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ASSESSMENT OF WATER QUALITY USING ENVIRONMENTAL VARIABLES AND DIATOM DIVERSITY IN VADDARAGUDI LAKE OF MYSURU DISTRICT, KARNATAKA, INDIA.

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ABSTRACT

During the present investigation water quality analysis by environmental variables and diatom diversity were studied for a period of two years from January 2015 to December 2016. Samples were collected monthly in three different sites of lake and environmental variables such as pH, water temperature, electric conductance, Total dissolved solids, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, total hardness, total alkalinity, carbon di-oxide, calcium and chloride etc. were examined along with the diatom diversity. During the study period, total 63 species of diatom were identified in which the most abundant taxa were *Synedra acus*, *Synedra ulna*, *Cocconeis placentula*, *Cyclotella meneghiniana*, *Nitzschia palea, Nitzschia frustulum* and *Fragilaria construens* was found in large number followed by *Achnanthidium minutissimum*, *Gomphonema sps.*, *Cymbella powainia*, *Cymbella bengalensis* and *Navicula sp.* Diatom diversity observed more in summer followed by winter whereas least number of diatom were observed during monsoon. This study concluded that lake threatened ecologically due to various anthropogenic activities which lead to organic pollution and eutrophication status.

Keywords: Environmental variables, Water quality, Diatom diversity, Physico- chemical analysis, Lake.

Introduction

Fresh water is an important resource required for the survival of most terrestrial organisms and it is also required for drinking, agriculture and many other purposes. Fresh waters refer to bodies of water such as ponds, lakes, rivers and streams. Lakes are large water bodies surrounded by land, inhabited by aquatic life forms. Environmental factors such as pH, dissolved oxygen, nutrient concentrations, and light availability are affected by lake stratification. When too much of undesirable and harmful substances flow into water bodies, exceeding the natural ability of water to remove or recycle or convert into harmless form, the stage is called water pollution. Biological monitoring may be defined as application or study of particular species or communities (single or multiple groups), which by their presence or absence provide information on the physical and/or chemical conditions of their immediate environment. The presence or abundance of specific organisms in a particular habitat and their ability to grow and outcompete with other organisms under particular conditions of water quality explains the ecological significance of those organisms and their use as bio indicators.

Diatoms are widely used in bio assessments, and a substantial number of diatom indices have been developed for estimation of water quality in various geographic areas. They are recognized as good, potential bioindicators due to their quick response and are sensitive to a number of environmental pressures including changes in salinity, pH, nutrients, turbidity, various pollutants, water depth, substrate availability etc. Diatom indices have been developed to monitor eutrophication (Descy and Coste 1990; Van Dam *et al*., 1994; Kelly and Whitton 1995), organic pollution (Watanabe *et al*., 1988) and human disturbance and recently, they have been widely applied for biomonitoring of the river/streams, assess ecological conditions and monitor environmental changes during the routine water quality. Some of the genera of diatoms are pollution tolerant. Palmer (1996) stated that *Synedra acus*, *Gomphonema sp*., *Cyclotella sp.* and *Melosira sp.* are found in organically rich water and play an important role in water quality assessment and trophic structure. Diatoms are important in Paleolimnological studies to reconstruct the past eutrophication of lakes on basis of paleolimnological evidences (Taylor *et al*., 2007). Diatom species like *Achnanthus brevipes, Gomphonema parvulum*, *Cymbella tumida, Melosira* sp., *Cyclotella* sp., play an important role in the indication of deterioration of water quality and act as bioindicators in the aquatic pollution (Shruthi *et al*, 2011).

The present work includes the study of trophic status of lakes by using physico-chemical Variables and diatom assemblages. The main objective of this study is to examine whether water chemistry differs from each other and how diatom community differs in term of environmental variables of the selected sites.

Materials and Methods:

Sampling sites:

Study was carried out in Vaddaragudi lake in Mysore district. Lake was selected depending on the area, surrounding and the source. Vaddaragudi lake lies at latitude of 12°13´07.5˝N, longitude of 76°18´45.7˝E.

There is less residential area but lake is surrounded more by agriculture field. The water is used for agriculture, washing clothes and other anthropogenic activities. Aquatic plants like *Nymphaea, Nelumbo, Aquatic Ipomea, Salvinia, Typha* are observed in the lake. During the study period anthropogenic activities and sewage inflow was observed in the lake. The main source for the lake is rainfall with catchment area of about 40.8 hectare and depth of about 4-5 meters.

Sample collection:

Water samples were collected every month from three different sites of the lake for a period of two years (January 2015 to December 2016). Tests for water physico- chemical parameters like pH, electric conductivity (EC), water temperature (WT), salinity, total dissolved solids (TDS), carbon di oxide (CO_2), dissolved oxygen (DO), and turbidity were done in the field immediately after the collection of the sample using digital instruments. For other chemical parameters like total hardness (TH), calcium (Ca), chloride (Cl), total alkalinity (TA), chemical oxygen demand (COD), Bio- chemical oxygen demand (BOD), nitrate and phosphate. Water samples were stored and carried to laboratory for analysis using standard methods given in APHA (2005) and Trivedy and Goel (1997).

