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Limnological and Microbiological Study of Jaisamand Lake, Alwar (Raj.)

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ABSTRACT

Limnological and microbiological parameters are important criteria for determining the suitability of water for irrigation and drinking purpose. The physico-chemical and microbiological study of Jaisamand Lake has been done during the year of 2014-15. Higher values of most of the parameters give a clear indication that water is highly polluted.

KEYWORDS: Limnological, microbiological parameters, Jaisamand Lake.

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INTRODUCTION

Jaisamand Lake was constructed by Maharaja Jai Singh in 1910 AD. It has an earthen embankment of 1.67 kilometers in length and 10.6 meters in height. The lake has been arising out from the overflow of Siliserh Lake and Ruparail River. The water of this reservoir has been used for irrigation and drinking purpose since last 100 years. Disposal of domestic wastes in this lake causes undesirable change in physico-chemical and biological characteristics of water. The pollution of surface water by discharge from human activities is one of the major environmental problems. Organic enrichment of these water bodies results in low dissolved oxygen in water. An estimation of bacterial production is a crucial step in understanding quantitatively the function and contribution of bacteria in material cycling within given aquatic habitats.[1]

Assessment of indicator bacteria namely coliform is a convenient way to evaluate sanitary condition of any water body in which fishing is being done.[2] Majority of studies in this line have been done in piscine, avian and mammalian system. A considerable amount is still remains to be understood regarding the impact of microbiological parameters. The present study is an attempt to find out limnological and bacteriological parameters of the Lake, so that it would be helpful to combating the problems associated with public health.

STUDY AREA

For analysis of quality of water, 4 sites have been selected in the lake. Samplings at different sites were made at monthly intervals from July, 2014 to June 2015.

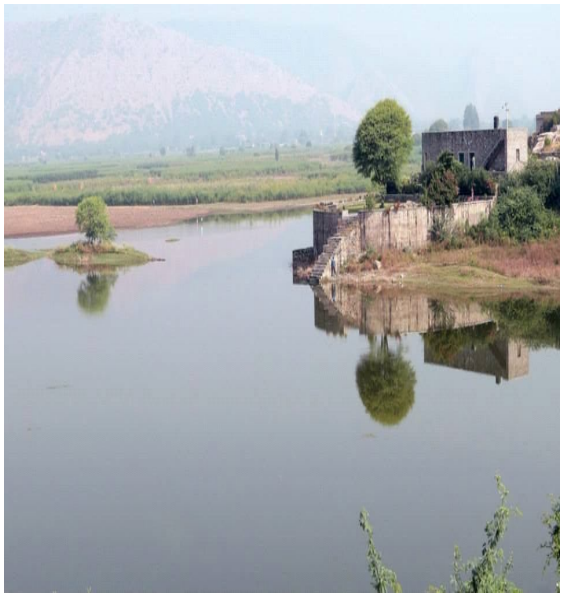


Fig.1 : Eastern view of Jaisamand lake

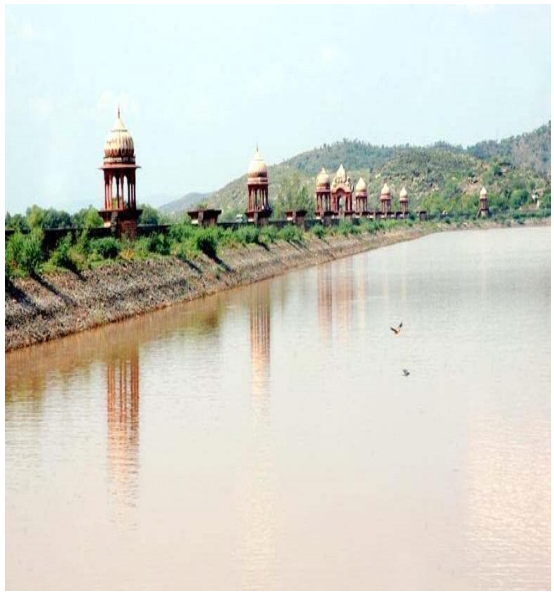


Fig.2: Western view of the lake

Table 1: Meteorological and geological data of the dam on the lake

SN	Attributes	Values
1	Year Completion	1910 AD
2	River	Banganga/ Ruparail
3	Dam type	Earthen/Gravity/ Masonry
4	Purpose of construction	Irrigation
5	Latitude	27.492519/ 27^0 $29^{'}$ $33^{''}$ North
6	Longitude	76.585666/ 76^0 $35^{'}$ $83^{''}$ East
7	Average rain fall	550 mm/year
8	Length of Dam	1671 meter
9	Height of Dam	10.6 meter
10	Designed flood	410 Cumec
11	Seismic Zone	III level
12	Gross storage capacity at FRL	26.95 mcm
13	Live storage capacity	24.91 mcm
14	Dead storage capacity	2.04 mcm
15	Maximum depth	26 feet
16	Average depth	8.3 feet (At full tag in Aug, 2014)
17	Average depth	6.2 feet (Round the year)
18	Submerged area	10, 000 hectare
19	Basin name	Ganga
20	Distance from main city	6 kms

Fig 3: Pavilion towers erected on dam of the lake.

