

## Limnological Studies of Man Sagar lake, Jal Mahal Jaipur, Rajasthan

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**Abstract** – Limnology (scientific study of bodies of fresh water) is the examination of the systemic and utilitarian interrelationships of individual of interior water as they affected by their vigorous chemical, physical and biotic environment. Water is on earth surface such an important source which is very essential for life but due to the decrease in its quality and quantity day by day, it contain a lots of pollution. In this paper, the limnological study of Man Sagar Lake at Jal Mahal has been done. The study analysis with different physiochemical parameter of lake. As a result of the study various types of physiochemical parameter, algal counts, phytoplankton and zooplankton were studied in Man Sagar lake.

**Keyword-** limnology, interior water, physiochemical parameter, algal counts, phytoplankton, zooplankton

**1. INTRODUCTION** – Water is one of the indispensable constituent on earth surface for all living form. Water pollution is the contagion of water sources e.g. rivers, ocean and groundwater. This form of environmental degradation occur when the pollutants are directly and indirectly send out into water sources without adequate treatment. Water pollution is the physiochemical change in water quality which affect the aquatic life. Water pollution is the contamination of water bodies which causes adverse impact on aquatic life. Different types of harmful component are discharged in water which cause pollution.

The quality of water decreasing due to the presence of pollutant. Overcrowding, industrilization and urbanization has led to the reduce accessibility of water. Due to the deteriorating condition of water, it is getting polluted day by day. Different types of pollutants like as chemical, toxic elements, pesticides, bacteria and parasite are cause water pollution. According to World Health Organisation (WHO), polluted water is or toxic water is not drinkable, it spread various disease like as diarrhoea, typhoid, cholera and dysentery that kill more people worldwide every year. Water pollution also kill zooplankton and phytoplankton in aquatic sources.

Water pollution reduces the ability of water which is not drinkable as well as not good for aquatic animals. Only less than 1% of water is in the form of fresh water which we use in many purposes like drinking, heating, transportation, and industries etc.

### STUDY AREA-

Man Sagar lake is situated in northern of Jaipur also known as Pink city. It is the major attractive centre for excursionist due to the presence of Jal Mahal in the middle of Man Sagar lake. This is artificially lake made by Raja Man Singh in 1610 A.D. The quality of this lake degraded over the years because of untreated sewage, domestic effluents and toxic chemicals etc. from the factories and residential areas near it. Huge amounts of sewage waste, pesticides, fertilizers and other adulterant infiltration of and damage the recharge channels are now destroying the years old lake. Common types of contaminations are mainly categorized as point sources or non point sources of pollution (Adu and Kumarasamy 2018). Garbage and chemical effluents are causing large amount death of fish in mansagar lake. Reduction in water quality has an effect on the existing zooplankton and phytoplankton. Due to the decrease in the quality of water, large number of fish located in the Man Sagar lake are dying day by day.



**Man Sagar lake, Jal Mahal, Jaipur**



**Representation of Polluted Man Sagar lake, Jal Mahal, Jaipur**

Anthropogenic activity and sewage in water cause water pollution. Domestic waste and other waste like as plastic containers, wrapper, sacks, garbage etc also produce water pollution in aquatic sources. Because of these quality of water is affected highly in range.

Mansagar Lake is ecologically adaptable wetland site that attract migratory bird species like as Common Teal, Eurasian Wigeon, Gadwall, Northern Pintail etc. comes every year. It is there nesting, playing and breeding site. Many ornithologists and bird lovers come here to see this bird.

## **2. MATERIAL AND METHOD -**

Limnological study of sampling water analysed following method with different types of physiochemical parameter. Samples were collected from different sampling point of the lake. Samples were examined at monthly interval. Six different sampling point of surface area were pinpoint named S1-S4. The physiochemical properties of the lake are explained in table. Sample collected in one litre plastic bottle. For determination of biological diversity all data were subjected to Shannon Weaver's index. It is enumerate by using the following method. The samples were taken to the laboratory for testing different physiochemical parameter of lake such as pH value, Total suspended solid (TSS), Total dissolved solid (TDS), Calcium, Nitrate, Magnesium, Potassium, Sulphate, Phosphate, Alkalinity, Acidity, Biological oxygen demand (BOD), Chemical oxygen demand (COD), Dissolved oxygen (DO).

