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# Seasonal variations of physicochemical parameters of Korattur lake, Chennai, Tamil Nadu, India

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## Abstract
Chennai, formerly known as Madras, is the fourth largest metropolitan area in India and the capital city of the Indian state of Tamil Nadu. Located on the Coromandel coast of the Bay of Bengal, Chennai has an estimated population of 4.9 million, with an area that has grown from 176 to 426 sq.km. after an expansion from the year 2011. It is one of the worst affected cities as it has suffered long spells of water shortages combined with rapid and haphazard urbanization. Korattur lake is a chain of three lakes comprising of Ambattur lake, Madhavaram lake and Korattur lake, spread over 990 acres in Korattur, Chennai, Tamil Nadu, India (13°07'19.2"N 80°11'04.4"E). It is one of the largest lakes in the western part of the city. Prior to 1970, the water from the lake had been used for drinking water supply to the city, however, over the years, the lake has been contaminated with sewage and industrial effluents from the surrounding areas. In view of the aforementioned factors, the present study was carried out to assess the physicochemical parameters of Korattur lake. The samples were analysed for a number of physicochemical parameters *viz*., colour, odour, temperature, turbidity, Electrical conductivity (EC), pH, alkalinity, Total dissolved solids (TDS), Total hardness (TH), Dissolved oxygen (DO), chloride, fluoride, calcium, magnesium, ammoniacal nitrogen, nitrate, nitrite, sulphate and phosphate using standard protocols.

**Keywords:** Physicochemical parameters, Korattur lake, Chennai

## Introduction
Water is a vital resource that has many uses, including domestic, recreation, transportation, hydroelectric power, industrial and commercial uses. It also supports all forms of life and influences human health, lifestyle and economic wellbeing [1]. Uncensored human activities in developing countries contribute immensely to the poor quality of ground water [2]. Improper land and water use in urban and rural areas has led to a decline in the health of watersheds and water quality. Pollutants such as herbicides, pesticides, fertilizers and hazardous chemicals can make their way into the water supply [3-5]. When water supply is contaminated, it is a threat to human, animal and plant health unless it goes through a costly purification procedure [6]. The problems of ground water quality are much more acute in areas which are densely populated, with localization of industries [7]. Water pollution is a major environmental issue in India, where most rivers, lakes and surface water are polluted [8]. Almost 70% of the water in India has become polluted due to the discharge of domestic sewage and industrial effluents into natural water source such as rivers, streams and lakes [9]. The largest source of water pollution in India is untreated sewage and the other sources of pollution include agricultural runoff and unregulated small scale industry [10].

Chennai, formerly known as Madras, is the fourth largest metropolitan area in India and the capital city of the Indian state of Tamil Nadu. Located on the Coromandel coast of the Bay of Bengal, Chennai has an estimated population of 4.9 million, with an area that has grown from 176 to 426 sq.km. after an expansion from the year 2011. The urban agglomeration, which includes the city and suburbs, has a population estimated at nine million. This makes it the fourth most populous metropolitan area in India and the 31st largest urban area in the world [11]. It is one of the worst affected cities as it has suffered long spells of water shortages combined with rapid and haphazard urbanization [12]. Korattur lake is a chain of three lakes comprising of Ambattur lake, Madhavaram lake and Korattur lake, spread over 990 acres in Korattur, Chennai, Tamil Nadu, India (13°07'19.2"N 80°11'04.4"E). It is located to the north of the Chennai-Arakkonam railway line and is one of the largest lakes in the western part of the city. Prior to 1970, the water from the lake had been used for drinking water supply to the city, however, over the years, the lake has been contaminated with sewage and industrial effluents from surrounding areas such as Pattaravakkam, Athipet and Ambattur [13]. In view of the aforementioned factors, the present study was carried out to assess the physicochemical parameters of Korattur lake.

## 2. Materials and methods

### 2.1. Sampling sites

Korattur lake in Korattur, Chennai, Tamil Nadu, India, one of the largest lakes in the western part of the city was selected for analysis. Four stations were identified for collection of water samples and labelled Station A, Station B, Station C and Station D (Figure 1).


**Fig 1:** Satellite map of Korattur lake, Chennai showing the four sampling stations

### 2.2. Collection of samples

Water samples were collected from the four stations for a period of twelve months from January 2008 to December 2008 on a monthly basis to study the seasonal variations. Two litre polyethylene cans which were previously cleaned, rinsed and washed with deionised water and then rinsed with sample water several times were used for collection of samples.