Fig. 4: Durga statue and other accessories *during 'mata pooja'* dispersed in the water which led organic pollution.

Fig. 5: Jaisamand Lake changing in to a marsh land due to excessive silting, succession of aquatic plants and less amount of water in summers. (Pic. taken by author dated on 19/04/2015, 2:35 PM)

Fig 6 : Author measuring temperature of water

Fig.7:Collecting water sample.

MATERIAL AND METHODS

The water samples from the lake were collected in pre-washed and well dried glass bottle. The bottles were ringed three times with sample water. The sample water were taken from the surface at a depth of 6-9 inches from four certain points, integrated and a representative sample was

drawn. The sampling was carried out in the every month of July, 2014 to June, 2015. The temperature of the water was measured with mercury thermometer. The water samples were immediately brought in to laboratory for the estimation of various parameters.

Fig 8 and 9 : Author doing titration in chemistry laboratory of Raj Rishi College, Alwar.

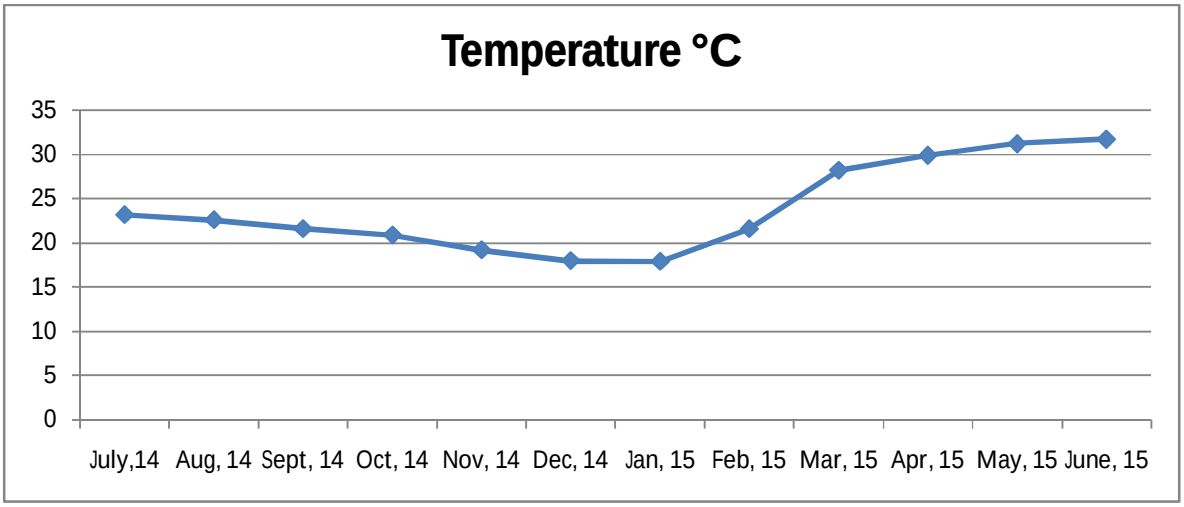
The pH was measured in laboratory by the Philips digital pH meter. Transparency of water was measured by disc immersion method. Dissolved oxygen was measured by curing Wrinkler`s azide modification method. Spectrophotometer was used to determine phosphate and nitrate level. Sulphate was determined by Persulphate acid digestion method. BOD, COD and TSS were determined by using standard method given in APHA[3] and NEERI.[4] For bacteriological examinations samples were collected in 125 ml pre-sterilized (at 121°C) borosil bottle and analyses was carried out within 6 hours of sample collection using standard methods outlined in WHO (2005). Standard plate counts (SPC) for assessing bacterial load was made by pure plate technique. Total and fecal coliform was determined by multiple tube fermentation technique (MTF technique) using Mc Conkey broth media.

RESULTS AND DISCUSSION

Table 2 : The following data were collected from July, 2014 to Dec, 2014

Parameters Months↓	Temp °C	pH	Transpa-rency cms	DO mg/l	BOD mg/l	COD mg/l	TSS mg/l	PO_4^{-3} mg/l	NO_3^- mg/l	SO_4^{-2} mg/l	SPC	TCC	FCC
July,14	23.2	6.9	60.75	9.04	3.6	86.4	1850	9.5	4.33	88.2	58000	2460	2303
Aug, 14	22.6	6.8	61.75	8.79	5.1	88.2	2030	7.06	3.46	112	56000	2380	2400
Sept, 14	21.6	7.3	58.5	9.05	7.5	93.5	770	4.4	4.53	107.2	46000	2140	2215
Oct, 14	20.9	7.6	92.5	8.82	10.4	113.7	626	5.4	4.41	98.0	43000	1860	1602
Nov, 14	19.2	8.1	82.5	10.6	12.5	122.3	555	7.6	3.86	72.6	39000	1210	798
Dec, 14	18.0	6.9	67.25	15.21	17.3	136.7	385	4.9	6.23	65.6	35000	748	340
Jan, 15	17.9	7.4	42.0	18.25	18.6	144.6	260	2.6	9.67	66.6	38000	885	297
Feb, 15	21.6	7.0	10.5	16.06	15.5	142.8	588	3.2	9.07	114.2	42000	1003	333
March, 15	28.2	7.3	9.75	12.5	10.2	112.1	1030	2.3	6.97	157.7	42000	1262	369
April, 15	29.9	8.2	7.5	15.1	5.8	96.3	1120	3.2	5.52	182.3	48000	1569	1026
May, 15	31.2	8.3	6.0	15.5	4.1	64.2	1242	4.4	4.85	204	49000	1499	265
June, 15	31.7	8.3	9.5	11.19	3.7	35.2	1212	6.1	2.63	246	47000	1609	445