### **SHANNON WEAVER'S INDEX**

For measuring biological diversity, it is widely used index. It is one widely used index for comparing diversity between various habitat. According to this index-

$$H = - \sum_{i=1}^S p_i (\ln p_i)$$

Where

H = Shannon index

i = index of species diversity

$p_i$  = proportion of total sample belonging to the  $i^{\text{th}}$  species ( $n_i/N$ )

( $n_i$  = number of individual in species and  $N$  = total number of individual in the sample)

s = number of species collected in a sample

$\ln$  = Natural logarithm

Physiochemical Parameter of Lake with Suitable Methods-

**Table -1**

<b>Water test</b>	<b>quality</b>	<b>Description</b>	<b>Method</b>
pH value		The pH scale is a real-world indicator of the free hydrogen ion to hydroxyl ion ratio in water. It provides a valuable indicator of chemical changes.	IS-3025(P-11)
Total dissolved solids		The measurement of the quantity of particulate solids that are present in water.	IS-3025(P-16)
Total Alkalinity (as CaCO <sub>3</sub> )		Carbonate hardness is a word that may be used interchangeably with total alkalinity	IS-3025(P-23)
Total hardness (as CaCO <sub>3</sub> )		Milligrams of calcium carbonate per liter, a measure of water hardness	IS-3025(P-21)
Calcium (as Ca)		To calculate proportion of calcium in water	IS-3025(P-40)
Magnesium ( as Mg )		To calculate proportion of calcium in water	IS-3025(P-46)
Chloride ( as Cl)		The corrosiveness of water is further heightened by the presence of chloride.	IS-3025(P-32)
Sulphate (as SO <sub>4</sub> )		Calculate proportion of sulphate in water	IS-3025(P-24)
Electrical conductivity (EC)		It is a measurement of water's ability to conduct electricity	IS-3025(P-14)
Sodium (as Na)		Calculate proportion of sodium in water	IS-3025(P-45)
Potassium (as K )		Calculate proportion of potassium in water	IS-3025(P-45)
Nitrate (as NO <sub>2</sub> )		Calculate proportion of nitrate in water	IS-3025(P-34)
Phosphate (as PO <sub>4</sub> )		Calculate proportion of phosphate in water	RTHTS-07

Total suspended solids	The term "total suspended solids" (TSS) refers to the mass in dry terms of all the suspended particles in a given water sample that are not dissolved.	IS-3025(P-17)
Dissolved oxygen (DO)	The concentration of oxygen molecules in a given volume of water is referred to as the dissolved oxygen (DO) concentration.	IS-3025(P-38)
Biological oxygen demand (BOD)	The biochemical oxygen demand (BOD) is the measure of the quantity of oxygen required by bacteria and other microbes as they break down organic matter.	IS-3025(P-44)
Chemical oxygen demand (COD)	The quantity of dissolved oxygen needed to oxidize chemical organic compounds like petroleum is known as the chemical oxygen demand (COD) of the water in which they are dissolved.	IS-3025(P-58)

### 3.RESULT AND DISSCUSSION –

Different physiochemical parameters were analysed in Mansagar lake like as pH value, Total suspended solid (TSS), Total dissolved solid (TDS), Calcium, Nitrate, Magnesium, Potassium, Sulphate, Phosphate, Alkalinity, Acidity, Biological oxygen demand (BOD), Chemical oxygen demand (COD), Dissolved oxygen (DO), electrical conductivity (EC) and results are discussed below. The experimental results were discussed in Table – 3. The experimental results were compared with BIS water quality standards (Table -2). The statistical analysis includes mean, standard deviation. Various physiochemical parameters are explained with suitable methods in Table-1.

