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RESEARCH ARTICLE

POLLUTION STATUS OF RAMMAKKAL LAKE WITH SPECIAL REFERENCE TO DISSOLVED OXYGEN, AMMONIA, NITRITE, BOD AND COD

[1]Krishna Kumar, M. and *[,2]Ebanasar, J.

[1]Research Scholar, Bharathiar University, Coimbatore, Tamilnadu, India
[2]Department of Zoology and Wild Life Biology, Govt. Arts College, Ooty- 643 002, Tamilnadu, India

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ABSTRACT

The Ramakkal Lake is situated at Dharmapuri, Tamil Nadu, India, this Lake is extensively been used for the purpose of irrigation, fishing and also for the animal requirements. The fresh water pollution has long been an issue of concern for the life scientists. This work is intended to determine the overall water quality of the Lake. Lakes are the most fertile, diverse, productive and interactive ecosystem in the world. For the present research work four sampling sites were identified and lake water quality was analysed for pollution status on a monthly basis over a period of 13 months. Every water sample was analysed for temperature, pH, salinity, conductivity, total dissolved solids, total alkalinity, hardness, turbidity, dissolved oxygen, chloride, nitrate, phosphate, ammonia, biological oxygen demand and chemical oxygen demand. The study revealed that the lake water was alkaline. The chloride, Ammonia, Nitrite and conductivity concentrations were high in all the four sites chosen. The sites which showed greater pollution had lower levels of dissolved oxygen. High levels of pollutants in lake water causes an increase in biological oxygen demand (BOD), Chemical oxygen demand (COD), Dissolved Oxygen, Nitrites, Ammonia and hence make such water unsuitable for drinking. The remedial measures suggested for the restoration of this lake include increasing the water levels in the lake, increasing the ground water level and improving the lake water quality. Checking of soil erosion, desilting the lake, establishing a water treatment plant and creating public awareness can be some of the constructive efforts to revive this ancient lake.

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INTRODUCTION

Water is one of the most essential components for the existence of life on the earth. Lakes are one of the most productive ecosystems, comparable to tropical evergreen forests in the biosphere and play a significant role in the ecological sustainability of a region. They are essential part of human civilization meeting many crucial needs for life on earth. Moreover lakes, transition zones between land and water are efficient in filtering sediments. They can intercept run off them land before in reaches the water and help in filtering nutrients, wastes and sediments from flood waters. In certain lakes are so efficient in removing wastes that artificial waste water treatment-systems use aquatic plants for the removal of pollutants from water. Lakes remove nutrients (especially nitrogen and phosphorus) particulates and total biological oxygen demand from flooding waters for plant growth and it helps prevent eutrophication or over-enrichment of other forms of natural waters. However, overloading of nutrients beyond its threshold impairs its ability to perform basic functions.

Human influence on these water bodies causal by rapid cutting of surrounding vegetation thus increasing silt and nutrient load, disposal of the sewage and industrial waste, use for open defecation cultural activity agriculture around the water bodies using agrochemical greatly increase the quantity of nutrients and organic matter input to a water body. Thus the lakes start getting eutrophical at a very early stage. Several studies have been conducted so far to understand the physic-chemical properties of lakes, ponds and reservoirs in India (Jain *et al*., 1996; Sreenivasan *et al*., 1997; Mohanraj *et al*., 2000; Srinivasa 2000; Thorat and Masarrat 2000; Dutta and Sharma 2001; Shastri and Pendse 2001). So far, there is no study on this lake. Ramakkal Lake is main source of agricultural irrigation and fishing purpose in Dharmapuri District. The Government has also a proposal to be converted the Ramakkal Lake in to bird sanctuary because varieties of bird are arriving from the different part of countries. More over settlement sewage water

Corresponding author: Ebanasar, J.
Department of Zoology and Wild Life Biology, Govt. Arts College, Ooty- 643 002, Tamilnadu, India.

and industrials effluent dump into the lake. As Ramakkal Lake has polluted in different ways. The present work was undertaken to analyze the quality of water. In the present investigation an attempt has been made to assess the physic-chemical aspects of Ramakkal Lake.

