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## RESEARCH ARTICLE

## The Study of Physico-Chemical Properties of Sahapura Lake, Bhopal (India)

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**Key words:**Lake, Physicochemical,  
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The present study objectively conducted to analysis the physico-chemical parameters of Sahapura Lake. For this study the water samples were collected from five sampling stations during the June to November 2006. The range of physico-chemical parameters were observed Temperature (24.7-36.6) °C, Conductivity (280-380)  $\mu$  mhos /cum , Total Dissolved Solid (345 - 388) mg/l, pH (7.0-8.6), Free CO<sub>2</sub> 8.9-16 mg/l, Free alkalinity (14-31) mg/l, Total alkalinity (120-265) mg/l, DO (3.2-7.5) mg/l, BOD (2.6-15.2) mg/l, COD (14-45) mg/l, Chloride (10-39) mg/l, Calcium hardness (89-135) mg/l, Total hardness (100-289) mg/l, Nitrate-nitrogen (0.60-2.9) mg/l during the study. The analysed result is compared with permissible limits as prescribed by WHO, BIS for drinking water quality. It was concluded that temperature, pH, total alkalinity, dissolved oxygen, biological oxygen demand, chemical oxygen demand, calcium hardness beyond the prescribed limits of WHO and BIS. It is indicating for increasing in pollution of Sahapura Lake, which need control industrial waste, sewage discharge and human activity in the water body.

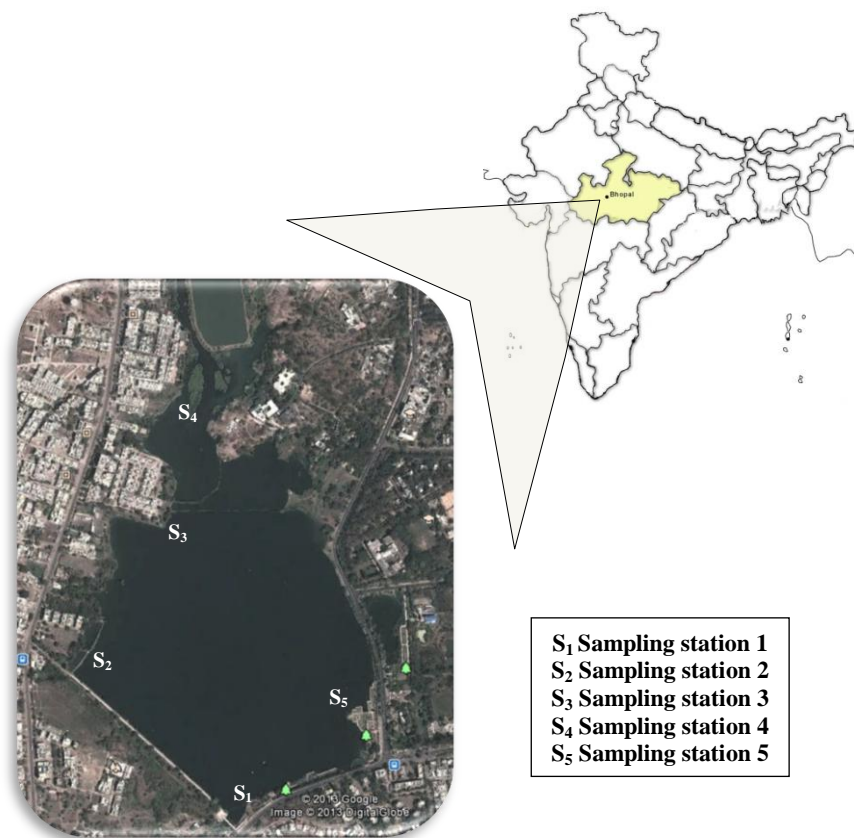
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**Introduction**

