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Limnological Studies Related to Physico-Chemical Characteristics of Water in Anasagar Lake, Ajmer, Rajasthan

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ABSTRACT

The study deals with the seasonal limnological investigation related to physico-chemical characteristics of water of the Anasagar Lake in Ajmer (Rajasthan). The limnological parameters were tested following standard methods at three sampling sites/stations in the lake. The physico-chemical parameters (temperature, turbidity, pH, DO, BOD, COD, free CO_2, total alkalinity, conductivity, TSS, TDS, Chloride, Ammonia, Nitrate, Phosphate, etc.) showed distinct temporal or seasonal variation in the lake. Higher nutrient content (nitrate, phosphate) was present in the lake. This finding also signifies eutrophication/higher trophic level. Water transparency, dissolved oxygen, BOD, total alkalinity, conductivity, $CaCO_3$ hardness, TSS, nitrate and phosphate was correlated with various physico-chemical parameters in the lake. The physico-chemical characteristics of water of the lake revealed the poor water quality in Anasagar Lake.

Keywords: *Physio-Chemical Parameters; Limnology; Anasagar Lake; Eutrophication.*

1.0 Introduction

Water is one of the most important compounds that profoundly influence life. The quality of water is usually described according to its physical, chemical and biological characteristics. Rapid industrialization and indiscriminate use of chemical fertilizers and pesticides in agriculture are causing heavy and varied pollution in aquatic environment leading to deterioration of water quality and depletion of aquatic biota.

Due to use of contaminated water, human population suffers.

Lake and their surrounding are unique assets and valuable ecosystems of society and nature. These are resources of social, cultural, and aesthetic value. Maintaining lake water quality helps maintaining healthy surroundings. But, an excessive introduction There has been a large fluctuation in the water quality of the Anasagar Lake.

The lake has significant of nutrients by humans has led to severe eutrophication of certain freshwater systems worldwide. Anasagar Lake is one of them. environmental problems. Around 30% of the city's population resides in the catchment area of the lake. The agricultural run-off and the municipal waste are washed of in the lake.

Although, heavy rains in the last two-three years have improved some water quality parameters, but the lake water quality is still unfit for general water uses.

Undesirable values of total dissolved solids, chloride, fluoride, BOD, total coliform organism's etc. makes the water unfit for drinking and other household uses.

2.0 Study Area

Anasagar Lake was made in the 12^{th} century by building a dam across the river Luni and was named after the ruler Anaji Chauhan who constructed the lake during 1135-1150 AD. Later, Mughal Emperor Jehangir contributed the Daulatbagh gardens and Shah Jehan built the Baradari.

It is situated at the centre of the Ajmer city (74^0 38' - 74^0 42' and 26^0 25' - 26^0 29' N). Lake has a capacity of 4.75 million cubic metre upto a maximum depth of 4.4 m. It has a catchment area of 56 sq. kms.

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Among the existing lakes in Ajmer, Anasagar Lake is the biggest one with the maximum catchment area.

Foy Sagar is another major lake of the city. There are more than a dozen small ponds in the Ajmer city.

Table 1: Geographical Features of Anasagar Lake

Characteristics	Description
Geographical Location	74^0 38' - 74^0 42' and 26^0 25' - 26^0 29' N
Location in Ajmer	North West in Ajmer
Catchment Area	56 sq. km (gross), 20 sq. km (intercepted by foysagar), 5 sq. km (built up area)
Nature of catchment area	Steep to gentle slope with low vegetal cover
Storage capacity	4.75 million cubic meter (for max depth of 4.4 m
Circumference	4.81 km (Nov, 06), 7.3 km (maximum water level)
Depth	Maximum 4.4 m
Overflow arrangement	Four overflow gates of size 4' X 6'

3.0 Methodology

Three representative stations, (station - I, II and III) located in different stretches of the water area were selected for collection of water samples, considering the disturbance aspect on the water body such that the samples may provide reasonably representative status of water quality.

The station were Centre of Electric tower (AW 1S), Floating Fountain (AW 2S) and Baradari (near boat house) (AW 3S).

All the samples were collected at a fixed time, from 9 a.m. to 2 p.m. on a specified date during October- 2012 to August- 2013.

The methods of instrumentation and procedures for the analysis of the water samples were carried out elsewhere following the standard methods mentioned in the APHA, 21st Edition, 2005.

The testing of the chemical parameters in Anasagar Lake is carried out in a laboratory which is under National Lake Conservation Program (NLCP) (under Ministry of Environment and Forest (MoEF)).

