IMPACT OF MODERN AGRICULTURAL PRACTICES ON WATER QUALITY OF A RURAL FRESHWATER LAKE

Abstract

The present study was carried out at Thenmugam Vellode Lake of Erode district, Tamil Nadu, India. The lake is a rain fed tank and not connected with any channel system. Geological position of the lake is $11^0 23.3'68.79"$N and $77^0 6.3'88.72"$ E with elevation of 712 ft. In the present study, water samples were collected from T. Vellode Lake during the period of two years from January 2021 to December 2022. In present study presence of heavy metals is detected in lake sediment. Which, clearly indicates the high volume of fertilizers and pesticides usage in the surrounding water bodies is the major reason for these heavy metals. Because other observations showed that there is no input of effluents and sewage or any other serious factor for these heavy metals. In the correlation analysis with independent sediment values and dependent water quality parameters, clear seasonal impact of sediment on water quality is witnessed. Especially, during summer and monsoon the lake sediment took more advantage over water quality. Thus, the present study clearly recorded the negative impact of lake sediment on the water quality of Thenmugam Vellode Lake. An important finding of the present investigation is the lake have its own self buffering feature. It may be due to physiological activities of the aquatic biota and other processes like chemical transformations, substitution, oxidation and reduction. However, seasonal impact only create aggressive rise of heavy metals especially during summer months.

Keywords: T. Vellode Lake – water quality – sediment – heavy metals

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I. INTRODUCTION

Rural lakes are assorts of our country due to their abundant biotic distribution and also base for the most of the rural based economy. In other words, rural lakes can strengthen the economy of our country. Rural lakes provide protection during floods and droughts. They replenish ground water in its surroundings. They also provide positive environmental impact through the dilution of the pollutants in the various smaller nearby water bodies. They are the home of abundant floral and faunal species. Especially tropical freshwater rural lakes supports wide range of biota. They also have excellent recreational value in every village. The rural lakes of the Indian villages are interconnected with each other and also with history and traditional values. Indian traditional medicinal plants are habitually collected from the shore area of the rural lakes. These lakes are the prime water source for the all agricultural activities of Indian villages.

Water quality analysis are conducted to ensure the portability of the water for human purpose or the survival of the flora and faunal diversity. In most of the time water analysis are conducted in a water body to find out the rate of pollution and its causes. Based on the need of the investigator the water analysis may be conducted as short time experiment or even as long time monitoring. Long time monitoring of a water body provide the real current status of the water body and all other associated things. Well planned standard procedure and methodology alone results better outcome. Otherwise real water quality measurements are not possible. Therefore collection of water samples, proper transportation, preservation, selection of parameters, calculation method and application of suitable statistical tools are consider as major concern during a typical water quality studies. In addition, suitable supporting analysis like sediment and biological analysis are need of the hour to get actual water quality status a selected water body (Roy, 2018).

The lake sediment is act as reservoir of various nutrients. It provides all vital nutrients for the aquatic organisms. Thus it act as prime nutrient source for the producers of an aquatic ecosystem (Archana and Nisar, 2014).

As a non-degradable and toxic compound heavy metals are considered as important compound in water analysis to find the serious and hazardous pollution rate in an aquatic environment, because even presence of a trace level heavy metal also create lethal effect to aquatic biota (Jumbe and Nandini, 2009).

However, modern industrialization and other human activities including agricultural activities are directly or indirectly releasing the wide range of heavy metals into the environment which ultimately reached the aquatic environment.

For the understanding of the ecological fitness status of an ecosystem the biotic components including plants, animals and microbes act as indicator, so they are collectively called ad bio indicators. The bio indicators are used to assess the physico-chemical and biological process of the ecosystem. For example, presence of plankton provide several

information regarding the ecosystem. By their presence and absence the bio indicators signal the environmental conditions (Trishala et al., 2016).

The development of phyto plankton is only because of the interactions of both biotic and abiotic components of the aquatic ecosystem. The interactions are external or internal process of the ecosystem. Therefore, presence of certain phytoplankton itself explain the status of the water quality of the ecosystem. In traditional method, diversity and distribution of phyto plankton are studied by using light microscopy method (Malashenkov *et al.,* 2021).

