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WATER QUALITY ASSESSMENT IS A TOOL FOR THE MONITORING OF CULTURE POND –A STUDY OF UPPARAPALLE FRESHWATER LAKE OF WARANGAL DISTRICT, TELANGANA STATE

K. Sandhya & G. Benarjee

Research Scholar, Department of Zoology, kakatiya University, Warangal, Telangana, India

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ABSTRACT

The present study is an investigation that was carried out on the assessment of water quality through its physico- chemical parameters. A freshwater lake situated in Upparapalle village in Warangal district, Telangana State. The study has been conducted for a period of one year i.e. from February, 2016 to January, 2017. Monthly variations in Physicochemical parameters such as Temperature, PH, Electrical Conductivity, Total Dissolved Solids, Dissolved Oxygen, Biological Oxygen Demand, Turbidity, Free Carbon dioxide, Alkalinity, Carbonates, Bicarbonates, Hardness, Chlorides, sulphates and Nutrients like Nitrates, Phosphates were analyzed. The data obtained on the water samples was analyzed and the observations were made on the physicochemical parameters of water samples have been compared with standard values recommended by WHO. All the Physicochemical parameters are at the nearly permissible limit at all the four sampling stations of the lake where the water samples were collected. Continues monitoring of water quality parameters is necessary to give a boost to the Fish culture here in this lake. However, human-induced water pollution should be monitored in a proper manner and it needs appropriate management to achieve sustainable development.

KEYWORDS: *Freshwater Lake, Water Quality, Fish Culture*

INTRODUCTION

Water is one of the most important known components for living things. It is abundant on the earth's crust. Water is an elixir of the body and it is a primary need of all living organisms. A large area of water available on earth is saline water and only a small quantity is found as freshwater. Freshwater has become a scarce commodity due to over exploitation, population growth and due to pollution. The fresh water must be recognized as the “Blood of Society” (Wetzel, 2000). However, with the rapid increase in the population of the country and the need to meet the increasing demands of irrigation, human and industrial consumption, the available water resources in many parts of the country are getting depleted and the water quality has deteriorated. This has led to the scarcity of potable water affecting the human health (Agarkar, 2003). Many natural water bodies in India receive millions of liters of fresh water for the agricultural runoff with different concentrations of pollutants in various farms. The environmental changes will affect the water parameters like Temperature, DO, BOD, and other parameters of a lake (Patra, 2010 and Salanki, 2007). The Productivity depends on the Physicochemical characteristics of the water body (Huct, 1986). The entry of the pollutants in the fresh water affects on the enhancement of oxygen demand and nutrient load in the water. Promoting toxic algal blooms and leading to a destabilized aquatic ecosystem (Morrison *et al.*, 2001). Deterioration of the water quality is not a global

problem (Mahananda *et al.*, 2010). The poor quality of drinking water in our country is more due to contamination than due to the inferiority of the source (Gibbons, 1984). The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life. Without the knowledge of water quality, it is difficult to understand the biological phenomena at length. Because the physicochemical nature of water reveals much about the nature of the ecosystem and it reveals the general biological inter-relationship. Therefore there is a need to study that rate of the inter-relationship among key water quality parameters in relation to water quality management and productivity. The physicochemical parameters of water and the dependence of life process to these factors make it desirable to make the water an environment. It is necessary to know details about different physicochemical parameters such as Temperature, PH, Ammonia, Electrical Conductivity, Total Dissolved Solids, Dissolved Oxygen, Biological Oxygen Demand, Alkalinity, Carbonates, Bicarbonates, Hardness, Sodium, Potassium Chlorides and Turbidity are important to know the tropic nature of the water body. The proper balance of physical, chemical and biological properties of water in lakes, ponds, reservoirs and rivers is an essential ingredient for the successful production of fish and other aquatic resources. The Physicochemical parameters affecting aquatic environment which are supposed to be the limiting factors for the continued existence of aquatic life of flora and fauna. Hence regular monitoring of Physicochemical and biological water quality parameters is essential to determine the status of a water body. These include those that are beneficial and those harmful to man and aquatic animals including fish. In the growing aquaculture industry, it is accepted that, good water quality is needed to maintain viable aquaculture production (King, 1998). Fishponds in freshwater areas of Warangal District play a vital role in fisheries to supply the much-needed animal protein to the people inhabiting especially rural areas. There is a dearth of information on the production of fish from fish ponds in Warangal district, especially in freshwater zones. It is therefore important to know about water quality parameters and their management.

