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Studies on physico-chemical parameters of Mul Lake, Maharashtra, India

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ABSTRACT

India has 2.4 % of worlds land mass 4 % as water resources and 16 % of worlds population therefore no scope to underutilize water resources. Since the quality of the aquatic life depends on water quality, a thorough assessment of the water quality is an integral part of lakes evaluation. Study site located near Mul town in the Chandrapur district of eastern part of Maharashtra and is situated between 20^0,07,N and 79^0 ,67, E. Water samples were collected in polythene bottles (two litters capacity) once in month from the selected sampling sites of two lakes to analyze the water quality parameters for the period of 12 months i.e. from January 2011 to December 2011. Annual variations in physico-chemical parameters, such as B.O.D., C.O.D., nitrate, phosphate, Chloride, alkalinity, D.O.,CO_2 etc. indicates that, the Mul lake is polluted and may be classified as mesotrophic or mesosaprobic.

Keywords – Mesotrophic, Mul, water quality, physico-chemical

INTRODUCTION

The inland water resource on the surface of earth such as Rivers, Lakes, Reservoirs and Ponds became the focus of special attention in the early stage of development of science of ecology. (Edmondson, 1959) Lakes maintain ecological balance of flora and fauna and their interrelationship regulate surrounding climate and recharge ground water, but unfortunately they are dying. (Hatchinson, et al., 1967) The lakes are getting polluted due to inflow of domestic effluents, apart from pollution, resulting from washing of clothes, Vehicles, Cattle, immersion of Idols during certain festivals etc. All these activities are deteriorating the quality of the water in the lake resulting in the accumulation of the toxic chemicals and other sludge leading to ecological imbalance.

India has 2.4 % of worlds land mass 4 % as water resources and 16 % of worlds population therefore no scope to underutilize water resources.

Total water spread area of Maharashtra is 317000 hectare of which in Chandrapur district there are 11052 ponds and lakes with a total area under fish culture of 16768 hectares (as per fisheries department, Government of Maharashtra).

Since the quality of the aquatic life depends on water quality, a thought assessment of the water quality is an integral part of lakes evaluation. (Welch, 1952; Hatchinson, 1967). Lakes can also be categorized on the basis of their richness of nutrients, which typically affect plant growth. (Sarkar, *et al*., 1962) Nutrient poor lakes are said to be oligotrophic and are generally clear, having a low concentration of plant life. Mesotrophic lakes have good clarity and an average level of nutrients. Eutrophic lakes are enriched with nutrients resulting in good plant growth and possible algal blooms. Hypertrophic lakes are bodies of water that have been excessively enriched with nutrients. (Kaushik, *et al*., 1990).

Although many reports are available on the limnological profiles of lentic ecosystems from other district in these lakes, no attempt has been made to assess their potentialities for enhancing fish production. (Kedar, 2002; Lohar, 2008; Murkute, 2009; Meshram, *et al*, 2012) Such studies are imperative for sustainable development of the lakes, therefore the present investigation was under taken. The water of the lake is use for irrigation of paddy fields in the vicinity and also for washing, cleaning and other social culture practices like immersion of idol of Krishna, Ganesh and Durga etc. The unplanned urbanization and the encroachment by various people is consequently increasing the anthroprogenic wastes which may lead to eutrophication in near future.

MATERIAL AND METHOD

The Mul town is in the Chandrapur district of eastern part of Maharashtra and is situated between 20^0,07ˈN and 79^0 ,67ˈ E. The Mul Lake was constructed about 60/70 years before by the then land lord of the area for irrigating the paddy cultivation fields. It is situated in the heart of the town, near bus Maharashtra, no attempts have been made to record the limnological profile of these lakes, and although the aquacultural practices are followed in stand with an area of 26.11 hectare.

Sampling

Water samples were collected in polythene bottles (two litters capacity) once in month from the selected sampling sites of two lakes to analyze the water quality parameters for the period of 12 months i.e. from January 2011 to December 2011. The analysis of temperature, transparency, pH and dissolved oxygen was done on the field and remaining parameters were analysed in the laboratory. The samples were preserved by refrigeration at 4 degree Celsius which is generally the most accepted method. For analyzing the various parameters methods given in APHA (1975), Saxena (1987) were followed. The recorded data was segregated into the following three seasons:

1. Summer period (February to May)
2. Monsoon period (June to September)
3. Winter period (October to January)
4. Following physicochemical parameters were studied to assess the water quality.