II. OBJECTIVES OF THE STUDY

1. To record the seasonal impact on physico-chemical quality of a tropical freshwater lake.
2. To find out the impact of seasonal variations on biological components of the lake.
3. To estimate the influence of agricultural activities on the rural lake water quality.
4. To illustrate the suitable management strategies for tropical freshwater lakes to avoid seasonal impacts.

III. MATERIALS AND METHODS

The present study was carried out at Thenmugam Vellode Lake of Erode district, Tamil Nadu, India. This lake ecosystem is situated 14 km away from Erode. The lake is situated only 2 km away from Vellode Bird Sanctuary.

The lake is a rain fed tank and not connected with any channel system. Lower Bhavani Project Canal (LBP canal) which runs near the lake has no separate sluice to this tank and the tank is fully depending upon the seepage water from the channel and the monsoon. Only one outlet at eastern region is used for irrigation purpose. Total area of 45.935 ha, only 25 ha has water throughout the year i.e., the eastern region of the lake. The lake holds maximum water volume during post monsoon and in winter season and it will set decreased in early summer until the late summer up to 50 % of water.

Geological position of the lake is $11^023.3'68.79"$N and $77^06.3'88.72"$ E with elevation of 712 ft (photo plate 1).

1. **Water Quality MonitoringL:** Water quality monitoring is mainly consists of field recordings like temperature measurements, proper sample collection and transportation including timing of sample collection and preservation, standardized analytical method with proper procedure and calculation methods and suitable statistical analysis and presentation of results.

   In the present study, water samples were collected from T. Vellode Lake during the period of two years from January 2021 to December 2022. The samples were collected in four months of interval, i.e during three different seasons including winter (January), summer (May) and monsoon (September).

From selected four sample points of the T. Vellode Lake, water samples were collected at one foot depth. Four liters of water were collected in thoroughly cleaned plastic container. The plastic containers are not temperature sensitive. After proper collection, date of collection, time, sample collector and temperature on sample collection were labelled on the container by using permanent marker. However, separate water samples were collected for the analysis of dissolved oxygen, biological oxygen and coliform populations. For these analysis water samples were collected in well sterilized glass bottles without formation of any air bubbles. These sample bottles are also properly labelled.

In laboratory, physical parameters including water colour, appearance of water sample, odour of the water and turbidity were measured through simple detection methods by using the reference of American Public Health Association (APHA, 1998 and 2005).

2. **Sediment Quality Monitoring:** In the modern limnological study, sediment quality monitoring took inevitable place due to the very close intact contact with the water column in an aquatic ecosystem. Sediment is almost actual reservoir for the most of the soluble chemical constituents of the water column. Even after the out flow water, the sediment act as evidences for finding or tracking the history of the water body. By the sediment analysis, a limnologist can find the information on geochemical substances and other inward chemical substances which are major interruptions of the hydrological process of the lake.

During the sampling month bottom sediment were collected by using the sampler at four sampling points of four directions. From sampler, the sediment samples were properly packed by using non-reactive plastic container. In laboratory, the samples were shadow dried for the further textural and chemical analysis.

Chemical characters including pH, Electrical Conductivity (EC), Total Organic Carbon (TOC), Available Phosphates (PO_4^-), Nitrates (NO_2^-), Nitrites (NO_3^-), Total Nitrogen (TN), Total Phosphates (TP), Total Potassium (K^+), Chlorides (Cl^-), Calcium (Ca^{2+}), Magnesium (Mg^{2+}) and Sodium (Na^+) were analyzed by using the standard methods. C: P ratio and N:P ratio were calculated by using simple formulas.

3. **Heavy Metal Analysis:** In view of finding the impact of agriculture activities on water and sediment quality of the lake, the present study included the estimation of heavy metals in the sediment samples. Heavy metals like Arsenic (As), Cadmium (Cd), Chromium (Cr), Lead (Pb) and Mercury (Hg) were estimated by using Atomic Absorption Spectrometer.

For the present heavy metal analysis Perkin Elmer model 400/HGA900/AS800 coupled with MHS-15 (Mercury Hydride System 15) was used. EDL (Electrode less Discharge Lamp) was used as light source. Acetylene was used as thermal energy source for atomization. Argon was the carrier gas.

With the use of proper standardized solutions and calibration methods, all the heavy metals were estimated with highly precise manner.