Water is essential for life on earth without it, life is impossible. Water, due to its great solvent power, is constantly threatened to get polluted easily. The requirement of water in all forms of lives, from micro-organisms to man, is a serious problem today because all water resources have been reached to a point of crisis due to unplanned urbanization and industrialization Singh, *et. al.*, (2002). Sahapura lake situated in the center of Bhopal city, and lies at latitude 23°12'00" E and longitude 77°25'30" N. The area has a subtropical climate with pronounced summer, winter and rainy seasons. The lake is shallow ecosystem, mostly muddy due to the accumulation of silt. The main inlet the Nalla joins the lake at its northern end. Total catchments area 8.29 km<sup>2</sup>, depth 6 m , mean depth 6017 m, maximum length 3 km, Full reservoirs level 72.07 m cum, Submerged area 0.965 km, Gross stroge 2.29 cum. Several studies have been conducted to understand the physical and chemical properties of lakes. The physical and chemical properties of freshwater body are characterized by the climatic, geochemical, geomorphological and pollution conditions. Various physico-chemical parameters were studied to analyse the water quality of the lake. The pollution of this lake is a matter of great concern, since it has reached an alarming level due to inflow of large volume sewage and solid wastes. The lake receives a large amount of raw sewage from its densely populated habitation. The water body is a eutrophic lake where the amount of nutrient is very high and oxygen depletion is prominent (Varughese *et al.*, 2004). Anaerobic conditions predominate throughout extensive areas of highly eutrophic lakes observed by Hutchinson (1975). Hypolimnion is often observed with the phenomenon of frequent oxygen depletion with the consequent increase in BOD, COD reported by Pani and Misra (2000). Johri (1990) studied the limnological and water quality status of two lakes of Bhopal. Saxena (1990) assessed the limnological and water quality status of Lower Lake of Bhopal.

## Material and Methods

For this study the water samples were collected from different five sampling stations as depicted in Figure. 1 at monthly interval from June to November 2006. The water samples were collected in the morning hours from these sampling stations of lake. In each samples pH, temperature, and dissolved oxygen were analyzed *in situ* while the samples for Conductivity, Total Dissolved Solids, Free CO<sub>2</sub>, free alkalinity, Total alkalinity, BOD, COD, Chloride, Calcium hardness, Total hardness and Nitrate-nitrogen were preserved and analyzed at research laboratory of departmental. For these water sample were preserved and analyzed the standard methods of APHA (1995) were followed.



**Figure1. Map of Study area (Sahapura Lake of Bhopal)**

## Result and Discussion

It is fact that maintenance of healthy aquatic ecosystem is dependent on the physico-chemical properties of water. The physico-chemical properties of the lake were summarized in Table 1.

### Temperature

Temperature is one of the most important ecological factors, which controls the physiological behavior and distribution of organisms. In present study, lowest value of water temperature found in November 24.7°C and highest in July 36.6 °C (Fig 2a) while the average temperature 29.75 ±0.591 that shows the optimum ranged for growth of aquatic fauna and flora. This result agrees with the reported by Swaranlatha and Rai (1998) in Banjara Lake.

### Electrical Conductivity

Conductivity is the measure of mineral content, in present investigation, lowest value (280) µmho/cm September and high value (376) µmho/cm in June (Fig 2b) with the average Conductivity was 311.3 ± 5.100.

Similar observation found by Naik *et al.*, (2012) conductivity(136.75-154.25) respectively in Kunigal Lake of Karnataka.

#### **Total dissolved solids (TDS)**

TDS is measure of all the dissolved substances, both organic and inorganic in water. The lowest TDS was observed in October 345 mg/l and high in September 388 mg/l (Fig 2c) while the average TDS in the lake was  $377.65 \pm 1.915$ . Similar results were also reported by Chaturbhuj *et al.*, (2004) in the Jamwa Ramgarh Lake, Jaipur.

#### **pH**

In the Sahapura lake lowest (7) in November and highest (8.4) in September (Fig 2d) with the average value of pH  $7.61 \pm 0.078$ . pH regulated most of biological processes and bio-chemical reactions. Scuthorpe (1967) has reported that pH, free CO<sub>2</sub> and ammonia are more critical factors in the survival of aquatic plants and fish than the oxygen supply. Chaturbhuj *et al.*, (2004) that present study was support in the observations.

#### **Free CO<sub>2</sub>**

Free carbon dioxide showed an irregular pattern in the lake which reflects less load of organic matter in water. In the present investigation, minimum (8.9) mg/l October and maximum (12.8) mg/l September (Fig 2e) while the average Free CO<sub>2</sub> in the lake was  $11.28 \pm 0.300$ . According to Gang (1994) reported similar occasional presence of free carbon dioxide in some water bodies of Jodhpur, Rajasthan.

#### **Free alkalinity**

Free alkalinity of water is usually caused by carbonate, bicarbonate and hydroxyl ions and less frequently by borates, silicate and phosphates (APHA, 1995). In the present study, it varied from (14 to 31) mg/l. Low value 14 mg/l November while it was high 31 mg/l September (Fig 2 f) and the average value of Free alkalinity was  $20.25 \pm 0.954$  mg/l.