Temperature: The most common physical assessment of water quality is the measurement of temperature. Temperature impacts both the chemical and biological characteristics of surface water.

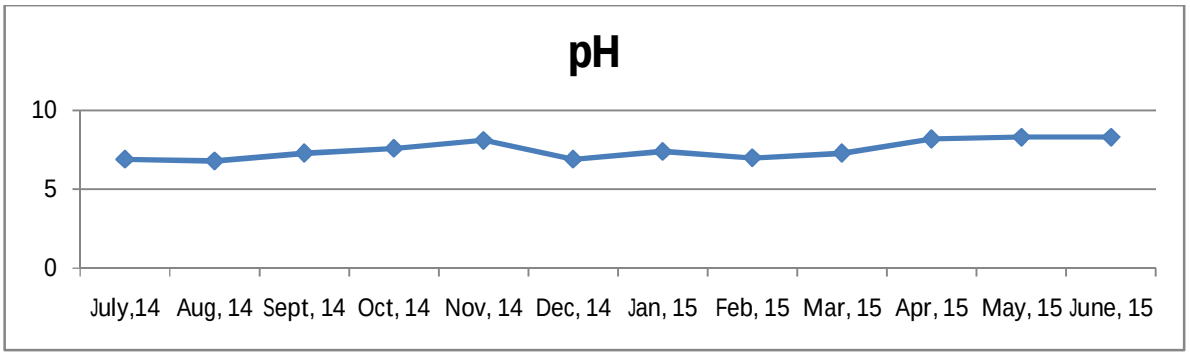


Graph 1: Monthly temperature variation.

The water temperature followed the same trends at all four sites of the lake. A trend of monthly fluctuation in the surface water temperature was approximately similar to that of the atmospheric temperature. The temperature ranges 17.9 (in January) to 31.7 ˚C (in June 2015). Higher

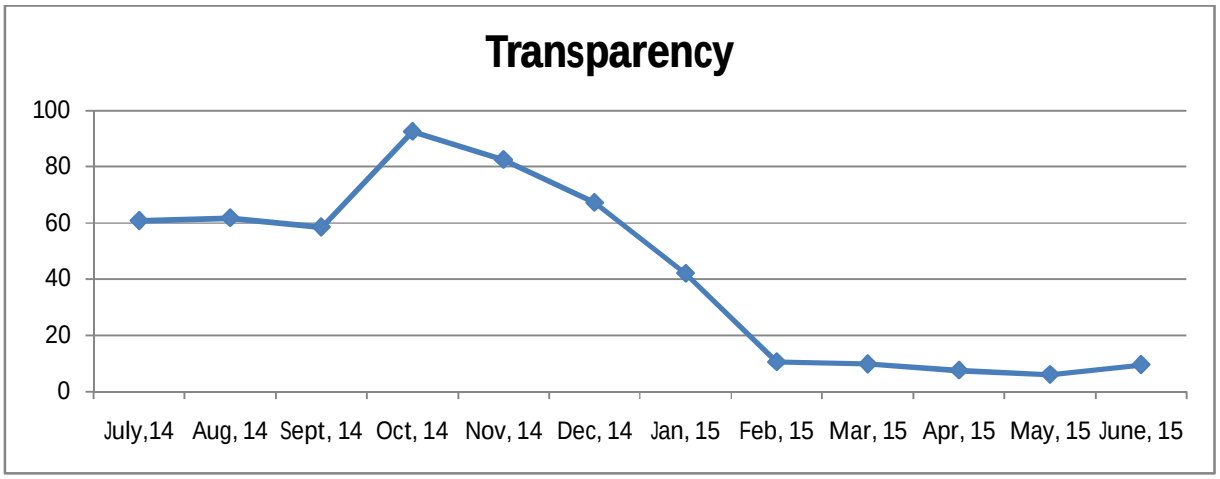
temperature in summer was probably due to the increase load of suspended solids, soil particles and decomposed organic matter in the lake because they absorb more heat.[5]

pH- The pH exhibit slightly acidic and alkaline in nature and ranged between 6.8 to 8.3. Minimum pH was found in July, 2014 and January, 2015, and maximum in march, may and June, 2015. This was probably due to much more concentration of OH^- ions released from the dissociation of alkaline salts. High pH induces the formation of tri halomethanes which are toxic.[6] Acidic nature of lake water in monsoon and winter could be attributed to reduced photosynthetic activity.