Diatom samples were collected along with water samples fromthe lake (January 2015 to December 2016) using standard protocol (Karthick *et al*., 2010). Diatom samples were collected from stones, submerged plants and sediments of the lake. The samples were carried to laboratory for cleaning and enumeration. Cleaning of diatom samples was done using hot HCl and $KMnO_4$ method to see the clear frustules of diatom without cytoplasmic content. Then cleaned diatom samples were taken and slides were prepared with the help of pleurax mountant. 400 frustules in each slide were counted using light microscope (Labomed trinocular microscope (LX400) with image transferor DCM 35 USB 2.0) for microphotographic system. Enumeration of diatoms were done by using taxonomic literatures of Hustedt, 1909, 1933; Krammer and Lange-Bertalot, 1986, 1988, 1991; Lange-Bertalot, 2001; Taylor *et al*., 2007a and Karthick *et al*., 2010.

For the statistical analysis Principal Component Analysis (PCA) and Bray-Curtis analysis was carried out to prioritize those environmental factors that better demonstrate variation among species. PCA was performed using PAST version 2.19 (Hammer *et al*., 2001).

PCA is mostly used as a tool in exploratory data analysis, for making predictive models and shows major significant factors by reducing environmental variables on the correlation matrices to produce components explaining variations across sites to make predictive models. It is based on multivariate analyses of the true eigenvector often consists data involving a substantial number of correlated variables and was developed to study linearly correlated variables. The Bray-Curtis dissimilarity is frequently used by ecologists to quantify differences between samples based on abundance or count data. Bray- Curtis similarity index was obtained by employing a data to PAST Software. This measure is usually applied to raw abundance data, but can be applied to relative abundances just like the chi-square distance. It is a statistic used to quantify the compositional dissimilarity between two different sites, based on counts at each site. When it comes to ecological abundance data collected at different sampling locations, the Bray-Curtis dissimilarity is one of the most well-known ways of quantifying the difference between samples.

Results:

In the present study, the physico-chemical characteristics of Vadaragudi Lake (Table 1 and Table 2) explains that pH value varies from 7.19 to 9.34 and Water temperature from a minimum of 24.63°C to a maximum of 33.83°C. The electric conductance value ranged between a minimum of 270.67 µs/cm to a maximum of 519.67 µs/cm. Lake showed the TDS value from a minimum of 189.67 mg/L to a maximum of 347 mg/L. Salinity value varies from a minimum of 134.67 mg/L to a maximum of 251.67 mg/L. The turbidity value ranged from minimum of 0 during August, September, October, November and December 2015 to a maximum of 54.85 NTU during May 2015. CO_2 value does not show much variation during the study period. Dissolved Oxygen ranged from a minimum of 6.76 mg/L to a maximum of 11.35 mg/L. The Hardness ranged from a minimum of 104 mg/L to a maximum of 221.33 mg/L. The Calcium value ranged from a minimum of 17.10 mg/L during February to a maximum of 40.61 mg/L during June. Chloride ranged from a minimum of 17.99 mg/L to a maximum of 40.71 mg/L. Total alkalinity ranged from a minimum of 153.33 mg/L in July 2016 to a maximum of 313.33 mg/L during March 2015. Chemical oxygen demand ranged from a minimum of 30.22 mg/L during September to a maximum of 77.33 mg/L during December 2015 and minimum of 18.67 mg/Lin February to a maximum of 64 mg/L during May 2016. Biochemical oxygen demand value ranged from a minimum of 10.81 mg/L to a maximum of 41.09 mg/L. Nitrate and phosphate values does not show much variation during two years of study period.

A total of 63 diatom species were identified during the period from January 2015- December 2016 (Table 3). The most abundant taxa were *Synedra acus*, *Synedra ulna*, *Cocconeis placentula*, *Cyclotella meneghiniana*, *Nitzschia palea, Nitzschia frustulum* and *Fragilaria construens* was found in large number followed by *Achnanthidium minutissimum*, *Gomphonema sps.*, *Cymbella powainia*, *Cymbella bengalensis* and *Navicula sp. Cyclotella meneghiniana* were found more during the months of June and July whereas *Nitzschia palea, Nitzschia frustulum* and *Fragilaria construens* were found more during the