#### **Total alkalinity**

Total alkalinity of water is the quality of water and kinds of components present in water such as bicarbonate, carbonate and hydroxide. Spence (1967) classified the lake into three categories based on alkalinity. On the basis of this classification, Sahapura lake considered as a nutrient rich lake because during the present investigation the lowest value of total alkalinity was observed in August 120 mg/l and high value in November 265 mg/l (Fig 2g) with the average  $211.1 \pm 6.821$ .

#### **Dissolved oxygen**

Dissolved oxygen is an important limnological parameter indicating level of water quality and organic production in the lake. It ranged was 3.5 to 7.5 mg/l, lowest value of DO was observed in July 3.5 mg/l and highest value in November 7.5 mg/l (Fig 2h) while the average DO in the lake was  $4.69 \pm 0.221$  mg/l. The results were reviewed by the observation from Kumar (2009) in the Jawahar Sagar Lake.

#### **Biochemical oxygen demand**

Biochemical oxygen demand determines the amount of oxygen required for biological oxidation of organic matter with the help of microbial activities. In the present study, lowest value of BOD was recorded in June 2.6 mg/l and high value in October 15.2 mg/l (Fig 2i) while the average BOD<sub>in</sub> the lake  $5.045 \pm 0.401$ . The similar result was observed by Agarwal and Rajwar (2010) in the Tehri dam.

#### **Chemical oxygen demand**

Chemical oxygen demand determines the amount of oxygen required for chemical oxidation of most organic matter and oxidizable inorganic substances with the help of strong chemical oxidant. In present investigation, Low value of COD (14) mg/l July and high in October (48) mg/l (Fig 2j) while the average COD in the lake was  $28 \pm 1.575$ . These results were in conformity with the study of Mathur *et al.*, (2009) found the similar COD in Pushkar Lake, Ajmer.

#### **Chloride**

Chloride is found widely distributed in nature in the form of salt sodium, potassium and calcium. The chloride status in water is indicative of pollution, especially of animal origin. In the present investigation, It varied from (10-39) mg/l. Minimum Chloride in June 10 mg/l and maximum value recorded in September 39 mg/l (Fig 2k)

while the average  $30.35 \pm 1.421$ . Zutshi and Khan (1988) attributed high chloride values due to bathing activity and urination in the Dal Lake.

### Calcium hardness

Calcium is essential for all the organisms. It is required as micronutrient for algae and important nutrient for the metabolism of plants. In present study, the lowest (89) mg/l in November and high (135) mg/l in July (Fig 2l) with the mean value  $110.3 \pm 2.577$ . Ohle (1934) observed that the biota of the lakes in north Germany to be good when calcium ranged between 10 to 25 mg/l and very good to rich if the calcium exceeded 25 mg/l. The present studies also supported the findings of Ohle (1934).

### Total hardness

The hardness of water is mainly governed by the content of calcium and magnesium which largely combine with bicarbonates & carbonates (temporary hardness) and with sulphate, chlorides and other anions of minerals (permanent hardness). In the present study, it ranged was 100-289 mg/l. The minimum and maximum value in the month of June to October respectively (Fig 2m) While the average value  $288.55 \pm 11.898$ . Kannan (1991) has classified water on the basis of hardness and Sahapura Lake comes under the category of very hard.

### Nitrate-nitrogen

Nitrate-nitrogen is basic nutrient, which is determined the productivity of lake. The value of Nitrate-N was observed in June 0.6 mg/l was low and in July 2.9 mg/l was high (Fig 2n) while the average Nitrate-N in the lake was  $1.08 \pm 0.120$ . Similar results were found by Sahu *et. al.*, (2007) from Daphrin hospital discharge, sagar Madhya Pradesh.

**Table1. Statistics description of the analyzed physico-chemical parameters.**

Parameters	Units	Min.	Max.	Ave.	S E	WHO/BIS permissible limits
Temperature	$^{\circ}\text{C}$	24.7	36.6	29.75	0.591	30-35 <sup>1</sup>
Conductivity	$\mu$ mhos	280	380	311.3	5.100	750 <sup>1</sup>
T.D.S	mg/l	345	388	377.65	1.915	1000 <sup>1</sup>
pH		7.0	8.6	7.61	0.078	6.5-8.5 <sup>1</sup>
Free CO <sub>2</sub>	mg/l	8.9	16	11.28	0.300	22 <sup>1</sup>
Free alkalinity	mg/l	14	31	20.25	0.954	-
Total alkalinity	mg/l	120	265	211.1	6.821	200 <sup>2</sup>
Dissolved oxygen	mg/l	3.2	7.5	4.695	0.221	5-7 <sup>1</sup>
BOD	mg/l	2.6	15.2	5.045	0.401	6.0 <sup>1</sup>
COD	mg/l	14	45	28	1.575	10 <sup>1</sup>
Chloride	mg/l	10	39	30.35	1.421	250 <sup>1</sup>
Calcium hardness	mg/l	89	135	110.3	2.577	100 <sup>1</sup>
Total hardness	mg/l	100	289	228.55	11.898	300 <sup>2</sup>
Nitrate-nitrogen	mg/l	0.60	2.90	1.084	0.120	45 <sup>2</sup>

1= WHO (1993), 2= BIS (IS: 10500: 1991).

