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Studies on Physico-Chemical Characteristics of the Madhav Lake, Shivpuri, M.P., India

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Abstract: *Limnological study was carried out on Madhav Lake of Shivpuri town and it is one of the ancient man made water bodies of the town. Physico-chemical characteristics of Madhav Lake were studied for a period of twelve months from January, 2013 to December, 2013. The present investigation is focused on the determination of water quality parameter such as Temperature, pH, Conductivity, DO, Chloride, TDS, Hardness, Carbonate, Bicarbonate, Calcium, Magnesium, Sodium, Potassium, Iron, Sulfates, Chloride, Nitrates and Fluoride. From the results obtained the lake is polluted freshwater body due to the continuous discharge of municipal sewage and runoff. The pollution of lake becomes noticeable in the form of visible changes of the Lake Environment as well as water quality tests.*

Keywords: *Limnology, Madhav Lake, Water quality, Pollution, Physico-chemical characteristics, Madhav National Park.*

I. Introduction

India has vast fresh water resources in the form of both lentic and lotic ecosystems. The lentic ecosystems include ponds, lakes, tanks and reservoirs. The perennial reservoirs play an important role for domestic, agriculture and aquaculture as a valuable water resource. The lentic ecosystems have long attracted attention of ecologists, both for their importance as a source of drinking water and the development of fisheries (Beckerman, 2014). To employ scientific method for aquaculture, understanding of environmental conditions prevailing in the water body is essential. Therefore, the attention is given on the physico-chemical factors which affect fishes and other aquatic inhabitants (Alaka, 2014). Wetlands are very productive ecosystems, which help in the regulation of biological cycles, maintenance of water quality, nutrient movement and support for food chains. In addition, they provide refuge for endangered species of plants and animals and economic benefits such as fish breeding. Wetlands reduce the impact of floods by acting as storage areas. Stored water percolates downward, getting purified in the process, and replenishes the groundwater but our wetlands are shrinking rapidly because of mans need for space. They are reclaimed for construction purposes to erect industrial colonies and to dump urban wastes, therefore the present concern. The quality of water is of vital concern for mankind since it is clearly linked with human welfare. The natural aquatic resources are causing heavy and varied pollution in aquatic environment leading to pollute water quality and depletion of aquatic biota (Basavaraja et al., 2011). Pollution refers to undesirable changes in the physical, chemical or biological characteristics of our environment namely air, water and soil. This has adversely affected the humans and other species of our biosphere directly or indirectly (Kuzhali et al., 2012).

II. Materials and Methods

Area of study

Deep inside the Madhav National Park, Shivpuri an 'M' shaped water body is situated which is named Madhav Lake. This is man-made lake spread about 49 hectares and surrounded by thick growth of trees and bushes. It is located 9.6 km. from Shivpuri town on Shivpuri-Jhansi National Highway near village Ghasari. The Madhav Lake has steep rocky bank and is surrounded by trees. The eastern side of the lake is bounded with masonry wall and water from this lake for drinking purposes is drawn from this side. It is situated about 500 meters away from the eastern side of the Sakhya Sagar Lake and connects with it by a canal. Madhav Lake has mound area inside the water where trees, bushes and reeds grown up well. Water from this lake used to be released for irrigation during Rabi Crop and a minimum level of water was maintained in the lake to ensure water supply to the Shivpuri town. The water spread area fluctuates due to irregular rainfall and extensive usage of water (Fig. 1).