MATERIAL AND METHODS

Study Area

One of the important freshwater Lake in Upparapalle Village was selected in Warangal district of Telangana State. It is located 79˚ 37 ' 13" longitudes and 17˚ 49' 18" latitude. The Submergence area is 36 Acres; Length of Bund is 1400 Million Cubic Feet. Weir and Sluice are present in this lake. This lake shows the good diversity of Ichthyofauna along with other fauna. Where the fish cultivation is in practice for the past several years. The assessment of water quality parameters have been taken up to assess the water suitability for fish culture in this Lake.

Figure 1: Satellite Image of Upparapalle Lake

Sample Collection and Analysis

Water samples were collected in every month on specific dates. Only surface water samples were collected by using clean plastic containers to study the various physicochemical parameters. In order to collect the water samples from the Upparapalle Lake, there are four sampling stations in Lake fixed and a composite sample prepared in order to minimize the error in the water quality if any. The water samples were always collected during the early hours of the day. Prior to sample collection, all the sampling bottles were thoroughly washed, sun-dried and rinsed with the same water to be collected in the pond. The sampling bottles were labeled with dates and collection sites. Until analysis, the collected water samples were kept in a cool container maintaining the temperature below 25^{o}C. Water temperature was measured at the Lake stations using a mercury-in-glass thermometer graduated in degree Celsius (0-100^{o}C). The transparency of water was measured by the Secchi disc. The pH, ammonia, total alkalinity and total hardness were determined with Hach's Model FF-2 Aquaculture test kit. Dissolved Oxygen (DO) and BOD were determined by Winkler's method (Singh and Ram, 1971). CO_2 is a normal component of natural water. In polluted water, it is formed by the biological oxidation of organic matter. It is measured by a Titrometric method. The Turbidity was determined using a Hach ratio Turbidimeter described by APHA standard method (APHA 1992). The electrical conductivity was measured with a conductivity meter (Lovibond US meter, type CM-21). The Total Dissolved Solids (TDS) was measured by filtering the water sample to remove the particulate matter, the filtrate evaporated to dryness and the residue weighed. The TDS was calculated according to (Boyd CE 1979). The exact amount of sulphates was measured from a standard curve of standard sulphate solution. Phosphates were measured by Ammonium Molibdate stannous chloride method. Nitrate, the most highly oxidized state of the element found in the water was measured by Brucine method. Sodium and potassium ions were estimated by the flame photometric method. Chlorinity was estimated by titration with silver nitrate (AgNO3) in presence of chromate ions.

Data Analysis

The data obtained were subjected to Analysis of Variance using the Statistical Analysis System User's Guide (SAS, 1999). Duncan's Multiple Range Test (Duncan, 1955) was performed to compare the means of the stations and significance levels**.**