IV. RESULTS

In the present study, during the period of two years i.e. from January 2021 to December 2022 water analysis, sediment analysis and bio monitoring programme were conducted at Thenmugam Vellode Lake of Erode District. In addition to that documentation of possible floral and faunal species of the rural lake was also conducted. In view of finding the impact of agricultural activities in and around the lake area, analysis of heavy metals also included in the study.

During the study period of two years, collection of water, sediment samples and recoding of biological components of the lake area are conducted in seasonal manner. Based on local climatic conditions for winter season January month, for summer season May month and for monsoon season September month were chosen.

1. **Water Quality Monitoring:** Physico-chemical and biological analysis of Thenmugam Vellode lake water during January 2021 to September 2022 was conducted. Atmospheric and water temperature of the lake was recorded as typical tropical values in between 30^0C to 31^0C. pH of the water was always fall on purely alkaline range i.e above pH 7.6. Electrical conductivity of the lake water was recoded high in summer, especially during the second year it is highly notable. Dissolved oxygen was not showed much changes from 4.1 mg/l to 6.5 mg/l. Turbidity was recorded high in second year when compared to the first year.

   Both dissolved and suspended solids are high elevated from the first year to second year with the average of 406 mg/l and 32.8 mg/l respectively. Total hardness was very much raised up during the year 2022 with the total average of 115 mg/l. Phenolphthalein alkalinity and total alkalinity were recorded respectively with the average of 188 mg/l and 20 mg/l. Ammonical nitrogen was not detectable during winter months. However, in remaining months it recorded with an average of 2.24 mg/l. But total nitrogen was recorded in all the seasons with the maximum average of 8.21 mg/l and notable maximum value of 12.32 mg/l.

   Chemical oxygen demand and biological oxygen demand were recorded highly varied range with the average of 408 mg/l and 33.27 mg/l respectively. Major nutrients like nitrites, nitrates, phosphates, potassium were recorded with the average of 0.12 mg/l, 5.75 mg/l, 0.14 mg/l, 34.83 mg/l. Minor nutrients like sodium, calcium, magnesium, chlorides, sulphates, bicarbonates and carbonates were recorded respectively with the average of 72 mg/l, 26.5 mg/l, 9.17 mg/l, 72.67 mg/l, 36.67 mg/l, 168.67 mg/l and 20 mg/l.

   Chlorophyll –a was recorded with the average of 13.63 µg/l. Total and fecal coliforms are counted with the average of 703 MPN/100 ml and 242 MPN/100 ml. As a whole number of all the parameters, water quality index was calculated, which was recorded with an average of 43.63 and highly notable maximum of 46.68 in January 2021.

   Results of water quality analysis for the period of two years are presented in table 1a and 1b.

2. **Sediment Analysis:** Sediment samples of the lake were collected during the study period and they were preserved properly after shadow drying. Textural analysis and chemical analysis were conducted.

pH of the sediment samples were highly alkaline and varied between 7.87 and 8.18. Electrical conductivity is recorded with an average of 0.832 dSm^{-1}. Total organic matter and total organic carbon were recorded with an average of 4.23 % and 2.454 % respectively.

Major nutrient like available phosphates, available potassium, nitrites and nitrates of the sediment samples were recorded with 0.048 %, 198 mg/kg, 1.82 mg/kg and 65 mg/kg. Total phosphates, total potassium and total nitrogen were recorded as 293 mg/l, 296 mg/l and 0.188 %. Calculated average ratio between carbon and nitrogen was 13.65 and the ratio between nitrogen and phosphorus is 5.2.

Minor nutrients like chlorides, sulphates, calcium, magnesium and sodium are recorded with the average of 58 mg/kg, 42 mg/kg, 48 mg/kg, 17.6 mg/kg and 65 mg/kg respectively. Results of sediment analysis were presented in table 2.

Table 1: Physico-Chemical and Biological Analysis of Thenmugam Vellode Lake Water During January 2021 to September 2022 (All Values are Mean of Four Sampling Points)

S.N.	Parameter	Unit	JAN '21	MAY '21	SEP '21	JAN '22	MAY '22	SEP '22	Avg.
1	Atmospheric temperature	ºC	23	30	27	25	31	27	27.67
2	Water temperature	ºC	20	26	23	23	25	25	23.67
3	pH	-	7.85	8.23	8.63	7.64	8.29	8.20	8.14
4	Electrical conductivity	ms/cm	423	503	487	487	627	615	523.67
5	Dissolved oxygen	mg/l	5.3	5.3	4.5	5.4	4.1	6.5	5.18
6	Turbidity	NTU	4.0	6.2	9.0	7.8	8.2	7.3	7.08
7	Total dissolved solids	mg/l	308	417	431	409	452	420	406