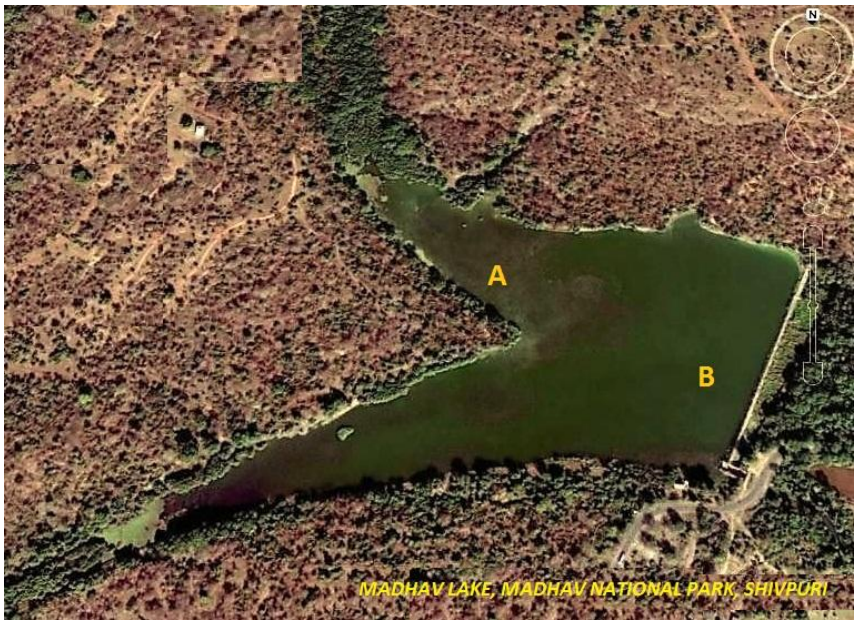

Fig. 1: Map of Madhav Lake located inside the Madhav National Park, Shivpuri

Salient Features of the Madhav Lake	
Name of water body	**Madhav Lake**
Town (District)	**Shivpuri (9.6 km. eastern of town)**
Basin	**Yamuna**
Sub Basin	**Sindh**
Construction Period	**Year of Starting - 1915**
	Year of Completion - 1918
Geographical Position	**Latitude - 20º - 26'N**
	Longitude - 77º - 44'E
Topo Sheet No.	**54-G/11**
Catchment Area	**1.29 Sq. Km**
Submergence Area	**217.00 Ha.**
Principle Levels	
Top of Bond Level (T.B.L.)	**330.48m**
Maximum Water Level (M.W.L.)	**229.87m**
Full Tank Level (F.T.L.)	**228.65m**
Lowest Sill Level (L.S.L.)	**323.17m**
Length of Dam	**630 m**
Maximum height of Dam	**7. 31m**
Top width of Dam	**2 m**
Type of Dam	**Masonry**

Methodology

Water samples were collected for physico-chemical analysis from two sampling stations at the Madhav Lake. Samples were taken once every month from January, 2013 to December, 2013. Water samples were collected in one liter plastic bottles and collection was usually completed during morning hours between 6:00 a.m. to 10:00 a.m. For each sampling event, temperature, pH and dissolved oxygen were monitored at the sampling sites while Chloride, Conductivity, TDS, Hardness, Carbonate, Bicarbonate, Calcium, Magnesium, Sodium, Potassium, Iron, Sulfates, Nitrates and Fluoride were analyzed in the laboratory in accordance with APHA (1989); Trivedy & Goel (1986).

III. Result and Discussion

The results are shown in table no. 1 and 2.

pH: The maximum pH recorded was 8.2 in the April and minimum 7.4 in November at the sampling station A. The pH considered an important environmental factor. According to Hora and Pillay (1962) the pH variation is mostly due to diurnal interplay of photosynthesis and community respiration of the biota and also is one of the most important single factors, which influences aquatic production.

Temperature: Temperature is a vital parameter for growth of organisms. It plays an important role in the physico-chemical and physiological behavior of the aquatic system. It also influences the metabolic behavior of aquatic ecosystem, Welch (1952), Alaka (2013). The maximum value of temperature was recorded to be 33.5 °C in the month of June at the both sampling stations A and B and minimum 19 °C in January at sampling station A.

Conductivity: Maximum value of conductivity was recorded to be 540 mhos/cm in May and minimum 390 mhos/cm in October at sampling station A. It is a measure of how well the water can conduct an electrical current. Conductivity increases with increasing amount and mobility of ions. These ions come from the breakdown of compounds. Therefore it is an indirect measure of the presence of dissolved solids such as nutrients and can be used as an indicator of water pollution (Shivayogimath et al., 2012).