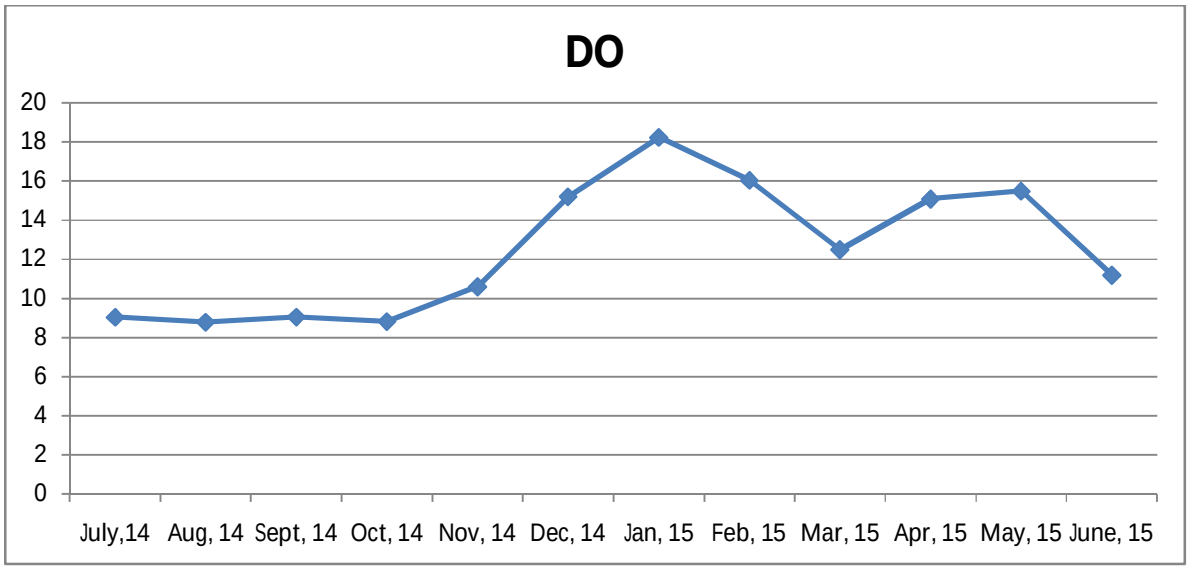
Graph 2: Monthly fluctuation in pH

Transparency- The unique triangular size of 20 cms black and white painted disc immediately disappears on immersion indicating zero or nil transparency. It may due to hyper turbidity of the lake. Monsoon season represented the minimum values of light penetration. This reduction in light penetration was noted in Udaipur lake water.[7,8,9,10,11,12,13]



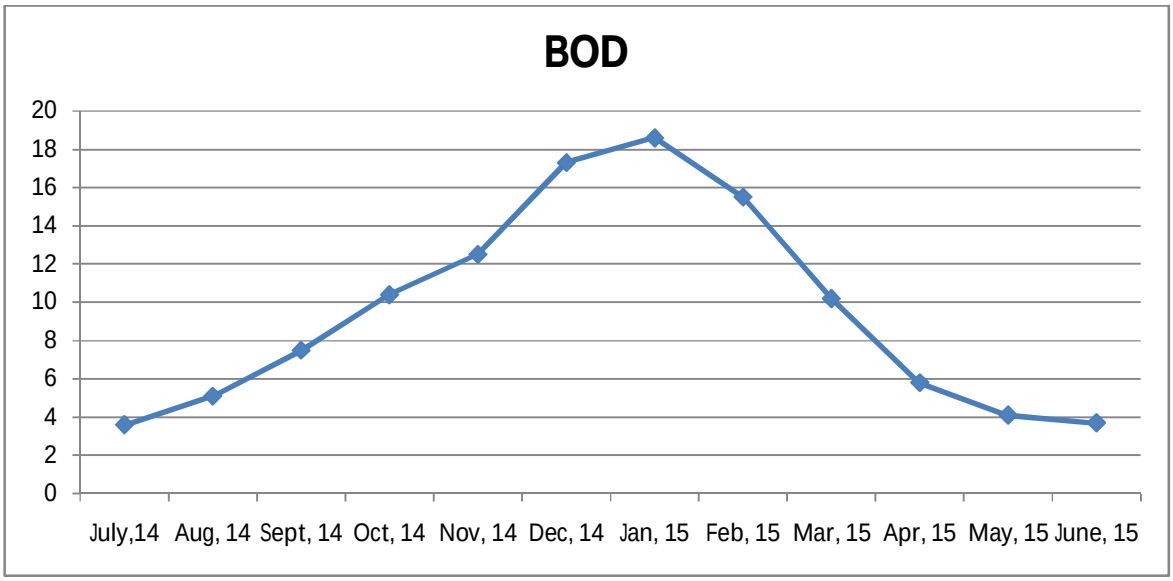
Graph 3: Monthly fluctuation in Transparency