### 2.3. Analysis

The samples thus collected were analysed for a number of physicochemical parameters *viz*., colour, odour, temperature, turbidity, Electrical conductivity (EC), pH, alkalinity, Total dissolved solids (TDS), Total hardness (TH), Dissolved oxygen (DO), chloride, fluoride, calcium, magnesium, ammoniacal nitrogen, nitrate, nitrite, sulphate and phosphate using standard protocols [14]. The instruments used were of precise accuracy and the chemicals used were of analytical grade (Table 1).

## 3. Results and discussion

The mean values of the water quality parameters of the present study are presented in Table 2 and discussed on the basis of the four seasons *viz*., post-monsoon, summer, pre-monsoon and monsoon.

**Table 1:** Parameters and methods for analysis

| Parameter for analysis | Unit | Method |
|---|---|---|
| Temperature | °C | Mercury-in-glass thermometer |
| Turbidity | NTU | Nephelometric method |
| EC | µS/cm | Conductivity meter-Extech EC 150 |
| pH | - | Systronic digital pH meter |
| Alkalinity | mg/L | Acid titration method |
| TDS | | Ion selective method |
| TH | | Titration method-EDTA |
| DO | | Winkler's method |
| Chloride | | Argentometric titration method |
| Fluoride | | SPADNS spectrophotometric method |
| Calcium<br>Magnesium | | Complexometric EDTA titration method |
| Ammoniacal nitrogen | | Selective electrode method |
| Nitrate<br>Nitrite<br>Sulphate | | Spectrophotometric method |
| Phosphate | | Stannous chloride method |

**Table 2:** Physicochemical parameters of Korattur lake, Chennai

| Parameter | Post monsoon | Summer | Pre monsoon | Monsoon | Average |
|---|---|---|---|---|---|
| Colour | UC | UC | UC | UC | - |
| Odour | OB | OB | OB | OB | - |
| Temperature | 28.6 | 31.8 | 30.3 | 27.2 | 29.5 |
| Turbidity | 9 | 12 | 8 | 14 | 11 |
| EC | 816 | 1014 | 1694 | 913 | 1109 |
| pH | 7.8 | 7.5 | 7.6 | 7.6 | 7.6 |
| Alkalinity | 194 | 192 | 298 | 215 | 225 |
| TDS | 530 | 658 | 1099 | 593 | 720 |
| TH | 229 | 264 | 398 | 265 | 289 |
| DO | 2.59 | 7.47 | 8.8 | 4.13 | 5.75 |
| Chloride | 163 | 252 | 460 | 234 | 277 |
| Fluoride | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Calcium | 39 | 48 | 65 | 53 | 51 |
| Magnesium | 32 | 35 | 57 | 32 | 39 |
| Ammoniacal nitrogen | 0.49 | 0.85 | 0.64 | 0.77 | 0.69 |
| Nitrate | 7.1 | 5.8 | 9.1 | 12.9 | 8.73 |
| Nitrite | 0.41 | 0.53 | 0.53 | 0.47 | 0.49 |
| Sulphate | 41 | 30 | 36 | 41 | 37 |
| Phosphate | 0.01 | 0.01 | 0.04 | 0.01 | 0.02 |
| UC - Unclear OB - Objectionable | | | | | |

### 3.1. Colour
The water samples collected from all the four stations of Korattur lake throughout the year had an unclear, greenish appearance indicating a high growth of algae. The colour of the lake water reflects the type and amount of dissolved organic chemicals it contains [15] especially waste water with high amounts of nitrogen and phosphorus leading to high algal and weed growth and may also be due to organic substances such as humics, metals such as iron and manganese and industrial wastes [16]. Evidently, Korattur lake has been contaminated with sewage and industrial effluents from surrounding areas such as Pattaravakkam, Athipet and Ambattur [13].

### 3.2. Odour
The odour of Korattur lake water was objectionable with a strong algal odour. Odour is associated with the presence of living microscopic organisms; or decaying organic matter including weeds, algae; or industrial wastes containing ammonia, phenols, halogens and hydrocarbons [16].

### 3.3. Temperature
The temperature varied between 27.2 °C during monsoon and 31.8 °C during summer. The average temperature of all the four seasons was 29.5 °C. The highest temperature was recorded during summer and lowest during monsoon which is a normal feature in fresh water bodies. In the Indian sub-continent, the temperature in most of the water bodies range between 7.8 and 38.5 °C [17]. Temperature is an important limiting factor, which regulates the biogeochemical activities in the aquatic environment. Generally, the surface water temperature is influenced by the intensity of solar radiation, evaporation and fresh water influx [18]. Any increase in temperature decreases the DO [19, 20]. Water temperature closely follows the air temperature except for a short spell in winter, when water temperature is slightly higher than the air temperature as supported by Young [21]. Water temperature of Korattur lake was found to be within normal limits.