8	Total suspended solids	mg/l	23	31	26	33	37	38	32.8
9	Total hardness	mg/l	86	106	118	104	124	132	115.00
10	Total alkalinity	mg/l	156	196	200	176	220	180	188.00
11	Phenolphthalein alkalinity	mg/l	BDL	12	20	BDL	24	24	20.00
12	Ammonical nitrogen	mg/l	1.12	2.24	BDL	1.12	4.48	BDL	2.24
13	Total Kjeldhal nitrogen	mg/l	5.60	7.84	8.96	7.84	12.32	6.72	8.21
14	Chemical oxygen demand	mg/l	248	392	520	424	472	392	408.00
15	Biological oxygen demand	mg/l	27.2	31.4	42.1	34.3	39.8	24.8	33.27

Table 2: Physico-Chemical and Biological Analysis of Thenmugam Vellode Lake Water During January 2021 to September 2022 (All Values are Mean of Four Sampling Points)

S.N.	Parameters	Units	JAN '21	MAY '21	SEP '21	JAN '22	MAY '22	SEP '22	Avg.
16	Nitrites	mg/l	0.16	0.1	0.09	0.16	0.12	0.06	0.12
17	Nitrates	mg/l	4.22	5.23	6.67	5.84	7.23	5.32	5.75
18	Phosphates	mg/l	0.088	0.160	0.096	0.140	0.210	0.130	0.14
19	Potassium	mg/l	19	35	36	36	37	46	34.83
20	Sodium	mg/l	50	74	75	74	79	80	72.00
21	Calcium	mg/l	23	27	34	27	27	21	26.50

22	**Magnesium**	**mg/l**	6	9	8	5	14	13	9.17
23	**Chlorides**	**mg/l**	48	80	68	68	86	86	72.67
24	**Sulphates**	**mg/l**	20	36	36	34	43	51	36.67
25	**Bicarbonates**	**mg/l**	156	172	168	176	176	164	168.67
26	**Carbonates**	**mg/l**	BDL	24	32	BDL	8	16	20.00
27	**Chlorophyll-a**	**µg/l**	4.8	9.2	16.2	8.2	21.7	21.7	13.63
28	**T. Coliforms**	**MPN/ 100 ml**	820	820	580	480	580	940	703.33
29	**F. Coliforms**	**MPN/ 100 ml**	316	312	229	189	215	193	242.33
30	**WQI**	**-**	46.68	42.43	41.85	44.62	41.48	44.7	43.63

Table 3: Results of Chemical Analysis of T. Vellode Lake Sediment During January 2021 To September 2022 (Each Value Represents Mean Of Four Samples)

S. N.	Parameters	Units	Jan. '21	May '21	Sep. '21	Jan. '22	May '22	Sep. '22	Avg.	Mini.	Max.
1	Ph	-	7.87	8.03	8.18	7.97	8.13	8.17	8.06	7.87	8.18
2	EC	Dsm⁻¹	0.562	0.733	0.816	0.817	0.832	0.727	0.748	0.562	0.832
3	Total Organic Matter	%	3.93	3.83	3.20	4.23	4.14	4.07	3.900	3.200	4.230
4	Total Organic Carbon	%	2.280	2.222	1.856	2.454	2.401	2.361	2.262	1.856	2.454
5	Available Phosphates	%	0.044	0.038	0.046	0.048	0.041	0.035	0.042	0.035	0.048
6	Available Potassium	Mg/Kg	193	195	198	192	187	182	191	182	198
7	Nitrites	Mg/Kg	1.365	1.530	1.385	1.238	1.820	1.780	1.520	1.238	1.820
8	Nitrates	Mg/Kg	62	57	65	59	63	54	60	54	65
9	Total Phosphates	Mg/Kg	289	268	255	268	293	283	276	255	293
10	Total Potassium	Mg/Kg	296	286	287	287	289	285	288	285	296
11	Total Nitrogen	%	0.167	0.188	0.186	0.183	0.186	0.182	0.182	0.167	0.188
12	C : N Ratio	-	13.65	11.82	9.98	13.41	12.91	12.97	12.457	9.980	13.650