Dissolved Oxygen - The dissolved oxygen content of water indicates health of an ecosystem and provides a broad indicator of water quality. The value of DO range from the table 2 is 8.79 to 18.25 mg/litre. The decomposition and oxidation of organic matter reduce the solubility of oxygen in water. The low value during the monsoon may be due to high load of suspended particles, soil particles and decomposed organic matter which reduce the penetration of light that in turn lowers the photosynthesis. The deficiency of the oxygen in the water is shelter for bacteria and other pathogens, which are anaerobic and injurious to human health. In winter O_2 holding capacity of water increases, may be due to its high solubility at low temperature and less degradation of organic matter.[14]



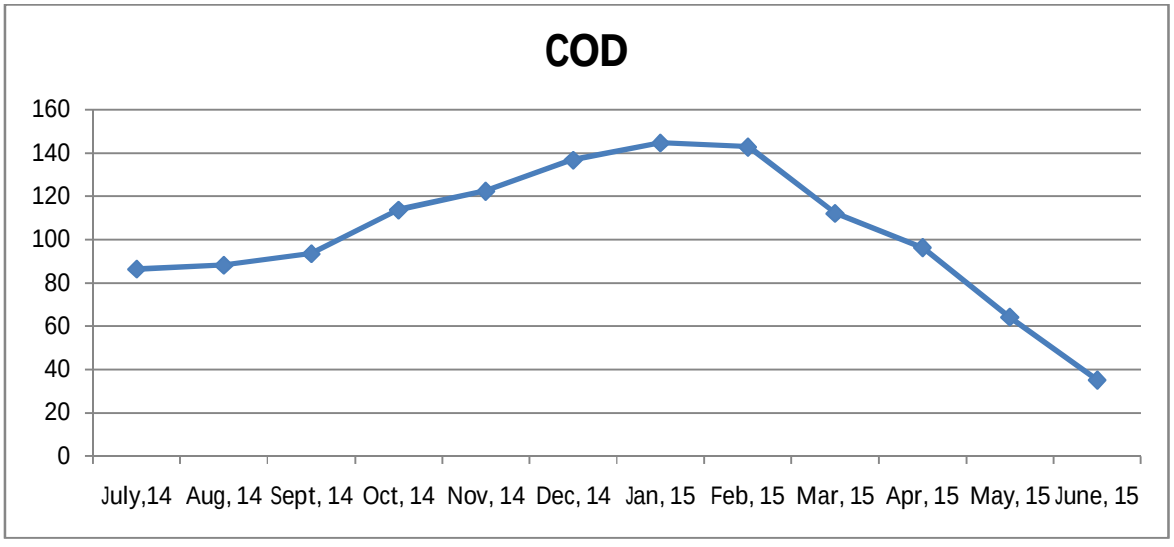
Graph 4: Monthly fluctuation in DO

BOD (Biological oxygen demand) - BOD represents the amount of oxygen that microbes need to stabilize biologically oxidizable matter. It is found to be more sensitive test for organic pollution. BOD value of the lake water ranged between 3.6 to 18.6 mg/lit. The highest BOD (18.6 mg/lit.) was observed in winter (Dec, 2014) and the lowest was in June, 2015. Increased temperature and sedimentation load reduce BOD (Pyatkin and Krivoshein, 1980). According Indian standards, desirable limit of BOD is 4.0 mg/l. and permissible limit is 6.0 mg/l. Biological oxygen demand 3 mg/l or less is required for the best use.