Physical Parameters:

Temperature was measured by using a sensitive thermometer ($1/10^0$ celcius) and expressed in (^{0}C). Transparency was measured by using a Secchi disc to determine the photic zone. Electrical Conductivity and Total Dissolved Solid (T.D.S.) was measured by digital portable water analysis kit (VIS, MODEL-07) 4.

Chemical Parameters:

pH (Hydrogen ion concentration) was determined by using the water analysis kit (VIS,MODEL-07). Dissolved Oxygen was determined by adopting modified Winkler's method. Free Carbon dioxide (CO_2),Total Alkalinity, Total Hardness, Calcium Hardness, Magnesium Hardness, Chloride, Nitrate, Phosphate and Sulphate was determined by EDTA titrimetric method (APHA,1975) B.O.D. and Chemical Oxygen Demand (C.O.D.) was determined by using direct and dilution method given in the Handbook of methods in Environmental studies (S.K.Maiti,2001;APHA,1975 and Saxena,1987).

RESULTS

Profiles of physico-chemical characteristics of water quality:

The analysis of various physico-chemical characteristics of water quality of Mul Lake were carried out for two years i.e., from January 2011 to December 2012. Monthly and seasonal variations are represented in the table no.1.

Table 1: The month wise variations in above parameters during Jan, 2011 to Dec. 2011

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temp	22	23	24	30	32	23	27	27	29	29	24	23
Transperency	35	27	25	21	23	27	28	22	26	28	30	32
TDS	400	490	550	600	750	310	250	220	180	200	300	190
Conductivity	540	750	820	815	760	580	640	620	700	500	570	550
pH	7.3	8.2	8.5	8.4	7.8	7.5	7.7	7.8	8.2	7.2	7.4	7.8
DO	12.3	6.4	6.2	6.6	5.2	7.8	8.3	7.2	7.6	9.6	9.8	10.2
CO2	5.6	4.8	5.3	4.4	3.7	3.6	3.2	4.2	4.9	6.8	7.5	6.4
Total alkanity	176	241	293	166	226	200	245	184	191	170	198	108
Total Hardness	200	140	160	112	96	220	320	280	310	110	210	206
Ca Hardness	142	104	98	66	48	146	176	182	266	60	126	96
Mg. hardness	58	36	62	46	48	74	144	98	44	50	84	110
Cl. Hardness	48	46	41	38	36	73	67	78	59	43	45	52
Nitrate	1.7	3.4	3.6	2.9	3.8	3	2.5	2.7	2.9	2.8	2.5	1.3
Phosphate	0.07	0.08	0.07	0.09	0.08	0.07	0.08	0.04	0.06	0.03	0.04	0.06
Sulphate	12.8	15.7	16.0	16.6	17.0	10.7	12.0	9.5	10.0	9.8	13.2	14.0
BOD	16.0	14.0	11.9	12.2	13.6	15.0	12.0	13.4	14.0	21.0	18.0	15.0
COD	66.0	46.0	38.0	44.0	42.0	52.0	60.0	48.0	64.0	70.0	62.0	58.0

Physico-chemical parameters analysed during the course of study were: Water Temperature (^{0}C), Transparency (cm), Conductivity (µmhos/cm^2), Total dissolved solids (mg/L), pH, Dissolved Oxygen (mg/L), Free CO_2 (mg/L), Alkalinity (mg/L), Total Hardness (mg/L), Calcium Hardness (mg/L), Magnesium Hardness (mg/L), Chloride (mg/L), Sulphate (mg/L), Phosphate (mg/L), Nitrate (mg/L), Biological Oxygen Demand (mg/L), Chemical Oxygen Demand (mg/L).