Table 1: Analysis of Physico-Chemical Parameters of Vadaragudi Lake from January 2015 to December 2015

	pH	WT	EC	TDS	Sal	Turb	CO_2	DO	TH	Ca	Cl	TA	COD	BOD	NO_3^-	PO_4^{3-}
Jan	8.45	26.83	381.33	270.67	184.33	4.93	35.20	9.74	165.33	33.67	24.61	240.00	39.11	15.14	0.04	0.02
Feb	8.29	30.53	423.67	299.67	205.00	16.06	22.29	8.11	190.67	17.10	27.45	306.67	51.56	10.81	0.02	0.01
Mar	8.62	30.33	470.67	337.33	230.33	44.72	31.68	8.11	238.67	37.94	31.24	313.33	34.67	10.81	0.07	0.02
Apr	8.47	33.83	465.33	330.33	224.00	23.33	0.00	7.57	196.00	35.27	33.13	266.67	62.22	15.14	0.02	0.05
May	8.64	30.46	519.00	224.00	250.67	54.85	0.00	8.92	241.33	35.27	35.97	313.30	39.11	12.98	0.14	0.23
Jun	8.52	29.53	449.33	318.33	217.67	22.20	0.00	9.74	202.67	40.61	27.45	240.00	60.44	15.14	0.05	0.01
Jul	8.04	28.66	329.00	233.33	158.67	5.85	0.13	6.76	125.33	33.13	22.72	193.33	24.89	12.98	0.06	0.01
Aug	8.48	26.96	318.67	226.00	153.67	0.00	8.80	10.55	140.00	32.06	22.72	166.67	46.22	17.30	0.03	0.03
Sep	8.34	30.30	327.33	232.67	159.00	0.00	0.58	10.82	165.33	35.80	27.45	200.00	30.22	23.79	0.07	0.02
Oct	8.31	27.40	350.33	249.00	168.67	0.00	1.17	9.20	166.67	36.34	23.67	233.33	46.22	19.46	0.07	0.01
Nov	8.46	25.57	399.00	283.33	192.67	0.00	0.00	8.65	181.33	34.20	28.40	240.00	45.33	15.14	0.05	0.03
Dec	8.29	25.17	442.67	320.67	219.00	0.00	2.93	11.35	214.67	39.01	27.45	286.67	77.33	34.60	0.06	0.04

months of December, January, September and October.

Table 2: Analysis of Physico-Chemical Parameters of Vadaragudi Lake from January 2016 to December 2016

	pH	WT	EC	TDS	Sal	Turb	CO_2	DO	TH	Ca	Cl	TA	COD	BOD	NO_3^-	PO_4^{3-}
Jan	8.58	28.27	468.00	333.00	226.67	4.71	0.00	9.19	214.67	26.72	33.13	280.00	45.33	36.77	0.05	0.04
Feb	8.43	29.43	470.67	333.33	227.67	6.41	0.00	9.19	200.00	28.86	30.29	273.33	18.67	41.09	0.06	0.06
Mar	8.72	29.50	488.67	347.00	237.00	0.00	0.00	9.19	221.33	33.67	33.13	286.67	29.33	38.93	1.05	0.06
Apr	9.34	30.47	519.67	337.67	251.67	0.07	0.00	8.11	189.33	22.98	40.71	266.67	37.33	21.63	0.09	0.10
May	8.53	24.67	295.00	211.33	149.00	19.92	0.00	8.38	104.00	29.39	18.93	166.67	64.00	21.63	0.08	0.26
Jun	8.60	26.63	383.33	272.00	185.00	0.00	0.00	6.76	152.00	37.94	24.61	213.33	29.33	30.28	0.06	0.07
Jul	8.52	25.53	294.67	210.67	141.33	0.00	0.00	7.57	144.00	27.79	21.77	153.33	26.67	25.95	0.06	0.03
Aug	8.25	26.27	279.33	198.00	136.67	0.20	0.00	7.30	113.33	29.93	17.99	153.33	42.67	17.30	0.03	0.02
Sep	8.34	26.80	270.67	189.67	134.67	0.00	5.87	7.57	106.67	31.53	20.83	173.33	53.33	23.79	0.07	0.01
Oct	8.22	26.80	310.00	221.00	151.00	0.00	0.00	7.03	121.33	32.60	24.61	173.33	61.33	23.79	0.07	0.02
Nov	7.77	24.63	396.33	282.33	192.67	0.00	4.69	8.38	142.67	35.27	22.72	220.00	37.33	12.98	0.04	0.01
Dec	7.19	27.03	372.33	265.33	180.00	0.00	0.00	8.38	172.00	26.72	21.77	240.00	29.33	21.63	0.07	0.02

All values are expressed in mg/L except pH, WT (° C), EC (µs/cm) and turbidity (NTU). WT- Water temperature, EC- Electric conductance, TDS- Total dissolved solids, Sal- Salinity, Turb- Turbidity, CO_2- Carbon di oxide, DO- Dissolved oxygen, TH- Total hardness, Ca- Calcium, Cl- Chloride, TA- Total alkalinity, COD- Chemical oxygen demand, BOD- Biochemical oxygen demand, NO_3^- Nitrate and PO_4^{3-}- Phosphate.

