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Seasonal Variations In Physico – Chemical Parameters of Seven Different Lakes In Chennai, Tamil Nadu, India

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Abstract: *The present studies were made on the analysis of heavy metals in relation to physico-chemical parameters with respect to pollution status of lake water from various regions (Ambattur lake, Chembarambakkam lake, Korattur lake, Porur lake, Pulicat lake, Puzhal lake and Retteri lake) in Chennai, Tamilnadu, during April 2017 to November 2017, Tamil Nadu, India. Surface water samples were collected from seven different regions at monsoon, post monsoon, summer and pre-monsoon seasons. The samples were analyzed for physico – chemical parameters include colour, odour, pH, EC, TH, Turbidity, TDS, BOD, COD, DO, F, Ca, Mg, Mn, Cl, Fe and SO_4. In the present study results showed that higher level of heavy metal concentration in the water has a high potential to concentrate heavy metals like lithium, Cd, Pb, As, Al, Ni and Cr though the observed concentrations are above the permissible limits except two metals (Zn and Al) are within the permissible limits. Based on these results there is serious heavy metal pollution in these lake. There is an urgent need to control the industrial pollution and save the above water bodies for the welfare of the present and future generations.*

Keywords: *Chennai lakes, seasons, physicochemical parameters, heavy metals*.

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I. Introduction

Water has a number of properties that are of critical importance to life and the environment. Water is the only naturally occurring inorganic liquid. It is also the only chemical on this planet that occurs naturally in all three states of matter solid, liquid and gaseous (Cuihang et al., 2011, Franks 1976 and Govindasamy et al., 2000). Water pollution is defined as the addition to water of an excess material or heat that is harmful to the living organisms or which impairs the beneficial uses of water. Pollution makes water physically impure, foul or filthy. It changes the natural qualities of water, so that it becomes unsuitable for the uses to which is normally put to. Pollutants maybe present in water either as suspended particles or as dissolved compounds or both. The dissolved compounds are more difficult to remove and hence these taint the water sources more seriously that the suspended impurities. Water pollutants are classified into four broad categories chemical, physical, physiological and biological. Chemical contaminants are subdivided into organic pollutants and inorganic pollutants, the former being more threatening to the environment (Kumar 2007, Kistan et al., 2015 and Mahanta et al., 2004).

Water pollution is a major problem related to the economic/ industrial growth of any country. The number of industries in India, during the last decade has grown more than ten times and accordingly the development of economic growth and industries. Some of the industries release their effluent water and ultimately groundwater (Kumar et al., 2010 and Sonune et al., 2015). The effluent contains various inorganic and organic substances in different concentration may affect the nature and quality of lake water. Most of the industries discharge their effluent without proper treatment into nearly open pits or pass them through unlined channels, resulting in the contamination of ground water. The incidence of ground water pollution is highest in urban areas where large volumes of waste are concentrated and discharge into relatively small areas (Acharya 2003 and Owity et al., 2007).

Water quality of the freshwater habitats provides substantial information about the existing resources which depends on the influences of physico – chemical parameter and biological features (Sawyer 1978). Water pollution is a major environmental issue in India, where most rivers, lakes and surface water are polluted. Almost 70% of the water in India has become polluted due to the discharge of domestic sewage and industrial effluents into in India is untreated sewage and the other sources of pollution include agricultural runoff and unregulated small scale industry. Chennai, formerly known as Madras, is the fourth largest metropolitan area in

Indian state of Tamilnadu (APHA 1998). The purpose of the present study is to determine the effect of seasonal variations on physico – chemical parameters and heavy metal in lake water from various regions in Chennai.

II. Experimental Section

Geographical Location of Study area

Ambattur lake: The ambattur lake is located in ambattur municipality of Thiruvallur district, Tamilnadu. It is governed by Chennai Metropolitan Development authority (CMDA) and covers an area of 40.36 sq.m. The ambattur lake mainly depends on the monsoon rainfall.

Chembarambakkam lake: The chembarambakkam lake is located in Chennai, Kanchipuram district of Tamilnadu, about 40km from Chennai. The lake lies between 13º0'22' North 80º3'35' East.

Korattur lake: The korattur lake, spread over 990 acres in korattur (13º07'19.2" N and 80º11'04.4E"). It is located to the north of the Chennai – Arakkonam railway line and is one of the largest lakes in the western part.