Permission for using the data has been obtained from Executive Engineer, UIT, Ajmer (Rajasthan)

Figure: Anasagar Lake, Sampling stations (10)

There is a mutual agreement between Government of Rajasthan and MoEF for rejuvenating the lake's health. The samples from the lake are tested every month. Various parameters mentioned in the Table 2, Table 3 and Table 4 are obtained from the office under NLCP.

Temperature: Seasonal change was observed in the lake temperature. Minimum and maximum temperature recorded was 18.2^0 C and 29^0 C.

pH: Maximum and minimum values of 8.9 and 7.3 were recorded in the lake water. pH values are in accordance with earlier work by Wetzel (et al 1975) who reported that the value of pH ranges from 8 to 9 in Indian waters.

Turbidity: When water is cloudy, sunlight will warm it more efficiently because suspended particles absorb the sunlight, warming the water. This can lead to problems associated with increased water temperature

Dissolved oxygen: DO level in the lake reached to almost negligible some years back in 2007-2008. Situation is now under control as the outflow channel gates' level has been increased and the area under lake has now increased, hence improving the dissolved oxygen in the lake (9).

Nitrates: Minimum and maximum values of Nitrates were 10.1 mg/L and 17.8 mg/L.

Electrical conductivity: In Anasagar, the value varied between the range 2140 to 3500 μmho/cm indicating high salt content.

Salinity: The water of Anasagar Lake is slightly saline as the average values were found to be above 1000 ppm throughout the monitoring period. Range of values observed was 1400-1700 ppm.

Chloride: Observed values were in the range 430- 590 mg/l with an average of 510 mg/l.

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4.0 Results and Discussions

The major problem of the lake relates to the advanced level of eutrophication due to heavy nutrient and pollution loading. Three four years back one of the problems was insufficient water in the lake. Scanty rainfall in the area was an obvious reason.

But in the last two years, heavy rains over the city have improved overall quality of the lake water. But the quality of the lake water is still the same because of the simultaneous increase in pollutants inflow.

The pollution loads of the lake originate from various point and non-point source and include nutrients and fecal coliform from sewage. Also, lechate from the waste adds to the bad health of the lake.

There was a seasonal Temperature change with maximum and minimum of 18.2^0 C and 29^0 C. The temperature has greater role in the dynamic of aquatic ecosystem. Temperature dictates the behavioral characteristics of organisms, solubility of gases and salts in water bodies.

The bacterial action in a lake, which is responsible for the decomposition of organic matter for nutrient cycle, is directed by the temperature of the water.

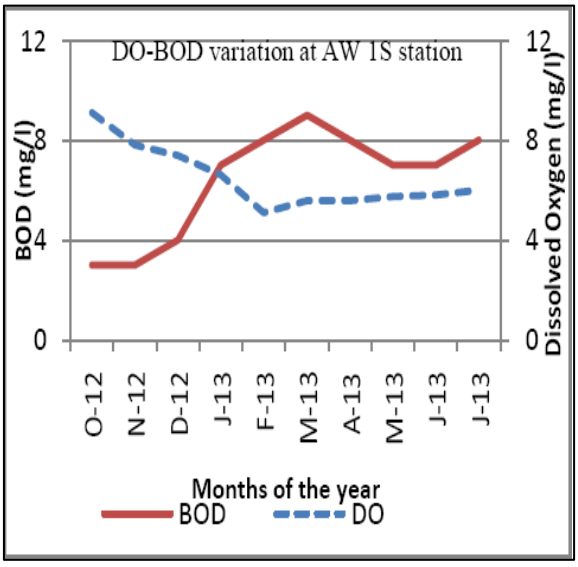
The hydrogen ion concentration of a body is generally controlled by the concentration of CO_2, which in turn is controlled by the photosynthetic activity of the producers (Hutchinson, 1857).

High pH in the lake will have serious problems as high pH promotes cyanobacteria to form blooms. Anasagar Lake's pH has been recorded above the neutral scale and the values range was 7.3-9.

The free CO_2 concentration in Anasagar Lake was found to be almost negligible.

Low level of free CO_2 might be either due to its consumption in carbon assimilation or its complete conversion into carbonic acid and ultimately into stable carbonates and bicarbonates.

Fig 1: Graph Showing DO-BOD Variation at the Station AW 1S



The DO, an important physico-chemical parameter of water quality, has special significance for aquatic organisms in natural waters (7). The DO content in the Anasagar Lake's surface layers varies between 5.3 mg/l and 10 mg/l and the nature of variation at different sites is almost similar to that of variation of temperature (between 18.2^0 C and 29^0 C) and pH (between 7.3 and 9). The DO content in the surface layer is found to be higher with respect to higher water temperature, which has also been observed by several authors (8).