Table 3: Variations of diatom diversity in three different sites of lake from January 2015 to December 2016

Species name	Site 1	Site 2	Site 3
Achnanthes hungarica (Grunow) Grunow	-	C	C
Achnanthes inflata (Kützing) Grunow	-	C	C
Achnanthidium minutissimum (Kützing)	R	-	-
Achnanthidium pyrenaicum (Hustedt) H.Kobayasi	R	-	-
Amphora costata W.Smith	R	-	-
Anomoeoneis sphaerophoria (Kutzing) Pfitzer	-	R	R
Aulocoseira granulata (Ehrenberg) Simonsen	-	R	C
Caloneis bacillum (Grunow) Cleve	A	A	A
Cocconeis placentula Ehrenberg	A	A	A
Craticula ambigua (Ehrenberg)	P	-	P
Cyclotella meneghiniana Kützing	A	A	A
Cymbella affinis Kützing	A	A	A
Cymbella powainia Gandhi	C	C	C
Cymbella bengalensis Grunow	-	R	R
Cymbella gracilis (Rabenhorst) Cleve	-	R	R
Cymbella microcephala Grunow	R	-	-
Cymbella tumida (Brébisson) van Heurck	-	C	-
Eunotia arcus Ehrenberg	-	R	P
Fragilaria biceps (Kützing) Lange-Bertalot	-	C	P
Fragilaria ulna (Nitzsch) Lange-Bertalot	R	R	R
Fragilaria brevistriata Grunow	R	R	R
Fragilaria construens (Ehrenberg) Grunow	A	C	P
Fragilaria pinnata Ehrenberg	C	-	-
Fragilaria rumpens (Kützing) G.W.F.Carlson	-	-	C
Gomphonema affine (Kützing) A.Cleve	-	-	C
Gomphonema parvulum Kützing	-	C	C
Gomphonema spiculoides H.P. Gandhi	C	R	14
Gomphonema augur Ehrenberg	-	P	R
Gomphonema gracile Ehrenberg	R	P	P
Gomphonema hebridense W.Gregory	R	-	-
Gomphosphaeria aponina Wolle	-	R	R
Gyrosigma spenceri W.Smith	C	C	C
Mastogloia smithi Thwaites	-	R	R
Melosira granulata (Ehrenberg) Ralfs	R	-	-
Melosira granulata var. angustissima Otto Müller	R	R	-
Navicula rhynchocephala Kützing	C	-	C
Navicula halophila (Grunow) Cleve	R	R	0
Navicula rostrata Ehrenberg	-	-	C
Navicula symmetrica R.M.Patrick	A	A	C
Navicula tripunctata (O.F.Müller) Bory	R	-	-
Navicula veneta Kützing	-	R	A
Navicula bacillum Ehrenberg	R	-	-
Navicula gotlandica f. minor Cleve-Euler	C	R	P
Navicula gracilis Ehrenberg	C	R	P
Nitzschia frustulum (Kützing) Grunow	-	-	A

Nitzschia gracilis Hantzsch	A	-	-
Nitzschia palea (Kützing) W.Smith	A	-	-
Nitzschia sigma (Kutzing) W.M. Smith	C	-	-
Phormidium fragile Gomont	P	R	R
Pinnularia acrospheria Rabenhorst	R	C	-
Pinnularia gibba Ehrenberg	-	R	-
Pinnularia major (Kützing) Rabenhorst	-	A	C
Pinnularia stauroptera (Grunow) Rabenhorst	-	C	C
Pleurosigma elongatum W.M. Smith	-	P	P
Pleurosigma sp.	-	P	P
Pleurosira laevis (Ehrenberg) Compère	C	-	-
Stauronei sphoenicenteron (Nitzsch) Ehrenberg	-	P	P
Surirella ovata Kützing	-	P	P
Synedra acus Kützing	C	A	A
Synedra tabulata (C.Agardh) Kützing	A	-	A
Synedra ulna (Nitzsch) Ehrenberg	A	C	A
Tabularia fasciculate (Agardh) D.M. Williams & Round	-	-	P

Note: A- Abundant, C- Common, R- Rare and P- Present to minimum

The outcome of PCA during the study period is represented in fig 1 and 2 for physico- chemical parameters. Calcium, COD, TDS, TH, BOD, DO, pH and Phosphate shows highly positive correlation but CO_2, WT and turbidity shows negative correlation.