Porur lake: Porur lake is located on the fringes of the suburb pf porur in South – West Chennai and is a primary source for people residing in Chennai.

Puzhal lake: It is located in Ponneri Taluk of Thiruvallur district, Tamilnadu.

Pulicat lake: Pulicat lake (latitude 13º24' and longitude 80º03' and 80º18'E) is the second largest coastal lake in India located 40km north of Chennai city, Tamilnadu, India.

Retteri lake: Located on the Grand Northern Trunk (GNT) road of Chennai, also known as Kolkata highway. The lake is spread over 5.42million square meters and fed by adjacent water bodies such as Redhills reservoir and Korattur lake.

III. Materials And Methods

Collection of water samples

Water samples are collected from seven different lakes in Chennai. The water samples were collected undisturbed from the surface water in the study area as the depth of water was very less (<5m) during early morning throughout the study area. Samples were collected from April 2017 to November 2017 on seasonal variation. The water samples were collected in two – liter polyethylene cans which were previously cleaned, rinsed and washed with deionized water and then rinsed with samples several times. The collected water samples were brought to the laboratory and preserved. The various physico – chemical parameters as given in Table 1, like colour, odour, pH, Turbidity, TDS, Total Hardness, Electrical Conductivity, BOD, COD, DO, F, Fe, Ca, Mg, Mn, SO_4 and Cl were analyzed by adapting the standard methods of examination of water and waste water (APHA 1998).

Table 1: Analysis of Physico – chemical parameters

S.No	Parameters	Unit	Test procedure
1	Colour	Hazen	IS: 3025 (Part4) 1983 Reaffirmed – 2012 Platinum cobalt (Visual comparison method).
2	Odour	Nil	IS: 3025 (Part5) 1983 Reaffirmed – 2012.
3	pH@25ºC	Nil	IS: 3025 (Part 11) 1983 Reaffirmed – 2012.
4	Turbidity	NTU	IS: 3025 (Part 10) 1984 Reaffirmed – 2012.
5	Electrical conductivity	µS/cm	IS: 3025 (Part 14) 1984 Reaffirmed – 2013.
6	Total hardness ($CaCO_3$)	Mg/l	APHA 22nd edition 2340 – C
7	Calcium (Ca)	Mg/l	APHA 22nd edition 3500 – Ca – B.
8	Magnesium (Mg)	Mg/l	APHA 22nd edition 3500 – Mg – B.
9	Iron (Fe)	Mg/l	APHA 22nd edition 3500 – Fe/B (Phenanthroline method).
10	Chloride (Cl)	Mg/l	APHA 22nd edition 4500 – Cl/B.
11	Sulphate (SO_4)	Mg/l	IS: 3025 (Part 24) 1986 Reaffirmed – 2014 (Turbidity method).
12	Total dissolved Solids (TDS)	Mg/l	IS: 3025 (Part 16) 1984 Reaffirmed – 2012.
13	BOD(3 days @ 27ºC)	Mg/l	IS: 3025 (Part 44) 1983 Reaffirmed – 2014.
14	COD	Mg/l	APHA 22nd edition 5220 – B.
15	DO	Mg/l	IS: 3025 (Part 38) – 1989 Reaffirmed – 2014.
16	Fluoride (F)	Mg/l	APHA 22nd edition 4500 – F/ B, D.
17	Manganese (Mn)	Mg/l	APHA 22nd edition 3500 – Mn/ B (Persulphate method).

Heavy metal concentrations cadmium, zinc, lead, arsenic, aluminium, nickel, chromium and lithium were measured using a flame atomic absorption spectrophotometer (Perkin-Elmer AA700) equipped with a deuterium background corrector. Suitable internal chemical standards (Merck Chemicals, Germany) were used

to calibrate the instrument. All the reagents used were analytical grade of high purity. The results of the heavy metal concentrations were determined on a dry weight basis ppm g-1.

IV. Results And Discussion

The analyzed Physico – chemical parameters were tabulated to understand the water quality. A comparative study of these parameters has done to understand the seasonal variations. The details of the seven sampling stations are tabulated as (Table 2 & Table 3). The result of physicochemical parameters observed from seven different lakes were tabulated in Table 1 and 2. The pH of the water sample registered alkaline in nature i.e. 6.70 to 8.78. This range is good for growth of aquatic organisms like phyto and zoo planktons reported by many authors (Nirmala et al., 2012 and Osborne 1987).