RESULTS AND DISCUSSIONS

The results of this study are presented in Table 1 &2. A total of 17 different Physico Chemical parameters were analyzed. The ecological studies on Upparapalle Lake have been investigated to know the physicochemical parameters with an emphasis on their significance and interrelationship with fish diversity and also their adverse effect on the enhancement of fish production. This detailed investigation enabled a comprehensive and systematic analysis of the seasonal physicochemical characteristics of this freshwater Lake in Warangal district in three different seasons, pre-monsoon, monsoon and post-monsoon in one year and compared the results. During this study, the literature revealed that different regions receive variable precipitation and hence meteorological factors governing the physicochemical properties of the Lake in turn influence the planktonic population. The physicochemical parameters of water however, have a tremendous influence on fish Culture if not agriculture practices. Water temperature is a measure of the intensity of heat, stored in a volume of water. The water temperature is an important factor indicating its quality, which influences the aquatic life, other dissolved gases and also other chemical substances. The temperature of water bodies varies with climatic conditions, light intensity and depth. It is basically important for the effect on certain chemical and biological reactions. The water temperature observed in this Lake in this study is considered as a normal temperature for aquatic life especially in India. Which is considered as the characteristic feature of medium humid climate Mustapha and Omotosho, (2005)? Pawar and Pandarkar, (2011) observed that water temperature and atmospheric temperature were minimum during winter and maximum in the summer season. The temperature observed in this study consider with the earlier report of (Boyd CE 1982) which is good for fish production. Temperature fluctuations have been reported by Nath *et al.,* (2009), Siddamalayya and Pratima (2008), Venktesh *et al*., (2009). The Hydrogen ion concentration (pH) of natural water is an important chemical factor which can be linked up with all process of life and also influence the colonization of aquatic macrofauna of the water body. Water pH affects the metabolic and physiological processes of fish and also exerts considerable influence on the toxicity of ammonia (ICAR 2006). This observation was thoroughly applicable here as no lime has been used in this Lake to regulate the pH values. In the present investigation, the pH values from 7.1 to 7.4 which is good for fish production, hence the Lake water at Upperapalle was appeared to be more conductive for fish culture… The acceptable range would be 6.5 to 9.0. Fish can become stressed in water with a PH ranging from 4.0-6.5 and 9.0-11.0. Fish growth is limited water of pH <6.5, reproduction ceases and fry can die at pH<5.0 (Boyd CE 1982). While pH more than 9.0 is unsuitable for fish growth (Swingle, 1967). Manjare *et al.,* (2010) reported that the minimum PH value was recorded during winter and maximum during the summer season. The water transparency was estimated, which was at the range of 29.00 to 52.00cm. The minimum transparency was recorded in the month of January and maximum in the month of May. Bhatnagar Chayya *et al.,* (2007) recorded the minimum transparency 70.5cm in the month of August and maximum 155.6cm in February. The lower values of transparency might be due to turbidity caused by eroded soil and higher values during post-monsoon period, may be lesser due to turbulence and decantation of suspended particles. Kadam *et al.,* (2007) and Manjare *et al.,* (2010) also reported similar observations from different water bodies in Maharashtra. Ammonia is the importance parameter in fish culture. Ammonia is introduced into the Lake through dead phytoplankton, leftover feed,

