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Seasonal influence of physico - chemical parameters on Algal diversity of an urban lake in Hyderabad, India

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Abstract

Limnological studies of an urban lake, Nadimi Cheruvu, Hyderabad were carried out monthly over a period of two years. The present paper highlights seasonal variation between various physico-chemical parameters and their influence on algal diversity and distribution in this water body. During the study period, the algal flora fluctuated between 31,000 nos/L (in winter) - 70,300 nos/L (in summer) and phytoplankton diversity of the lake revealed the presence of 88 algal species that belongs to 41 genera. Chlorophyceae is the most dominant group while Euglenophyceae is least represented group. Chlorophyceans exhibited high multiplication in summers and low in winters. Cyanophyceaen minima occurred in monsoon and its maxima in summers. Dinophyceaen were recorded more in number during winter months and less during summer months. Bacillariophyceaens found to be maximum in summer and minimum in monsoon season in the first year and during winter season in the second year. Pearson's correlation analysis has been calculated to find out the relative importance between physico-chemical variables and phycoflora. Chlorophyceae and Bacillariophyceae exhibited a marked degree positive correlation with water temperature, pH, TH and calcium; Dinophyceae expressed a marked degree negative correlation with water temperature; Cyanophyceae displayed a moderate degree positive correlation with DO, COD, BOD, organic matter, phosphates, nitrates, silicates, magnesium, bicarbonates, carbonates, alkalinity and EC.

Keywords: Nadimi Cheruvu, Safilguda Lake, Limnological studies, Seasonal variation

1. Introduction

Algae, one amongst the diverse groups of living organisms are distributed in different types of water habitats. The phytoplankton community plays a key role in aquatic ecosystems and provides basic requirements such as carbon fixation, oxygen production and as food generation (Fathi et al. 2001; Khan 2003). Phytoplankton communities exhibit rapid succession shifts in response to environmental changes. The complex interaction between physical, chemical and biological factors in aquatic environment influences the diversity, dynamics and distribution of phytoplankton population (Smayda, 1980).

Phytoplankton community structure, composition and species diversity in aquatic ecosystem are determined by several limnological factors (Sin et al., 1999; Ghosh et. al., 2012). Phytoplankton follows a fairly recognizable annual cycle of growth, but sometimes the synchrony in their normal

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annual cycle is disrupted by the explosive growth of some species (Vaulot, 2001). The occurrence and abundance of diverse algae vary seasonally and their study provides a relevant focus for research on eutrophication of water bodies and its adverse impact on aquatic life (Pranita and Papiya, 2018).

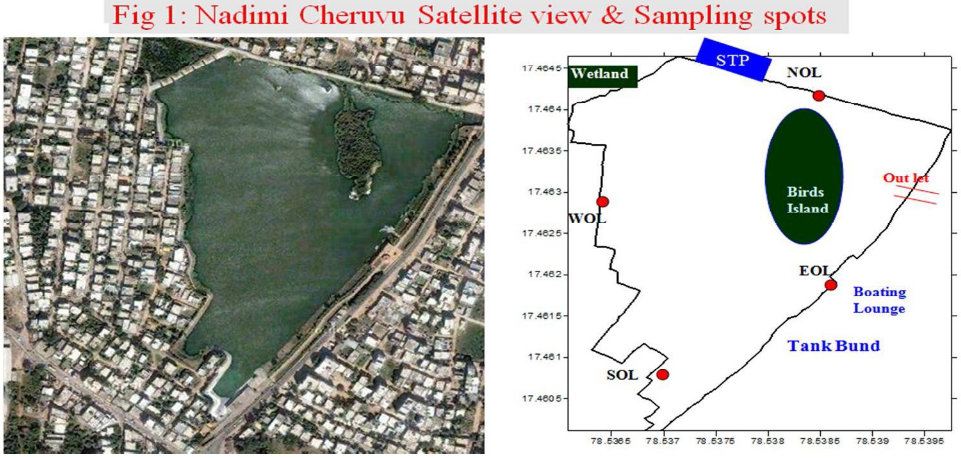
In India, many studies on the influence of physico-chemical factors on algal diversity of Freshwater bodies were carried by various scholars (Pruthi, 1933; Ganapati, 1960; Zafar, 1967; Mary Cynthia 1980; Venkateswarlu and Manikya Reddy, 1985; Hosmani et, al,.1999; Annie sheron, 2003; Kumawat and Jawale, 2004; Banakar et. al., 2005; Veereshakumar and Hosmani, 2006; Ruchira and Rachana, 2009)

The present investigation focuses on a comprehensive study of seasonal influence of various limnological variables on phytoplankton diversity, their species composition, population density and their distribution in an urban lake of Hyderabad. Further, The Pearson correlationcoefficient was used to establish the relationship among various environmental variables with phytoplankton density. The field work was spread over a period of two years from March 2004 to February 2006.