Maximum and minimum acceptable limit of some physio-chemical parameters and heavy metals in water BIS –

**Table – 2**

S.No.	Parameters	Units	Minimum acceptable unit	Maximum acceptable unit
1.	pH value	-	6.5	8.5
2.	Total dissolved solids	mg/l	200	500
3.	Total Alkalinity (asCaCO <sub>3</sub> )	mg/l	200	600
4.	Total hardness (as CaCO <sub>3</sub> )	mg/l	220	600

5.	Calcium (as Ca)	mg/l	-	75
6.	Magnesium ( as Mg )	mg/l	-	30
7.	Chloride ( as Cl)	mg/l	-	200
8.	Sulphate (as SO <sub>4</sub> )	mg/l	-	200
9.	Electrical conductivity (EC)	µS/cm	-	250
10.	Sodium (as Na)	mg/l	-	200
11.	Potassium (as K )	mg/l	-	-
12.	Nitrate (as NO <sub>2</sub> )	mg/l	-	45
13.	Phosphate (as PO <sub>4</sub> )	mg/l	-	0.07
14.	Total suspended solids	mg/l	-	2000
15.	Dissolved oxygen (DO)	mg/l	3.5	5.0
16.	Biological oxygen demand (BOD)	mg/l	-	5.0
17.	Chemical oxygen demand (COD)	mg/l	-	50

Different types of physiochemical parameters were studied in Mansagar lake. For this, four samples(S1-S4) were collected from different sites of Mansagar lake in a month of July and August. The results obtained after studying different parameters in Mansagar lake are shown in Table 3.

The demonstration of the Water samples from Jalmahal, clearly represents about their deteriorating quality. While considering the water sample first and taking its pH value it shows its alkaline nature which is lower (pH 8.25) in the month July and greater (pH 9.15) in the month of August. Since the pH range 5-9 is suitable for the survival of aquatic life (Lloyd, 1960). The value of Total Dissolved Solids is more than the minimum and maximum value conforming to the BIS and thus makes water inappropriate for the utilization like. Maximum TDS observed in the month of mid August (1150 mg/l) due to the enlargement of the particulate substance from ambience hilly areas in Monsoonic Climate. In terms of Hardness water of Jalmahal is hard including calcium and magnesium ion accumulation which makes the water profile hard. The higher range of hardness is measure in month of August which is 410.123 mg/l. Higher amount of chloride is measure in month of July (333.735mg/l) which is an indicator of organic pollution of water. The amount of Acidity and Alkalinity added to the water greatly affects the life of aquatic animal. Rainfall and temperature range are the reason for the increasing acidity and alkalinity. Here the values of Alkalinity are measured higher in month of August (310.99 mg/l). Concentration of sodium affects the water sources and aquatic environment directly and indirectly both.

Highest concentration of sodium is measured in the month of mid August (43.23 mg/l) and lowest in the month of July (35.4 mg/l). Nitrate concentration is also very limited and low in the water samples collected. Dissolved Oxygen and Biological Oxygen Demand of the water source show the present ongoing water quality eradication and declining status for the survival of aquatic life. Dissolved Oxygen is more important for survival of the aquatic life but on the other hand the Biochemical Oxygen Demand shows the more demand of oxygen due to the microbial population and show their great status inside

the water body. All this leads to the condition of the oxygen deficiency, low light penetration because of algal bloom and the process of “Eutrophication” of the water body. Dissolved oxygen range is higher in the month of August (3.91 mg/l) and biological oxygen demand is higher in the month of July (160.9 mg/l).

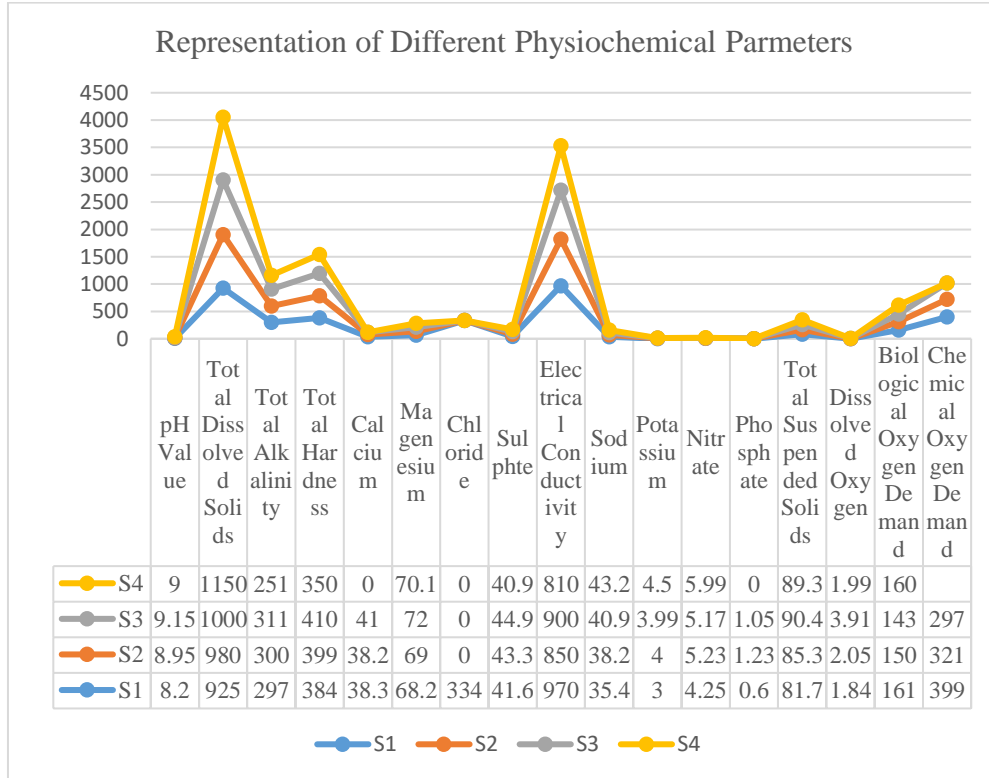
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**Table 3**