13	N : P Ratio	-	3.8	4.95	4.04	3.81	4.54	5.2	4.4	3.8	5.2
14	Chlorides	Mg/Kg	38	58	50	34	50	28	43.0	28.0	58.0
15	Sulphates	Mg/Kg	42	39	34	33	35	33	36	33	42
16	Calcium	Mg/Kg	48	48	48	48	44	36	45	36	48
17	Magnesium	Mg/Kg	15.4	16.5	16.2	17.6	17.2	14.5	16.2	14.5	17.6
18	Sodium	Mg/Kg	65	63	62	63	57	57	61	57	65

Table 4: Analysis of Correlation Co-Efficient between Chemical Characteristics of Lake Sediment and Water

S. N.	Parameters	Winter		Summer		Monsoon	
		Correlation value	Nature of correlation	Correlation value	Nature of correlation	Correlation value	Nature of correlation
1	pH	-0.054	Very slightly negative	0.652	Highly positive	-0.043	Very slightly negative
2	Electrical Conductivity	0.978	Very highly positive	0.745	Highly positive	0.888	Very highly positive
3	Available Phosphates	0.293	Slightly positive	0.815	Very highly positive	0.282	Slightly positive
4	Available Potassium	-0.685	Highly negative	0.696	Highly positive	-0.635	Highly negative
5	Nitrites	-0.618	Highly negative	0.674	Highly positive	-0.516	Highly negative
6	Nitrates	-0.844	Very highly negative	0.352	Slightly positive	-0.914	Very highly negative

7	Total Phosphates	-0.417	Moderately negative	0.777	Highly positive	-0.420	Moderately negative
8	Total Potassium	0.183	Very slightly positive	-0.803	Very highly negative	0.114	Very slightly positive
9	Total Nitrogen	0.221	Slightly positive	-0.395	Slightly negative	0.224	Slightly positive
10	Chlorides	-0.326	Moderately negative	-0.361	Slightly negative	-0.316	Moderately negative
11	Sulphates	0.327	Slightly positive	-0.654	Highly negative	0.321	Slightly positive
12	Calcium	-0.454	Moderately negative	-0.293	Slightly negative	-0.428	Moderately negative
13	Magnesium	0.584	Moderately positive	0.771	Highly positive	0.578	Moderately positive
14	Sodium	0.384	Slightly positive	0.428	Moderately positive	0.276	Slightly positive

3. **Correlation between the Chemical Characteristics of Water and Lake Sediment:** In summer months most of the water parameters including pH, electrical conductivity, available phosphates, available potassium, nitrites, nitrates, total phosphates, magnesium and sodium were highly correlated with the sediment parameters. In winter and monsoon seasons all the water parameters have varied relationship with sediment parameters from very slightly negative correlation to very highly positive correlation. Results of correlation analysis were presented in table 3.

4. **Heavy Metal Analysis:** Heavy metals including Arsenic (As), Cadmium (Cd), Chromium (Cr), Lead (Pb) and Mercury (Hg) of water and sediment samples were estimated during the study period.

Table 5 : Heavy Metal Analysis in Thenmugam Vellode Lake During January 2021 to September 2022

S. N.	Heavy Metals	Jan. '21	May '21	Sep. '21	Jan. '22	May '22	Sep. '22
1	Arsenic (As) mg/kg	43.7± 3.6	49.2 ± 2.4	51.3± 2.6	44.9± 1.3	56.8± 2.5	51.5± 7.1
2	Cadmium (Cd) mg/kg	7.3 ± 0.3	7.4 ± 0.6	7.4 ± 0.2	9.1± 0.8	12.8± 0.6	12.5± 0.4
3	Chromium (Cr) mg/kg	68 ± 18	71 ± 14	72 ± 23	69 ± 17	65 ± 16	59.7± 13
4	Lead (Pb) mg/kg	417 ± 11	403 ± 19	401 ± 21	408 ± 14	409 ± 11	407 ± 17
5	Mercury (Hg) mg/kg	9.4 ± 1.2	11.9 ± 2.2	10.8 ± 2.4	10.3 ± 2.3	9.5 ± 2.3	9.7 ± 1.9

V. DISCUSSION

As a striking and sensitive chunk, lakes are often called as 'Eye of the Earth'. However, development of human society pollutes the lake and make them as blind eyes. Seasonal variations are natural phenomenon of all types of water bodies.