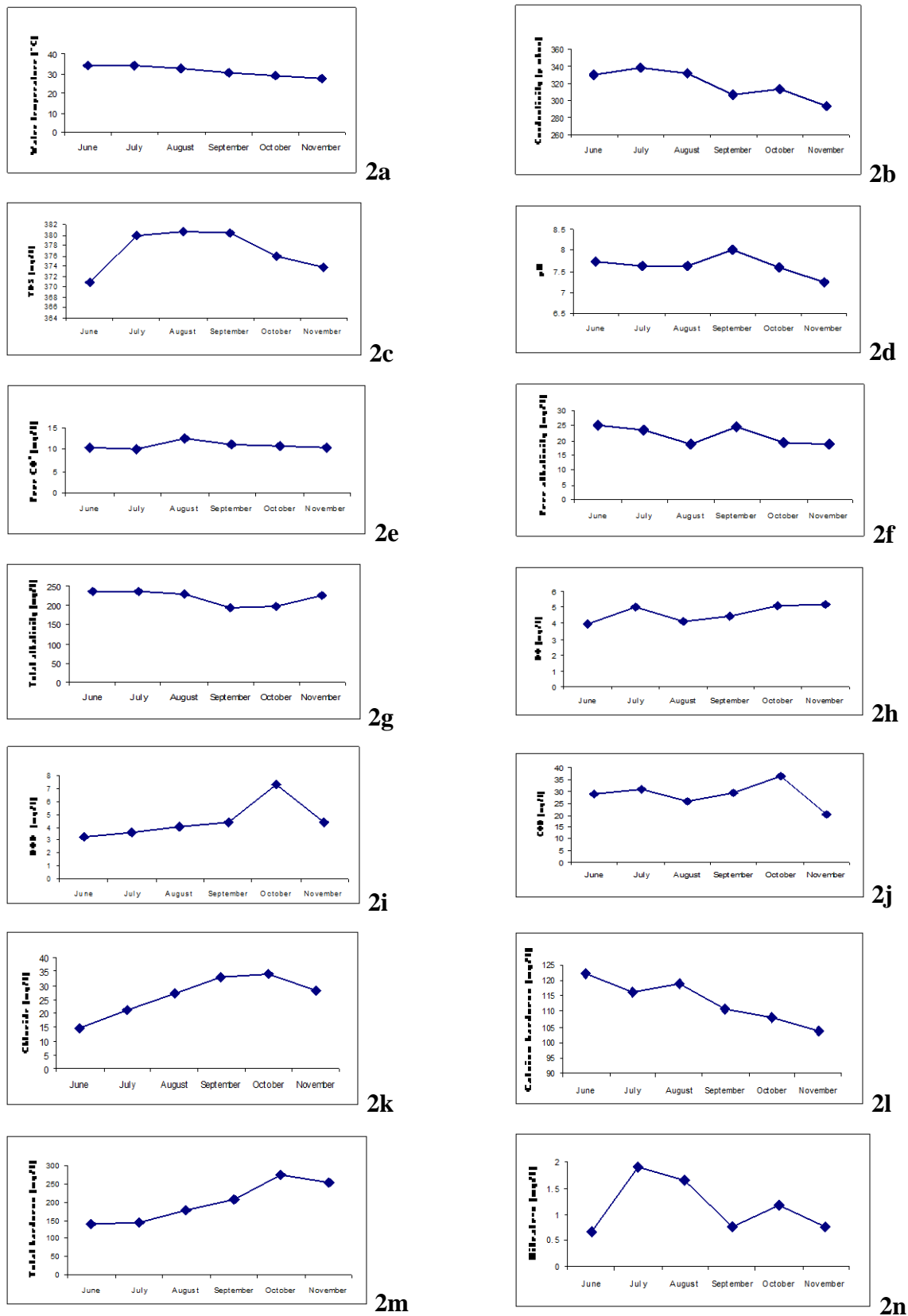


Figure 2. Monthly variation on physico-chemical parameters of Sahapura Lake

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