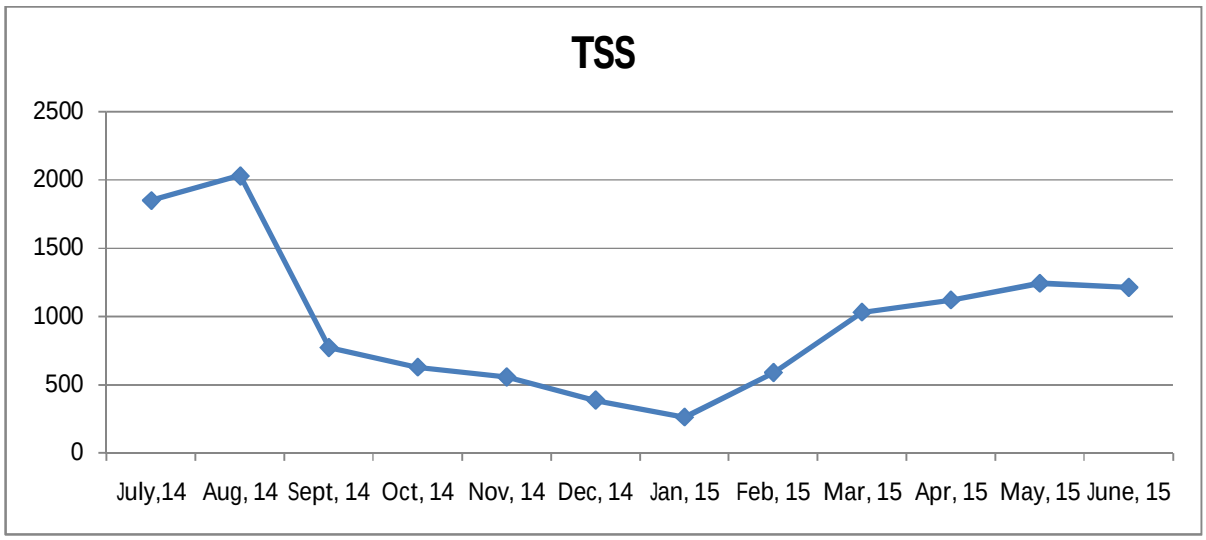
Graph 5: Monthly fluctuation in BOD

COD (Chemical Oxygen Demand) – COD determines the amount of oxygen required for chemical oxidation of organic matter in the solution. COD value conveys the amount of dissolved oxidizable organic matter including non biodegradable matter present in it. The COD values ranged 35.2 to 144.6 mg/litre. Its higher value during winter may be due to high concentration of organic pollutants and low value may be due to low organic matter.



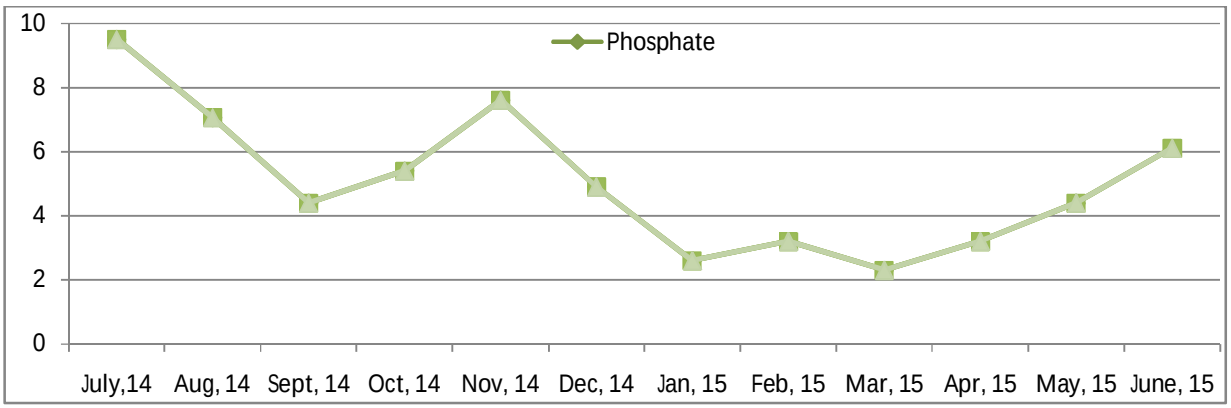
Graph 6: Monthly fluctuation in COD

TSS (Total Suspended Solids) **-** TSS includes things such as mud, algae, detritus and faecal material. TSS ranged 260 to 2030 mg/l. High level of TSS in monsoon indicates high level of turbidity and contamination of the lake. The amounts of the suspended solids in the lake were not within the permissible limit as per Indian standard (i.e.1000 mg/l).



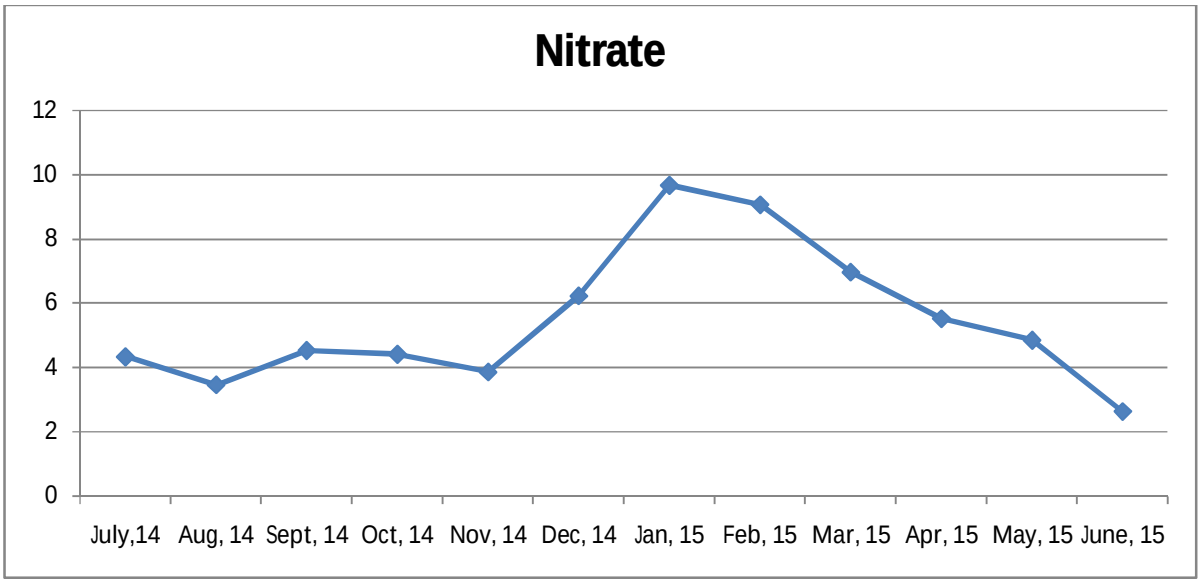
Graph 7: Monthly fluctuation in TSS

Phosphate- Phosphate value was estimated and ranged between 233 to 953 mg/lit. Indicating good biotic utilization by the variety of aquatic biotic life forms and that it is not a limiting factor to biological growth in the lake. Further phosphate values indicate eutrophication trends in the lake.



