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Evaluation of water quality index of Upper Lake - A Ramsar site

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ABSTRACT

During the present survey some physicochemical properties of Upper Lake, Bhopal were investigated in order to assess its water quality status. Physicochemical parameters which were analyzed throughout the study include pH, TDS, dissolved oxygen, total alkalinity, total hardness and nitrate. It was found that the overall water quality of Upper Lake comes under 'Fair' to 'Poor' quality at all the sampling stations. The major sources of pollution in this lake were sewage, agricultural runoff and other anthropogenic activities.

Key words*:* Ramsar site, Upper Lake, Water quality index, pollution.

INTRODUCTION

Water is a natural resource available to us. All living organisms on earth need water for their survival and growth. Humans are using it for benefits in numerous ways [1]. The water is available to us for consumption, washing, irrigation, hydroelectricity generation [2]. Water supports population in many ways. But due to increased human population, industrialization, use of fertilizers in the agriculture and other anthropogenic activities it gets highly polluted [3]. Therefore it is necessary that the quality of drinking water should be checked at regular interval of time because contaminated drinking water may cause different water born diseases to human population [4, 5].

Upper Lake is a fresh water lake in the city of lakes, Bhopal. It is a source of drinking water for population of Bhopal. It is an artificial lake. In last few decades it came into notice that its water quality is deteriorated. Hence, it became imperative to study the changes brought in this water body so far [6]. In the present study, an attempt has been made to know the present status of water quality of Upper Lake - a Ramsar site.

MATERIALS AND METHODS

Study area

The present study was conducted on Upper Lake, Bhopal which is the capital city of the state Madhya Pradesh, India and also known as 'City of Lakes'. The Upper Lake is an east-westerly elongated, shallow lake with dense growth of macrophytes. The location of Upper Lake is between latitude $23°10' - 23° - 20'N$ and longitude $77°15' - 77°25'$E with the catchment area of 361 km. The maximum depth of lake is 13 m and minimum depth is 0.34 m and above 503 msl. During the present study, the samples for analysis of water quality of Upper Lake were collected between 7:00 am to 4:00 pm from six sampling stations. The details of stations are given below:

Table 1: Showing physical stations at different stations			
S. No.	**Stations**	**Name of stations**	**Physical conditions**
1.	Station-I	Kamla park	Bathing, washing
2.	Station-II	Hamidia	Hospital waste, sewage
3.	Station-III	Garam gadda	Macrophytes
4.	Station-IV	Central zone	No human interference
5.	Station-V	Van vihar	Agricultural waste
6.	Station-VI	Boat club	Inorganic waste

Methodology

Water samples were analyzed for various physicochemical parameters. The methods were followed from scientific methods given in books and manuals [7,8].

Water quality index

Water quality index is an efficient mathematical method to interpret status of water quality [9]. The water quality index was calculated by following equation [19] :

$$\mathbf{WQI = \Sigma q_i W_i \; / \; \Sigma W_i}$$

$W_i = K / Si$

Where,

W_i = unit weight for nth parameters
S_i = standard value for nth parameters
K = constant for proportionality

$q_i = 100(Vi - V_{10}) / (Si - V_{10})$

Where,
q_i = quality rating for the nth water quality parameter
S_i= standard permissible value of nth parameter
V_i = estimated value of the nth parameter at a given sampling station
V_{10}= ideal value of *n*th parameter in pure water

All the ideal values are taken as zero (except for pH=7.0 and dissolved oxygen=14.6mgl$^{-1)}$

Table 2: Showing water quality index legends	
Range	**Quality**
90-100	Excellent
71-90	Good
51-70	Medium
26-50	Fair
0-25	Poor

RESULTS AND DISCUSSION

The present work includes the detailed structure of physicochemical parameters depicting water quality status of Upper Lake – A Ramsar site, Bhopal. Different physicochemical aspects play a crucial role in ecology of aquatic ecosystems [10]. The values of various parameters vary at different stations in Upper Lake. In the present study, air temperature ranged between 23^{0}C to 32.5^{0}C and water temperature ranged between 22^{0}C to 34.5^{0}C. pH is the most important and commonly studied property of natural water and waste water. In Upper Lake pH ranged between 5 to 9.1. Similar pH values ranged between 6.7 to 8.1 were also recorded by some experts [11]. All the samples of lake water are slightly acidic to alkaline in nature. In the present study, TDS ranged between 110 to 180 ppm with minimum value recorded at Station-I and the maximum value was recorded 180 at Station-II due to anthropogenic activities like washing [5]. Similar values ranged from 40 to 80 mgl -1 were also reported in some other lentic water bodies [11]. The concentration of oxygen in saturated water depends upon the temperature of water. During the present investigation, dissolved oxygen ranged between 5.6 to 8.5. The minimum value was recorded at Station-II and the maximum was recorded at Station-IV. The total alkalinity is largely governed by the chemical composition