High P^H values were recorded during the rainy season due to the discharge of domestic waste water, sewage and industrial effluent etc. The turbidity of the water sample varied from 90.1NTU (Chembarambakkam lake) and 36NTU (Puzhal lake) during summer in 2017. In monsoon Nov 2017 turbidity varied from 66.4NTU (Porur lake) and 13.3NTU (Ambattur lake). Increased turbidity cause decrease light penetration, plant growth and oxygen production in the water. Therefore, breeding and survival of fish and other aquatic animals were reduced. Suspended particles absorb heat which causes water temperature to increase and it holds less oxygen than cold water (Holum 1977).

Table 2: Physico – chemical parameters of seven different lakes – In Summer

S.No	Parameters	Permissible Limit	1	2	3	4	5	6	7
1	Colour	-	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	Odour	-	None	None	None	None	None	None	None
3	pH@25ºC	6.5 – 8.5	8.01	7.67	7.11	6.70	7.40	7.56	7.80
4	Turbidity	5.0	6.2	90.1	41.4	8.2	2.3	36	0.4
5	EC	-	2460	488	7110	453	45600	780	1917
6	TH ($CaCO_3$)	600	392	51	608	88.2	6324	137	284
7	Ca	200	24	13.4	78.5	16	695	27.5	35.3
8	Mg	100	81	4.3	100	12	1115	17	48
9	Fe	1.0	1.4	7.1	1.8	0.8	0.9	BDL (DL – 0.1)	1.2
10	Cl	1000	403	102	1700	62	15493	114	379
11	SO_4	400	162	92	267	19	3344	86.1	101
12	TDS	2000	1322	360	3486	202	42682	412	926
13	BOD(3 days @ 27ºC)	-	5.8	6.86	154	50.4	75.5	13.4	18.2
14	COD	-	57.1	95.1	533	257	571	95.2	114
15	DO	-	0.58	0.98	1.3	0.79	1.8	0.86	1.06
16	F	1.5	1.5	0.4	1.3	BDL (DL – 0.1)	1.2	0.8	1.4
17	Mn	0.3	BDL (DL – 0.1)	BDL (DL – 0.1)	BDL (DL – 0.1)	BDL (DL – 0.1)	BDL (DL – 0.1)	BDL (DL – 0.1)	BDL (DL – 0.1)

Table 3: Physico – chemical parameters of seven different lakes – In Monsoon

S. No	Parameters	Permissible Limit	1	2	3	4	5	6	7
1	Colour	-	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	Odour	-	None	None	None	None	None	None	None
3	pH@25ºC	6.5 – 8.5	7.52	8.78	6.83	7.30	6.98	7.34	7.51
4	Turbidity	5.0	13.3	0.2	17.4	66.4	0.7	6.0	9.5
5	EC	-	1480	205	1042	370	15420	398	570
6	TH ($CaCO_3$)	600	270	56	270	80	4080	132	136
7	Ca	200	36.1	14.4	68.1	20	288.6	32.1	32.9
8	Mg	100	43.8	4.9	24.3	7.3	816.5	12.6	13.1
9	Fe	1.0	BDL (DL – 0.1)	0.3	1.2	0.7	0.5	3.7	1.6
10	Cl	1000	270.8	20.9	451.3	73.2	13966	34.2	104.5
11	SO_4	400	127	45.6	100.5	17.2	2035	77.8	96

12	TDS	2000	858	94	622	286	29472	486	228
13	BOD(3 days @ 27ºC)	-	6.0	BDL (DL – 0.1)	25.0	18.0	12.0	5.0	BDL (DL – 0.1)
14	COD	-	60	39.2	200	90	264.7	49	BDL (DL – 0.1)
15	DO	-	0.9	1.1	1.1	0.8	1.1	0.9	1.0
16	F	1.5	0.6	0.6	1.0	BDL (DL – 0.1)	1.5	0.5	0.6
17	Mn	0.3	BDL (DL – 0.1)	BDL (DL – 0.1)	BDL (DL – 0.1)	BDL (DL – 0.1)	BDL (DL – 0.1)	BDL (DL – 0.1)	BDL (DL – 0.1)