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Dissolved Oxygen: Maximum DO was recorded to be 8.6 ppm in January and minimum 5.4 ppm in June at sampling station B. In any aquatic ecosystem the level of DO depends on the factors like temperature of water, concentration of dissolved solids and biological activity of all life.

TDS: Total dissolved solids denote mainly the various kinds of minerals available in the water. In natural waters dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, sulfates, phosphates, nitrate, calcium, magnesium, sodium, potassium and iron (Esmaeili and Johal, 2005). In the present investigation maximum value of TDS was recorded in April (595 mg/l) at sampling station B and minimum value of (510 mg/l) was observed in October at sampling station A.

Hardness: Maximum value of hardness was recorded to be 392 mg/l in June and minimum 250 mg/l in September at sampling station A. Major Contribution of hardness comes from calcium and magnesium, Rath et al., (2000).

Carbonate: Maximum value of carbonates was recorded to be 12 mg/l in May and minimum 04 mg/l in January at sampling station A.

Bicarbonate: Maximum value of bicarbonate was recorded to be 540 mg/l in October at sampling station B and minimum 280 in January at sampling station A.

Calcium: Calcium is one of the most abundant substances of the natural water. In aquatic environment calcium serves as one of the micronutrients for most of the organisms (Shah and Shah, 2013). Calcium concentration in Madhav Lake was maximum 165 mg/l in May at sampling station B and minimum 85 mg/l in January at sampling station A.

Magnesium: Magnesium was maximum 30 ppm in October at sampling station A and minimum 16 ppm in January at sampling station B. Magnesium is essential for chlorophyll bearing organism, since it goes into composition of the pigments. Decrease value of magnesium may be due to plankton and algal uptake Rath et al., (2000).

Sodium: Maximum value of sodium was recorded to be 105 ppm in September month at the sampling station B and minimum 40 ppm in January at sampling station A.

Potassium: The maximum value of potassium was recorded to be 18 mg/l in July at sampling station A and minimum value of 05 mg/l in January at both sampling station A and B. Potassium plays a vital role in metabolism of fish environment and is an important macronutrient.

Iron: Maximum value of iron was recorded to be 0.6 ppm in May and minimum value of 0.2 ppm in February at sampling station A.

Sulfates: The maximum value of sulfate was recorded to be 180 mg/l in July at sampling station B and minimum value of 50 in January at sampling station A. Rain was has quite high concentration of sulfate particularly in the areas with high atmospheric pollution. Discharge of industrial waste and domestic sewage in water tends to increase its concentration. A high concentration of sulfate stimulates the action of sulfur reducing bacteria, which produce hydrogen sulfide, a gas highly toxic to fish life.

Chloride: The maximum chloride was recorded to be 390 mg/l in June and minimum 220 mg/l in January at sampling station A. Large amount of chloride in freshwater is an indicator of organic pollution. The result shows higher concentration in summer and lower in winter season. The pattern has also been recorded by Lendhe and Yeragi (2004) and Chavan et al., (2004).

Nitrate: Nitrate is one of the most important nutrients in aquatic ecosystem. High concentration of nitrates is useful in irrigation but there entry in to the water resources increases the growth of nuisance algae and triggers eutrophication and pollution (Gupta and Ahirwar 2013). The maximum Nitrate was recorded to be 22 mg/l in July at both sampling station A and minimum 05 mg/l in February at sampling station A.

Fluoride: The maximum fluoride was recorded to be 0.7 ppm in August at sampling station A and minimum 0.2 ppm in February at both sampling station A and B.

From the results obtained, it can be concluded that the Madhav Lake is polluted freshwater body due to the continuous discharge of municipal sewage and runoff. Higher amount of nutrients leads to eutrophication. More nutrients in the water body and makes the water unfit for human consumption. Local peoples are ignorantly polluting the lakes and the dreadful conditions of the lakes are also visible from the study. Due to high organic matter contamination hydrophytes are growing drastically and deposited into the lake after death which consequently reducing the depth of the lake day by day. If present condition is continue for the longer period, very soon the lakes will become ecologically barren. So concern authority should take firm decision on urgent basis to resolve the problems of the lake. The results obtained from the present investigation shall be useful in future management of the lake. It is also recommended that a periodical survey is essential to find out the water quality and carryout abatement programs.