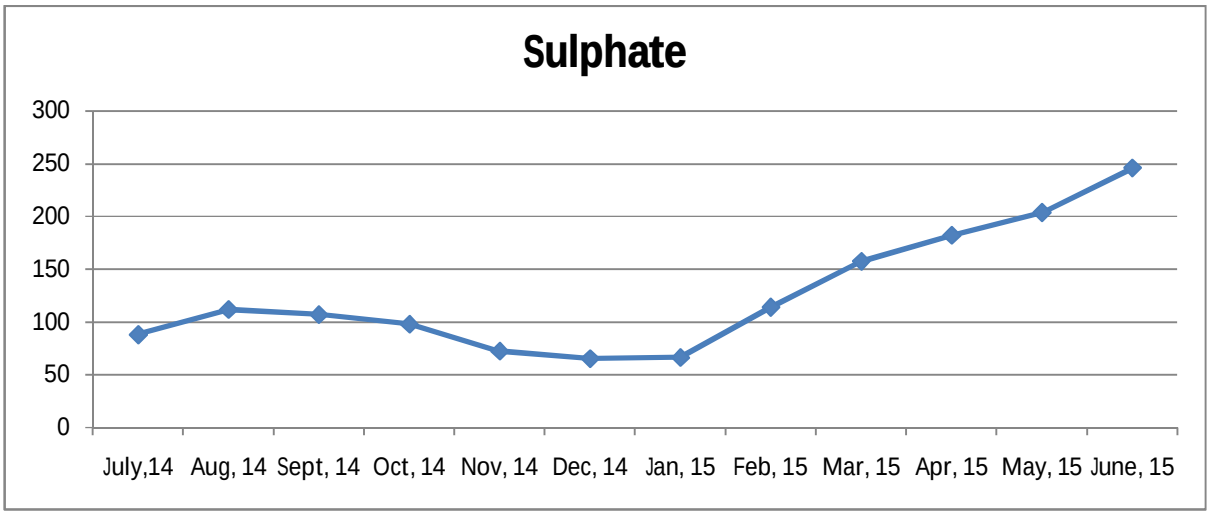
Graph 8: Monthly fluctuation in phosphate in the lake water.

Nitrate- In most of the natural aquatic ecosystems often nitrogen is a limiting factor to plant production. The range values of nitrates recorded were 2.63 to 9.67 mg/lit. The natural concentration rarely exceeds 10 mg/lit. (Lind, 1979).



Graph 9: Monthly fluctuation in nitrate in the lake water.

Sulphate- Sulphate (So_4^{-2}) is a major anion abundant in freshwater lake. Sulphate ion concentration was minimum (65.6 mg/l) in rainy and winter season and maximum (246 mg/lit.) in summer. Water bodies located in arid and semiarid zones of Rajasthan are rich in sulphate (Ranu, 2001). Concentration of sulphate has laxative effect which is enhanced when sulphate is consumed with magnesium. Water containing $MgSO_4$ (1000 mg/l) acts as purgative in human adult.

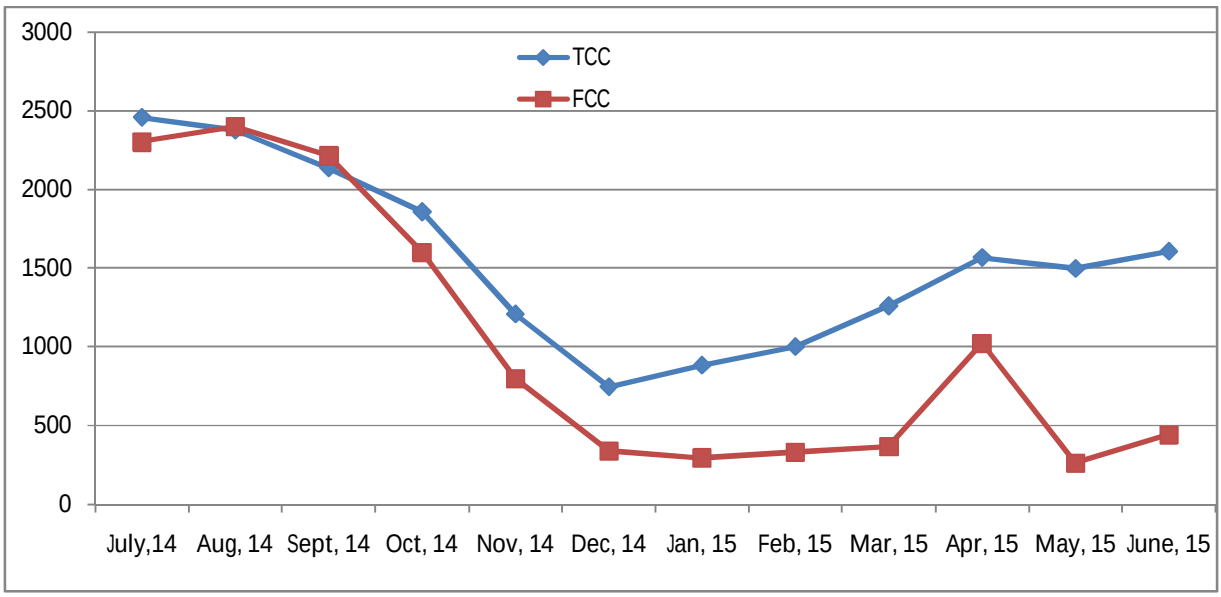


Graph 10: Monthly fluctuation of sulphate in the lake water.