EC varied from 45600µS/cm (Pulicat lake) and 453µS/cm (Porur lake) during summer in 2017. In monsoon 2017 EC varied from 15420µS/cm (Pulicat lake) and 205µS/cm (Chembarambakkam lake). EC is controlled by geology of the area where the water body situated, the size of the watershed, wastewater from sewage treatment plants, wastewater from septic systems, urban runoff from roads and agricultural runoff. The total hardness ranged from 6324mg/l (Pulicat lake) and 51mg/l (Chembarambakkam lake) in summer 2017. In monsoon 2017, TH varied from 4080mg/l (Pulicat lake) and 56mg/l (Chembarambakkam lake). High values of hardness are probably due to regular addition of large quantities of detergents used by the nearby residential localities which drains into the water bodies (CPCB 2008).

The ranges of nutrients viz. calcium (13.4 to 695mg/l in summer and 14.4mg/l to 288.6mg/l in monsoon), magnesium (4.3mg/l to 1115mg/l in summer and 4.9mg/l to 816.5mg/l in monsoon), iron (BDL (DL – 0.1) to 7.1 mg/l in summer and BDL (DL – 0.1) to 3.7mg/l in monsoon), Chloride (62 mg/l to 15493 mg/l in summer and 20.9 mg/l to 13966 mg/l in monsoon), Sulphate (19 mg/l to 3344 mg/l in summer and 45.6 mg/l to 2035 mg/l in monsoon), Fluoride (BDL (DL – 0.1) to 1.5mg/l in summer and BDL(DL – 0.1mg/l) to 1.0mg/l in monsoon) and the manganese values is as, below the desirable limit in seven different lakes for both seasons. Distribution of nutrients is due to the season, tidal conditions and freshwater flow from land sources. The maximum values of calcium, magnesium, iron, chloride and sulphate concentration were recorded at summer season and minimum was recorded at monsoon season. The presence of high amount of these nutrients in summer may be due to heavy influx of fresh water derived from land drainage, electroplating, tanning, dyeing and textile manufacturing industries as well as for boiler use (Michaud 1991).

The TDS content in the water sample ranged from 202mg/l to 42682mg/l in summer and 94mg/l to 29472mg/l in monsoon. The BOD, ranged from 5.8mg/l to 154mg/l in summer and. BDL (DL – 0.1) to 25mg/l in monsoon. The COD, ranged from 57.1mg/l to 571mg/l in summer and 39.2mg/l to 264.7mg/l in monsoon. Dissolved oxygen content in the water sample ranged from 0.58mg/l to 1.8mg/l in summer and 0.8mg/l to 1.1 mg/l in monsoon. The high BOD might be due to the decomposition of organic matter and decay of vegetation in river which mixed sea water during rainy season and high COD due to runoff from the surrounding areas of the lakes. The concentration of water quality parameters depends upon the fresh water inflow, discharge of domestic sewage and industrial effluent. The partial of dissolved oxygen in water depends upon the partial pressure of gas in the air close to water, rate of photosynthesis and oxygen holding capacity of water (Moore 1976).

Heavy metal concentration

Table 4 shows the overall heavy metals accumulations in the water samples in summer season were represented in the following sequential order lithium (0.1249ppm/g to 0.4786 ppm/g) > lead (0.0402 ppm/g to 0.0628 ppm/g) > arsenic (0.01863 ppm/g to 0.0483ppm/g) > nickel (0.0219 ppm/g to 0.0413 ppm/g) > chromium (0.0188 ppm/g to 0.0320 ppm/g) > Cadmium (0.0157 ppm/g to 0.0286 ppm/g) > Zinc (0.0129 ppm/g to 0.0152 ppm/g) > aluminium (0.0000 ppm/g to 0.0000 ppm/g). The five heavy metals (lithium, arsenic, nickel, chromium and cadmium) concentrations of the water samples by discharge of untreated effluent from various industries located near lakeshore (Chang 2003).