In general, lakes are not only a water storage body. It have own physico chemical features which are highly complex including geology, topography, climate, hydrology and biological features too. In addition, human influences are act as more influential factor for the determination of the lake features. Rural lakes can play major role in various ecological functions including hydrological cycle, bio-geo chemical cycle and diversification and distribution of biota. Ground water recharge, flood management and providing of microclimate of the biodiversity are some other additional services of the rural lakes (Barman et al., 2021).

However, as a standing water body lake can façade more sequential changes with lot of imprinting on its morphological features too. The present study is conducted to find the impact of agricultural activities in a lake ecosystem along its usual seasonal variations. The study ultimately looking for the basic remedial actions which are based on real ground knowledge.

1. **Water Quality Monitoring:** Recorded temperature of the lake water clearly witnessed that the lake is belongs to typical tropical region, where the atmospheric temperature always measured above 23^0C with an average of 27^0C. Water temperature is highly affected by the atmospheric temperature. pH is an important chemical parameter of an ecosystem which maintains acidic and basic property and controls all bio-chemical process. In the present study pH of lake water was very high with an average pH of 8.14. High pH may change the water salty and also causes eye irritation and skin associated problems (Gupta et al. 2017). Thus, it is a kind of warning alert for the lake managers. The studies of Deepa et al. (2016), Ajayan and Kumar (2016) observed same pH variations due to seasonal climatic and hydrological changes.

   Electrical conductivity was recorded high in summer months, especially in second year it was maximum of 627 ms/cm. It may be due to reduced water volume and which ultimately rises ionic concentrations. It can cause serious damage to cellular activities of biota.

   Dissolved oxygen of the lake water was quantified as maximum of 6.5 mg/l during September 2022. Based on rainfall and inflow of water volume dissolved oxygen concentration varied throughout the study. It was always recorded more than 4 mg/l, which means suitable for the survival of all aquatic organisms. However, in summer month of the second year dissolved oxygen was just over 4 mg/l, which literally denotes that there is heavy load of organic components in lake.

   Turbidity was recorded with high fluctuations due to sudden inward of water. Total amount of dissolved organic and inorganic solid materials called as total dissolved solids of

water. Changes in the balance state of ionic concentrations may be caused natural and human activities. In the present study raise in TDS leads to changes in appearance of water, rise in water temperature and reduced rate in photosynthesis.

To find the suitability of water for the domestic, industrial and drinking purposes determination of total hardness is considered as important water parameter. Total hardness is caused by the ions of ferrous iron, bicarbonates, sulfates, chloride and nitrate of calcium and magnesium (Deepa et al. 2016). Water alkalinity naturally caused by dissolution of CO_2 and artificially raised by input of alkaline industrial waste water and sewage (Patil et al. 2018). In the present water monitoring, total hardness and total alkalinity were recorded as high during monsoon season due to ions carried by certain inflow of water from surroundings of the lake area. The similar results were reported by Sudarshan et al., (2019).

In the present study, average of total 8.21 mg/l total nitrogen, 2.24 mg/l ammonical nitrogen, 0.12 mg/l nitrites and 5.75 mg/l nitrates were recorded. The level of nitrogen indicated the presence of more nitrogenous sources, which can felicitates the certain blooming of algal and other floral populations. If phosphorus, sun light and magnesium are available means, the lake water might be faces the certain blooming, which may cause sequential eutrophication and aging effect of the lake. In the productivity of an aquatic ecosystem, nitrates plays deciding key role and accelerates the growth of algal and other floral species. In addition to the natural sources, sewage, food processing, agricultural and other industrial activities increases the nitrates of water bodies. High level of nitrates in water can cause reduced oxygen carrying capacity of hemoglobin in man (Deepa et al 2016).

Organic pollution rate can be calculated by the measurement of Biological Oxygen Demand (BOD). It is determined by the rate of oxygen utilized by aerobic micro-organisms including bacteria for the fragmentation of organic matter of the measured water samples. High biological oxygen demand indicates the stressful condition of aquatic biota for respiration. (Dhinamala et al. 2015). Recorded BOD of the study showed that due to availability of more nutrients and other favorable conditions, lake water at present support moderate level of biota and also carries more organic compounds.