2.0 Materials and Methods

2.1 Study area: Founded in 1591 on the banks of the river Musi, the city of Hyderabad is located in the heart of the Deccan plateau at 1700 feet above sea level. The city is bestowed with enthralling topography and beautiful landscapes decked with amazing prehistoric formations and natural lakes. According to Census of India, 2011, it is the 4th populous city in India and a multitude of factors such as population growth, industrialization, construction activities put this city under continuous stress. Once known as ‘City of Lakes’ lost most of its water bodies to pollution and other human centric developmental activities.

Fig 1: Nadimi Cheruvu Satellite view & Sampling spots



The urban waterbody chosen for the present study is ‘Nadimi Cheruvu’ which is also known as ‘Safilguda Lake’ situated in Malkajgiri municipality of Hyderabad Metropolitan area and lies in the coordinates of 17.2730°N, 78.3220°E.

According to the state gazette the water spread area of the lake 50 years before was FTL of 537 Mts and spread over 3.95 square miles and was a good water source of irrigation and drinking. Due to the unprecedented population growth and industrialization in the last few decades the extent of water spread is reduced to 27.5 Acres (Annie Sheron, 2003). In 2001 this the lake was restored, Demarcated, dredged and fenced under 'Lake Conservation Programme' initiated by Hyderabad Urban Development Authority (HUDA). A sewerage treatment plant (STP) of capacity 0.6 MLD, has been constructed to treat the dry weather flow of sewage and it is functional since January' 2003.

2.3: Collection and analysis of samples : Water samples were collected for physico chemical and phycological analysis from these water bodies at monthly intervals for two years i.e. from February 2004 to January 2006. .

Samples were collected in plastic Jerry cans of two liters capacity at four different spots of the lake. All the samples were kept in the icebox and were brought to the laboratory for enumeration of quantitative and qualitative analysis. Parameters like Water temperature, pH, Electrical Conductivity (EC) and Dissolved Oxygen (DO) were recorded at the time of collection in the field itself by using YSI Environmental Field probes. Variables like Total solids (TS), Total Dissolved Solids (TDS), Total suspended Solids (TSS), alkalinity, Silicates, Nitrates, Phosphates, Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD) have been analysed using methods described by APHA (1998); Carbonates, Bicarbonates, Total Hardness, Organic Matter, Calcium, Magnesium, Chlorides were analysed by standard methods described by Wilcox and Hatcher (1950).

Qualitative and quantitative estimation of Phytoplanktonic algae was taken into consideration under phycological parameters. For algal studies, Surface water samples were collected in one liter sterilized clean high density polyethylene bottles and were kept in the sedimentation columns after adding 2-3 ml of Lugol's solution. The samples were set aside undisturbed for about 4 weeks for a complete setting of the organisms and finally the sample is concentrated to 100 ml. Detailed analyses of phytoplankton populations are done by estimating the numbers in each species. The algal samples were identified under the binocular compound microscope and counting was done by Drop count method (Trivedi and Goel, 1984). Motile algae was identified from fresh samples. Qualitative identification of phytoplankton forms up to species level was done with the help of monographs (Desikachary, 1959; Suxena and Venkateswarlu, 1966; Phillipose, 1967; Anand, 1998 and Rai, 2006).

3.0 Results and Discussion:

3.1 Physico chemical parameters

Results of the physico- chemical analysis of lake water collected are represented in Tables 1 & 2. For the convenience of discussion, three seasons viz. Summer, Monsoon and Winter are considered to compute the water quality trends in two years of study. Monthly Variations in Physico-Chemical Parameters at Nadimi Cheruvu were represented in Fig. 1.