MATERIALS AND METHODS

Study area

Dharmapuri district is one of the districts in Tamil Nadu state. This district was formed on 2nd October 1965, covering an area of 4497.77 Sq. km, which is 3.46% of Tamil Nadu state. It is surrounded by Krishnagiri district on the north, Kaveri River on the west, Salem district on the south and Tiruvannamalai and Villupuram districts on the east. The district lies between latitudes North 11° 47' and 12° 33' and longitudes East 77° 02' and 78° 40. The total population of the district is 2856300, consisting of 1473597 males and 1382703 females.

Almost 70% of the districts economy is dependent on agricultural and horticulture activities. People are engaged in the cultivation of paddy, millets, pulses, and sugarcane. The district has highest area covered for fruit crops where, mango is the main horticulture crop that is grown nearly up to 1/3 of the area. Tomato is cultivated in Palacode area and chili is cultivated especially at Pennagaram. Dharmapuri district is gifted with huge reserves of granite and quartz.

MATERIALS AND METHODS

Physico-chemical analysis of water samples was done on four selected sites of the Ramkkal lake in the following steps:-

Step 1: Selection of sites & collection of samples:

The water samples were collected from four different sites (C1, C2, C3 and C4). These sites covered almost all four direction of the lake which was helpful for the analysis of lake as whole.

The water samples were collected from surface zone from the depth of 0.3m on the second week of each month from July 2012 to July 2013.

Map of the study area shown in Figure 1

View of lake with all four sites shown in Figure 2

The collection of water samples was done during morning hours (5am to 8 pm) on a fixed date in acid washed 1.5 liters capacity plastic bottles with necessary precautions (Brown *et al*., 1974).

Step II: Physico-chemical analysis of samples

Physico-chemical analysis of water was carried out referring the 'standards methods' (APHA 1992). Various methods used are listed in Table 1. The temperature, pH and dissolved oxygen were determined in the field. The collected samples were brought to laboratory and analyzed within 24 hours, except the biological oxygen demand, which require a period of five days for incubation at a temperature of 20°C using standard methods (APHA 1992).

Table 1. Physicochemical analysis by different method

Parameter	Method / Equipment Used
Temperature	Digital Thermometer
pH	Digital pH meter
Alkanity, DO, BOD, COD	Titrimetry method
Phophate, Nitrate	UV Visible spectro-photometry

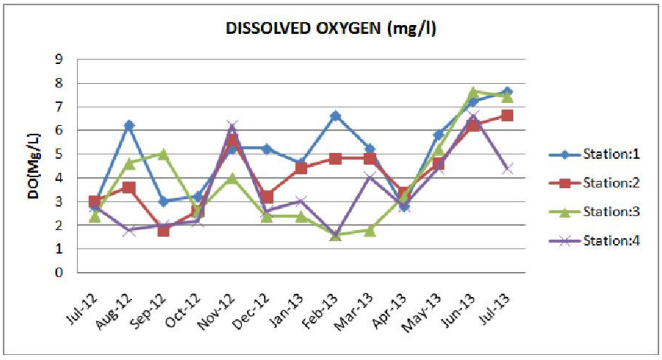


Figure 3. Seasonal variation of dissolved oxygen (mg/L) in four stations during July 2012 to July 2013

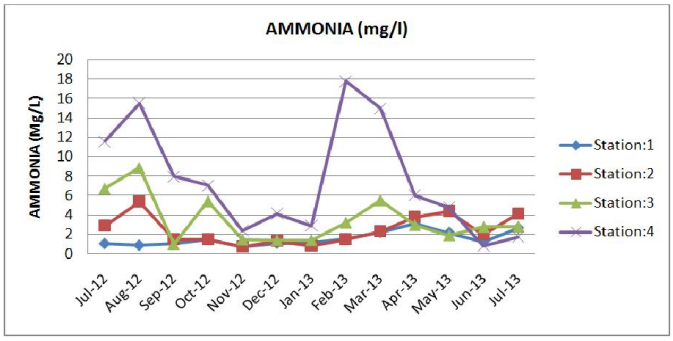


Figure 4. Seasonal variation of Ammonia (mg/L) in four stations during July 2012 to July 2013

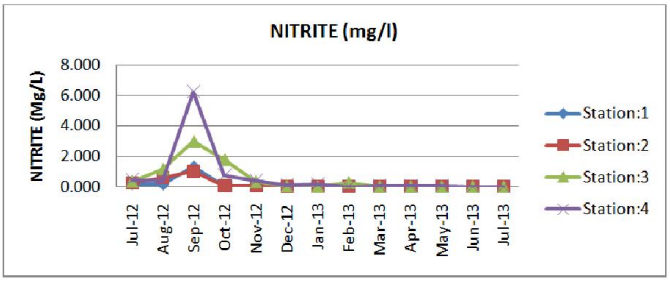


Figure 5. Seasonal variation of Nitrite (mg/L) in four stations during July 2012 to July 2013

