162.727	14.11	162.727	13.56
DO	11.259	17.68	9.635	9.11
BOD	49.058	20.84	49.408	23.01

(All parameters are expressed in mg/l except EC in µmhos/cm and pH)

Table 2(a): Rating scale (Vr) classes for the different physico-chemical parameters

Parameter	Class-1	Class-2	Class-3
pH	6.5-8.5	8.6-8.7	8.8-8.9
		6.3-6.4	6.1-6.2
TDS	0-250	251-500	501-750
DO	>5.0	4.6-5.0	4.1-4.5
BOD	0-3.0	3.1-4.0	4.1-5.0
Hardness	0-100	101-200	201-300
Alkalinity	0-200	201-300	301-400
Rating Scale	**100**	**80**	**60**

Table 2(b): Rating scale (Vr) classes for the different physico-chemical parameters

Parameter	Class-4	Class-5
pH	9.0-9.1	>9.1
	5.9-6.0	<6.0
TDS	751-1000	>1000
DO	3.0-4.0	<3.0
BOD	5.1-6.0	>6.0
Hardness	301-400	>400
Alkalinity	401-500	>500
Rating Scale	**40**	**0**

Table 3: Unit weights (Wi) for the different physico-chemical parameters

Parameter	Unit Weights (Wi)
pH	0.178
TDS	3.024×10^{-3}
DO	0.3025
BOD	0.504
Hardness	5.040×10^{-3}
Alkalinity	7.561×10^{-3}

Table 4: Rating scale (Vr) and the significance of pollution level

Rating Scale (Vr)	Significance
100	Clean
80-99.99	Slightly Polluted
60-79.99	Moderately Polluted
40-59.99	Excessively Polluted
0-39.99	Severely Polluted

Table 5: Water Quality Index (WQI) for the lake water sampling stations

Station No.	WQI	Water Quality
Station-1	49.61	Excessively Polluted
Station-2	49.61	Excessively Polluted
Station-3	46.05	Excessively Polluted
Station-4	46.05	Excessively Polluted

Results and Conclusion

From the results presented in table 1(a) and 1(b), it is concluded that, the physico-chemical characteristics of Rajaram 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 coefficient of variation, (CV%) on water quality parameters revealed that the variation in Alkalinity, Acidity, Total Dissolved Solids, Total Suspended Solids, Total Solids and Biochemical Oxygen Demand is towards higher level. This study revealed that there is variation in values but the trend is same as that of the observed values. The study also helps in selecting the treatments to minimize contaminants in lake water.

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 2 and 3 respectively. Then the range of rating scale (Vr) and its significance for the physico-chemical parameters of river water is tabulated in table 4 and the WQI of river water samples at 4 stations of Rajaram lake are presented in table 5. From the study it is observed that, the Water Quality Index for Station-1 (WQI = 49.61), Station-2 (WQI = 49.61), Station-3 (WQI = 46.05), Station-4 (WQI = 46.05) are found to be excessively polluted and are totally unfit for drinking purpose. This is mainly due to regular addition of domestic sewage, runoff from the nearby areas, immersion of Ganesh idols, dumping of religious waste, garlands and other waste matter from nearby area in each station and it may lead to excessive pollution.

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