### 3.4. Turbidity
The turbidity values ranged from 8 to 14NTU during pre-monsoon and summer respectively. The average turbidity value for all the four seasons was 11NTU. This was well above the desirable limit of 5NTU and the permissible limit of 10NTU in the absence of an alternate source [22]. Korattur lake receives runoff from silt and clay soils, therefore often possessing high turbidity. Turbidity refers to the amount of light scattered or absorbed by a fluid and is an optical property of the fluid [23]. Turbidity in water is because of suspended solids and colloidal matter. It may be due to eroded soil caused by dredging or due to the growth of microorganisms [16]. Increased turbidity decreases 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 [24].

### 3.5. EC
EC values ranged from 816 µS/cm during post-monsoon to 1694 µS/cm during pre-monsoon. The average value for the four seasons was 1109 µS/cm. EC is a numerical expression ability of an aqueous solution to carry electric current. This ability depends on the presence of ions, their total concentration, mobility, valence, relative concentrations and temperature of measurement. High value of EC in pre-monsoon could be due to inflow of high quantum of domestic sewage and low values might be due to higher temperature and stabilization of water due to sedimentation and increased concentration of salts because of discharged domestic sewage and organic matter in the lake [25]. EC estimates the amount of total dissolved salts, or the total amount of dissolved ions in the water. EC is controlled by geology of the area where the water body is situated, the size of the watershed, wastewater from sewage treatment plants, wastewater from septic systems, urban runoff from roads and agricultural runoff. Apart from these, evaporation of water from the surface of a lake concentrates the dissolved solids in the remaining water and so it has a higher EC [26, 27]. Low conductivity (0 to 200 µS/cm) is an indicator of pristine or background conditions. Mid-range conductivity (200 to 1000 µS/cm) is the normal background for most rivers and lakes. Conductivity outside this range could indicate that the water is not suitable for certain species of animals. High conductivity (1000 to 10,000 µS/cm) is an indicator of saline conditions. EC of Korattur

lake falls just outside the mid-range indicating a shift towards pollution.

### 3.6. pH

pH ranged from 7.5 to 7.8 during summer and post-monsoon respectively. The average pH value for all the four seasons was 7.6 which is slightly alkaline. The term pH is used to indicate the acidity or alkalinity of a substance. The desirable pH may range from 6.5 to 8.5 and there is strictly no relaxation for this limit [22]. Generally, temporal fluctuations in pH could be attributed to factors like removal of carbon dioxide by photosynthesis through bicarbonate degradation, freshwater influx, low primary productivity besides decomposition of organic matter [28]. The recorded high pH values during summer might be due to the influence of seawater penetration and high biological activity. pH of water is an important environmental factor and is generally considered as an index for suitability of the environment. Increased pH appears to be associated with increased use of alkaline detergents in residential areas and alkaline material from wastewater in industrial areas [29]. Most natural water has pH values between 5.0 and 10.0, with the greatest frequency of values falling between 6.5 and 9.0 [30]. The largest variety of aquatic animals prefer a range of 6.5 to 8.0. When pH is outside this range, diversity within the water body may decrease due to physiological stress and result in reduced reproduction. Extremes in pH can produce conditions that are toxic to aquatic life [31]. The pH of Korattur lake did not exceed the desirable limit of 8.5.

### 3.7. Alkalinity

Alkalinity ranged from 192mg/L during summer to 298mg/L during pre-monsoon. The average alkalinity of the four seasons was 225mg/L. Alkalinity of Korattur lake was moderately above the desirable limit of 200mg/L, whereas the permissible limit reaches upto 600mg/L in the absence of an alternate source [22]. Alkalinity of water is a measure of weak acid present in it and the cations balanced against them. Total alkalinity is the total concentration of bases in water usually carbonates and bicarbonates. Total alkalinity depends on the concentration of the substance which would raise the pH of the water. High levels of alkalinity indicate the presence of strongly alkaline industrial waste water and sewage. The degradation of plants, living organisms and organic waste in the water body might also be one of the reasons for increase in carbonate and bicarbonate levels, thereby showing an increase in alkalinity [32].