Chemical oxygen demand is recorded with an average of 408 mg/l, which is slightly higher than the normal unpolluted rural water. It may be due to the input of more agricultural runoff which carries more chemical constituents. The lake is 100% free from the input of sewage and effluent, therefore the only reason is agricultural runoff from nearby catchment area.

The major nutrient phosphorus can be added more to the water by the decomposition of bottom sediment due to microbial actions especially during summer months where water volume was reduced (Rajasekar, 2003). This summer escalation of phosphate levels may cause certain blooming of algae (Havens and Schelske 2001). Potassium was recorded with varied concentration due to temperature and changes. Similar results were observed by Sathya and Shanker (2009).

Magnesium is a basic element for the formation of chlorophyll and also in its lower concentrations contributes to water hardness. In association with calcium it determines the hardness of the water. Rise in chlorides of a water body is clear indication of pollution by sewage and farm drainage (Patil et al. 2018). And the rise may deplete the dissolved oxygen level of the water (Deepa et al.2016). Other minor nutrients like sodium, calcium, sulphates, bi-carbonates and carbonates were recorded with wide variations due to certain increased inflow.

Both fecal and total coliform populations were recorded with 242 MPN/100 ml and 703 MPN/100 ml respectively. These coliforms were added to this rural lake due to the birds which are visited from nearby Vellode Bird sanctuary (Morris and Lewis, 1992).

Water quality index of the lake water express the alarming state of the lake. The average WQI that is midrange of 43.63% is expressed that at present there is no notable grumbles but for the better future of the lake, there is need of immediate strategic management.

2. **Sediment Quality Monitoring:** As a part of sediment analysis, textural analysis was conducted and the results were presented in table 4. Texture, moisture and other physical composition of the lake sediment are highly affected during summer and monsoon due to reduced water volume and high wind actions (Upadhyaya and Avinash, 2010). The variations in the texture and other physical nature have high impact on microbial actions and nutrient release.

pH of lake sediment changed in rainy season due to decomposition of organic matter, addition of more fertilizers (De S ,2009). Runoff water carries more ions from surrounding and causes addition more nutrients like calcium and magnesium (Bernstein 1975).

Density of the sediment is much influenced during monsoon due to increase of organic matter, high rate of evaporation, deep percolation and moist extraction by cultivated plants and trees which ultimately lost from transpiration (Jat, 2002). Inward of more chlorides during monsoon reduces the density and also causes poor soil quality (Bajpai A.2002). C/N ratio is used to differentiate the proportion of allochthonous and autochthonous sources of Organic Matter (Meyers and Ishiwatari 1993; Meyers and Teranes 2001).

Reduced water volume and sudden heavy inflow of water during monsoon causes high fluctuations in potassium and phosphates level of the lake sediment. These fluctuations with the other favorable changes can cause serious troublesome to the water quality of the lake. Especially, when water volume reduces the lake may faces the sequential changes like certain blooming of a single algal species, reduced oxygen level, death and decomposition of aquatic biota, changes in odour and appearance of the lake water, deposition of more organic matter and ultimately reduced depth and water holding capacity (Upadhyaya and Avinash, 2010). Minor nutrients like sulphates, calcium, magnesium and sodium were recorded as normal range and they retains only the normal eco physiological role in the lake.

3. **Impact of Agricultural Activities:** In present study presence of heavy metals is detected in lake sediment (table 7). Which, clearly indicates the high volume of fertilizers and pesticides usage in the surrounding water bodies is the major reason for these heavy metals. Because other observations showed that there is no input of effluents and sewage or any other serious factor for these heavy metals (Salim et al, 2013), whereas varied amount of pesticides and fertilizers usage in the nearby agri-fields may resulted the seasonal variations in the heavy metal concentrations of the lake sediment (Bahnasawy et al. 2011 and Khan et al. 2012).

If the agricultural activities are not properly managed, it can affect the water quality in nearby water bodies. Especially rural lakes are affected by accelerated aging process. Agricultural practices including cropping along banks of lakes, fertilizer and pesticide application can influences physical, chemical and biological features of the water bodies (Holden et al., 2015).

Cultivation on banks of lakes increases the level of organic matter in lakes which sequentially resulted in depletion of level of dissolved oxygen in water (Weiner and Group, 2007) and distribution of faunal population.

Due to the cultivation of crops on lake banks should be avoided to avoid loading of organic matter and siltation process (Tundu, Tumbare and Onema, 2018).