DISCUSSION

In the lake ecosystem, the physicochemical environment has profound influence on its biota. It controls diversity, biomass and spatial distribution of biotic communities in time and space. The physico-chemical parameters exert their influences both individually and collectively and their interaction produce abiotic environment which conditions the origin, development and ultimately their succession. Fluctuations in physico-chemical parameters often create an adverse effect on organisms, limiting their production and reduce their ability to compete with other population within the environment. On the basis of physico-chemical characteristic, Rawson (1960) proposed a scale far oligotrophic and eutropic lakes, physicochemical parameters may be used to evaluate trophic status of lakes (Hutchinson,1967).

The productivity of lentic ecosystem is influenced by the degree and annual variations in temperature. (Haakonsson, *et al*., 2017). In the present investigation, minimum temperature were recorded in January and maximum in the month of May in Mul lake. Higher temperature in the summer season may be due to the low water level, and greater solar radiation with clear atmosphere and winter minima may be due to the higher water level, high humidity and lower solar radiation. Transparency is a measure of light penetration in water body and is determined by using a Secchi Disc. Seasonaly in the Mul lake the transparency was minimum in summer(18 cm) and maximum in winter(35 cm).

All biological controlled processes including decomposition of dead organic matter occurs at specific pH value, most of the animal species can survive at narrow range of pH from slightly acidic to slightly alkaline condition. Present investigation shows maximum pH values 8.9 during summer season and minimum values are recorded in the winter season (7.1) in Mul lake. APHA, (1998) suggested that waters with hydrogen ions ranging between 6.5 to 9.0 are most suitable for fish production and other aquatic life. Maximum pH was recorded during summer season in both the lakes which may be due to high temperature clear sunlight and high photosynthetic rate. Minimum pH recorded in Mul lake during winter may be

attributed to lower temperature, less metabolic rate and less photosynthesis. From the above observation it is clear that Mul lake are alkaline in nature and the pH is within the permissible limit, therefore have a potential for fish culture.

In natural waters, total dissolved solids (TDS) consist of carbonates, bicarbonates, sulphates, chlorides, phosphates, and nitrates of calcium, magnesium, sodium, potassium, iron and manganese etc. (Grasby, *et al*., (1997). In the present investigation, maximum value of TDS of 800 mg/lit was recorded in the month of May and minimum of 180 mg/lit in the month of September. Similar observations are reported by Jayabhaye et. al. (2008) who reported high TDS in summer followed by monsoon and winter season. Murkute (2009) reported higher TDS values during summer in the three ponds under study at Bramhapuri, Dist Chandrapur (M.S.) and lower value during winter. In the present investigation higher TDS in summer in Mul lake may be due to the inflow of domestic sewage from the locality, in the vicinity and low water level , and lower value in monsoon season may be due to the dilution of lake water due to the receipt of heavy runoff from catchment area during monsoon.

BOD is the amount of oxygen required by microorganisms for stabilizing biologically decomposable organic matter (carbonaceous) under aerobic conditions. In the present investigation in the Mul lake, minimum BOD was recorded during summer (11.9 mg/L) and maximum during winter season (22mg/L). Maximum B.O.D. during winter season is attributed to the release of domestic sewage, bird droppings, human faecal matter which increases organic load, ultimately increasing B.O.D. High B.O.D. during winter is attributed to immersion of idols, during Durga and Ganesh festival which are particularly celebrated during post monsoon and early to mid-winter season.

COD (Chemical Oxygen Demand) is a measure of all organic matter in the sample including biodegradable fraction as well as the fraction which survives bacterial attack but is oxidized by strong chemical oxidants (Kadam, *et al*., 2007). In the present investigation in the Mul lake, minimum COD was recorded, in the summer season (36 mg/L) and maximum during the winter season (76 mg/L). The higher value of COD during winter may be due the entry of domestic sewage and immersion of idols during Ganesh and Durga festivals in the late monsoon and early winter season, ultimately increasing the nutrient load during winter season and lower values during summer may be due to the evaporative loss of water while moderate values during monsoon might be due to inflow from the catchment area, containing various chemicals in the agricultural runoff.