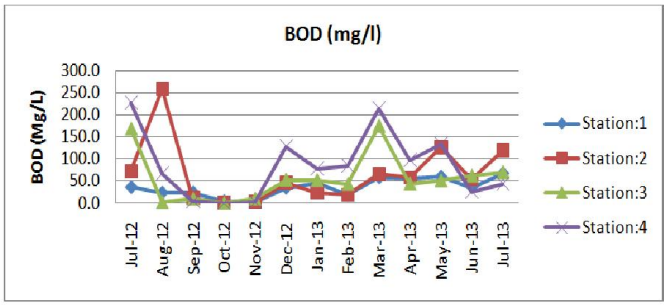


Figure 6. Seasonal variation of BOD (mg/L) in four stations during July 2012 to July 2013

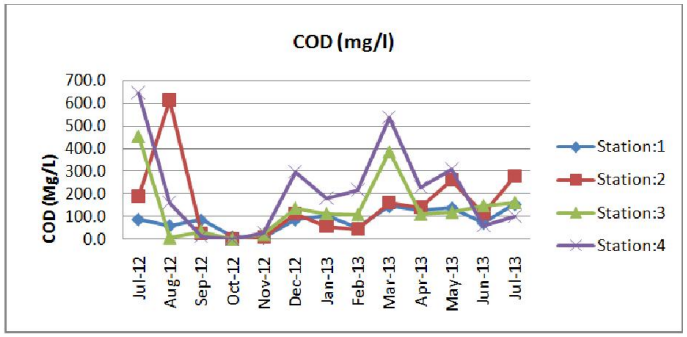


Figure 7. Seasonal variation of COD (mg/L) in four stations during July 2012 to July 2013

RESULTS AND DISCUSSION

The results obtained by physic-chemical analysis of all samples are marked differences in various parameters were observed due to the climatic conditions and pressure of anthropogenic activities.

Dissolved oxygen in water is of great importance to all aquatic organisms and is considered to be the factor which reflects physical and biological process taking place in a water body. It is important in the production and support of life. It determines the nature of an entire aquatic ecosystem to a great extent. Water body receives the supplies of oxygen mainly from two sources directly from atmosphere and during the process of photosynthetic activity of chlorophyll bearing plants. Concentration of dissolved oxygen also depends on surface agitation due to temperature, respiration rate of the living organisms and decomposition rate of dead organic matters. In the present investigation, the low content of dissolved oxygen at Station-III (1.61 mg/L) in Feb 2013 may be related to microbial activity. This is in agreement with the findings of Zutshi *et al*. (1988). The maximum amount of dissolved oxygen was (7.64 mg/L) recorded at Stations-I &III in June 2013 when there was plenty of aquatic vegetation covering the lake surface. The dissolved oxygen does not significant difference among the four stations.

Biochemical Oxygen demand determines the amount of oxygen required by bacteria in stabilizing the decomposable organic matter. The biodegradation of organic materials exerts oxygen demand. BOD gives an idea about the extent of pollution. BOD has been a fair measure of cleanliness of any water on the basis that values less than 1-2 mg/l are considered clean, 3 mg/l

fairly clean, 5 mg/l doubtful and 10mg/l definitely. BOD was found to be exceeding the permissible limits in all the stations. The high BOD value (259.7 mg/L) was noted at station IV in Feb.2012 in the Lake which may be due to absorption of pollutants by aquatic flora in lake system. The BOD does not significant difference among the four stations. It may be due to the over loaded input of organic matter by human activities like dumping industrial waste, domestic waste, sewage disposal and use of soap and detergents for washing cloths and bathing, etc.,

Chemical Oxygen demand determines the amount of oxygen required for chemical oxidation of most organic matter and oxidizable inorganic substances with the help of strong chemical oxidant. The untreated discharge of municipal and domestic waste in water bodies increases the amount of organic content and organic load due to allochthonous and autochthonous sources. Shukla and Kumar confirm the above results. Chemical oxygen demand (COD) was much higher (98.2 mg/l) and dissolved oxygen and COD maximum permissible limit for DO as per WHO is 4.6-6.0 mg/l. In the present investigation the value of Chemical Oxygen Demand (COD) value ranged from 0.00 mg/L to 646.0 mg/L. The highest values were noted in the month of July 2012 at station-IV and lowest values were noted in the month of October 2012 at stations- II, III and IV. The COD does not significant difference among the four stations.