dead and decaying organic matter. Fishes are very sensitive to un-ionized ammonia and need an optimum range of 0.02-0.05mg/l (ICAR, 2006). Robinette (1976) reported that 0.12mg/l NH3 caused reduction of growth and gill damage in Channel Catfish. From the values of the present study, It is observed that the levels of this Upparapalle Lake water were higher than the desired range which may affect the growth of fish. High ammonia levels can arise from overfeeding, protein- rich, excess feed decays to liberate toxic ammonia gas, which in conjunction with the fishes, excreted ammonia may accumulate to dangerously high levels under certain conditions. The higher ammonia content formed in the water may be attributed to the decomposition of various components in the Lake water adding to the enhancement of ammonia content. Dissolved Oxygen (O_2) in the water body is an important parameter which is intimately linked with the availability of oxygen for the survival of aquatic life. The distribution of oxygen is a net result of consumption for oxidation of organic matter and replace from the atmosphere. It is induced into the Lake mainly through photosynthesis by aquatic green plants and dissolved oxygen from the air.The dissolved oxygen in water is essential to all chemical and biochemical processes which occur in natural waters, and it is necessary for the survival of fish and other aquatic organisms; thus, it is also the main indicator of ecosystem condition (Ilijevic *et al.,* 2012). Dissolved oxygen is an important indicator of water quality and its productivity. The dissolved oxygen content in water is a consequence of the equilibrium between oxygen consumption and supply (Svobodová *et al.,* 1993). The level of dissolved oxygen depends upon the temperature and the time of contact. A dissolved oxygen content of the water is measured as the amount of gaseous oxygen dissolved in an aqueous solution that plays a vital role in the biology of fish culture (Dhawan, Karu, 2002 and Ehiagbonare *et al.,* 2010). The mean DO values obtained in this Lake range from 7.5 ± 0.32 to 8.7±0.4 mg/l and which can sustain aquatic life. These values also agree with the minimum DO of 5.0 mg/l as reported for tropical fishes by Saloom and Duncan (Robinette, 1976). The BOD values are higher than the desirable levels are reported in Table 1. The higher BOD values and their magnitudes may depend upon temperature, the density of plankton, a concentration of organic matter and the other related factors. The data on BOD in this Lake were ranging from 1.75 to 6.82mg/l. Biological oxygen demand indicates a potential parameter for reducing the Dissolving Oxygen content in water and this could result in organisms being stressed, suffocated and eventually leads to the death (APHA 1992). Limited light penetration and increased DO consumption in the bottom may cause significantly lower DO compared to the top layer of the water column. If these causes DO to deplete to lower than critical levels, a disastrous effect on the aquatic animals include fish may happen. However, no fish was observed or seen under these stated conditions in this study. The Alkalinity of water is the capacity to neutralize a strong acid and is characterized by the presence of hydroxyl ions. However, a number of factors contribute to the alkalinity of water but in natural waters carbonate and bicarbonates are considered to be predominant. The alkalinity of water mainly contributed by bi-carbonates. The alkalinity is considered as an indicator of pond productivity (Davis, 1955). Alkalinity value provides an idea of natural salts present in water and it is a measure of buffering capacity (Gawas *et al.,* 2006). It may be caused due to the evolution of Co_2 during decomposition of organic matter (Venkadesh *et al.,* 2009). A total alkalinity of at least 20ppm is necessary for good Lake Productivity. As a matter of fact, the Water with high alkalinity and similar hardness Levels has a neutral or slight basic PH and does not fluctuate widely. The values obtained in this study are appreciable and fall within the desirable range (Boyd, 1979). Turbidity levels in natural waters seldom exceed 20,000mg/l (Irwin WH 1945). Turbidity occurs due to organic or inorganic constituents. In fish ponds, water turbidity can result from planktonic organisms or from suspended clay particles. Turbidity restricts light penetration limits, photosynthesis and production of undesirable macrophysics in ponds. Higher turbidity can cause temperature and

DO stratification in ponds. Planktonic organisms are desirable when not excessive, but suspended clay particles are undesirable. It can cause clogging of gills or direct injury to tissues of fish. Similar findings were made by (Phawa and Mehrotra, 1966) Parashar *et al.,* 2006; Sharma and Capoor (2010). Ashraf (1987), Ali *et al.,* (1994), Salam and Perveen (1997) and (Salam *et al.*,2000).