In the present investigation maximum D.O. in Mul Lake (12.3 mg/L) during winter is attributed to fall in temperature, increasing the solubility of oxygen, increased photosynthetic activity and high aeration rate and the minimum D.O. during summer in both the lakes may be due to the higher temperature, high rate of oxygen consumption by oxidisable matter entering into the lake along with the run off and also with the sewage in the Mul Lake. Minimum D.O. in summer (5.0 mg/L) is also due to less flow of water, decomposing organic matter and evaporation of water, as at higher temperature water has a lesser oxygen holding capacity and surplus oxygen is lost to the atmosphere (Kaushik, et al., 1990; Lohar, 2008).

The electrolytes in a solution dissociate into anions and cations and impart conductivity. Thus, higher the concentration of electrolytes in water the more is its electrical conductivity. (Grasby, *et al*., (1997). Measurement of electrical conductivity can be used to estimate the number of ions in the solution. In the present investigation seasonal variation in conductivity values increased during summer 840 µmhos/cm decreased during winter, 480 µmho/cm). Maximum conductivity value during summer which may be due to higher rate of evaporation and discharge of domestic sewage in Mul lake, minimum values in winter in the Mul lake may be due to sedimentation and utilization of minerals by phytoplankton and macrophytes and also due to lower temperature with reduced decomposition activity and minimum conductivity value during monsoon in Janala pond may be due to the dilution of lake water by large input of runoff.

The CO_2 content of water depends upon the temperature of water, depth of water body, rate of respiration, decomposition of organic matter and chemical nature of bottom. Polluted water acquires CO_2 by the biological oxidation of organic matter. (De, 2002) Murkute (2009) reported higher values of CO_2 during winter in all three ponds in Bramhpuri and in Barai and Kalikar pond it was minimum during monsoon season. In the present study maximum (7.8 mg/L) free CO_2 was recorded during the winter season and minimum (3.2 mg/L) during monsoon season at Mul lake. Maximum free CO_2

in winter may be due to the excessive concentration of biodegradable wastes in the water, mainly through sewage and surface runoff, algal blooms, microbial decomposition of organic matter and also absorption from atmosphere.

Natural water bodies in tropics usually show a wide range of fluctuations in total alkalinity values depending upon the location, season, plankton population and nature of bottom deposits; the water infested with submerged weeds usually have low total alkalinity values. In the present investigation, the Mul lake showed the maximum value alkalinity during summer season (293 mg/L) and minimum (108 mg/L) during the winter season. Maximum alkalinity was recorded during summer which may be due to rise in temperature with consequent evaporation of water and concentration of nutrients and bicarbonates in particular. The minimum value observed in this lake during winter might be due to photosynthetic utilization of bicarbonate by phytoplankton. In the Janala lake maximum alkalinity recorded during winter may be due to the inflow agricultural run off after paddy harvesting from the nearby agriculture fields.

Hardness of water is due to natural accumulation of salt from contact with soil and geographical formation or it may enter from direct pollution by industrial or domestic sewage. Hardness of water is an important consideration in determining the suitability of water for domestic and industrial uses. The World Health Organization (WHO) International Standard for Drinking Water (1998) classified water with a total hardness of $CaCO_3$ less than 50 mg/L as soft water, 50 to 150 mg/as moderately hard water and above 150 mg/L as hard CaCO3. In the present investigation, total hardness range from 96 mg/L to 380 mg /L, minimum value was recorded during summer, 96 mg/L and maximum during the monsoon season 380 mg/L. Minimum hardness during summer might be due to complete utilization of carbonate and bicarbonate by phytoplankton during active photosynthesis and its maximum value during monsoon might be due to input of more salts carried with runoff from the catchment area.

The presence of chloride in natural water can mainly be attributed to the dissolution of salt deposits in the form of ions (Cl^-). It is the major form of inorganic anion in water for aquatic life. The high chloride concentration considered to be an indicator of pollution due to organic wastes of animal origin. (NEERI, 1986) In the present investigation, maximum value of chloride was recorded during monsoon season (80 mg/L) and minimum during summer season (36 mg/L). The Mul lake receives high amount of domestic sewage and the lake basin during summer is used for open defaecation, when greater part of the lake dries up. The human excreta is carried with runoff during monsoon their by more chloride value is observed in this season. However lower value during summer may be due to high sedimentation rate. (Kedar, 2002; Murkute, *et al*., 2009).