Khatavkar S D and R. K Trivedy (1992) observed COD of the Panchganga river water went above 100 mg/l many times at sites 3 and 5 and all the sites during the month of February. Ajmal & Raziuddin (1988) report COD values up to 300 mg/l from Kali Nadi in U.P. Polluted by industrial effluents.

Nitrite

Nitrite was recorded more or less similar in all the stations and seasons (Figure 5). Nitrite contents high (6.246) were noted in the month of September 2012 at station-IV and low nitrite contents (0.000) were noted in the month of June 2012 at Station IV. The Nitrite does not significant difference among the four stations. The peak values of nitrite observe during the monsoon may be attributes to the influence of seasonal rainfall. The higher concentration of nitrite and seasonal variation may also be attributes to the variation in phytoplankton excretion and oxidation of ammonia (Kannan, 1991). Parveen Mathur *et al*. (2008) observed that nitrite level 0.2mg/l at the time of Kartik Poornima (November) in Pushkar Lake. It was above the permissible limits and cause responsible for the degradation of the lake. Abdel Samie A. Elewa *et al*. (2009) revealed that the area of the Rosetta branch of Nile water contained nitrite concentration showed the maximum value of 23.09 µg1 $^{-1}$ at station III as compared with the minimum value of 1.3 µg1 $^{-1}$ at station IX. It showed that Rosetta branch polluted by effluents also include fertilizers, pesticides and herbicides.

Table 2. One-Way Analysis of Variance comparing the dissolved oxygen levels in different stations of Ramakkal Lake

Analysis of Variance

Source	DF	SS	MS	F	P
Factor	3	18.37	6.12	2.13	0.109
Error	48	138.31	2.88		
Total	51	156.68			

Level	N	Mean	StDev
ST 1	13	5.056	1.677
St 2	13	4.221	1.433
St 3	13	3.881	2.009
St 4	13	3.432	1.619

Pooled StDev = 1.697

Individual 95% CIs For Mean
Based on Pooled StDev

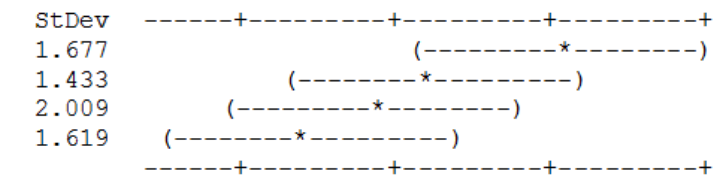


Table 3. One-Way Analysis of Variance comparing Ammonia levels in different stations of Ramakkal Lake

Analysis of Variance

Source	DF	SS	MS	F	P
Factor	3	268.3	89.4	8.70	0.000
Error	48	493.5	10.3		
Total	51	761.7			

Level	N	Mean	StDev
C1	13	1.570	0.739
C2	13	2.480	1.493
C3	13	3.508	2.419
C4	13	7.520	5.701

Pooled StDev = 3.206

Individual 95% CIs For Mean
Based on Pooled StDev

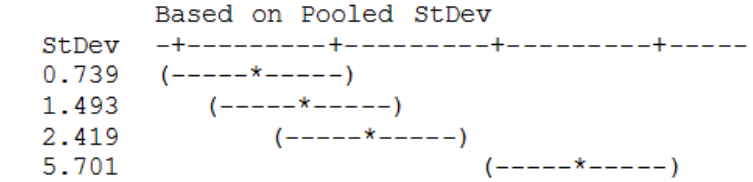


Table 4. One-Way Analysis of Variance comparing Nitrite levels in different stations of Ramakkal Lake

Analysis of Variance

Source	DF	SS	MS	F	P
Factor	3	2.755	0.918	0.94	0.429
Error	48	46.936	0.978		
Total	51	49.691			

Level	N	Mean	StDev
C1	13	0.1475	0.3568
C2	13	0.1634	0.3057
C3	13	0.5473	0.9103
C4	13	0.6680	1.6917