of the aquatic ecosystem [12]. In the present investigation, the total alkalinity was recorded between 82 to 135 mgl^{-1}. The alkalinity values between 110 mgl-1 to 215 mgl-1 were reported in Kayad Lake, Rajasthan [13]. Some workers also reported similar findings in the study of the Halali Reservoir which favors the present findings [14]. The main sources of nitrate in water are industrial effluents, use of fertilizers and discharge of sewage [15]. In the present study, the value of nitrate ranged between 0.25 to 0.78 mgl^{-1}. The minimum value was recorded at Station-IV and maximum value was recorded at Station-II. It was observed that surface water have much lower nitrate concentration than dug well waters [16]. Detailed observations of physicochemical properties were given in Table 3. During the present investigation the water quality status based on six variables showed that the water quality in Upper Lake comes under 'poor' to 'fair' water quality. The WQI values ranged from 10.89 to 49.82 at all the stations during the present study. The highest value was calculated at Kamla Park while the lowest value at Hamidia. It is inferred from the results that the overall quality of water is poor to fair at all the sampling stations in Upper Lake. Similar observations were observed by other workers while their study on Upper Lake [12, 15].

It was observed that water of Upper Lake at Station-II is highly polluted and less polluted at the rest of the stations. The pollution of the water at Station-II is due to the incoming of sewage and effluents from the hospital lying near. Likewise, Station-V receives the inorganic and dead organic matter with the surface runoff making it polluted [12,18].The water of Upper Lake is unsuitable for direct drinking, bathing and other domestic uses so, in order to make it suitable certain positive steps should be taken. In some other lakes of Bhopal, water quality parameters were assessed and it was revealed that the water of those lakes is also highly contaminated and not suitable for drinking purposes as it receives a large amount of raw sewage from its densely populated habitation [5].

Table 3: Showing mean values of physicochemical parameters in Upper Lake

Mean	Station-I	Station-II	Station-III	Station-IV	Station-V	Station-VI
pH	8.3	5.5	6.67	8.13	6	5.9
TDS	126.67	153.33	138.33	128	137.33	139.33
Dissolved oxygen	6.8	6.33	6.4	7.56	7.23	7.16
Total hardness	61.33	66.67	55.67	56	50.33	60.67
Total alkalinity	123.33	108	106.33	119.33	104	103
Nitrate	0.42	0.63	0.50	0.34	0.53	0.46

Table 4:Showing estimated value of quality rating (q_i) in Upper Lake

Parameters	Station-I	Station-II	Station-III	Station-IV	Station-V	Station-VI
pH	86.67	-100	-22	75.33	-66.66	-73.33
TDS	25.334	30.666	138.33	138.33	138.33	138.33
Dissolved oxygen	81.25	86.14	85.41	73.33	76.77	77.5
Total hardness	20.44	22.22	55.67	55.67	55.67	55.67
Total alkalinity	61.66	54	106.33	106.33	106.33	106.33
Nitrate	0.93	1.4	1.11	0.75	1.17	1.02

Table 5:Showing water quality status of Upper Lake

Parameters	Station-I	Station-II	Station-III	Station-IV	Station-V	Station-VI
pH	18.90	-21.81	-4.79	16.43	-14.54	-15.99
TDS	0.0939	0.113	0.512	0.512	0.512	0.512
Dissolved oxygen	30.12	31.94	31.67	27.19	28.46	28.73
Total hardness	0.126	0.137	0.340	0.344	0.339	0.341
Total alkalinity	0.571	0.500	0.985	0.985	0.985	0.985
Nitrate	0.006	0.010	0.008	0.005	0.008	0.007
∑qi Wi	**49.82**	**10.89**	**28.72**	**45.47**	**15.77**	**14.59**
WQI Legend	**26-50**	**0-25**	**26-50**	**26-50**	**0-25**	**0-25**
WQI Status	**Fair**	**Poor**	**Fair**	**Fair**	**Poor**	**Poor**

CONCLUSION

It was concluded during the study that with the advancement of time the water of Upper Lake eventually become polluted. The present findings revealed that the water quality status of Upper Lake is deteriorated gradually as also reported by many workers [15, 17]. Thus, the there is need of effective check on the inflow of sewage and other wastes at various stations in Upper Lake.

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