Figure 1: PCA analysis for physico- chemical parameters during the period January 2015 to December 2015

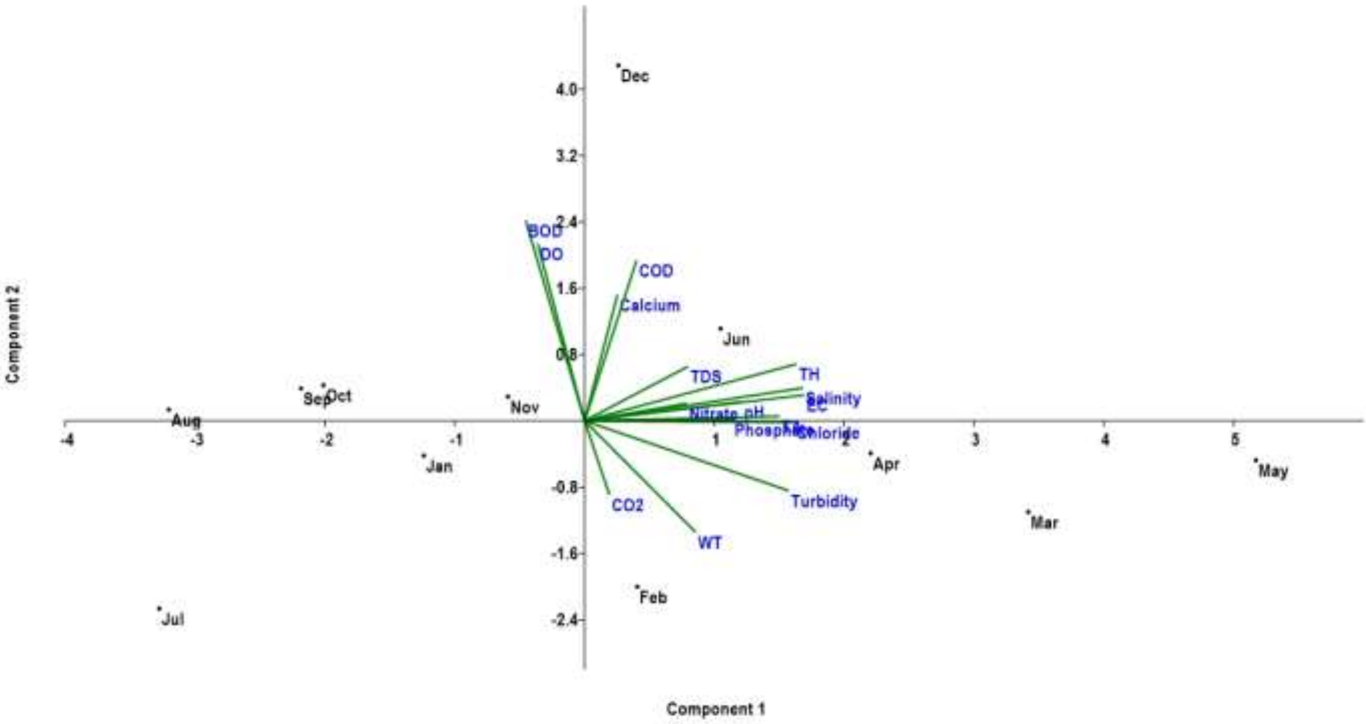
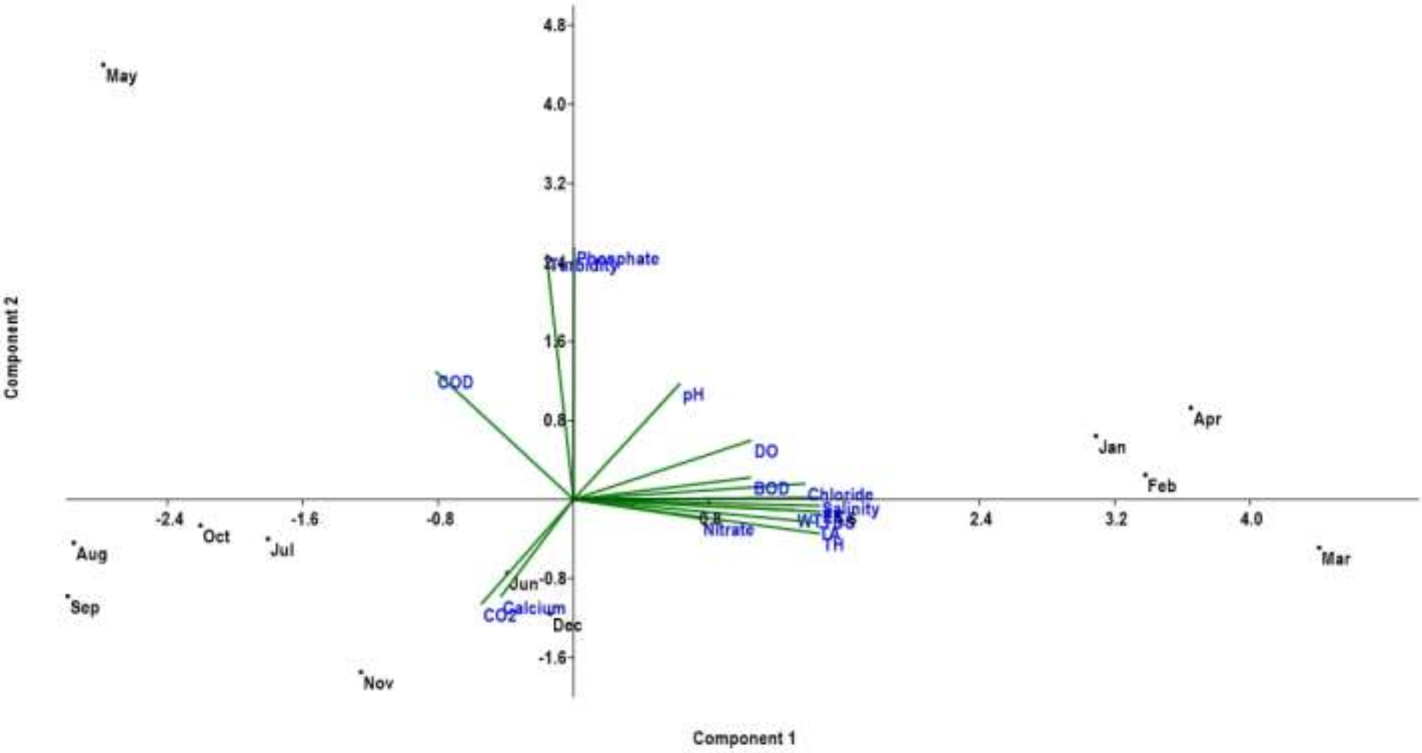