Throughout the study period the colour of the Safilguda Lake water was found to be light greenish in colour but during the summers it was found to be green in colour emitting algal odour. The water temperature ranged between 21.6^{0}C (Jan, 2006) - 32.6^{0}C (May 2004) with a mean temperature of 26.5^{0}C. Seasonally, water temperature has been recorded high during the summer (28.9^{0}C) and low during winter (23.3^{0}C). Increase in water temperature during summer and decrease during winter seasons were reported by many authors (Sakhre and Joshi, 2003 and Garg *et al.,* 2009). pH of the lake water was always alkaline in nature, ranging from a maximum of 10.9 against a minimum of 7.27 with an average of 8.7. Season wise, pH was more in summers followed by monsoon and less in winter.

EC was recorded maximum in summer (1540.8 mhos/cm) and minimum in winter (1286 mhos/cm). Low average turbidity values were recorded during monsoon (45.8 NTU) and high in summer (57.4 NTU). Summer maxima of EC and turbidity could be due to decomposition of organic matter, decrease in water level due to evaporation. The results are in agreement with the findings of Sulabha and Prakasham (2006). Alkalinity ranged between 72 mg/L - 360 mg/L and season wise, the average total alkalinity was found to be high during summer (221 mg/L) and low in monsoon (135 mg/L) which can be attributed to low water level and high evaporation in lake water. Similar results were reported by Sakhre and Joshi (2003)

Total hardness was recorded low in monsoon (209 mg/L) and high in summer (300 mg/L). Carbonates were observed in lower concentrations when compared to bicarbonates. TSS and TDS was optimum in rainy season and minimum in winter. This indicates that the dissolved materials were of allochthonous in origin which were brought into the lake with surface run off and leaching of bund soil. Similar opinion has been expressed by Hosmani et, al, (1999) and Narain and Chauhan (2002). High amounts of calcium recorded in summer (231mg/L) and low amounts in monsoon (149.6mg/L). Magnesium content was more in summer (68.9 mg/L) and less in monsoon (59.1mg/L). During the entire period of study Magnesium was observed always lower than calcium concentration and calcium richness of the water could be attributed to the high concentrations of bicarbonates and it is in conformity with the investigations of Janardhan Rao (1982) and Unni et al., (1992).

Low Chlorides and Silicates concentration is recorded in monsoon (83 & 40 mg/L) and Chlorides concentration is more in summer (123mg/L) where as Silicates in winter (56.8 mg/L). Nitrates and Phosphates were found in low concentration in the range of 0.41mg/ L - 2.8 mg/ L and 0.65 mg/ L – 4.58 mg/ L. It may be due reduced load of these nutrients as the water is treated by the sewerage treatment plant before letting into the lake.

Lake water was well aerated. High concentration of DO was noticed throughout the period of investigation and it never reached less than 9.1 mg/L and it was always higher than organic matter. The free CO2 was found to be high during winter (13 mg/L) and low during summer (8.1 mg/L). BOD & COD found to be high in summer (32.9 mg/L & 85 mg/L) and low during winter (24.3 mg/L & 76.5 mg/L). Singh et. al.,(1999) and Banakar (2006) who concluded that high temperatures enhances the biological activities resulting in the increase of BOD.

Concentration of EC, TS, TDS, alkalinity, carbonates, bicarbonates, Mg, Chlorides, Silicates, Nitrates, Phosphates, BOD and COD has increased from 1st year to 2nd year of study period.

3.2 Phycoflora During the study period, the algal flora fluctuated between 31,000 nos/L (in winter) - 70,300 nos/L (in summer) and phytoplankton diversity of the lake revealed the presence of 88 algal species that belongs to 41 genera and the order of dominance of various algal groups was Chlorophyceae > Cyanophyceae> Bacillariophyceae> Dinophyceae> Euglenophyceae that occupied a portion of 57%, 25.2%, 12.7%, 4.7%, and 0.4% respectively in the total phytoplankton bulk. Algal species recorded during the study period were listed in table 3 and Monthly variation in algal flora is represented in Fig. 2.