MICROBIAL STATUS

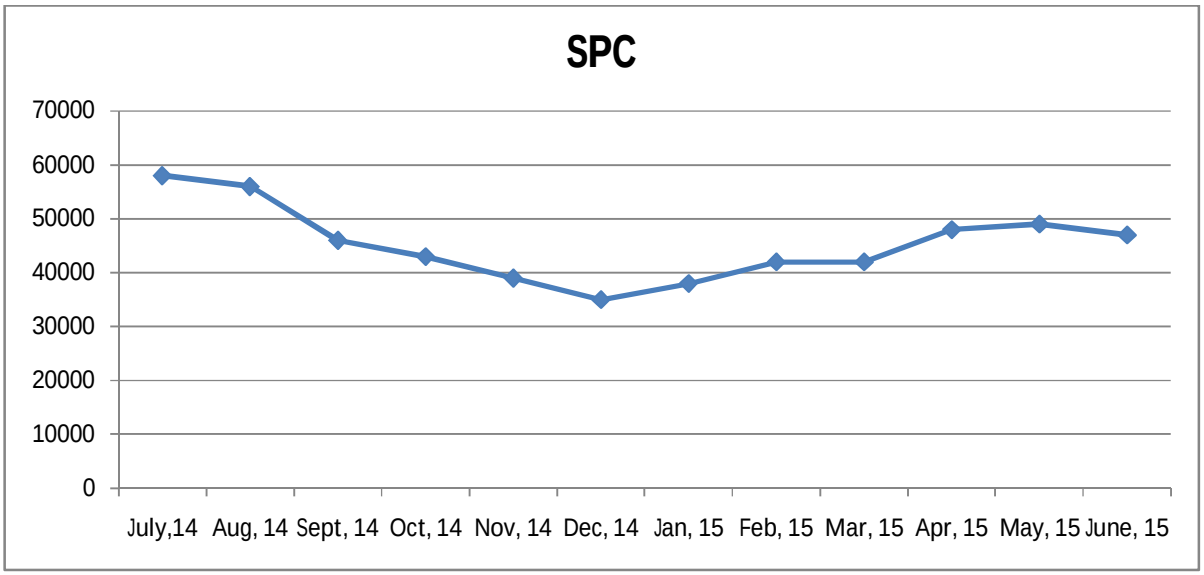
The coliform bacterium is the primary bacterial indicator for fecal pollution in water. As per the results of present study shown in table no.-1, all the microbial parameters were found low range than laid for fresh waters by CPCB . The maximum number of Total coliform was found to be 2460/ 100ml in July, 2014 and the minimum number of total coliform were found to be 748/100 ml in Dec, 2014. The maximum numbers of faecal coliform were found to be 2400/100 ml in Aug, 2014 and the minimum number of faecal coliform were found to be 265/100 ml in May,2 015. It is observed that the trends in table 2 indicate higher bacterial population with the commencement of monsoon and relatively lower bacterial density during winter. [7,8,9]

The fairly high values of total coliform and faecal coliform are indicative of increasing microbial pollution of the lake by organic means particularly through the discharge of sewage and domestic effluents in to the lake. The total coliforms and faecal coliform were found maximum in monsoon which is due to mixing of discharge of excreta.



Graph 11: Monthly bacterial fluctuation of FCC and TCC in the lake water.

Therefore a potential health risk exists due to presence microbial pathogen in water.



Graph 12: Monthly fluctuation in SPC.

Table 3: Suggested values of coliform/100ml for beneficial use of water (Pandey and Sharma, 1999).

SN	Quality	Grade	Bathing and swimming	Public water supply
1	Excellent	I	<10	<100
2	Good	II	4	200
3	Satisfactory	III	250	800
4	Poor	IV	1500	1000
5	Unacceptable	V	>6000	>8000

Abbreviations

1. MPN- Most probable Number
2. SPC- Standard Plate Count
3. FCC – Faecal coliform count
4. FSC – Faecal streptococcus count
5. TCC - Total Coliform count

CONCLUSION

The conclusion from the present investigation may be drawn that maximum parameters were present at the level of pollution in the lake water. Jaisamand Lake is going to be contaminated day by day with human activities and ultimately eutrophication affects aquatic life, unsafe for human use. Bacterial parameters exceed the drinking water permissible limit suggested by WHO, ICMR and ISI. Therefore water of this lake is very unsafe for human use.

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