The high amount of oxygen in the surface layers is due to the diffusion of atmospheric oxygen by wind action and partly due to mechanical agitation (for example fountains and mechanical aerators placed in the lake) (9).

Low DO in lakes is due to the presence of inorganic reductants such as, H2S, ammonia, nitrates, ferrous ions and other oxidisable substances.

The BOD, a widely accepted parameter in determining water quality, varies between 3 mg/l and 10 mg/l, which on an average is 6.5 mg/l, whereas the COD varies from 10 mg/l to 41 mg/l, with an average of around 25.5 mg/l. As calculated in the Table 5, the ratio of BOD to COD is very low (0.2 to 0.4), implying the presence of large portion of undegraded organic matter of refractory origin arising from allochthonous and autochthonous sources in the medium.

Phillipose (1960) was able to categorise lakes in to three categories based on the alkalinity values. According to his criteria, water with alkalinity range 4-50 mg/l are believed to be nutrient poor, 50-100 mg/l indicates moderate nutrient concentration and those having 100-600 mg/l concentrations are nutrient rich. As per his categorization, Anasagar Lake has high dissolved solids content with values ranging from 1400-1600 mg/l.

Nitrate ions (NO_3-) found in water samples result from a variety of natural and manmade sources. Nitrates are an important source of nitrogen necessary for plants and animals to synthesize amino acids and proteins enter the lake ecosystem through run-off and decomposition of organic matter. In Anasagar Lake the Nitrate level was 11 mg/l to 19 mg/l. The higher inflow of water and consequent land drainage cause high value of Nitrate. Nitrate level in freshwater is usually found in the range of 0.1 to 4 mg/L. Unpolluted waters generally have nitrate levels below 1 mg/L.

The effluent of some sewage treatment plants may have levels in excess of 20mg/L. The city's municipal waste is released directly into the lake.

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Low Conductivity (0 to 200 µmho/cm) is an indicator of pristine or background conditions. Mid-range conductivity (200 to 1000 µmho/cm) is the normal background for most major freshwater lakes. Conductivity outside this range could indicate that the

water is not suitable for certain species of fish or bugs. High conductivity (1000 to 10,000 μmho/cm) is an indicator of saline conditions. Waters that have been heavily impacted by industry can fall into this range (13).

The increase of E. C. in Anasagar Lake is an indication of the enrichment of the ions in water bodies which is may be due to natural sources or by the anthropogenic sources.

It was noticed that the concentration of Cl- was high in the water of the lake. This could be attributed to evaporation from surface water leaving the relative high content of chloride (13). Chloride contamination in Lake Water is considerably harmful for humans to drink and irrigation at high levels, because it is made of chlorine chemically combined with heavy metals.

The National River Water Quality (NRWQ) standard ranges from 45 to 155 mg/l. As observed, the chloride content is very high in Lake, indicates that Lake Anasagar water is not at all suitable for drinking and other aquatic organisms. Also, the chloride and EC relationship indicates that electrical conductivity is sharply increased with increasing chloride concentration in water.

Table 2: BOD and COD Ratio at the AW 1S Station of Anasagar Lake

BOD (mg/l)		COD (mg/l)	BOD/COD
Oct-12	4	15	0.27
Nov-12	3	11	0.27
Dec-12	3	10	0.30
Jan-13	9	29	0.31
Feb-13	8	32	0.25
Mar-13	7	33	0.21
Apr-13	9	28	0.32
May-13	7	28	0.25
Jun-13	7	26	0.27
July-13	7	21	0.33
Aug-13	10	41	0.24

5.0 Conclusions

The pH of the lake water is slightly high then the limits mentioned in the CPCB guidelines for the water use. DO of the lake water satisfy the bathing water quality criteria (for example Class B as per the CPCB and IS 2296, 1963) but the level of the BOD and coliform count are well above the permissible limits for human use.

Thus, the water becomes unsuitable even for outdoor bathing. Samples collected adjacent to the lake bank show higher concentrations in the water quality parameters, as compared to the mid- reach samples, implying the entry of the non-point sources and extreme thrust on the water body due to the anthropogenic activities.

The water of Anasagar is not fit for 1-4 guidelines mentioned in CPCB. The quality of water in the lake has improved considerably over the last 5-6 years but it continues to be unfit for day-to-day human consumption.