Pooled StDev = 0.9889

Individual 95% CIs For Mean Based on Pooled StDev

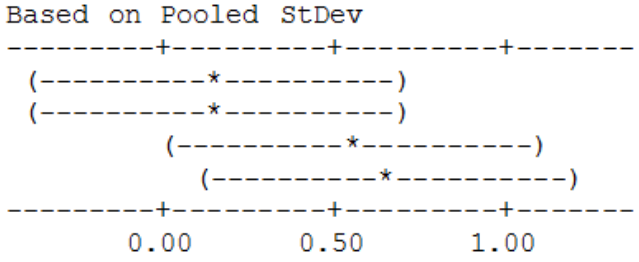


Table 5. One-Way Analysis of Variance comparing BOD levels in different stations of Ramakkal Lake

Analysis of Variance

Source	DF	SS	MS	F	P
Factor	3	16525	5508	1.54	0.217
Error	48	171948	3582		
Total	51	188473			

Level	N	Mean	StDev
C1	13	35.77	20.90
C2	13	66.04	70.90
C3	13	57.13	56.30
C4	13	85.38	75.47

Pooled StDev = 59.85

Individual 95% CIs For Mean Based on Pooled StDev

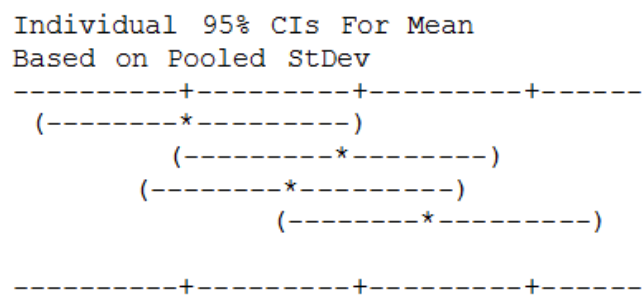


Table 6. One-Way Analysis of Variance comparing COD levels in different stations of Ramakkal Lake

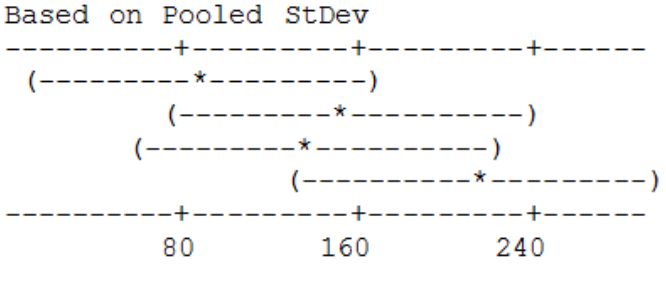
Analysis of Variance

Source	DF	SS	MS	F	P
Factor	3	106180	35393	1.62	0.197
Error	48	1049429	21863		
Total	51	1155609			

Level	N	Mean	StDev
C1	13	86.7	47.5
C2	13	153.5	164.6
C3	13	138.7	137.6
C4	13	213.5	197.9

Pooled StDev = 147.9

Individual 95% CIs For Mean Based on Pooled StDev



Ammonia (NH3) presence of ammonia in water is water dangerous pollution. In the study area the concentration of Ammonia is ranged from 0.740 to 17.81 mg/L. The lowest value 0.740 mg/L is measured in November at stations-I and II whereas the highest value 17.81 mg/L is funded in February at station-IV. According to WHO the allowable amount of free ammonia in water 0.3 mg/L. Further the dissolved oxygen in different stations is found to differ significantly (P> 0.01) in different stations (Table 3). Bujar H Durmishi *et al*. (2008) observed that the water of River Shkumbini are from the first category, which follow as consequence of descent of industrial objectives productivity. Small pollution of river water follows from canalization waters, which without anyone anticipatory treatment in river water.

These results show us that concentration of nitrites, nitrates and ammonia such as nitrogen is in cadres of recommendatory values of lake water. According to we can summarize that the waters of Ramakkal Lake is polluted and unfit for uses.

Conclusion

The study shows that Ramakkal lake's water exhibits low DO, high BOD, COD, nitrite, nitrate and ammonia. Higher pH value indicates slightly alkaline nature of water. The analysis shows that turbidity, COD, BOD, hardness, chloride, phosphate, nitrate were above the permissible limits. It is observed that siltation is one of the key causes responsible for the degradation of the lake.

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