Table 4: Heavy metal analysis of seven different lakes – Summer

S. No	Parameters	1	2	3	4	5	6	7
1	Cadmium	0.0157	0.0206	0.0178	0.0286	0.0196	0.0210	0.0258
2	Zinc	0.0134	0.0187	0.0164	0.0129	0.0149	0.0152	0.0133
3	Lead	0.0421	0.0623	0.0597	0.0619	0.0628	0.0402	0.0491
4	Arsenic	0.0316	0.0483	0.0248	0.0299	0.0186	0.0325	0.0226
5	Aluminium	0.0036	0.0045	0.0051	0.0012	<0.00	0.0011	<0.00
6	Nickel	0.0396	0.0413	0.0245	0.0228	0.0219	0.0246	0.0238

7	Chromium	0.0320	0.0275	0.0188	0.0303	0.0268	0.0200	0.0276
8	Lithium	0.2687	0.2056	0.1495	0.1249	0.4786	0.1390	0.1251

Table 5 shows that the overall heavy metals accumulations in the water samples in summer season were represented in the following sequential order lithium (0.5371 ppm/g to 1.0360 ppm/g) > lead (0.1053 ppm/g to 0.1240 ppm/g) > arsenic (0.0770 ppm/g to 0.1040 ppm/g) > nickel (0.0908 ppm/g to 0.1023 ppm/g) > chromium (0.0881 ppm/g to 0.0903 ppm/g) > Cadmium (0.0929 ppm/g to 0.1002 ppm/g) > Zinc (0.0690 ppm/g to 0.0821 ppm/g) > aluminium (0.0000 ppm/g to 0.01660 ppm/g). Most of the heavy metals concentrations high in the water samples during the monsoon season due to the addition of heavy metals by soil erosion and run off during the rainy season (Brian 2007).

Table 5: Heavy metal analysis of seven different lakes –Monsoon

S.No	Parameters	1	2	3	4	5	6	7
1	Cadmium	0.0992	0.1002	0.0973	0.0948	0.0991	0.0931	0.0929
2	Zinc	0.0690	0.0730	0.0725	0.0720	0.0821	0.0715	0.0708
3	Lead	0.1108	0.1186	0.1184	0.1240	0.1238	0.1053	0.1102
4	Arsenic	0.0802	0.1040	0.0858	0.0946	0.0770	0.0938	0.0898
5	Aluminium	0.0114	0.0129	0.0166	0.0097	<0.000	0.0063	0.0058
6	Nickel	0.1023	0.1014	0.0982	0.0966	0.0908	0.0962	0.0961
7	Chromium	0.0891	0.0885	0.0896	0.0903	0.0884	0.0881	0.0899
8	Lithium	0.6763	0.5371	0.5680	0.5441	1.0360	0.5404	0.5631

V. Conclusion

The present study enhanced the various physico – chemical parameters in (Ambattur lake, Chembarambakkam lake, Korattur lake, Porur lake, Pulicat lake, Puzhal lake and Retteri lake) Chennai. The pH values recorded in the accepted levels. It poses a direct or indirect effect on photosynthesis and growth in plants. High levels of TDS may produce undesirable taste. Leaves, silt, industrial wastes, sewage, pesticides and inorganic materials may raise the levels of TDS in water body (Bhat, 1999). Electrical conductivity is a basic index to select the suitability of water for agricultural purposes. EC in water is due to ionization of dissolved inorganic solutes and measure of TDS & salinity (Naik and Purohit, 1997, Sonune et al., 2015). Hardness is governed by the Ca & Mg. DO is an important measure of purity for all waters and the productivity of aquatic systems. The reduction of DO might be due to organic load through the sewage. The factors affecting the DO content are atmosphere, photosynthesis, respiration and decomposition. BOD increases as the biodegradable organic content increases in water. BOD above 6mg/l in water body is considered polluted and high BOD values are attributed to the stagnation of water body leading to the absence of self – purification. COD high level indicates pressure of all forms of organic matter, biodegradable and non – biodegradable, hence the degree of pollution in water. It is the measure of oxygen consumed during the oxidation of organic matter (Sonune et al., 2015). Most of the heavy metals concentrations high in the water samples during the monsoon season due to the addition of heavy metals by soil erosion and run off during the rainy season (Brain, 2007). The reason for high values of physico – chemical parameters and heavy metals at certain sampling location may be due to the unscientific disposal of the water. It may cause laxative effects on health. Lakes and their areas are fragile ecosystems that face increasing threats from water abstraction, fast growing townships and human population. From this research study, it can be concluded that lake water of the study area is not suitable for drinking purpose and must to do the recycling procedure before using irrigation purpose also. So, we must take special care for lake water further more pollution should be avoided in and around lake water.

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