

IMPACT OF POLLUTION ON THE QUALITY OF WATER IN THREE FRESHWATER LAKES OF SUBURBAN CHENNAI

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ABSTRACT

The metropolitan cities of India are reeling under the pressure of severe water scarcity. Chennai is among the worst affected as it has suffered long spells of water shortages combined with rapid and haphazard urbanization of its ever-expanding suburbs. In light of the above, the water bodies that supply precious water to the human population and to the flora and fauna gain paramount importance. The present study was undertaken to assess the quality of water in three important lakes of southern suburban Chennai which recharge the ground water as well as harbours a diversity of plant and animal life. All the three lakes suffer from encroachments, dumping and burning of wastes, and unchecked inflow of domestic and industrial effluents. The parameters studied were: colour, odour, temperature, pH, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, alkalinity, total hardness, total solids, total dissolved solids, total suspended solids, sulphate and chloride.

INTRODUCTION

Rapid development, increase in population of the metro cities and urbanization of their suburbs have resulted in the manifold increase in environmental pollution. The most affected are the water bodies which become highly polluted by addition of foreign materials such as plant and animal matter, and domestic sewage and industrial effluents. Dumping of solid wastes and indiscriminate encroachments also add to the chaos. The diminishing quality of water seriously delimits its use for human consumption and for aquatic life. Therefore, the continuous and periodical monitoring of water quality is necessary so that appropriate preventive and remedial measures can be undertaken. The present study was done to evaluate various physico-chemical parameters of the three important freshwater lakes from the southern regions of Chennai metro. These water bodies recharge the groundwater and also harbour numerous aquatic lives. The physico-chemical characteristics of an aquatic body not only reflect the type and diversity of aquatic biota but also the water quality and pollution (Mir et al. 2004).

MATERIALS AND METHODS

Sampling sites: Three freshwater bodies viz., Chitlapakkam lake, Selaiyur lake and Sembakkam lake were selected for the study. These lakes are strategically located in the rapidly expanding southern region of Chennai city and catering to a large population. The water bodies were labelled Site 1, Site 2 and Site 3 respectively.

Collection of samples: The water samples were collected for a period of 12 months, starting from January 2006 to December 2006. 125 mL glass bottles were used to collect and fix samples for estimation of dissolved oxygen (DO) content. Samples were collected in triplicate from each site during the four quarters of the year using PET bottles as per standard procedures.

Analysis: The samples were analysed for a number of physico-chemical parameters employing standard methods (APHA 1998). The parameters included colour, odour, temperature, pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), alkalinity, total hardness, total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), sulphates, chlorides.

RESULTS AND DISCUSSION

Based on the cyclic phenomenon of the climate, four seasons are recognized at Chennai even though it falls in the tropical zone. The seasons are post-monsoon (January-March), summer (April-June), premonsoon (July-September) and monsoon (October-December). The data presented here are discussed on the basis of these seasons. The results of physico-chemical analysis of three freshwater bodies for different seasons are given in Tables 1, 2 and 3.

The temperature of water varied between 23.4°C and 32.5°C at Site 1, between 22°C and 34°C at Site 2, and 24.3°C and 36.4°C at Site III. In all the three sites a high temperature was recorded during summer and lower temperature during post-monsoon, which is a normal feature of water bodies in this region. The average pH values were 7.03, 6.98 and 7.38 at Sites 1, 2 and 3. The lowest pH values were recorded during monsoon and postmonsoon seasons, which indicates the influence of run-off water entering into the water bodies. The pH was slightly alkaline during summer and premonsoon which may be due to dumping of wastes, garbage and sewage water. The desirable limit of pH recommended by BIS (1992) is 6.5-8.5.

The dissolved oxygen (DO) values at Site 1 ranged from 4.3 to 8.1 mg/L with a mean of 6.75 mg/L, and the values at Site 2 from 5.9 to 8.6 mg/L (mean 7.03 mg/L). At Site 3 DO from 5.4 to 7.6 mg/L with a mean of 6.55 mg/L. Dissolved oxygen is an important factor, which influences the health of an aquatic ecosystem. Higher values of DO were recorded during postmonsoon period at all the sites. The higher values of DO may be due to the influence of run-off water from monsoon rain. Lower level of DO was recorded during premonsoon season at all the sites. Atmospheric aeration and photosynthetic production of O₂ by phytoplankton may be low during premonsoon and higher during postmonsoon seasons. DO levels between 5.3 and 8.0 mg/L are satisfactory for survival and growth of aquatic organisms.