Chlorophyceae was observed as a stable and dominant algal community (38 species belonging to 20 genera) and seasonally, it exhibited high multiplication in summers and low in winters. It is represented by the members belong to order Volvocales, Chlorococcales and Desmids. Volvocales multiplied profusely during monsoon and meagrely during winter and is predominantly represented, *Chlorogonium, Gloeocystis and Pandorina*. Chlorococcales multiplied copiously in summers and formed a peak in May of both the years of study period. Similar findings was made by Kumawat and Jawale (2004). Desmids started multiplying during January and February months and reached a peak towards April and their populace low during November and December months. *Staurastrum* species were found to be more in number during monsoon.

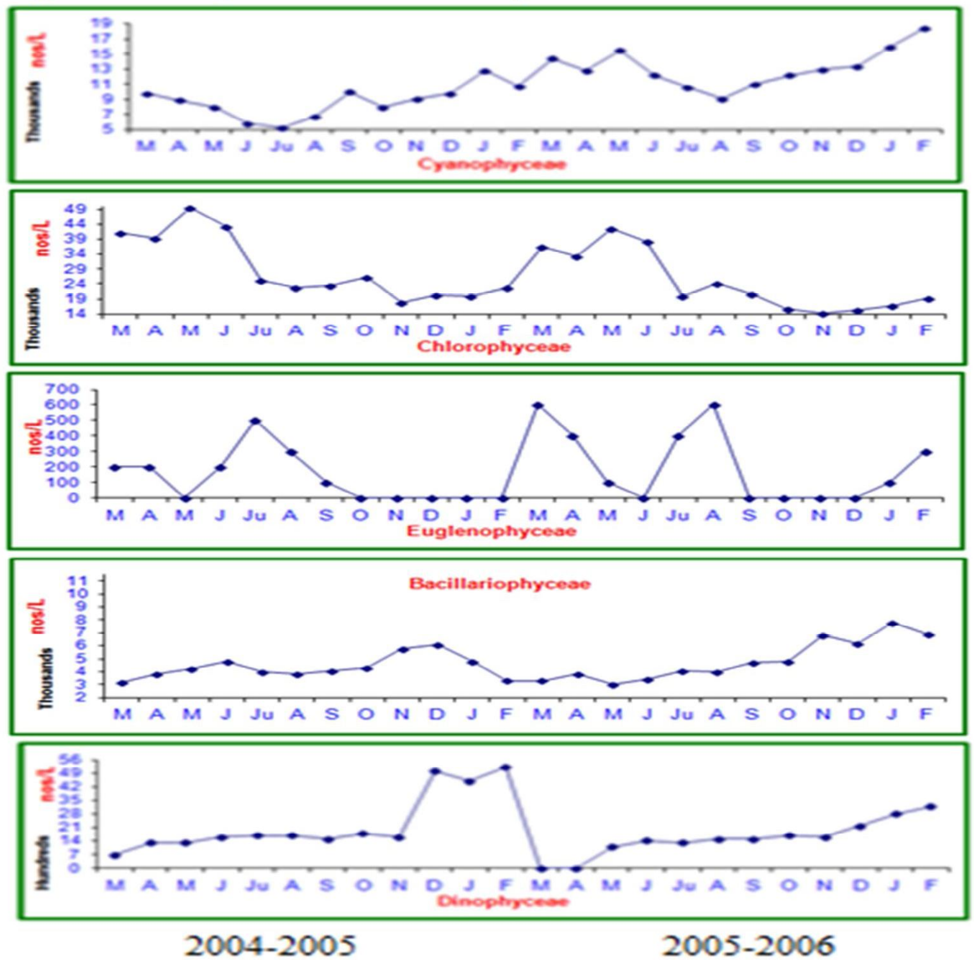
Cyanophyceae is represented by 9 genera and 18 species and exhibited a well-marked periodicity by showing a winter peak that extended to early summer with a distinct monsoon peak. The summers were dominated by *Oscillatoria curviceps, Merismopedia glauca*.

Bacillariophyceans were fairly represented (11 genera and 27 species) and their number is maximum in summer and minimum in monsoon season of the first year and winter season of the second year.

Euglenophyceae is the least represented group (4 species belonging to 2 genera). Euglenophyceaens number is more in monsoon and they are not recorded in the 1st year winter season and their presence in the 2nd year winter is very low.