The turbidity values obtained in this Lake are within the desirable range, are above the lower limit. Turbidity relates to the amount of materials present in the water. Water from the various ponds vary in solids concentrations depending on the degree of mineralization, amount of suspended clay and abundance of plankton (Boyd CE 1982). Excessive organic manuring and feed wastage have been reported to increase TDS often lead to poor water quality (ICAR 2006). This could have also been responsible for the variation of TDS values (range 27.9±4.70 to 145.4±91.01mg/l). In the present investigation, the total dissolved solids ranged between 32 ± 1.5 mg/l to 48 ± 2.3 mg/l. The minimum value recorded in the month of January and maximum in the month of August. Choudhari *et al.,* (1999) studied the water quality of chatri lake in Amaravathi city and noted TDS values in 40-80mg/L. Total solids ranged between 458-940mg/L. TDS were high in rainy followed by summer and comparatively low in winter. High TDS values in rainy attributed to leaching of soil and silt carried in the lake by ingression water lake from the catchments area. Water hardness is a measure of the alkaline earth metals such as Calcium and Magnesium concentration in water samples (Ehiagbonare and Ogundiran 2010). Optimum hardness for aquaculture is in the range of 40 to 400 ppm. Hard waters have the capability of buffering the effects of heavy metals such as copper or zinc which are in general toxic to fish. The hardness is a vital factor in maintaining good Lake equilibrium. Calcium and Magnesium are essential to fish for metabolic reactions in bone and scale formation. Additionally, hardness and total alkalinity can affect PH through interaction with the carbon dioxide cycle. Hard water has a higher concentration of alkaline earth metals, Thus the water in this Lake under study was not hard but softer. The content of the electrical conductivity was at average levels of 109 ± 4.5 to 151 ± 6.1 µmhos/cm. These values show the extent to which the ponds contain dissolved solids and which enter the Lake water through pollutants. This could be detrimental to the survival of aquatic life in these ponds. (Boyd, 1982)stated that specific Conductance for fresh water often ranges from <25 to >500µmhos/cm, but in some polluted waters, it may reach 10,000 µmhos /cm. hence values obtained in this study fall within the acceptable limits. In comparison, the observed values of the parameters fall within FEPA and WHO (Venkatesharaju *et al.,* 2010). Standards for good water for Lake fish culture. Chloride anion is generally present in natural waters. Chloride concentration is higher in organic wastes and its higher concentration in natural water is definite indication of pollution from domestic sewage. The ecological significance of chloride lies in its potential to regulate the salinity of the water. Most of the water-soluble salts in a Lake environment generally remain in Cl^- form and hence the amount of Cl^- ions in Lake Water indicates very closely the amount of soluble salts present. The optimum concentration of chloride ion in freshwater aquaculture is not through studies, however, it is reported that 1-100ppm concentrations are usually considered to be favorable (Chattopadhyay,1998). Sarma *et al.,* (2007) recorded the range of chlorides as in between 13.5-24mg/l. High chloride values in summer could be due to their concentration as a result of evaporative water loss. Lower values in rainy could be attributed to dilution effect and renewal of water mass after summer stagnation. However, the standard limit set by WHO is 250ppm. This Lake has recorded less than the WHO standard. Sodium and Potassium is one of the major cations in water and soil. Sodium is one of the most abundant elements and is a common constituent of natural waters. The sodium concentration of water is of concern primarily when considering their solubility for agricultural uses or boiler feed water. The concentration ranges from very

low in the surface waters and relatively high in deep ground waters and highest in the marine waters. The sodium ion is ubiquitous in water. Fishponds are usually considered to be fairly well supplied with potassium (Dwivedi *et al.*,2002). High clay and organic matter content of productive fish Lake soils (Singh and Mathur, 2005). Associated with alkaline pH values usually tend to maintain moderate to the good amount of potassium (K) in Lake Soil and water (Chattopadhyay, 1998). However, with increasing use of N and P fertilizers, potassium is gradually becoming the limiting nutrient, and estimation of potassium ion in Lake Water is becoming important. The potassium ion concentration did not show significant concentration with any other parameter. Generally, Sodium (Na) is not included in the regular analysis of the lake water. However, in brackish water ponds, Na occurs in very high concentration and determination of this element may be felt necessary.

CONCLUSIONS

From the present study, it may be concluded that all the physicochemical parameters are at the nearly permissible limit at all 4 stations. The overall Lake is not considered as polluted one. The Lake is precious to all life on the earth. Farmers should be educated on better managerial practices bordering on feeding practices, Lake Management, good water exchange practice to reduce organic load and waste accumulation. The baseline data generated would help planning and future management decisions to develop freshwater ponds for better water quality and production of fish in the Lake water. This will ensure that some of the parameters in this study will not exceed levels that could be harmful to fish in the environment. Such a measure will guarantee the safety of the aquatic ecosystem, humans, and environment for good and healthy production of fish for consumption. Therefore, it is suggested that the measures are necessary to avoid further contamination of Lake due to anthropological activities. At present this Freshwater fish Lake is suitable for fish culturing and irrigation purpose.

