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Limnological Study of Lakes

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Abstract: ***Chennai is also blessed with presence shallow storage structures are called lakes. The rapid urbanization and industrialization, the change in land use pattern has resulted in flooding and also for more demand of water in the city. The paper studies two lakes Ayapakkam & Ayanambakkam in the Kosasthalaiyar basin of Chennai city. The study analyses the physio chemical parameters of lakes and assessing the water quality parameters. The results are revealed with presence of heavy metals, low dissolved oxygen and floating gardens all over the lakes. The lakes fall under hard water category. The importance of Chennai lakes and simple restoration methods are highlighted in the paper.***

Keywords: Ayapakkam, Ayanambakkam, alkalinity, peat moss, ammonia and Phytorid

1.Introduction

Chennai Basin is situated at the north-east corner of Tamil Nadu. Itis also blessed with presence shallow storage structures are called lakes. These lakes are in order of chain or cascade system. The total area of the basin is 7282 km².The basin is subdivided as Araniyar (covers 763 km²**), Kosasthalaiyar (covers 3,240 km²),** Cooum (682 km²) and Adyar (857 km²) are the four rivers of this basin group. The paper studies the **Kosasthalaiyar Basin** claiming of **260tanks.** The paper covers the two important lakes of our two lakes **"Ayapakkam and Ayanambakkam".** The lakes are completely Rainfed in a year divided into 2 periods Monsoon period spanning from June to December and Non-monsoon period spanning from January to May. The city of Chennai has a is having flat topography with very gentle slope towards east. The daily demand of fresh water resources of city is dependent on the ground water on a scale of 70 % percentage. The terrain was naturally blessed with undulations of lakes. lakes are the primary member which directly feeds the groundwater water table in Chennai region. The city is facing urbanization, mass migration, and development along the flood plains, industrialization and fragmentation/consolidation are the major driving force in altering the land use pattern and significantly affected the catchment of the basins. Eventually caused the flooding of Chennai in 2015.The paper has led to severe understandings of lakes importance in hydrological cycle. the present condition of our lakes are sewage disposal sites. Such substantial discards have altered the water quality of lakes and led to cultural eutrophication. Cultural eutrophication differs from natural eutrophication in that it is greatly accelerated in the sense of geological time. As the term implies, man is the causative agent for enrichment of natural water in various ways [1].

2.Study Area

"Ayapakkam and Ayanambakkam" are situated in Thiruvallur District, with predominant soils are **"Black soil, Red sandy soil, Sandy coastal alluvium, Red loam".**40 **species of birds** were recorded in the wetlands. Two species, the **spot blinded pelican and oriental darter** have been listed as near **threatened by IUCN are also observed**. The water hyacinth beds in lakes hosted plenty of purple swamphen and Eurasian coot. Asian openbill were recorded in Ayanambakkam. **The flora** of wetland is heavily dominated by invasive alien species. The periphery shallow water is covered by **Eichhorina crassipes called as agaya thamarai** in Tamil. The eastern side of lakes are generally covered by aquatic and semi aquatic plants were identified and recorded. The lakes were found to be major source for replenishment for ground water in area. The lake is a keystone reason for controlling the floods in districts. The command area of the tanks is plotted by collection of area maps of **5 villages** namely, **Ayanambakkam, Ayapakkam, Koladi, Perumalagaram, and Paruthipattu**. The command area was found to be 2.52 and 2.72 square kilometers.

CAPACITY (M.Cu.m)	8.2	11.25
FTL (m)	17.19	17.90
MWL (m)	17.81	18.51
TBL (m)	19.04	19.88
STORAGE DEPTH (m)	2.20	2.57
AYACUT (Ha.)	244.13	44
CATCHMENT (Sq. Km)	2.76	2.52
WATER SPREAD AREA (Ha.)	815.00	5.70
NO.OF. SLUICES	4	2
NO.OF. WEIRS	2	1
LOWEST STILL LEVEL (m)	15.80	-
MFL (m)	17.81	-
LENGTH OF BUND (m)	2335	-
LENGTH OF WEIRS (m)	12.00	-
DESIGNED DISCHARGE (Cumec.)	201	34.32