Table 3: Physio-Chemical Parameters in Anasagar Lake, Station- AW 1S, October-2012 to August- 2013

	Temp	pH	Condu-ctivity	TSS	TDS	Total Solids	Chloride	DO	BOD	COD	Flouride	Nitrate	P	Phosphate	Total Coliforms	Fecal coliforms
	^{o}C	-	µmho/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100 ml	MPN/100 ml
Oct-12	28	7.6	3040	42	1405	1447	490	10.7	3	14	0.1	11.12	0.68	0.28	5850	1100
Nov-12	24	7.8	2911	38	1446	1484	451	7.8	3	15	0.2	12.41	0.23	0.48	4990	1132
Dec-12	18	8.8	2631	16	1473	1489	457	7.4	4	17	1.0	14.43	0.35	1.05	3590	1200
Jan-13	21	8.9	2161	15	1513	1528	482	6.6	7	23	1.1	17.05	0.07	0.21	28301	2301
Feb-13	23	8.7	2241	21	1530	1551	503	5.1	8	28	1.2	17.33	0.12	0.55	11021	3012
Mar-13	27	8.6	2334	28	1540	1568	594	5.6	6	27	1.2	17.66	0.19	0.32	12110	4000
Apr-13	29	8.8	2616	16	1603	1619	498	5.6	10	31	1.1	11.13	1.07	1.74	24380	4032
May-13	34	8.6	2815	39	1707	1746	545	5.7	5	27	1.4	16.98	0.14	0.32	28443	4032
Jun-13	36	8.6	2715	29	1601	1630	531	5.8	7	29	1.4	17.1	0.21	0.41	30152	3800
Jul-13	28	8.5	2210	21	1445	1466	514	6	9	36	1.3	18.09	0.29	0.49	34127	3305
Aug-13	25	8.9	2350	21	1458	1479	433	8.9	8	32	1.1	14.64	0.09	0.12	34295	8083

Table 4: Physio-Chemical Parameters in Anasagar Lake, Station- AW 2S, October-2012 to August- 2013

	Temp	pH	Condu-ctivity	TSS	TDS	Total Solids	Chloride	DO	BOD	COD	Flouride	Nitrate	P	Phosphate	Total Coliforms	Fecal coliforms
	^{o}C	-	µmho/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100 ml	MPN/100 ml
Oct-12	29	7.4	2400	26	1603	1629	452	7.1	4	15	0.1	13.22	0.26	0.24	14990	1500
Nov-12	23	7.5	2510	20	1500	1520	466	10.7	3	11	0.2	10.12	0.24	0.52	11260	1500
Dec-12	18	8.7	2752	15	1541	1556	471	8	3	10	1.7	11.09	0.31	0.08	11260	1500
Jan-13	20	8.8	2140	20	1498	1518	492	6.1	9	29	1.1	17.8	0.08	0.24	16556	2500
Feb-13	23	8.8	2218	22	1501	1523	501	5.3	8	32	1.2	15.54	0.1	0.36	17002	3510
Mar-13	27	8.7	2317	23	1504	1527	506	5.9	7	33	1.3	16.45	0.2	0.41	16060	5882
Apr-13	29	8.8	3055	14	1490	1504	488	5.6	9	28	1.1	13.35	0.92	1.72	28587	4032
May-13	34	8.5	2870	26	1684	1710	535	6.1	7	28	1.4	17.33	0.08	0.17	20218	3305
Jun-13	35	8.6	2510	18	1512	1530	521	5.5	7	26	1.4	17.41	0.22	0.34	18992	3102
Jul-13	28	8.6	2182	9	1478	1487	543	4.6	7	21	1.3	17.68	0.58	1.07	12151	4031
Aug-13	25	8.9	2598	24	1612	1636	429	7.7	10	41	1.1	14.9	0.18	0.3	40012	3305

Table 5: Physio-Chemical Parameters in Anasagar Lake, Station- AW 3S, October-2012 to August- 2013