Figure 2: PCA analysis for physico- chemical parameters during the period January 2016 to December 2016



The outcome of Bray- Curtis cluster analysis during the period from January 2015 to December 2016 is represented in figure 3 and 4 for physico- chemical. The level of significance is taken to be 0.75 and above. In the first year the highly correlated clusters were those of DO, pH and BOD nearer to Y- axis. Another cluster formed which is nearer to Y- axis was calcium, water temperature, Chloride and COD which are highly correlated. The cluster of TH, TA, salinity and TDS showed high significance with each other but are far away from Y- axis. During 2016, the highly correlated clusters were those of DO and pH. Another cluster formed was calcium, water temperature, Chloride and BOD and are highly correlated. The cluster of TH, TA, and salinity showed high significance with each other but are far away from Y- axis.

Figure 3: Bray- Curtis analysis of physico- chemical parameters for the period January 2015 to December 2015

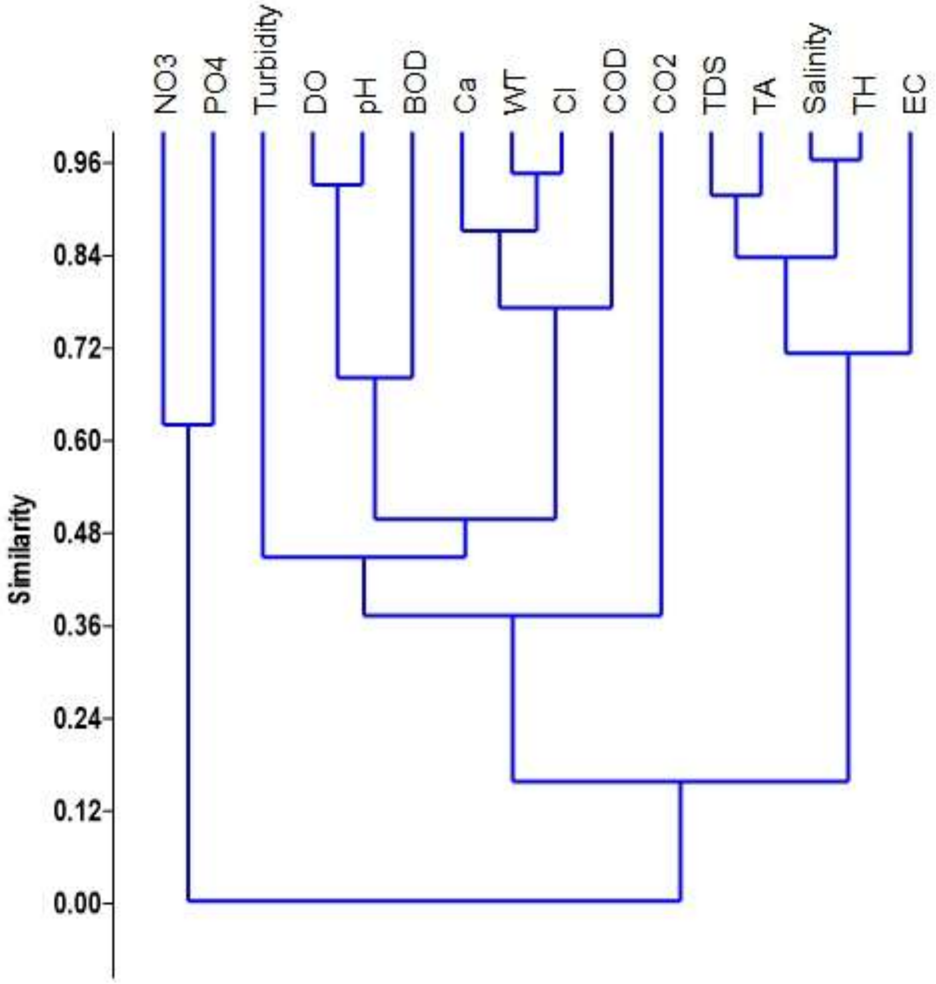
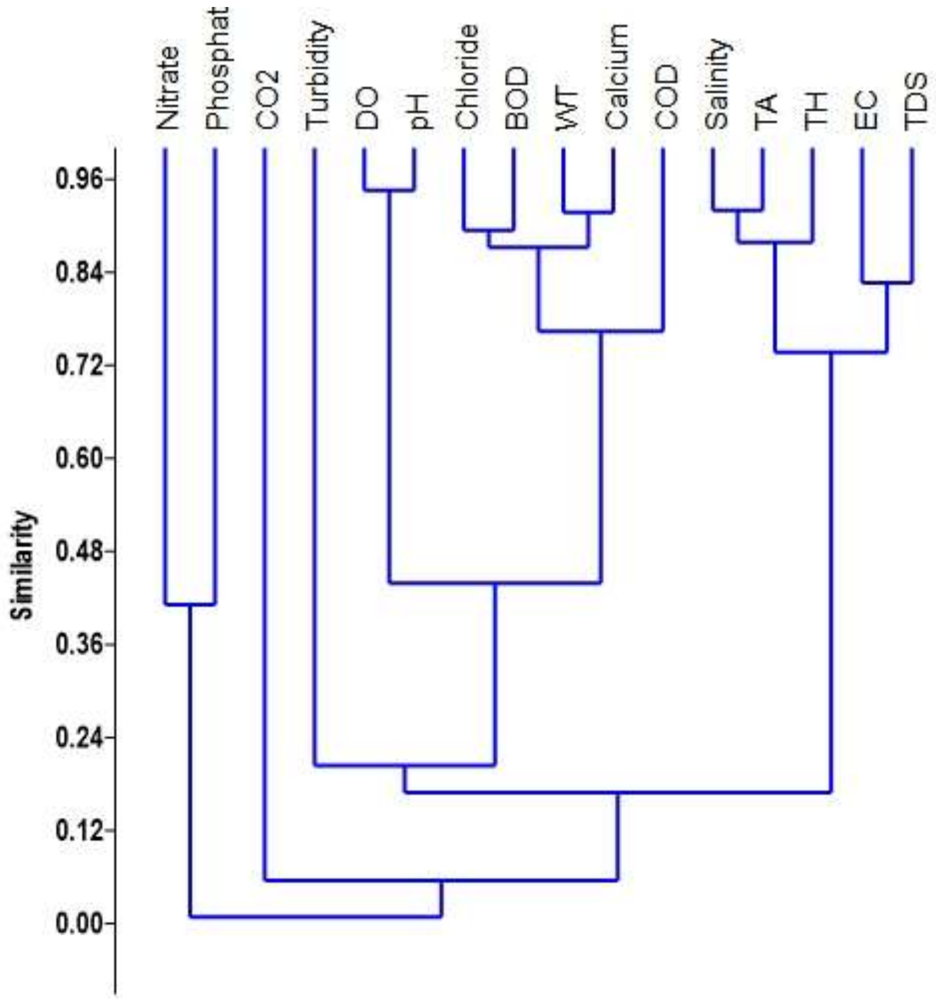


Figure 4: Bray- Curtis analysis of physico- chemical parameters for the period January 2016- December 2016



Discussion:

The outcome of physico- chemical analysis, PCA and Bray- Curtis analysis showed pH, DO, BOD, COD, TH, salinity, TA and EC are the parameters which influence the lake ecosystem. pH was high during summer season because it is controlled by the dissolved chemical compounds and biological processes in water (Chapman, 1996) and may be due to increased photosynthetic activity by phytoplankton and macrophytes as they demand more CO2 than quantities furnished by respiration and decomposition (Meenakshi Singh *et al*., 2011). The pH value indicated the alkaline nature of the water. The values of EC, Salinity and TDS are mainly depending on the concentration of dissolved salts in water. The variation in EC, salinity and TDS values were observed seasonally was mostly due to