### 3.8. TDS

TDS values ranged from 530 to 1099mg/L between post-monsoon and pre-monsoon respectively. The average TDS value for the four seasons was 720mg/L. The desirable level of TDS is 500mg/L whereas the permissible limit is 2000mg/L [22]. Variations in TDS may be due to the inflow of industrial, animal and agriculture wastes and also by evaporation and less rainfall. Verma *et al*. [33] observed that large amount of dissolved solids may result in high osmotic pressure in the organisms. Presence of excess TDS may cause gastrointestinal irritation and if used for cooking, will form scales on the cooking vessels [34]. Even though the TDS values of Korattur lake were above the desirable limit, it was well within the permissible limit.

### 3.9. TH

TH values ranged from 229mg/L during post-monsoon to 398mg/L during pre-monsoon. The average TH value for all the four seasons was 298mg/L. The desirable limit of TH is 300mg/L however it may go upto 600mg/l in the absence of an alternate source [22]. TH is used to describe the effect of dissolved minerals (mostly calcium and magnesium) determining suitability of water for domestic, industrial and drinking purpose attributed to presence of strontium, ferrous iron, bicarbonates, sulphates, chloride and nitrate of calcium and magnesium. Water is commonly classified in terms of the degree of hardness namely 0-75, 75-150, 150-300 and above 300 mg/L as soft, moderately hard, hard and very hard respectively [35]. Water that require considerable amount of soap to produce foam or lather and generate scale in hot-water pipes, heaters, boilers and others are called hard water. 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 [36]. The hard water can cause indigestion problem and possibilities of forming calcium oxalate crystals in urinary tracts [37]. Water of Korattur lake was found to be very hard as the TH exceeded 300mg/L.

### 3.10. DO

DO ranged from 2.59 to 8.8mg/L during post-monsoon and pre-monsoon respectively. The average DO value for all the four seasons was 5.75mg/L. High DO values recorded during pre-monsoon may be due to changes in turbidity, TDS and temperature. The correlation between temperature and DO was not as expected, however, lower levels of DO were observed during summer and pre-monsoon which may be due to high photosynthetic activity of phytoplankton [38]. DO is an important aquatic environmental factor, which influences the health of an aquatic ecosystem. Adequate DO is necessary for good water quality. As DO levels in water drops below 5.0mg/L, many life forms are put under stress [31]. DO levels are influenced by water temperature, water agitation, types and numbers of aquatic plants, light penetration and amounts of dissolved or suspended solids that use oxygen such as organic matter [39]. DO levels between 5.0 and 8.0mg/L are satisfactory for survival and growth of aquatic organisms. The low DO during post-monsoon in Korattur lake could be related to lesser input of freshwater and also due to the biochemical oxidation of organic matter and the combined effects of temperature and photosynthetic activity [40].

### 3.11. Chloride

Chloride ranged from 163 to 460mg/L between post-monsoon and pre-monsoon with a yearly average of 277mg/L encompassing all the four seasons. The desirable limit of chloride is 250mg/L and the permissible limit may go upto 1000mg/L in the absence of an alternate source [22]. Excess chloride would reduce the DO content of water, which turns harmful to aquatic organisms [31]. The high chloride concentration in water indicates the presence of large amount of organic matter. The higher concentration of chloride in water is an index of pollution of animal origin and there is a direct correlation between chloride concentration and pollution levels. Excess chloride in the form of human excreta and industrial wastes would reduce the DO content of water, which turns harmful for aquatic organisms [41]. Chloride in Korattur lake water was well beyond the desirable limit but within permissible limits.

### 3.12. Fluoride

Fluoride concentration in Korattur lake remained constant at 0.2mg/L for all the four seasons. The desirable limit of fluoride is 1.5mg/L whereas the highest permissible limit is 1.9mg/L [22] in the absence of an alternate source. Fluoride in Korattur lake was well below the permissible limit. Fluoride is universally present in almost every water, earth crust, many minerals, rocks, etc [42]. At decreasing levels, dental caries becomes a serious problem, and at increasing levels, dental fluorosis occurs [35].

### 3.13. Calcium

Calcium values ranged from 39 to 65mg/L during post-monsoon to pre-monsoon respectively. The average calcium value for all the four seasons was 51mg/L. The desirable limit for calcium in water is 75mg/L and the permissible limit in the absence of an alternate source is 200mg/L [22]. The calcium content was found to increase during pre-monsoon and decrease during post-monsoon. Calcium is essential for all organisms, being an important cell wall constituent and regulates various physiological functions in animals [43]. The decrease in calcium content during post-monsoon maybe attributed to dilution factor and comparatively high temperature during this season which is known to reduce calcium solubility in water. In most of the freshwater, TH is imparted mainly by the calcium and magnesium ions, which apart from sulphate, chloride and nitrates are found in combination with carbonates and bicarbonates. The average calcium concentration in Korattur lake was found to be below the desirable limit.