Figure 1: Physical Parameters of the Conceptual Wing

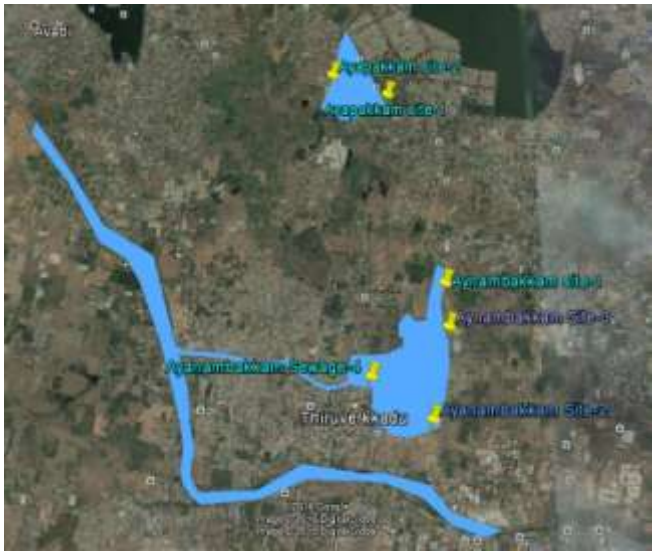

Figure 2: Ayapakkam & Ayanambakkam Zone

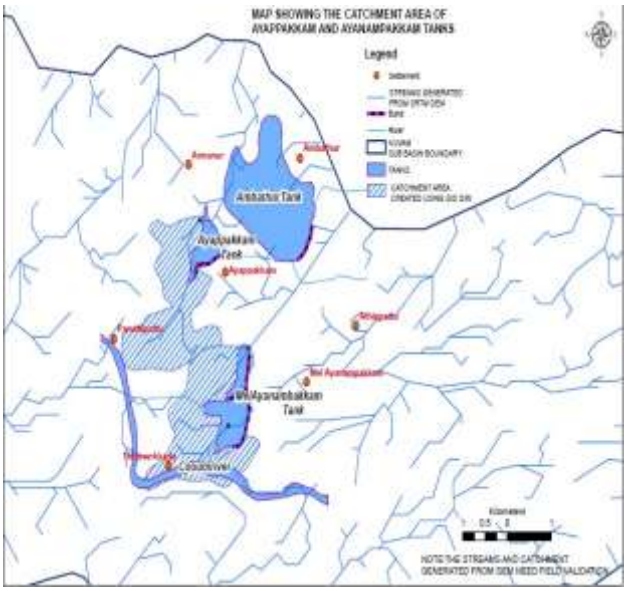

Figure 3: Catchment Area of Ayapakkam & Ayanambakkam Water Tanks

3. Present Site Condition

The main problem in both lakes has arisen due to discharge sewage of domestic sewage effluents from upstream and surrounding residential areas. Release of waste through inlet streams contributed to the internal nutrient loading of the lake. This has increased the nutrient load and concentration of toxic heavy metals in the lake water. The encroachments around the lakes has also caused the obstruction of inlet and outlet channel.

Figure 4: Ayapakkam Tank

Figure 5: Ayanambakkam Tank

Excessive nutrient load in the lakes (Ayapakkam and Ayanambakkam) has caused heavy growth of water hyacinth, water lily and algae. The acid produced cause release of phosphorus and nitrogen from organic sediments into the water column of the lake. Anaerobic bacteria toxic gases into the lake water including hydrogen sulphide, ammonia and methane. These compounds are toxic to fish thus reducing the food chainefficiency.

4. Discussions

The various parameters are investigated in lakes Ayapakkam and Ayanambakkam for period of four months and seasonal fluctuations are considered for the physical and chemical characteristics are considered separately.

The temperature of the water bodies is similar to that of basin characteristics (Wetzel, 1975). Since the tanks are recharged by the runoff from rainfall, transparency of the lakes is diminishing with constraints highest growth of phytoplankton. In an aquatic ecosystem water transparency is one of the most important features that control the energy relationship at different tropic levels. light Penetration in water is considerably reduced either as a result of high Plankton density or due to large quantities of suspended matter.

Considerations of both site I &II, the **pH of lakes** vary from 7.5 – 8.5 and 8.4-8.7 denotes the alkaline water with governing factors mentioned with soil characters of lakes

and sediment transport by rainfall. The lakes are found to be extremely alkaline.