	Temp	pH	Condu-ctivity	Turbidity	TSS	TDS	Chloride	DO	BOD	COD	Flouride	Nitrate	P	Phosphate	Free CO2	Total Coliforms	Fecal coliforms
	^{o}C	-	µmho/cm	NTU	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100 ml	MPN/100 ml
Oct-12	29	7.2	2910	7.8	9	1409	411	4.8	4	15	0.1	13.2	0.07	0.14	NIL	38834	7722
Nov-12	23	7.4	2700	6.1	11	1450	420	8.1	5	20	0.17	13.3	0.12	0.12	NIL	3590	1002
Dec-12	19	8.7	2650	3.9	10	1485	434	7.4	3	14	1.22	11.2	0.13	0.14	NIL	2062	734
Jan-13	21	8.8	2160	1.6	22	1512	506	4.2	9	29	1.11	17.9	0.75	0.80	NIL	28434	2305
Feb-13	25	8.5	2220	1.9	26	1520	530	5.1	6	24	1.12	15.2	0.18	0.50	NIL	10223	3055
Mar-13	27	8.6	2334	4.9	28	1540	594	5.6	6	21	1.17	17.7	0.19	0.32	NIL	7142	4000
Apr-13	28	8.7	2892	2.8	16	1578	498	5.6	8	26	1.05	10.7	0.91	0.80	NIL	34464	3305
May-13	35	8.5	2880	2.7	15	1732	563	6	4	19	1.39	16.8	0.12	0.36	NIL	20309	3305
Jun-13	35	8.6	2440	3.7	20	1604	560	5.4	6	21	1.25	14.6	0.16	0.37	NIL	24056	3500
Jul-13	27	8.9	2220	4.7	28	1513	552	4.3	7	25	1.27	15.5	0.15	0.38	NIL	28438	4032
Aug-13	25	8.7	2565	9.4	21	1590	433	5.1	11	29	1.13	15.4	0.12	0.10	NIL	34464	12124

References

[1] Water Research Center, Stream Water Quality Importance of Temperature, by: Mr. Brian Oram, PG. http://www.water-research.net/Watershed/temperature.htm

[2] Environment Canada: http://www.ec.gc.ca/eaudouce-freshwater/default.asp?lang=en&n=61A967F4-1

[3] Mohamed A.F. Toufeek and Mostafa A. Korium, 2009, Physicochemical Characteristics of Water Quality in Lake Nasser Water, Global Journal of Environmental Research 3 (3): 141-148, ISSN 1990-925X.

[4] Wetzel. 'The Oxygen Content in Freshwater' Limnology, M. Brown, 1983, p 172.

[5] APHA, AWWA, and WPCF, Standard Methods for the Examination of Water and Wastewater, 17th edition, American Public Health Association, Washington DC, U.S.A, 2000

[6] Wetzel, R.G., Limnology, W. B. Saunders Co., Philadelphia, USA, 74,1975

[7] A. Mazumdar, N. R. Samal, "Physico-chemical Characteristics of Water in a Shallow Lake", Rabindra Sarobar, Kolkata, 88, Sep 2007

[8] A L Ramanathan, R Ramesh, "Recent Trends in Hydro geochemistry", Capital Publishing Company, New Delhi, 2003, p 37, 2003

[9] A. L. Downing, Z. Turesdate. 'Some Factors Affecting Rate of Solution of Oxygen in Water', J App. Chem., 5, 1995, p 570

[10] https://maps.google.co.in/maps?hl=en&tab=wl, Map of Ajmer (Rajasthan), India- 305001.

[11] Rafiullah M. Khan, Milind J. Jadhav, I. R. Ustad, "Physicochemical analysis of triveni lake water of Amravati district in (MS) India", Bioscience Discovery, 3(1):64-66, Jan. ISSN: 2229-3469 (Print), 2012

[12] NEERI, A laboratory manual on water analysis, 1987

[13] A. Patra, K. B. Santra, C. K. Manna, Limnological Studies Related to Physico-Chemical Characteristics of Water of Santragachi and Joypur Jheel, W.B., India, Our Nature 8:185-203, 2010

[14] R. Purohit, S. P. Singh, Seasonal Variation in Physio-chemical Limnology of Shalow zones of Nainital Lake, Western Himalaya, Proc, Indian natn, Sci. Acad., B47, No. 2 pp 194-203, 1981.

[15] S. Jain, G. Sharma, "Effects of Pesticides on hormone and enzyme systems of aqua population: a view over Anasagar lake, Ajmer", IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) ISSN: 2319-2402, ISBN: 2319-2399, 1 (5) (Nov. - Dec.), PP 24-28, 2012

[16] Patil Shilpa G., Chonde Sonal Goroba, "Study of physicochemical and biological characteristics of lakes from Shivaji University Campus", Kolhapur, Maharashtra, Pelagia Research Library, Advances in Applied Science Research, 2 (6):505-519, 2011

[17] R. Jacklin Jemi, G.S. Regini Balasingh, "Studies on physico-chemical characteristics of freshwater temple ponds in Kanyakumari district", South Tamilnadu

[18] Pond and lake Management, Otterbine Barebo, Inc

[19] Rajasthan Travel Guide, http://www.indianholiday.com/tourist-attractions/rajasthan/ajmer.

[20] P. Mathur, S. Patan, "Assessment of Physico-chemical properties of Anasagar lake of Ajmer (India)", Journal of Environmental Research And Development 4(3), Jan-Mar 2010