

## Seasonal Variations in the Physico-chemical Properties of Ecologically Fragile Mandhal Lake of Nagpur District

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### Abstract

The present research work analyzes the seasonal variations in the physico-chemical properties of Mandhal lake of Nagpur District, during summer, monsoon and winter months to determine the water quality status for limnological study. The physico-chemical parameters such as water temperature, colour pH, dissolved oxygen and various other important inorganic contents were analyzed in three different seasons using standard methodology. The result of the present study revealed that the discharge of waste and drainage in to the lake have contributed a substantial increase in the pollution status of the lake as evident from physic-chemical analysis of different parameters. The significant variations in chemical parameters were observed at four different sites of Mandhal Lake depicting seasonal variations. From our studies it is found that sites C and D are anthropogenically affected.

**KEYWORDS** : Physico-chemical properties, Mandhal lake, Limnological study, seasonal variations.

### Introduction

Limnological Investigation of fresh water resources has become environmental priority today due to the lake contamination by man. One of the most important crises of the 21<sup>st</sup> century is the availability of fresh water, a resource basic to our survival. Most of the fresh water bodies all over the world are polluted thus decreasing the suitability of the fresh water for man's use.

The physico-chemical characteristics of any aquatic ecosystem and the nature and distribution of its biota are directly related to and influenced by natural regulatory mechanisms. A large number of investigators like Angadi *et al* (2005), Jakher and Rawat (2003), Jayakumar *et al* (2009), Arjariya (2003), Bharadwaj and Sharma (1999), Bhatt *et al* (1999), Bodhane (2015), Bharathi *et al* (2013), Deshpande and Aher (2009), Devaraju *et al* (2005), have worked on various water bodies of world as well as India which includes fresh as well as brackish waters.

As no research work has been reported till date on the water body of Mandhal in Nagpur district the present research work was undertaken on it.

### Materials and Methods

Mandhal lake a perennial freshwater lake is situated at the Mandhal village in the umred tehsil of the Nagpur district in the state of Maharashtra. The water body is about

23.75 acres and its water used for bathing, washing and other activities by local residents.

Water samples from Mandhal Lake were collected from four different sampling locations A,B,C,and D covering all the four sides from lake in the morning hours and immediately transported to the laboratory for the estimation of various physico-chemical properties during summer, monsoon and winter season. The site A served as untouched site without any visible contamination and free from human interference too, whereas Sites C and D are polluted due to anthropogenic activities.

Parameters like temperature, pH and dissolved oxygen were recorded at lake site itself where as the parameters like alkalinity, hardness, chlorides, total phosphates, nitrates, sulphates and other parameters were measured as per the guidelines given by APHA (2005) in the laboratory.

### Result and Discussion

The physico-chemical characteristics of water samples of Mandhal Lake are presented in Table no.1. During present investigation the observed water temperature ranged between 21.6<sup>o</sup>C to 31.2<sup>o</sup>C. In general the water temperature was low during winter and high during summer season. The low water temperature in winter might be due to high water levels and lower solar radiation where as maximum in the summer might be due to low water level, greater solar radiation and clear atmosphere. Fluctuation in air and water temperature is due to the influence of different seasons.

**Table 2: Physico-chemical parameters of different sampling stations of Ecologically Fragile Mandhal Lake of Nagpur District**

Parameters	Summer Season				Rainy Season				Winter Seasons			
	Site A	Site B	Site C	Site D	Site A	Site B	Site C	Site D	Site A	Site B	Site C	Site D
Temperature (°C)	31.2	31.2	31.2	31.2	27.5	27.5	27.5	27.5	21.6	21.6	21.6	21.6
Color (Hazen Unit)	Below Hazen	Below 5 Hazen	Below Hazen	Below Hazen	6.0	6.0	7.0	7.0	10.2	10.0	10.3	10.2
pH	7.98	8.1	8.1	8.15	7.0	7.1	7.2	7.5	7.6	7.7	7.8	7.9
Dissolved Oxygen (mg/l)	3.2	3.2	3.0	3.1	3.9	3.8	3.8	3.7	6.10	5.40	5.10	4.90
BOD (mg/l)	9.0	9.2	10	10.5	6.2	6.4	6.4	6.4	7.0	7.2	7.8	7.9
COD (mg/l)	110.0	112.8	114.2	116.2	75.6	76.8	78.5	79.0	80.5	80.6	81.5	81.7
Total Alkalinity (mg/l)	172.2	171.6	176.0	180.0	104.2	105.6	106.5	108.8	185.5	186.8	187.5	188.0
Total	750.1	749.	752.3	751.5	285.2	287.	288.5	286.	542.5	543.9	546.0	545.0