Dinophyceae is represented by 2 genera and 4 species and seasonally, they were recorded more in number during winter months and less during summer months. *Glenodinium* spp. multiplied and found a peak in monsoon and *Ceratium* sp. was observed in winters in few numbers when water temperatures dropped to 20^0C - 21^0C

Fig.2: Monthly Variations in Phycoflora at Nadimi Cheruvu



3.3 Influence of physicochemical parameters on phytoplankton distribution

The water temperature plays an important role in controlling the occurrence and abundance of phytoplankton. Summers showed maximum algal density and Minimum density of phytoflora was recorded during monsoon and it was due to low pH, low DO, turbid water similar observations were made by Kumawat and Jawale (2004) and Banakar, (2006).

High temperature, bright sunshine, slight alkaline pH, low calcium and low organic matter concentration appears to favour the abundance of desmids. Zafar (1967) indicated that calcium enrichment of water results in the general paucity of desmid population. Similar trend was observed in the present study where less calcium concentration (182mg/L) supported good desmid population.

Warm temperatures, total hardness supported luxuriant growth of Cyanophyceans. This is in conformity with the findings of Banakar et al. 2005 and Veereshakumar and Hosmani, 2006.

It is difficult to assess the periodicity of Euglenoids because some species appear abruptly, sometimes almost instantly and sometimes remain unseen from the surface water for long duration.

Silicate content fluctuated very effectively with the growth pulse of diatoms. The peak values in silicates were followed by diatom peak. This clearly indicates that pH above 9.0 is unfavourable for silica to dissolve in lake water. This is in conformity with the findings of Ruchira and Rachana (2009). Phosphate rich waters and high DO concentration supported luxuriant growth of diatoms. Venkateswarlu and Manikya Reddy (1985) and Banakar et. al. (2005) have also made similar findings.

Dinophyceans preferred low temperature, low organic matter, non-turbid conditions with low electrical conductivity and high DO concentrations. This is in conformity with the findings of Mary Cynthia (1980).

3.4 Correlation Studies

Pearson's correlation analysis has been calculated to find out the relative importance between various physico-chemical variables, between phycoflora and between physico-chemical variables and phycoflora

<u>3. 4a Correlation between physico-chemical parameters:</u> The water temperature revealed marked degree positive correlation with pH and a marked degree negative correlation with DO; pH exhibited a marked degree positive correlation with carbonates and total hardness; EC showed a marked degree positive correlation with COD, BOD and free CO_2; TS and TDS expressed a high positive correlation with each other; Carbonates expressed a marked degree positive correlation with EC, pH and BOD; Total hardness and calcium displayed a high degree of positive correlation; Nitrates expressed marked degree positive correlation with COD; DO expressed a high negative correlation with water temperature; COD and BOD showed a high degree positive correlation with each other, a marked degree positive correlation with EC.

<u>3. 4b Correlation between physico-chemical parameters and phycoflora:</u> Chlorophyceae and Bacillariophyceae exhibited a marked degree positive correlation with water temperature, pH, TH and calcium; With DO Chlorophyceae showed a marked degree negative correlation; Dinophyceae expressed a marked degree negative correlation with water temperature; Cyanophyceae displayed a moderate degree positive correlation with DO, COD, BOD, organic matter, phosphates, nitrates, silicates, magnesium, bicarbonates, carbonates, alkalinity and EC.

<u>3.4c Correlation between phycoflora:</u> Chlorophyceae and Bacillariophyceae exhibited high positive correlation where as Chlorophyceae and Cyanophyceae exhibited a low degree negative correlation. With Chlorophyceae and Euglenophyceae, Dinophyceae displayed a moderate degree negative correlation and with Bacillariophyceae it expressed a low degree negative correlation.

The present study affirms that plaktonic diversity and distribution can be best explained when environmental factors jointly influence. It can be concluded that the seasonal changes in the physico chemical factors either directly or indirectly influence the algal diversity.