Table- 1: **Analytical results of physico-chemical parameters of Madhav Lake, Shivpuri during January, 2013 to December, 2013 at sampling station 'A'**

Parameters	Units	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
pH	-	7.8	7.6	7.6	8.2	7.8	7.6	7.3	7.3	7.5	7.6	7.4	7.7
Temperature	C	19	20.5	26	31	33	33.5	32	28	27	25.5	25	21
Conductivity	mhos	400	430	465	510	540	510	412	405	385	390	398	422
DO	ppm	8.2	8.2	7.9	7.6	6.2	5.6	5.7	7.4	7.8	7.2	7.5	7.6
TDS	mg/l	520	540	585	535	542	562	580	560	573	548	510	512
Hardness	mg/l	280	260	360	372	430	410	365	350	285	270	310	340
Carbonate	mg/l	4	5	9	12	12	8	10	6	5	5	6	9
Bicarbonate	mg/l	280	285	310	385	390	410	430	490	480	535	360	335
Calcium	ppm	85	90	110	130	145	120	95	90	110	120	125	105
Magnesium	ppm	22	23	30	28	25	21	19	20	22	30	25	23
Sodium	ppm	40	42	45	50	62	45	65	72	85	90	95	78
Potassium	ppm	5	8	8	10	12	12	18	8	6	10	12	14
Iron	ppm	0.4	0.2	0.4	0.3	0.6	0.5	0.5	0.3	0.3	0.4	0.4	0.5
Sulfates	mg/l	50	55	65	98	105	115	135	120	105	78	102	110
Chloride	mg/l	220	285	265	260	365	390	285	310	285	265	250	255
Nitrates	mg/l	8	5	12	14	10	18	22	18	12	12	14	18
Fluoride	mg/l	0.2	0.2	0.4	0.5	0.5	0.4	0.2	0.7	0.5	0.4	0.5	0.3

Table- 2: Analytical results of physico-chemical parameters of Madhav Lake, Shivpuri during January, 2013 to December, 2013 at sampling station 'B'

Parameters	Units	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
pH	-	7.6	7.7	7.6	7.7	7.8	7.8	7.4	7.4	7.4	7.5	7.4	7.6
Temperature	C	19.4	20.3	25.5	30.5	33	33.5	31.5	27.8	27	25.2	24.5	20.5
Conductivity	mhos	380	390	395	410	433	485	430	390	375	365	350	378
DO	ppm	8.6	8.3	7.5	7.6	6.5	5.4	5.9	7.6	7.9	7.9	7.7	7.9
TDS	mg/l	510	520	508	595	530	560	525	510	535	545	585	545
Hardness	mg/l	265	252	310	345	385	392	342	315	250	265	285	310
Carbonate	mg/l	4	5	8	14	11	6	8	8	6	6	7	8
Bicarbonate	mg/l	265	272	290	365	375	390	385	398	425	540	350	320
Calcium	ppm	65	75	105	100	165	135	85	75	65	95	105	90
Magnesium	ppm	16	22	28	25	24	22	22	21	18	25	24	20
Sodium	ppm	30	42	45	50	62	45	65	72	105	90	95	78
Potassium	ppm	5	8	8	10	12	12	16	8	6	10	12	14
Iron	ppm	0.3	0.2	0.5	0.3	0.5	0.5	0.5	0.1	0.3	0.2	0.2	0.4
Sulfates	mg/l	40	42	55	87	95	102	180	95	100	85	85	92
Chloride	mg/l	230	280	280	265	310	320	300	287	268	256	238	232
Nitrates	mg/l	6	8	10	12	8	15	17	22	18	13	11	16
Fluoride	mg/l	0.2	0.2	0.3	0.4	0.3	0.3	0.4	0.5	0.4	0.6	0.5	0.5

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