Dissolved Solids (mg/l)		9				8		2				
Total Suspended Solids (mg/l)	40.5	40.0	42.2	41.2	56.0	57.0	58.0	58.0	45.0	46.0	47.5	48.8
Total Hardness (mg/l)	203.5	202.0	204.4	204.0	75.0	76.0	77.5	75.5	159.6	160.0	163.5	164.3
Calcium (mg/l)	113.3	113.1	114.2	113.5	43.0	44.0	44.5	43.5	42.5	43.2	43.5	44.0
CaCO <sub>3</sub> Hardness (mg/l)	172.8	171.6	172.5	170.5	75.5	76.0	77.5	75.7	107.0	108.0	110.0	107.5
Magnesium (mg/l)	21.1	21.7	22.7	21.5	7.5	7.8	7.9	7.6	11.5	12.7	13.4	13.0
Chloride (mg/l)	111.0	112.8	113.5	115.5	76.5	79.0	80.0	86.8	95.6	97.1	98.0	98.5
Sulphate (mg/l)	10.0	10.6	11.3	11.5	10.5	11.9	12.2	12.9	8.85	8.91	8.95	8.98
Nitrate (mg/l)	0.2	0.21	0.21	0.23	0.4	0.4	0.49	0.50	0.09	0.10	0.10	0.15
Total Phosphate (mg/l)	0.091	0.095	0.098	0.099	0.04	0.04	0.06	0.08	0.01	0.01	0.02	0.03
Turbidity NTU	1.2	1.2	1.3	1.4	18.6	19.0	19.5	20.5	0.68	0.72	0.78	0.79
Total Carbon Dioxide (mg/l)	15.00	15.63	15.80	15.90	9.55	9.82	9.93	10.00	19.8	19.9	20.00	20.1
Electrical Conductivity (µmhos/cm)	1020.0	1059.6	1063.	1067.5	420.5	428.8	429.1	421.6	765.0	768.6	769.2	769.6

Transparency in water is directly proportional to the amount of suspended organic and inorganic particulate matter present in water body. The other factors which affect the transparency of water body are plankton growth, wind velocity, rainfall, nature of water body and prevailing weather conditions. The minima & maxima of transparency in the lake water was recorded in the monsoon and winter seasons.

The pH of Mandhal lake was alkaline throughout the study period which range from 7.1 to 8.15 (Table 1). The maximum PH was recorded especially at site C and D which may

be due to receipt of sewage containing more carbonate and bicarbonate. The pH value ranged between 7.1 to 8.15. pH is the measure of the concentration of hydrogen ions, which provides the range of the acidity or alkalinity of a solution. The pH of water appear to be dependent upon the relative quantities of calcium carbonates and bicarbonates, being alkaline, when the quantities of Carbonates are high.

Dissolved oxygen is an important parameter which affects chemical as well as biological reactions in an aquatic environment. Dissolved oxygen content indicates the health and ability of water body to purify itself through biochemical processes. Oxygen is also needed for many chemical reactions that are important for proper lake functioning, such as oxidation of metals, decomposition of dead and decaying matters. The dissolved oxygen was found to be in the range of 3.7 to 6.10 mg/L. Minimum value was recorded in summer and maximum in winter season. Winter maxima might be due to the clear zone, fall in temperature, increase in the solubility of oxygen, slightly more photosynthetic activities & high aeration rate whereas summer minima might be due to the increased decomposition of organic matter in the lake and subsequent CO<sub>2</sub> release. Similar trend of dissolved oxygen was also observed by Yeole and Patil (2005) studied the physicochemical status of Yedshi lake in relation to water pollution. Carbon dioxide dissolved in water is the source of carbon that can be assimilated and incorporated into the living matter of all aquatic autotrophs (Hutchinson, 1957). A good water body should have solubility of oxygen about 7.0-7.5mg/l in its basin.

Biochemical oxygen demand is an important parameter which indicates water pollution by oxidisable organic matter. The main sources of organic pollution in the lake was entry of untreated domestic sewage and anthropogenic activities in the catchment. In the present study, minimum value of BOD was observed 6.2 mg/l in monsoon where as maximum value 10.5 mg/l was observed in summer. This is an important parameter to assess the pollution load of surface water, where contamination occurred due to the disposal of domestic wastes. Similar observations were made by Bagde and Verma (1985).

Chemical Oxygen demand is the amount of oxygen required by the organic matter present in the water for its oxidation by strong chemical oxidant. During summer maximum value of COD was observed while minimum was observed during monsoon.