### 3.14. Magnesium

Magnesium ranged from 32mg/L during post-monsoon to 57mg/L during pre-monsoon with an average concentration of 39mg/L for all the four seasons. The level of magnesium in Korattur lake was higher than the permissible limit of 30mg/L. Magnesium is also one of the important mineral for various enzymatic transformations within the cell especially in the trans-phosphorylation in algal, fungal and bacterial cell [44]. Magnesium ions contribute to the hardness of water along with calcium and other ions.

### 3.15. Ammoniacal nitrogen

Ammoniacal nitrogen ranged from 0.49mg/L during post-monsoon to 0.85mg/L during summer. The average value for all the four seasons was 0.69mg/L. Ammoniacal nitrogen ($NH_3$-N), is a measure for the amount of ammonia, a toxic pollutant often found in landfill leachate and in waste products, such as sewage, liquid manure and other liquid organic waste products. It can also be used as a measure of the health of water in natural bodies such as rivers or lakes, or in man-made water reservoirs [45,46]. Ammoniacal nitrogen is produced by the microbial activity of organic nitrogenous matter; therefore, it appears in many ground waters [47]. Ammonia is rapidly oxidized by certain bacteria, in natural water systems, to nitrite and nitrate, a process that requires the presence of DO. Ammonia, being a source of nitrogen is also a nutrient for algae and other forms of plant life and thus contribute to overloading of natural systems and cause pollution. The relative concentration of ammonia is pH and temperature dependent. Higher the pH, the more of ammonia will be present. Ammonia can block oxygen transfer in the gills of fish, thereby causing immediate and long term gill damage. Fish suffering from ammonia poisoning will appear sluggish and come to the surface, as if gasping for air. The US EPA [48] recommends a limit of 0.02 mg/L as ammonia in freshwater environments. Ammoniacal nitrogen was found to be in excess in the water of Korattur lake.

### 3.16. Nitrate

Nitrate values ranged from 5.8mg/L during summer to 12.9mg/L during monsoon. The average nitrate value was 8.73mg/L for all the four seasons. The desirable limit of nitrate in drinking water is 45mg/L which can go upto the maximum permissible limit of 100mg/L in the absence of an alternate source [22]. Nitrate is the most highly oxidized form of nitrogen compounds commonly present in natural waters, because it is a product of aerobic decomposition of organic nitrogenous matter. Significant sources of nitrates are fertilizers, decayed vegetable and animal matter, domestic and industrial effluents and atmospheric washouts [25]. Nitrate levels in surface water often show marked seasonal fluctuations with higher concentrations being found during monsoon months compared to summer and winter. During summer months, the reduction in nitrates could be due to algal assimilation and other biochemical mechanism and higher nitrate value during monsoon may be due to surface run off and domestic sewage and specially washing activities. Similar results have been reported by Gohram [49] and Rajashekhar *et al*. [50]. Excess amounts of nitrates in drinking water can create serious health problems in humans. Nitrates can change normal haemoglobin to methaemoglobin which reduces the ability of the blood to transport oxygen to cells. This oxygen starvation can lead to a bluish tint of the lips, ears and nose in mild cases (known as blue-baby syndrome in infants). In severe cases, it can lead to respiratory and heart problems and death. Infants are especially susceptible to the effects of nitrates in drinking water because of their high stomach pH, which increases the conversion of nitrate to nitrite [51]. Nitrate concentration in Korattur lake was found to be within the permissible limits.

### 3.17. Nitrite

Nitrite ranged from 0.41mg/L during post-monsoon to 0.53mg/L during pre-monsoon. The average nitrite value for all the four seasons was 0.49mg/L. The higher concentration of nitrite and its seasonal variations could be attributed to the variation in phytoplankton, excretion and oxidation of ammonia and reduction of nitrate to nitrite [52]. The low content of nitrite could be due to less freshwater input, higher salinity, higher pH and also uptake by phytoplankton. Nitrites are relatively short-lived because they are quickly converted to nitrates by bacteria. Nitrites produce a serious illness called brown blood disease in fish. Nitrites also react directly with haemoglobin in human blood to produce methaemoglobin, which destroys the ability of blood cells to transport oxygen. This condition is especially serious in babies under three months of age as it causes a condition known as methaemoglobinemia or blue-baby disease. Water with nitrite levels exceeding 1.0 mg/L should not be given to babies [48,53]. Nitrite concentration was within the limits in Korattur lake.