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Table 1: Physico-chemical parameters of Nadimi Cheruvu (March '04 - February '05)

S.No	PARAMETERS	Mar-04	Apr-04	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05	Feb-05	Avg
1.	Water Temp. (°C)	25.4	28.6	32.6	28.6	28.1	28	28.2	26.1	25.2	22.5	24	24.4	26.8
2.	pH	8.4	8.9	10.1	9.8	8.2	8.61	8.8	8.2	7.38	7.9	7.27	8.4	8.5
3.	Turbidity (NTU)	47.8	42	52	65.1	73	39.2	33	25	60	57.5	42	52.7	49.1
4.	EC (mhos/cm)	1204	1213	1609	1348	1224	1035	932	1067	920	1002	908	1012	1122.8
5.	TS	734	647	776	953	900	990	849	915	755	789	850	903	838.4
6.	TDS	633	616	722	876	817	925	784	827	742	756	765	846	775.8
7.	TSS	101	31	54	77	83	100	65	88	13	33	85	57	65.6
8.	Alkalinity	266	260	183	75	97	214	113.5	183	169	149	72	100	156.8
9.	Carbonates	16	22	24	12	0	0	22	26	0	0	0	16.2	11.5
10.	Bicarbonates	178	143	125	63	70	141	70	114	70	64	170	80	107.3
11.	Total Hardness	240	252	352	344	200	180	180	240	266	244	210	216	243.7
12.	Calcium	190	208	288	256	156	129	120	177	200	200	136	174	186.2
13.	Magnesium	50	44	64	88	44	51	60	63	66	44	74	42	57.5
14.	Chlorides	161	112	152	127	75	67	63	72	108	88	100	95	101.7
15.	Silicates	40	60	72	36	24	20	32	28	40	52	62	56	43.5
16.	Nitrates	0.41	1.1	1.6	0.54	0.41	0.42	1.08	0.61	1.58	0.72	1.3	2.2	1.0
17.	Phosphates	0.65	0.9	0.83	1.1	0.65	0.98	0.65	0.68	1.08	1.11	3.48	4.58	1.4
18.	DO	8.1	7.8	5.2	6.8	8.8	8.1	8.4	8.1	9.2	11.8	10.6	10.8	8.6
19.	Free CO_2	10.6	3.8	6.2	8	12	6	6	10	10	12.8	14	12	9.3
20.	Organic Matter	2.25	3	4.8	2.4	1.2	2.1	2	1.7	2	2.8	1.5	2.8	2.4
21.	COD	34	46	54	60	38	50	48	55	62	42	80	80	54.1
22.	BOD	18	16	22	30	14	18	20	19	20	12	32	28	20.8

All the parameters from 5 – 22 are in mg/L

Table 2: Physico-chemical parameters of Nadimi Cheruvu (March '05 - February '06)

S.No	PARAMETERS	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05	Sep-05	Oct-05	Nov-05	Dec-05	Jan-06	Feb-06	Avg
1.	Water Temp. (°C)	27.3	28.4	31.4	28.7	27.7	27.2	28	25.4	24.5	22.3	21.6	22	26.2
2.	pH	10.1	10.4	10.9	9.1	8.5	8.62	8.46	8.2	8.12	7.9	7.57	8.4	8.9
3.	Turbidity (NTU)	67.3	80.6	48	56	44.2	48.3	46	58	67	41.5	49.3	58.9	55.4
4.	EC (mhos/cm)	1734	1762	1789	1667	1780	1620	1724	1688	1431	1560	1440	2013	1684.0
5.	TS	973	850	981	1100	1225	1123	1032	978	806	814	872	897	970.9
6.	TDS	899	785	903	1000	1126	1008	925	903	713	727	785	800	881.2
7.	TSS	74	65	78	100	109	115	107	85	93	87	87	97	91.4
8.	Alkalinity	250	290	360	87	90	81	115	183	189	149	183	240	184.8
9.	Carbonates	40	54	28	32	18	14	28	22	28	0	12.4	37.8	26.2
10.	Bicarbonates	250	179.6	131	64.3	64	73	86.3	91.7	92	108	160	182	123.5
11.	Total Hardness	228	280	380	320	200	200	270	200	200	180	270	230	246.5
12.	Calcium	156	218	280	249	120	138	228	129	148	132	212	132	178.5
13.	Magnesium	72	62	100	71	80	62	42	71	52	48	58	98	68.0
14.	Chlorides	98	100	103	134	120	70	98	100	107	125	130	142	110.6
15.	Silicates	30	68	72	52	52	58	46	60	62	68	68	46	56.8
16.	Nitrates	0.9	3.5	2.1	2.2	2.2	0.44	2.8	2.1	2	1.56	1.28	2	1.9
17.	Phosphates	2.86	2.55	2.48	3.3	2.17	1.87	1.91	1.55	1.86	1.72	2.03	2.24	2.2
18.	DO	9.6	9.6	8.2	7.1	8.7	8.6	8.4	8.8	10.1	11	14	11	9.6
19.	Free CO_2	4	8	10	14	10	6	12	6.8	8.4	18	13.2	15.2	10.5
20.	Organic Matter	3.2	2.8	3.8	2.8	2.8	1.9	2	2.6	3.8	3	3.4	3.5	3.0
21.	COD	116	158	120	92	112	122	100	130	88	100	60	100	108.2
22.	BOD	42	62	48	25	30	38	30	30	22	30	22	32	34.3