Table 1: Shows the Seasonal Variation in Physico Chemical Parameters of Upparapalle Freshwater Lake

MONTH	TEMP (°C)	TURB. (ppm)	TOTAL DISS. SOLIDS (mg/l)	TRANSAP. (cm)	PH	DO (mg/l)	BOD (mg/l)	FREE CO2 (mg/l)
			Pre Monsoon					
FEB-16	25	26.5	37	38	7.1	7.5	1.75	1.44.
	±1.27	±2.4	±2.3	±1.1	±0.26	±0.32	±0.11	±0.21
MAR-16	26	29.11	39	41	7.1	7.7	3.46	1.57
	±1.25	±1.9	±1.9	±0.9	±0.35	±0.3	±0.22	±0.25
APR-16	27	34.2	41	48	7.15	7.6	2.55	1.65
	±1.42	±2.6	±2.1	±0.6	±0.22	±0.3	±0.41	±0.19
MAY-16	28.4	38.91	46	52	7.4	7.9	3.64	1.73
	±1.00	±1.63	±2.4	±0.7	±0.31	±0.2	±0.28	±0.17
			Monsoon					
JUN-16	28	38	44	43	7.26	8.2	2.89	1.38
	±1.11	±1.9	±1.4	±1.2	±0.15	±0.3	±0.16	±0.26
JUL-16	29	46.15	47	47	7.32	8.5	4.62	1.46
	±1.56	±1.4	±1.8	±1.2	±0.23	±0.3	±0.35	±0.46
AUG-16	28	47.39	48	48	7.2	8.7	5.23	1.54
	±1.14	±1.7	±2.3	±1.4	±0.37	±0.4	±0.28	±0.35
SEP-16	28.5	46.21	46	38	7.1	8.6	5.77	1.69
	±1.35	±2.4	±2.6	±1.7	±0.34	±0.3	±0.11	±0.41

Table 1 Contd.,								
MONTH	**TEMP (°C)**	**TURB. (ppm)**	**TOTAL DISS. SOLIDS (mg/l)**	**TRANSAP. (cm)**	**PH**	**DO (mg/l)**	**BOD (mg/l)**	**FREE CO2 (mg/l)**
			Post Monsoon					
OCT-16	28	34.27	38	35	7.1	8.3	3.64	1.66
	±1.12	±2.1	±2.1	±0.9	±0.21	±0.2	±0.31	±0.22
NOV-16	27	37.22	36	32	7.18	8.1	5.21	1.78
	±1.56	±1.5	±2.7	±1.4	±0.3	±0.2	±0.22	±0.21
DEC-16	26	35.25	35	31	7.15	7.6	6.82	1.87
	±1.32	±1.9	±1.1	±0.9	±0.24	±0.3	±0.36	±0.24
JAN-17	25	32.19	32	29	7.3	7.7	6.03	1.91
	±1.43	±2.5	±1.5	±1.2	±0.3	±0.4	±0.14	±0.41

Table 2: Shows the Seasonal Variation in Physico-Chemical Parameters of Upparapalle Fresh Water Lake