### 3.18. Sulphate

Sulphate values ranged from 41mg/L during post-monsoon to 30mg/L during summer. The average sulphate value was 37mg/L for all the four seasons. The desirable amount of sulphate in drinking water is 200mg/L and can go upto 400mg/L in the absence of an alternate source [22]. Sulphate concentration in Korattur lake was below the limit. Sulphate is present in fertilizers and contributes to water pollution and increases sulphate concentration in water body. They also come from runoff water, which contain relatively large quantities of organic and mineral sulphur compounds. The supply of sulphate ions in surface water under natural conditions are due to the reactions of water with sulphate containing rock and with the biochemical and partly chemical oxidation of sulphides and other compounds of sulphur [54]. Excess sulphate in water imparts an offensive taste [55]. Sulphates are discharged into water from mines and smelters and from pulp and paper mills, textile mills and tanneries. Sodium, potassium and magnesium sulphates are all highly soluble in water, whereas calcium and barium sulphates and many heavy metal sulphates are less soluble. Atmospheric sulphur dioxide, formed by the combustion of fossil fuels and in metallurgical processes, may contribute to the sulphate content of surface waters. Sulphur trioxide, produced by the photolytic or catalytic oxidation of sulphur dioxide, combines with water vapour to form dilute sulphuric acid, which falls as "acid rain" [56]. Levels of sulphate in rainwater and surface water correlate with emissions of sulphur dioxide from anthropogenic sources [57]. Cathartic effects are commonly reported to be experienced by people consuming drinking water containing sulphate in concentrations exceeding 600 mg/L [58, 59], although it is reported that humans can adapt to higher concentrations with time [60]. Dehydration has also been reported as a common side-effect following the ingestion of large amounts of magnesium or sodium sulphate [61].

### 3.19. Phosphate

Phosphate values ranged from 0.01 to 0.04mg/L during post-monsoon and pre-monsoon respectively. The average phosphate value for all the four seasons was 0.02mg/L. Phosphate is a nutrient for plant growth and a fundamental element in the metabolic reaction of plants and animals. It controls algal growth and primary productivity. Excess amounts of phosphorus can cause eutrophication leading to excessive algal growth called algal blooms [25]. Maximum phosphate values during pre-monsoon might be because of entry of detergents due to washing of clothes in the lake. Nitrogen and phosphorus are nutrients that are natural parts of aquatic ecosystems. Nitrogen is also the most abundant element in the air we breathe. Nitrogen and phosphorus support the growth of algae and aquatic plants, which provide food and habitat for fish, shellfish and smaller organisms that live in water. But when excess nitrogen and phosphorus enter the environment, usually from a wide range of human activities, the air and water can become polluted. Nutrient pollution has impacted many streams, rivers, lakes, bays and coastal waters for the past several decades, resulting in serious environmental and human health issues, and impacting the economy. Excess nitrogen and phosphorus in the water causes algae to grow faster than ecosystems can handle. Significant increase in algae harm water quality, food resources and habitats, and decrease the oxygen that fish and other aquatic life need to survive. Large growths of algae are called algal blooms and they can severely reduce or eliminate oxygen in the water, leading to illnesses in fish and the death of large numbers of fish. Some algal blooms are harmful to humans because they produce elevated toxins and bacterial growth that can make people sick if they come into contact with polluted water, consume tainted fish or shellfish, or drink contaminated water [62]. Phosphate in Korattur lake was within the limit of 0.05mg/L.

## 4. Conclusion

The present study has highlighted the various physicochemical parameters of Korattur lake, Chennai. Seasonal variations in water quality were observed. The lake was found to be moderately polluted and suffered from eutrophication. The survival of a lake within a metropolitan city has become impossible mainly due to rapid population growth and anthropogenic destruction. Korattur lake has also had its share of destruction due to pollution from nearby industries and sewage inflow from residential areas. Lakes and their surrounding areas are fragile ecosystems that face increasing threats from water abstraction, fast growing townships and human population [63]. Unchecked destruction of lakes have been halted by the intervention of the local government and the untiring efforts of Non-Governmental Organisations (NGOs). However, continued monitoring of water quality and stricter conservation measures are needed to preserve these beautiful natural repositories of flora and fauna.

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