All the parameters from 5 – 26 are in mg/L

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Table 3: List of Algal species recorded in Nadimi Cheruvu during study period

Cyanophyceae		31	*Dictyosphaerium ehrenbergianum*	60	*Achnanthes exigua*
1	*Aphanocapsa grevillei*	32	*Kirchneriella lunaris*	61	*Achnanthes inflata*
2	*Coelosphaerium kuetzingianum*	33	*Schroederia setigera*	62	*Achnanthes microcephala*
3	*Merismopedia glauca*	34	*Tetraedron caudatum*	63	*Achnanthes minutissima*
4	*Merismopedia punctata*	35	*Tetraedron hastatam*	64	*Navicula cryptocephala*
5	*Merismopedia tenuissima*	36	*Tetradron incus*	65	*Navicula cuspidata*
6	*Gloeocapsa coracina*	37	*Tetraedron limneticum*	66	*Navicula pupula*
7	*Microcystis aeruginosa*	38	*Tetraedron minimum*	67	*Navicula hustedtii*
8	*Microcystis flos- aquae*	39	*Tetraedron muticum*	68	*Navicula rhynchocephala*
9	*Chrococcus elegans*	40	*Tetraedron trigonum*	69	*Gyrosigma kutzingii*
10	*Chrococcus minimus*	41	*Tetraedron tumidulum*	70	*Gomphonema accuminatum*
11	*Chroococcus minutus*	42	*Crucigenia irregularis*	71	*Gomphonema gracile*
12	*Chroococcus turgidus*	43	*Crucigenia rectangularis*	72	*Amphora ovalis*
13	*Lyngbya spiralis*	44	*Scenedesmus acuminatus*	73	*Amphora veneta*
14	*Oscillatoria curviceps*	45	*Scenedesmus bijuga*	74	*Cymbella affinis*
15	*Oscillatoria formosa*	46	*Scenedesmus dimorphus*	75	*Cymbella aspera*
16	*Oscillatoria limnetica*	47	*Cosmarium contractum*	76	*Cymbella cuspidata*
17	*Oscillatoria princeps*	48	*Cosmarium lundelli*	77	*Cymbella cymbiformis*
18	*Nostoc verrucosum*	49	*Cosmarium tumidum*	78	*Cymbella tumida*
	Total - 18	50	*Staurastrum javanicum*	79	*Cymbella turgida*
Chlorophyceae		51	*Staurastrum paradoxum*	80	*Rhopalodia gibba*
19	*Pandorina morum*	52	*Staurastrum tetracerum*	81	*Nitschizia acicularis*
20	*Chlorogonium elongatum*	53	*Euastrum didelta*	82	*Nitschizia acuminata*
21	*Gloeocystis gigus*		**Total - 35**	83	*Nitschizia obtusa*
22	*Ulothrix subtilissima*	**Euglenophyceae**		84	*Hantzschia amphioxys*
23	*Chlorococcum humicola*	54	*Lepocinclus ovum*		**Total - 27**
24	*Characium falcatum*	55	*Lepocinclis sphagnicola*	**Dinophyceae**	
25	*Pediastrum boryanum*	56	*Trachelomonas armata*	85	*Glenodinium gymnodinium*
26	*Pediastrum duplex*	57	*Trachelomonas volvocina*	86	*Glenodinium palustre*
27	*Pediastrum ovatum*		**Total - 04**	87	*Glenodinium cinctum*
28	*Pediastrum simplex*	**Bacillariophyceae**		88	*Ceratium hirundinella*
29	*Pediastrum tetras*	58	*Fragilaria vaucheriae*		**Total - 04**
30	*Ankistrodesmus falcatus*	59	*Cocconeis placentula*		