The BOD values at Site 1 ranged from 43 to 96.5 mg/L with a mean of 73.5 mg/L, and at Site 2 from 51 to 75 mg/L (mean 61.75 mg/L). At Site 3 BOD ranged from 52.5 to 97.3 mg/L with a mean of 71.1 mg/L. BOD is the measure of quantity of oxygen required by bacteria and other microorganisms under aerobic condition in order to biochemically degrade and transform organic matter present in the water bodies. The highest BOD value was recorded during premonsoon season in all the three freshwater bodies. The COD at Site 1 varied between 45 and 62 mg/L with a mean value of 52.15 mg/L. The values at Site 2 ranged between 39.6 and 78 mg/L (mean 53.83 mg/L), while at Site 3 between 37.2 and 60.5 mg/L with a mean of 49.53 mg/L. The high COD value indicates a heavy load of organic and inorganic pollution that require more oxygen to oxidize under increased thermal conditions (Koushik & Saksena 1999).

The total alkalinity values at Site 1 ranged between 98.5 and 148.6 mg/L with a mean of 123.28 mg/L. The values at Site 2 ranged between 107.5 and 143 mg/L (mean 128.88 mg/L), while the values at Site 3 between 87.4 and 121 mg/L with a mean of 105.15 mg/L. Excess alkalinity gives a bitter taste to water. Maximum alkalinity values were registered during summer at Site 1 and Site 3, whereas at Site 2, it was during premonsoon. The higher alkalinity in itself is not harmful to human beings, but still it delimits the water for domestic uses. The higher alkalinity values may be due to

Table 1: Physico-chemical characteristics of Chitlapakkam lake (Site 1) from January to December 2006.

S. No	Parameter	Jan-Mar '06	Apr-Jun '06	Jul-Sep '06	Oct-Dec '06	Range
1.	Colour (visual)	Unclear	Unclear	Unclear	Unclear	-
2.	Odour (sensory)	Agreeable	Agreeable	Agreeable	Agreeable	-
3.	Temperature (°C)	23.4	32.5	31.6	27.5	23.4-32.5
4.	pH	7.2	7.6	6.9	6.4	6.4-7.6
5.	DO (mg/L)	8.1	6.7	4.3	7.9	4.3-8.1
6.	BOD (mg/L)	66	88.4	96.5	43	43-96.5
7.	COD (mg/L)	48.1	53.5	45	62	45-62
8.	Alkalinity (mg/L)	98.5	148.6	127	119	98.5-148.6
9.	Total Hardness (mg/L)	281	169	172	190	169-281
10.	TS (mg/L)	762	558	690.7	556	556-762
11.	TDS (mg/L)	656	460	596	445	445-656
12.	TSS (mg/L)	106	98	94.7	111	94.7-111
13.	Sulphate (mg/L)	296	317	305	245	245-317
14.	Chloride (mg/L)	262	194	142	147	142-262

Table 2. Physico-chemical parameters of Selaiyur lake (Site 2) from January to December 2006.

S. No	Parameter	Jan-Mar '06	Apr-Jun '06	Jul-Sep '06	Oct-Dec '06	Range
1.	Colour (visual)	Unclear	Unclear	Unclear	Unclear	-
2.	Odour (sensory)	Agreeable	Agreeable	Agreeable	Agreeable	-
3.	Temperature (°C)	22	29.4	34	33.5	22-34
4.	pH	6.4	7.2	7.4	6.9	6.4-7.4
5.	DO (mg/L)	8.6	7.2	5.9	6.4	5.9-8.6
6.	BOD (mg/L)	54	67	75	51	51-75
7.	COD (mg/L)	39.6	46.7	51	78	39.6-78
8.	Alkalinity (mg/L)	107.5	138	143	127	107.5-143
9.	Total Hardness (mg/L)	241	173	154	142	142-241
10.	TS (mg/L)	640	598.4	542	671	542-671
11.	TDS (mg/L)	543	510	630	537	510-630
12.	TSS (mg/L)	97	88.4	112	134	97-134
13.	Sulphate (mg/L)	313	321	284	261	261-321
14.	Chloride (mg/L)	271	223	161	138	138-271

the discharge of municipal sewage, domestic sewage and urban wash off into the freshwater bodies. The desirable limit of alkalinity prescribed for drinking water by BIS is 200 mg/L, whereas permissible limit goes up to 600 mg/L in the absence of alternate source. An increase in the free CO₂ may result in increase in alkalinity (Singhal et al. 1986).