Increased **specific conductivity** values have been suggested as an indication of high tropic levels. Increase in the state of enrichment values are may be imports of urbanization. Applying this criterion to the Ayapakkam lake (1238-1232µs) and Ayanambakkam (1000-939 µs) it is observed that the lake is at a higher level of enrichment. There was not much difference between bottom and surface conductivity values at both the sites.

5. Chemical Oxygen Demand

Chemical Oxygen Demand of water denotes the indirect measurement of amount of pollution (that cannot be oxidized biologically) in a sample of water. The higher the chemical oxygen demand, the higher the amount of pollution in the test sample. The analyzed sites I &II has already shown us the high presence of chloride and ammonia. The comparison of site II has shown us a drastic increase in COD evidence of urbanization.

Table 1: COD values

S.NO	COD VALUE (mg/l)
Ayapakkam	
Top	64
Bottom	112
Ayanambakkam	
Top	134.4
Bottom	140.8
Top	57.6
Bottom	80

6. Hardness

The hardness of water is due to the presence of calcium and magnesium minerals that are naturally present in the water. The hardness is made up of two parts: temporary (carbonate) and permanent (non-carbonate) hardness. The results denotes the ayapakkam and ayanambakkam are completely turned into hard water

Table 2: Ayanambakkam Site-I

S.NO	Hardness (mg/l)	Calcium (mg/l)	Magnesium (mg/l)
Top	205	100	105
Bottom	150	50	100

Table 3: Ayanambakkam Site-II

S.NO	Hardness (mg/l)	Calcium (mg/l)	Magnesium (mg/l)
Top	136	56	80
Bottom	182	82	100
Top	120	40	80
Bottom	160	60	100

Table 4: Ayapakkam Site-I

S.NO	Hardness (mg/l)	Calcium (mg/l)	Magnesium (mg/l)
Top	200	80	120
Bottom	160	60	100

Table 5: Ayapakkam Site-II

S.NO	Hardness (mg/l)	Calcium (mg/l)	Magnesium (mg/l)
Top	150	70	80
Bottom	120	50	70

7. Total Alkalinity

Total Alkalinity indicates the quantity of base present in water bicarbonates, carbonates, phosphates, hydroxides. The **alkalinity of water** is a measure of how much acid it can neutralize. If any changes are made to the **water** that could raise or lower the pH value, **alkalinity** acts as a buffer, protecting the **water** and its forms from sudden shifts in pH. The alkalinity of natural water is determined by the soil and bedrock through which it passes (limestone). Alkalinity is important for fish and aquatic life because it protects or buffers against rapid pH changes. Living organisms, especially aquatic life, function best in a pH range of 6.0 to9.0.

Whereas the site I - Ayapakkam of 110 -130 mg/l and Site II- 22.7 -30 mg/l shows us the guarded aquatic life in tanks but it will be on declining stages in forthcoming months due to the clear addition sewage influent by the people

Table 6: Ayanambakkam Site-I

S.NO	Alkalinity (mg/l)
Top	27.5
Bottom	22.5

Table 7: Ayanambakkam Site-II

S.NO.	ALKALINITY (mg/l)
Top	22.5
Bottom	90
Top	50
Bottom	95

Table 8: Ayapakkam Site-I

S.NO.	*ALKALIN ITY (mg/l)*
Top	120
Bottom	130

Table 9: Ayapakkam Site-II

S.NO.	*ALKALIN ITY (mg/l)*
Top	110
Bottom	122.5

8. Ammonia

Generally, exists in two forms in the water NH_3 (this is called unionized ammonia) NH_4^+ (this is called ionized ammonia). Together, these two forms of ammonia are called TANwhich means total ammonia nitrogen NH3 is the principal form of toxic ammonia. It has been reported toxic to freshwater organisms at concentrations ranging from 0.53 to 22.8 mg/L. Toxiclevels are both pH and temperature dependent. Toxicity increases as pH decreases and as temperature decreases. Plants are more tolerant of ammonia than animals, and invertebrates are more tolerant than fish. Hatching and growth rates of fishes may be affected and hence lethal concentration for a variety of fish species ranges from 0.2 to 2.0 mg/l. The results shows us the concentrations are extremely high, resulting in declining phase of aquatic life in the lakes .