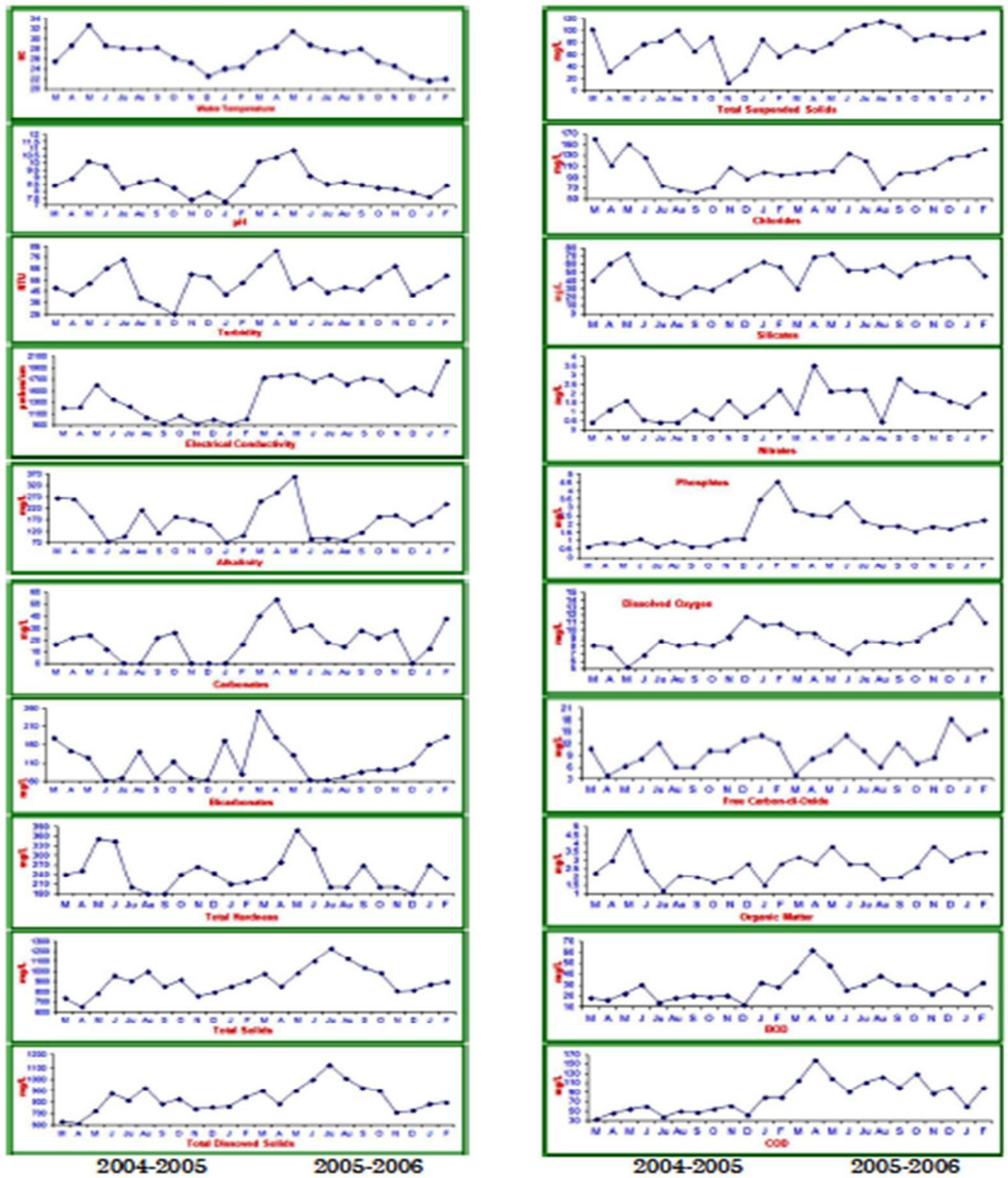

Fig.1: Monthly Variations in Physico-Chemical Parameters at Nadimi Cheruvu