MONTH	SO4 mg/l	NITRATE mg/l	AMMONIA (ppm)	NA (ppm)	K (ppm)	EC (µmhos/cm)	ALKALINITY mg/l	CL mg/l	PO4 mg/l
					Pre Monsoon				
FEB.16	28.4	0.31	0.87	3.8	1.48	109	32	30.11	2.01
	±1.5	±0.01	±0.1	±0.2	±0.1	±4.5	±2.2	±2.64	±0.16
MAR.16	32.72	0.34	0.98	4.5	1.59	118	37	36.42	2.15
	±1.6	±0.02	±0.3	±0.1	±0.2	±4.1	±1.6	±2.44	±0.15
APR.16	39.14	0.42	1.2	5.4	1,78	127	38	38.37	2.19
	±1.7	±0.01	±0.2	±0.2	±0.1	±3.9	±1.8	±2.03	±0.24
MAY.16	46.19	0.49	1.5	5.9	1.97	132	41	42.69	2.27
	1.8	±0.03	±0.1	±0.1	±0.3	±4.7	±2.7	±1.89	±0.23
					Monsoon				
JUN.16	37.42	0.47	1.3	4.9	1.68	129	41	43.71	2.11
	±2.5	±0.04	±0.2	±0.2	±0.1	±2.8	±2.1	±2.54	±0.11
JUL.16	43.55	0.57	1.4	5.5	1.85	137	46	49.36	2.27
	±1.8	±0.01	±0.2	±0.2	±0.2	±3.8	±3.6	±3.18	±0.19
AUG.16	49.69	0.65	1.6	5.9	1.95	145	48	53.19	2.36
	±2.8	±0.02	±0.3	±0.1	±0.3	±4.8	±2.5	±2.14	±0.19
SEP.16	54.38	0.69	1.7	6.7	2.06	151	51	51.26	2.26
	±2.6	±0.05	±0.1	±0.3	±0.2	±6.1	±1.5	±2.05	±0.23
					Post Monsoon				
OCT.16	46.74	0.46	1.3	4.7	1.88	126	44	46.73	1.94
	±1.9	±0.03	±0.1	±0.2	±0.3	±5.3	±1.9	±2.38	±0.18
NOV.16	50.52	0.53	1.4	5.5	1.96	132	45	52.82	2.16
	±2.8	±0.05	±0.3	±0.1	±0.1	±3.8	±2.1	±3.61	±0.16
DEC.16	57.92	0.59	1.6	6.1	2.12	137	49	54.22	2.14
	±3.7	±0.01	±0.3	±0.3	±0.2	±4.5	±2.4	±2.37	±0.13
JAN.17	59.38	0.47	1.5	5.8	2.07	134	39	57.11	1.89
	±2.6	±0.02	±0.2	±0.1	±0.2	±3.8	±1.3	±2.52	±0.23

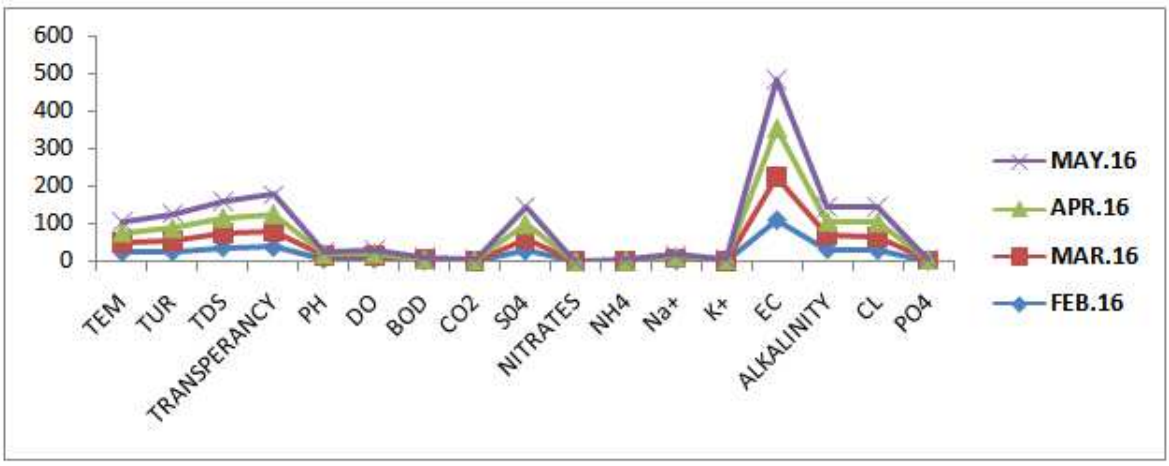

Figure 2: Physico-Chemical Parameters in Upperapalle Lake During Pre Monsoon Period