increase in the concentration of salts, because of evaporation (Trivedy *et al.,* 1989). Increase in electric conductance may be due to addition of pollutants (Tiwari *et al*, 2004). The highest value of TDS was observed during study might be due to anthropogenic activities which hindered the water quality (Senthilkumar and Sivakumar, 2008). TH during the study period was found to be high in summer months because hardness of water mainly depends on the concentration of calcium and magnesium. According to the study of Kaur *et al*. (1996), higher values of TH are probably due to the regular addition of large quantities of sewage and detergent in the water body from the nearby residential localities. The amount of calcium increases during summer season due to rapid oxidation/decomposition of organic matter (Billore, 1981). The amount of dissolved oxygen in water is a primary parameter in all pollution studies (Vijayan, 1991). During the study low value of DO was observed in lake during summer season it is mostly due to higher temperature and low solubility of oxygen in water (Singh *et al.,* 1991) and indicates the eutrophication nature of lake. Higher value of DO indicates oligotrophic nature of water and in those places there is good aquatic life. The COD is largely measured by the presence of various organic and inorganic materials like calcium, magnesium, potassium, sodium, nitrate etc. The observed COD values during the study were high indicating the polluted nature of water. Environmental variables like temperature, total alkalinity, dissolved oxygen, calcium, chloride, sodium, phosphorus, silica and COD had a profound effect on algal flora (Shaji and Patel, 1994). BOD measures the amount of oxygen required by the microbes in a water sample to degrade organic matter. BOD value is less than 2 mg/L for drinking water. If BOD value increases, it indicates polluted quality of water. During present investigation BOD values were observed high which implies that water quality is not good.