Table 10: Ayapakkam

Sample	Values (mg/l)
Top	106.3
Bottom	100.3
Top	94.2
Bottom	88.5

Table 11: Ayanambakkam

Sample	Values (mg/l)
Top	103.10
Bottom	102.60
Top	103.40
Bottom	102.40

9. Chlorides

The sites of I & II 265 -275 mg/l are beyond negligible were it lead to a chemical stratification which can impede turnover and mixing, preventing the dissolved oxygen within the upper layers of the water from reaching the bottom layers and nutrients within the bottom layers from reaching the top layers. This leads to the bottom layer of the water body becoming void of oxygen and unable to support aquatic life And Epa suggests 250 mg/l but suggest aquatic life.

Table 12: Ayapakkam

S.No	Site 1		Site 2	
	Top (mg/l)	Bottom (mg/l)	Bottom (mg/l)	Top(mg/l)
1.	263.74	266.58	269.42	275.092

Table 13: Ayanambakkam

S.NO	Site 1		Site 2	
	Top(mg/l)	Bottom (mg/l)	Bottom(mg/l)	Top(mg/l)
1	315	312.96	310	311.54

10. Total Dissolved Solids

Total dissolved solids are a measure of the combined content of all inorganic and organic substance contained in a liquid in molecular ionized or micro granular suspended form. Total dissolved solids are normally discussed only for fresh water systems, The samples are tested mainly for total dissolved solids and total suspended solids in which t The samples are filtered through the vacuum filter.

Table 14: Ayapakkam

Sample	TDS (mg/l)
Top	120
Bottom	173.1
Top	220.7
Bottom	257.7

Table 15: Ayanambakkam

Sample	TDS (mg/l)
Top	64.9
Bottom	369.9
Top	265.1
Bottom	119.6
Top	9.1
Bottom	161.2

11. Determination of Total Suspended Solids

Table 16: Ayapakkam

Sample	Concordant Value	TSS (mg/l)
1	0.099	1.6
2	0.121	3.8
3	0.078	0.3
4	0.100	1.7

Table 17: Ayanambakkam

Sample	Concordent Value	TSS (mg/l)
1	0.101	1.8
2	0.208	12.5
3	0.097	1.4
4	0.092	0.9
5	0.095	1.2
6	0.090	0.7

12. Sulphates

Sulphate are a combination of sulphur and oxygen and are a part of naturally occurring minerals in some soil and rock formations that contain ground water. The mineral dissolves over time and is released into ground water

Table 18: Ayapakkam

Sample	Values (mg/l)
Top	19.72
Bottom	19.72

Table 18: Ayanambakkam

Sample	Values (mg/l)
Top	19.72
Bottom	32.87
Top	26.29
Bottom	35.15

13. Determination of Nitrates

Nitrate is an inorganic compound that occurs under a variety of conditions in the environment, both naturally and synthetically. Nitrate both composed of one atom of nitrogen and three atoms of oxygen. The nitrogen is led by the dwellers in and around the lakes. The concentrations are nitrified or denitrified based on the water sample.

SAMPLE	VALUES (mg/l)
Ayapakkam	
Top	89.1
Bottom	80
Ayanambakkam	
Top	138
Bottom	640
Top	43.1
Bottom	100.02

14. Determination of Iron

A remarkable property of pure water is that it dissociates to form hydrogen ions and hydroxide ions. The increased dosage may cause skin disease and pollution of groundwater table.

Table 20: Iron Content for Ayapakkam & Ayanambakkam

Sample	**Iron** (mg/l)
Top	62.5
Bottom	88.7
Top	100.25
Bottom	158.9
Top	52.5
Bottom	41.0

15. Heavy Metals

Heavy Metals are analyzed by AAS shows us the negligible presence but are inevitable for various reasons. During the on sighting of other papers heavy metals were obsolete.