PARAMETER	JULY (S1)	MID JULY (S2)	AUGUST (S3)	MID AUGUST (S4)
pH value	8.28	8.95	9.15	9.00
Total dissolved solids	925	980	1000	1150
Total Alkalinity (as CaCO <sub>3</sub> )	297.1	300.00	310.99	250.88
Total hardness (as CaCO <sub>3</sub> )	383.895	399.450	410.123	350.40
Calcium (as Ca)	38.29	38.20	40.95	NA
Magnesium (as Mg)	68.15	68.99	72.03	70.13
Chloride (as Cl)	333.735	NA	NA	NA
Sulphate (as SO <sub>4</sub> )	41.6	43.3	44.9	40.9
Electrical conductivity (EC)	970	850	900	810
Sodium (as Na)	35.4	38.18	40.90	43.23
Potassium (as K)	3	4	3.99	4.5
Nitrate (as NO <sub>2</sub> )	4.25	5.23	5.17	5.99
Phosphate (as PO <sub>4</sub> )	0.6	1.23	1.05	NA
Total suspended solids	81.7	85.3	90.4	89.25
Dissolved oxygen (DO)	1.84	2.05	3.91	1.99
Biological oxygen demand (BOD)	160.9	150.45	143.39	159.69
Chemical oxygen demand (COD)	399.4	321.12	297.0	230.92
Total coliform per ml	800	1180	870	1050
Total faecal coliform per ml	750	940	990	1230

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oxygen range is higher in the month of August (3.91 mg/l) and biological oxygen demand is higher in the month of July (160.9 mg/l). Electrical Conductivity is the measuring amount of impurities in the Water sample. There is fluctuating range of the conduction which is more than the normal range, so in terms of purity water contains impurities in many forms which are dissolved inside in it and also makes it turbid too. Increase in conductivity was due to increased salt concentration released by discharged effluent and organic matter.



From the above graph, it is observable that value of each and every parameter over time along with their value table. The Water quality has been tested to check if water can be used for different purposes.

**Shannon index-**

No. of sample	No. of individual (ni)	Pi = ni/N	ln pi	Pi(ln pi)
Sample 1	10	0.416	-0.877	0.364832
Sample 2	6	0.25	-1.386	-0.3465
Sample 3	1	0.041	-3.194	-0.130954
Sample 4	7	0.291	-1.234	-0.359094
	Total = 24			$\sum pi (ln pi) = -1.20138$

To calculate So according to Shannon weaver index species diversity of different sample in Man Sagar lake is 1.20138.

#### **MICROBIAL COUNT-**

Present study shown the results in the table–3. As per results, the highest number of total coliform found to be 1180 /100 ml in the month of mid July and the minimum number of coliform found to be 800 /100 ml in the month of July. The maximum no of total faecal coliform present to be 1230 /100 ml in the month of August and minimum amount of total faecal coliform found to be 750 /100 ml in the month of July. Both gram positive and gram negative bacteria were count in mansagar lake.