Alkalinity is a measure of the capacity of water to absorb hydrogen ions. The total alkalinity of water samples of lake was 104.8 mg/l to 186.0 mg/litre. It is generally imparted by the salts of carbonates, bicarbonates, phosphates, nitrates, borates, silicates etc. together with the hydroxyl ions in free state. The minimum value was recorded in rainy season and maximum in summer. It is stated that fluctuations in alkalinity might be due to the entry of alkaline particles through surface runoff and low production of plankton population

Total dissolved solids refer to matter dissolved in water. Waters with high total solids generally are of inferior palatability. Total dissolved solids in case of water samples of Mandhal lake is in range of 285.5 and 751.1 mg/l .

Total hardness of water is the measure of the capacity of water to react with soap. Calcium & magnesium are the principal cations that imparts hardness. The total hardness of water therefore reflects as the sum total of alkaline metal cations present in it . During present investigation total hardness was found to be minimum in monsoon 120 mg/litre and maximum in summer i.e 204 mg/litre.

Chloride anion is generally present in natural waters. High chloride content has damaging effect on agricultural crops. In present investigation, the maxima in summer and minima in monsoon were noted. Karne and Kulkarni (2009) reported chloride maxima in summer while minima in winter from freshwater bodies in Khatau Tahsil of Maharashtra. Total hardness of water is the measure of the capacity of water to react with soap. Calcium and magnesium are the principal cations that imparts hardness. The total hardness of water therefore reflects as the sum total of alkaline metal cations present in it. The maxima in hardness was recorded in May at site C whereas minima was recorded at August. Similar findings are recorded by Patil *et al* (2008).

Sources of sulphates are mainly sulphate rocks such as gypsum and sulphur minerals such as pyrites and also due to air and water pollution. Sulphates contribute to the total solids content and in a reduced and anaerobic condition produced hydrogen sulphide which gives rotten egg odour to the water. In the present investigation the sulphate content ranged between 8.85 to 12.9 mg/L with maxima in summer and minima in monsoon season. Similar results were also reported by Angadi *et. al.*, (2005) from Papnash pond, Bidar, Karnataka. The present results are in conformity with above authors findings.

Phosphate is one of the major macronutrients responsible for biological productivity (APHA, 2005). In water bodies phosphate occurs both in its organic and inorganic forms. The major sources of phosphates are detergents, domestic sewage, agricultural effluents and weathering of rocks. During the natural process of weathering of rocks gradual release of phosphate occurs.

Nitrates are the most oxidized forms of nitrogen and the final product related to the decomposition of organic nitrogenous substances. The natural waters in their unpolluted state contains only a very small amount of nitrate. High concentration of nitrates trigger eutrophication (Trivedy and Goel 1986). The domestic sewage is the primary contributor of nitrogenous substances in water body. The major sources of nitrate in lake are agricultural waste, sewage, rainfall, suspended organics. Nitrate concentration is associated with rain water runoff, and sludge discharge (Jha & Barat, 2003). During present investigation nitrates of the fresh water body ranged from 0.1 to 0.58 mg/L with maxima in monsoon. Bagde and Verma (1985) recorded highest values of nitrate in Rainy season at Mayurakshi river in Santhal Parganas Jharkhand. Pejawar and Somani (2002) observed the range of nitrate between 0.06 mg/lit to 0.21 mg/lit from from Ambeghosale lake of thane. Similar observations were recorded by Sushmitha *et al* (2015) in Kavoor tank in Karnataka. During present investigation maximum nitrate in monsoon and minimum in winter is recorded.

The phosphate ranged from 0.01 to 0.09 mg/l with maxima at summer and minima in winter. Total carbon dioxide was maximum (20.1) during winter at Site C and minimum (9.5) during monsoon.

The conductivity is a numerical expression of the ability of a water sample to carry an electric current which in turn, depends on the total concentration of the ionized substance dissolved in the water. Electrical conductivity ranged from 420 to 1063  $\mu\text{mhos/cm}$  with maximum at summer and minimum during monsoon. The minimum conductivity in monsoon might be due to water dilution and the less human interference and maximum 1063.1  $\mu\text{mhos/cm}$  was recorded during summer might be due to increased concentration of dissolved solids usually due to evaporation in summer season.

The in depth analysis of Mandhal lake water indicates that the water samples of two sampling sites of Mandhal lake have been affected by man's use as compared to site B which is somewhat clean as reflected in analyzed values during seasonal variation of different parameters.

On the basis of above parameters site D is more polluted than site C. Therefore, it is suggested that the domestic waste should not be discharged into the mandhal lake of Nagpur district to safeguard its perennial and natural source and sustained efforts should be made to bring out greater awareness among masses about the importance of good quality of freshwater resources and saving it for future generations. The fragile and perennial nature of lake will be lost in due course due to anthropogenic activities.

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