Table 21: Heavy Metal Content for Ayapakkam

S.NO	Compounds	Site 1 (mg/l)	Site 2 (mg/l)
1.	Zinc	0.008	0.008
2.	Manganese	BDL	BDL
3.	Copper	0.02	0.046
4.	Lead	BDL	BDL
5.	Chromium	0.011	0.011

Table 22: Heavy Metal Content for Ayanambakkam

S.NO	Compounds	Site 1 (mg/l)	Site 2		
			TOP (mg/l)	BOTTOM (mg/l)	MIX (mg/l)
1.	Zinc	0.002	0.009	0.011	0.012
2.	Manganese	BDL	BDL	BDL	BDL
3.	Copper	0.011	0.028	0.028	0.021
4.	Lead	BDL	BDL	BDL	BDL
5.	Chromium	BDL	BDL	0.001	0.005

DL= below ***desired level***

16. Total Organic Carbon

Total Organic Carbon is a term used to describe the measurement of organic (carbon based) contaminants in a water system. The time it takes for the organics in water to be oxidized and measured in a TOC analyzer. In surface waters, total organic carbon concentrations are generally less than 10 mg/L. Our Sites I & II organic carbon are ranging from 1.95 – 3.5. The samples in fresh and marine waters include living material and waste materials and effluents

Table 23: Total Organic Compound for Ayapakkam & Ayanambakkam

SAMPLE	VALUES		
	TOC (mg/l)	TC (mg/l)	IC (mg/l)
1	2.094	4.425	2.331
2	4.38	4.94	6.55
3	3.410	5.297	1.887
4	3.225	7.312	4.086
5	2.376	5.477	3.101
6	1.951	4.629	2.678

17. Dissolved Oxygen

In limnology, dissolved oxygen is an essential factor second only to water itself. A dissolved oxygen level that is too high or too low can harm aquatic life and affect water quality, while shallow water fish need higher levels (4-15 mg/L). The sites I &II are having minimum level of dissolved oxygen leading us to stratification. oxygen in the lake is extremely deficit in Ayapakkam whilst of Ayanambakkam.

Table 24: Total Dissolved Oxygen content for Ayapakkam

SAMPLE	VALUE (mg/l)
Top	1.2
Bottom	1.1

Table 25: Total Dissolved Oxygen content for Ayanambakkam

SAMPLE	VALUE(mg/l)
Top	1
Bottom	0.6
Top	0.6
Bottom	0.8
Top	0.9
Bottom	0.75

18. Restoration techniques

The pollution in the lakes (refer figures) are easily seen in the present condition of lakes. The rehabilitation of lakes is planned in terms of biologically and mechanically. The biological treatment involves the introduction **of "Peat Moss and Phytoroid planation's".** Peat moss is the combination of coco peat + perlite +Vermiculture. It has high carbon content and can burn under low moisture conditions. Basically, peat moss is used to reduce pH of the water. That's from excessive pH to neutral**.** Restoration of lakes can be done in summer season. Initially the lake should be excavated. peat moss will be added with the combination of top soil. When water enters into the lake, water gets percolated to the soil and finally water gets converted. Slowly it gets converted from alkalinity to neutral nature

Phytorid Technology is re-engineered advanced wetland technology for sewage and waste water treatment with negligible maintenance cost. The process involves biological, physical and chemical action of plants on the waste water. The plants supply oxygen from atmosphere through plants to root zone where particles of effluent / waste water get attracted towards the roots and are absorbed by roots as nutrients. Thus, the process of aeration that is aerobic reaction takes along with anaerobic in a natural way. The figure shows the outline of Ayapakkam and Ayanambakkam Lake. From the quality test analysis, it is found that the heavy metals are present in objectionable quantity so the Phytorid bed can planted along the lake bund. Treatment efficiencies for the removal of faecal coliforms, BOD, COD, nutrients are up to 95%, which is greater than the traditional chemical methods. It is a very cost-effective technology when compared with the traditional wastewater treatment methods.

Figure 6: Ayapakkam Basin

Figure 7: Ayanambakkam Basin

19. Conclusion

The physio-chemical parameters and the study of the lakes and water quality had got adversely deteriorated. The lakes area slowly turning into disposal site. The prevailing condition may lead to chemical pollution of the ground water. Sadly, the urbanization has affected the natural profile of the city. The alteration of natural profile of the lakes caused the catastrophic floods in 2015. During the study, the urbanization had resized many lakes and they have extensive impact on controlling the hydrological cycle of the city. The ignorance is also a key factor in shrinking of lakes in Chennai city

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