Runoff water carries more nitrogen and phosphorus from agricultural fields reaches the lake water increasing nutrients and accumulate in sediment and become a source of nutrient for long time and leads to reduction in dissolved oxygen. The nutrient increase leads to blooming of microorganism and causes the death of fished and other biota (Lake Champlain Basin Program, 1998). The death decomposition of aquatic biota resulted in addition of nutrient in remarkable volume, which reduces the depth of the lake and leads to reduced water holding capacity of the lake.

Pesticides are chemicals generally used to control the insect pest of the crop fields. In addition they are also used for the control of rodents, weeds and fungi. They are essential for the purpose of high food production, however causes serious damage to the aquatic water bodies through the addition of heavy metals (Hilda, 2019).

These pesticides cause acute and chronic damages to human based on its concentrations. Because they are persistent for years in sediment as residue without any decomposition and transformation. They are the major constituents causing bio-magnification through food chain. Therefore developed countries banned these usage of certain highly toxic pesticides through the implementation of laws and regulations. The pesticides in its lower concentrations also causes indirect impact on biota by affecting reproductive and other behaviour (Moore et al., 2008).

The excessive usage of pesticides carried by runoff water can reaches the lake and slowly percolate through soil and reach the ground water and other drinking water supply

sources. So these pesticides easily reaches human body and they can causes serious diseases like cancer, deformation and organ failures, etc (Hilda, 2019).

In another major concern way like salinization of the water body, the usage of agrochemicals can cause even worst effects in lake and leads to deterioration of lake water quality (Stockle, 1996).

In the correlation analysis with independent sediment values and dependent water quality parameters, clear seasonal impact of sediment on water quality is witnessed. Especially, during summer and monsoon the lake sediment took more advantage over water quality. Thus, the present study clearly recorded the negative impact of lake sediment on the water quality of Thenmugam Vellode Lake. However, seasonal impact only create aggressive rise of heavy metals especially during summer months. An important finding of the present investigation is the lake have its own self buffering feature. It may be due to physiological activities of the aquatic biota and other processes like chemical transformations, substitution, oxidation and reduction. An earlier study of Home and Goldman (1994), hinted the same view in their review on lake ecology.

4. **Importance of Removal Of Sediment:** The lake sediment is act as a reservoir for wide range of nutrients and microbes which plays crucial role in the maintenance of the eco system functions of the lake ecosystem. However, when the sediment received undesirable chemical constituents through water inflow, certainly it change its role and causes serious damage to the lake ecosystem. Thus, periodic removal of bottom sediment always suggested to any kind of lentic water bodies. The periodic sediment removal also have following additional benefits (Neetu and Biswas, 2013).

- Prevention of algal blooming and eutrophication by excess nutrient addition.
- Increased water holding capacity.
- Accumulation of certain undesirable constituents like heavy metals and other toxic substances are eliminated.
- Summer effects like reduced oxygen and increased turbidity may be prevented.
- Blooming of monotypic species can be avoided.
- Increased of depth can improve the ground water level of the nearby areas.
- Certain sensitive species can continues their diversity in the lake ecosystem without unwanted troublesome created by continuous addition of excretory materials of the aquatic biota.
- Healthy wood chain may be maintained.
- Certain weeds and other wastes can be removed.
- Increased aesthetic value.

VI. CONCLUSION

Present study was conducted at Thenmugam Vellode Lake of Erode District, India. The lake is a typical tropical South Indian rural lake. The lake receives seepage water from nearby canal through surrounding agri-fields. Other than the inward of agri-field runoff, no other pollution sources were observed during the study period of two years from 2021 to 2022. The study includes water quality monitoring, sediment quality monitoring, bio-monitoring, heavy metal analysis and recording of other analysis of T. Vellode. Seasonal variations and its aggregative impact with modern agricultural practices have been clearly witnessed with the presence of heavy metals and certain elevations of certain nutrients. The combined effects also influenced in the dissolved oxygen and other physical parameters like appearance and odour too. The study observed the natural self –buffering potential of the lake ecosystem, especially by the reference of heavy metals. However, the continuous addition of heavy metals and other nutrients may lead to lethal effect to the lake biota. Thus, the study suggested various suggestions including periodic removal of bottom sediment for avoiding the seasonal and its aggregative impact on the lake water quality.

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