Nitrates are most important for biological oxidation of nitrogenous organic matter. The stimulation of plant growth by nitrates may results in eutrophication; especially due to algae. (Forbes, *et al*., 2008) In the present investigation, in Mul lake showed minimum values of nitrate in the winter (1.2 mg/L) and higher values during the summer season (3.8 mg/L). Low value of nitrate in winter is attributed to the abundance of phytoplankton and the activities of denitrifying bacteria. However, higher values during summer season might be due to the presence of higher concentration of nitrogen fixing algae, low water level more input of nitrogenous effluents.

Domestic and industrial effluents and agriculture runoff are major sources of phosphorus in water hence its high concentration indicates the pollution. Though present in low concentration, it is one of the most important nutrients for the growth of autotrophs and biological productivity in an aquatic ecosystem. Highest PO_4 content cause increased algal growth often as blooms. Besides sedimentation, high uptake by phytoplankton is also one of the reason of fast depletion of phosphorus from water. (Grasby, *et al*., (1997).

In the present investigation, 0.03 mg/L was recorded in the winter month and higher values, during the summer month, 0.09mg/L. Maximum values of phosphate was recorded during summer season which may be due to higher evaporation rate, higher temperature with consequent release of nutrients due to decomposition and also due to the algal decomposition and wind recycling and also due to the detergent entry into the lake due to washing of clothes. Minimum value of phosphate that was recorded during winter month may be due to its utilization in phytoplanktonic and macrophytic growth and its sedimentation at low temperature. (Chawan, *et al*., 2012).

In the absence of dissolved oxygen,nitrates and sulphates serve as a source of oxygen for biochemical oxidation by anaerobic bacteria. Under anaerobic condition, sulphate ion is reduced to sulphide ion which establishes equilibrium with hydrogen ion to form hydrogen sulphide. (Sahani and Yadav, 2012) Decomposition of organic matter containing proteinaceous sulphur and aerobic reduction of sulphate in water contribute to alter the condition that markedly affect the cycling of nutrients productivity and bottom sediments (Wetzel, 2006). In the present investigation, maximum sulphate value 17.6 mg/L was recorded during the summer season, while minimum value, 9.5 mg/L was recorded in the monsoon season. In the present investigation, the Mul lake shows higher values of sulphate during summer may be due to low water level, due to evaporative loss, biological oxidation of sulphur containing organic matter and due to other anthroprogenic activities. In Mul lake lower values during monsoon season might be due to the dilution effect due to the fresh influx of rain water from catchment area.

According to Welch (1986) calcium plays an important role in translocation of carbohydrates, increasing availability of other ions and act as an integral component of the plant tissues and for reducing the toxic effects of single salt solution of other elements. The calcium is a principal modifier of the toxicity of heavy metals in solution. In the Mul lake minimum value of Calcium was 48 mg/L and maximum of 266 mg/L. recorded during monsoon. Maximum value of Ca was recorded during monsoon and minimum during summer season. The higher calcium values during monsoon may be due to the input of calcium along with runoff. Whereas lower values during summer may be due to its utilization in the luxuriant growth of phytoplankton.

In the present investigation, higher values of magnesium were recorded during the monsoon season, 152 mg/Land lower values during the summer season, 36mg/L. Murkute (2009) reported higher values of Mg in Kalikar pond during monsoon and lower values during winter season. In the present investigation, the higher values of Mg were recorded during monsoon season, which might be due to its leaching from the rocks and its entry into ecosystem along with runoff from the catchment area. However, lower value recorded during summer month might be due to its utilization by algae, fungi and bacteria for enzymatic transformation particularly in photophosphorelation and also its precipitation.

CONCLUSION

Limnological studies have immense values in sustainable development of any ecosystem and also from the point of view of future environment impact assessment programmes. In this context, the present investigation deals with the physicochemical profile of Mul lake. Annual variations in physico-chemical parameters, such as B.O.D., C.O.D., nitrate, phosphate, Chloride, alkalinity, D.O.,CO_2 etc. indicates that, the Mul lake is polluted and may be classified as mesotrophic or mesosaprobic.

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