#### **PHYTOPLANKTON AND ZOOPLANKTON-**

Different types of phytoplankton such as Cynophycean (such as Oscillatoria, Nostoc sp., Anabaena sp. Etc.) Bacillariophycean (such as Diatoms such as Cyclotella, Pinnularia, Synedra, Epithemia etc) and Chlorophycean (such as Chlorella, Chlorococcum ) were demonstrated in the lake water. Different types of zooplankton were also count in lake water such as Euglena, Paramecium aurelia, Paramecium caudatum, Phacus etc.

#### **4. CONCLUSION AND IMPORTANT RECOMMENDATION-**

Natural water supplies around the world are in peril due to imbalances brought on by overuse, contamination, and environmental factors. Unprocessed waste releases, the direct dumping of residential and business sewage, and irrigation water from agricultural areas may all be to blame for the contamination. An severely negative impact on water is caused by an increase in industry, population growth followed by migration to urban regions, and excessive use of synthetic chemicals. In the end, soil and air pollution is caused by water pollution. By contaminating water supplies, pathogens and other aquatic living organisms that may or may not cause disease are given nutrients. pollutants in water consist of poisonous metals, organic substances like pesticides, fungicides, and insecticides, inorganic substances like fertilisers, heavy metal salts, acidic and basic chemicals, etc., which are even directly detrimental to living things.

All living things require water to survive, and everyone has a right to clean water in the natural world. The most valuable and important natural resource is water. According to Pattnaik et al., (2015), limnology is the study of the inland aquatic ecosystem's organism productivity, structural organisation, and physical relationships, all of which are influenced by physico-chemical factors and biotic communities. Riddhi et al., (2011) Due to increased human interference in ecosystems, biodiversity stabilises the ecological balance and human health, both of which are underthreat. Earth's life will be impacted by biodiversity loss. Due to improper or nonexistent waste water treatment, illegal waste disposal, and intense livestock operations, human activities in the lake's catchment area may discharge significant amounts of nutrients. The alteration of plankton populations shows the aquatic ecosystem's volatility and calls for monitoring it for protection.

Excessive rains wash away topsoil, so any pollutants that make their way into the soil also will spread along with the water. Yet, soil may be critically harmed if exposed to a large amount of phosphorus or other harmful material. The dumping of solid waste should be avoided wherever possible in favor of the trash. Water contamination needs careful consideration of all the potential problems that might arise.

By collecting data using a variety of ways and correlating the results using two or more statistical approaches, it is possible to get a complete picture of the aquatic ecosystem. There is a need for scientific research that examines conservation and lake management measures.

Important reccomondations are as follows-

- At community level and domestic level where individual sources like borewells and submersible pumps are being used, microbial contamination of water should be tasted. For this Hydrogen sulphide vials should be distributed to all concerns.
- If the quality of water in a particular distribution area is not upto the prescribed water standards,



awareness regarding treatment at household level such as use of water purifiers, boiling of water, use of chlorine tablets, treatment with sand and activated charcoal should be promoted.

- Presence of Heavy metals should also be tested regularly by public water supply system.
- Regular monitoring of physio-chemical and biological parameters of lakewater helps in detection and assessment of degree and sources of pollution of fresh water ecosystems and the damage caused by anthropogenic pressure.
- Analysis of plankton reveals the extinction of several species of aquatic environment, which is an alarm for future.
- Certain taxa of plankton that tolerate pollution and fecal origin Avoid the entry of untreated waste into lake water, which decreases the load of both infectious and non-infectious microorganisms which in turn reduces the risk of swimming related illness, skin infections and gastrointestinal infections.
- The domestic activities (washing and cleaning) around the lakes must be reduced to minimize pollution. Every house in the village should have its own septic tank and the waste especially untreated waste should not enter the lake ecosystem.
- Bacteria can be used as indicator organisms to detect pollution.
- Most of people, who took participation in this survey found with less knowledge of the Government act preventing the mixing of pollutants by the point sources (humans and domestic animals).
- Many of them were observed unaware of the Government policies and the objectives to maintain the quality of the lake water.
- There need to placed serious efforts by the Government agencies to start awareness programs and to involve the people participation in their corrective measures to keep the Jal mahal area and the Mansagar lake cleaned and for its beautification works.
- Vendors need proper education and strict directions from the responsible Government agencies to follows the guidelines for selling their products and to save surface water resources from dying.

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