According to Raupp *et al*. (2009) the changes in diatom populations could be attributed to their nourishment at different environmental conditions. Similar observations were made during the studies. Study of diatom distribution indicates that, *Synedra acus* and *Synedra ulna* species were highest in density among the all species. Other members found in large number were *Nitzschia palea*, *N. frustulum*, *Cyclotella meneghiniana* and *Navicula* sp. after this *Fragilaria ulna*, *Gomphonema gracile*, *Cymbella affinis*, *Eunotia arcus*, *A. minutessima, Gomphonema sp*. and *Pinnularia gibba* were high in number. *Achnanthidium minutissimum* and *Cymbella affinis* are present especially in unpolluted areas because these taxa were sensitive to organic pollution (Nather Khan, 1990; Kelly, 1998; Kwandrans *et al*., 1998; Gomez and Licursi, 2001; Solak *et al*., 2005; Solak *et al*., 2007). *Navicula* sp., *Nitzschia* sp., *Cyclotella* sp. *Synedra* sp. and *Cymbella* sp. among others are the pollution indicating organisms. More number of *Nitzschia*, *Cyclotella meneghiniana* and *Navicula* were observed in which *Nitzschia* is pollution tolerant species (Barlas, 1988; Steinberg and Schiefele, 1988; Klee, 1991; Kelly 1998) while *Cyclotella meneghiniana* was recorded to be more dominant at pH of 7.7 to 7.9 and increased EC (> 900μs cm^{-1}). These ranges of pH and EC confirm the distribution of *Cyclotella meneghiniana* to extremely eutrophic water condition. *Cyclotella meneghiniana* is known to significantly correlate with alkalinity, phosphates and water hardness (Lacerda *et al.,* 2004). *Nitzschia palea, Gomphonema parvulum* and *Navicula sp.* are significantly correlated with electric conductance (Segura-García *et* *al*., 2012). Furthermore, *Cyclotella, Tabellaria* and *Achnanthes* were related to phosphate levels (Chia *et al*., 2011). During the investigation diatom species assemblage was more during summer followed by winter which indicates environmental variable such as pH, EC, WT, TA and organic matters influences the diatom assemblage in water bodies. Similar observation was also made by Negro *et al*. (2003) and Vercellino & Bicudo (2006). During this study, the values of physico- chemical parameters were observed high during summer and winter and variation in diatom diversity clearly depicting highest number of diatoms in summer followed by winter. Similar observations were also made by Dubey and Boswal (2009). The diatom numbers attain maximum during winter and summer months indicating the pollution condition of the lake (Nautiyal *et al*., 1996). In the present study the species richness was found to occur in similar trend across all the study sites and diatom count revealed that no much fluctuation during the investigation period.

Conclusion:

The results of physico- chemical and diatom assemblage along with statistical analysis indicated that the lake is threatened ecologically during the study period due to various anthropogenic activities which lead to organic pollution and eutrophication status. The Presence of diatom species like *Navicula halophila, Nitzschia palea, Navicula bacillum, Achnanthes hungarica. Navicula rhyncocephala, Synedra acus and Synedra ulna* indicates that the lake is heavily polluted. This indicates that, in lake organic pollution and anthropogenic eutrophication is high. Principal Component Analysis (PCA) helped to determine the most important or principal variable and Bray-Curtis similarity index shows the correlation between physico- chemical parameters. There was no much variation among the different sites of lake and each site had a slightly different set of principal components. It implies that the ecology of lake can be affected by environmental factors along with the geographical regions. As wetlands are rich in life, reservoirs for sewage disposal, maintenance of local ground water levels and as a refuge for local and migratory wildlife, it's our responsibility to conserve the lakes in sustainable manner. Knowing the ecological status of the lake, it will help for carrying out restoring practices of the same.

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