The total hardness (TH) values at Site 1 ranged from 169 to 281 mg/L with a mean value of 203 mg/L. At Site 2 it ranged between 142 and 241 mg/L (mean 177.5mg/L), while at Site 3 it was between 168 and 212 mg/L with a mean of 183.25 mg/L. In general, Total hardness of water is due to the concentration of salts, especially of divalent metallic ions of calcium and magnesium. The desirable limit of TH is 300 mg/L. The excessive dumping of garbage, industrial wastes and sewage discharge may be the cause of high TH at Site 1.

The total solids (TS) at Site 1 ranged between 556 and 762 mg/L, and the values at Site 2 from 542 to 671 mg/L. At Site 3 TS ranged from 608 to 667 mg/L. Maximum value of TS was recorded during postmonsoon at sampling Site 1 and Site 3, whereas at Site 2 maximum value was noted during monsoon season. Run-off water, which contains more dissolved solids and organic matter from garbage dumping, contributes to higher TS to the freshwater bodies. Total dissolved solids

Table 3. Physico-chemical parameters of Sembakkam lake (Site 3) from January to December 2006

S. No	Parameter	Jan-Mar '06	Apr-Jun '06	Jul-Sep '06	Oct-Dec '06	Range
1.	Colour (visual)	Unclear	Unclear	Unclear	Unclear	-
2.	Odour (sensory)	Agreeable	Agreeable	Agreeable	Agreeable	-
3.	Temperature (°C)	24.3	36.4	33	29.4	24.3-36.4
4.	pH	6.8	7.4	8.1	7.2	6.8-8.1
5.	DO (mg/L)	7.6	6.3	5.4	6.9	5.4-7.6
6.	BOD (mg/L)	56	78.5	97.3	52.5	52.5-97.3
7.	COD (mg/L)	37.2	46.9	53.5	60.5	37.2-60.5
8.	Alkalinity (mg/L)	87.4	121	119	93.2	87.4-121
9.	Total Hardness (mg/L)	212	181	168	172	168-212
10.	TS (mg/L)	667	618	608	616	608-667
11.	TDS (mg/L)	542	480	496	512	480-542
12.	TSS (mg/L)	125	138	112	104	104-138
13.	Sulphate (mg/L)	247	318	336	282	247-336
14.	Chloride (mg/L)	181	162	134	175	134-181

(TDS) at Site 1 varied between 445 to 656 mg/L, at Site 2 between 510 and 630 mg/L and at Site 3 between 480 and 542 mg/L. Maximum value of TDS were registered during postmonsoon season at Site 1 and Site 3, whereas at Site 2, it was noted during premonsoon season. The permissible level of TDS is 500 mg/L in drinking. Presence of excess TDS may cause gastro-intestinal irritation.

The Total suspended solids (TSS) at Site 1 ranged from 94.7 to 111 mg/L, at Site 2 from 97 to 134 mg/L, and at Site 3 from 104 to 138 mg/L. Higher values of TSS were recorded during monsoon season at Site 1 and Site 2, and during summer at Site 3. Increased concentration of TSS would reduce light penetration into the water and affect the plankton and fish by decreasing dissolved oxygen in water.

Sulphate ranged between 245 and 317 mg/L, 261 and 321 mg/L, and 247 to 336 mg/L at Sites 1, 2 and 3 respectively. Sulphate can taint the taste of water and may create a laxative effect. Higher concentration of sulphate was observed during summer at Site 1 and Site 2 and during premonsoon at Site 3. Chloride values at Site 1 varied from 142 to 262 mg/L, at Site 2 from 138 to 271 mg/L, and at Site 3 from 134 to 181 mg/L. Chloride concentration was higher during postmonsoon.

Periodic determination of physico-chemical parameters of important water bodies is essential for assessing the suitability of water for human and animal use as well as for aquatic biota. Discharge of domestic, municipal and industrial effluents combined with dumping of solid wastes affects the water quality severely. It causes a variety of health problems to humans as well as to other organisms dependent either directly or indirectly on these ecosystems. The present study, therefore, urges the need for the restoration of these degrading freshwater bodies in southern Chennai to ensure sustainability of a healthy ecosystem.

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