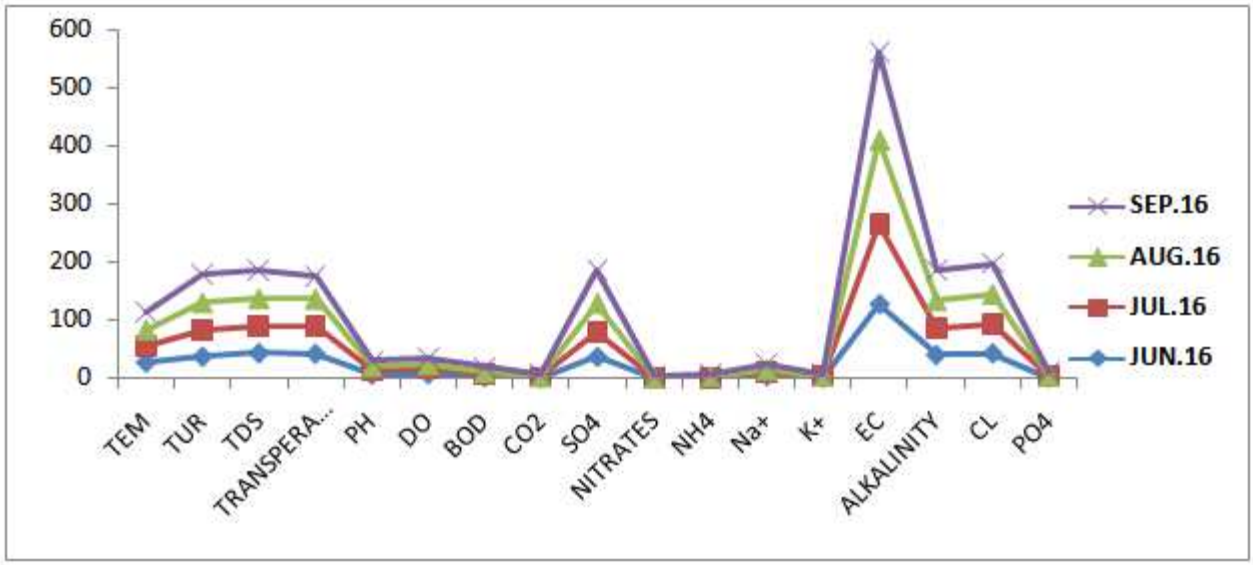

Figure 3: Physico-Chemical Parameters of Upparapalle Lake During Monsoon Period

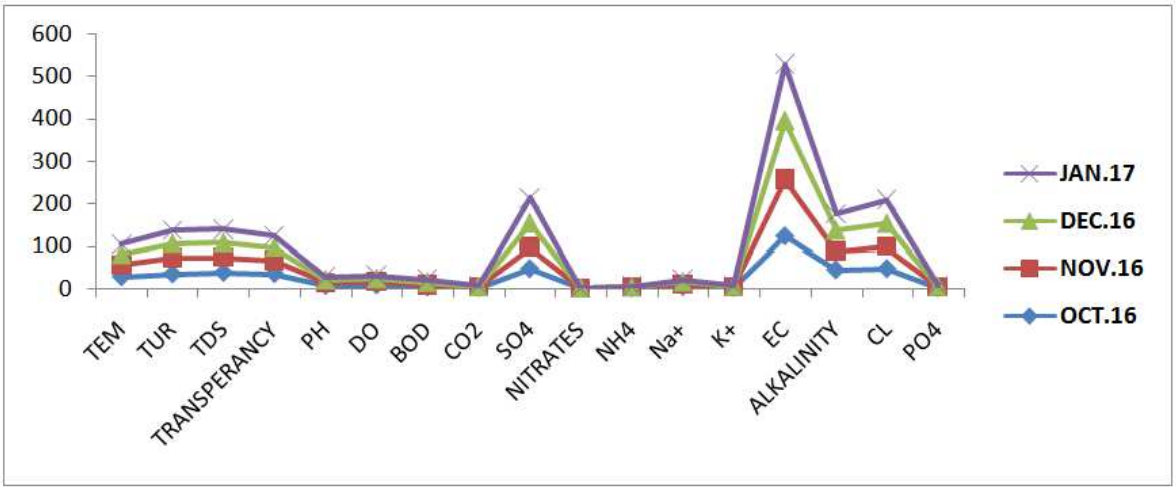

Figure 4: Physico-Chemical Parameters in Upperapalle Lake during Post Monsoon Period

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