Available online at http://www.journalcra.com

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

International Journal of Current Research
Vol. 4, Issue, 05, pp.047-051, May, 2012

ISSN: 0975-833X

RESEARCH ARTICLE

AN ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES AND PHYTOPLANKTON DENSITY OF TILYAR LAKE, ROHTAK (HARYANA)

Ajit Singh and J.S. Laura*

Department of Environmental Sciences, M.D. University, Rohtak (Haryana)

ARTICLE INFO

Article History:
Received 17th February, 2012
Received in revised form
19th March, 2012
Accepted 24th April, 2012
Published online 30th May, 2012

Key words:
Aquatic ecosystem,
Phytoplankton density,
Primary productivity and physico-chemical parameters,
Tilyar Lake.

ABSTRACT

Physico-chemical properties and phytoplankton density was estimated in Tilyar Lake (28º 52' 52.77" N and 76º 38' 12.05" E.), Rohtak (Haryana) India. Different water quality parameters (pH, Temperature, DO, BOD, COD, Total Alkalinity, Total Hardness, Calcium Hardness, Magnesium Hardness, Acidity, CO_2, TDS, TSS, Chloride, Total Kjeldal Nitrogen, Sulphate, phosphate, Net Primary Productivity and Phytoplankton Density) were estimated form January 2010 to December 2010 from three sampling stations sited in lake. The physico-chemical parameters have exhibited considerable variation during the study as pH (8.75-9.24), Temperature (13.50-32.67°C), DO (1.80-5.13), BOD (0.73-2.10), COD (18.47-62.67 mg/l), Total Alkalinity (85.33-106.67 mg/l), Total Hardness (84-104.67 mg/l), Calcium Harness (58.20-72.47 mg/l), Magnesium Hardness (5.69-8.94 mg/l), Acidity (1.80-6.67 mg/l), Free CO_2 (0-3.93 mg/l), Chloride (10.37-20.87 mg/l), TDS (99.33-122.33 mg/l), TSS (28.67-60.67 mg/l), TKN (70.17-95 mg/l), Sulphate (0.95-1.55 mg/l), Phosphate (0.02-0.10 mg/l), Primary Productivity (2.13-3.70 mg/l) and Phytoplankton Density (36-68 mg/l). Due to low dissolved oxygen concentration and low primary productivity the ecological balance in the lake was observed very fragile. Statistically phytoplankton density was found significantly correlated with pH, magnesium hardness and total nitrogen (P= 0.05) and with total alkalinity, total hardness, calcium hardness, total dissolved solids and net primary productivity (P= 0.01).

INTRODUCTION

Lakes are dynamic inland aquatic systems that support and maintain a balanced adaptive community of organisms having diverse species composition, and the functional organization of all organisms sustaining a unique biotic integrity. Study of lakes provides the tools necessary for understanding the functioning of aquatic ecosystem without significant human influence, and the limited range of human activities affecting those (Mathew *et al*., 2007). Lakes are the major life supporting systems facing ecological degradation today due to increasing deforestation, intensification of chemical based agriculture, industrial and domestic sewage runoff and unscientific and less modified fish culture (Chaurasia and Pandey, 2007). These undesirable activities and unscientific utilization are causing undesirable environmental problems like eutrofication, silt landing, changing in physicochemical characteristics, and thus threatening the biodiversity (Sudhira and Kumar, 2000). Phytoplanktons are bottom level organisms in a food chain and have a significant relationship with other living organisms at upper level in aquatic ecosystem. Phytoplankton productivity and density are the main sources for biogenic development upon which all higher trophic level depends (Vannote *et al*., 1980; Allan, 1995; Allan and Castillo, 2007). The most characteristic criterion to assess the trophic structure of an ecosystem remains to be the primary productivity. The estimation of phytoplankton density and productivity are very important factors to determine the ecological health of an ecosystem. Aquatic life is largely governed by physicochemical characteristics and their stability. Phytoplanktons are very sensitive community which is the first target of water pollution, thus any undesirable change in aquatic ecosystem effect diversity and density of the community (Sharma *et al*., 2009). Evaluation of phytoplankton primary productivity and density provide a valuable approach for characterizing natural and altered aquatic ecosystem. Physicochemical parameters, phytoplankton density and primary productivity of Tilyar Lake were assessed during the study period. It is situated 5 km away from Rohtak city, on Rohtak-Delhi road. It is geographically located on the latitude of 28º 52' 52.77" N and longitude of 76º 38' 12.05" E. Tilyar Lake is of crucial importance from the point of native and immigrant birds and conserves a very wide range of biodiversity. It harbors a large number of bird species, plant species and a wide diversity of micro flora and fauna. It is having an area of 132 acres and has three small islands (Fig 1). The lake serves as a recreational facility and is visited by a very large number of tourists. The study was undertaken for characterizing Tilyar Lake.

***Corresponding author:** jslmdu@gmail.com

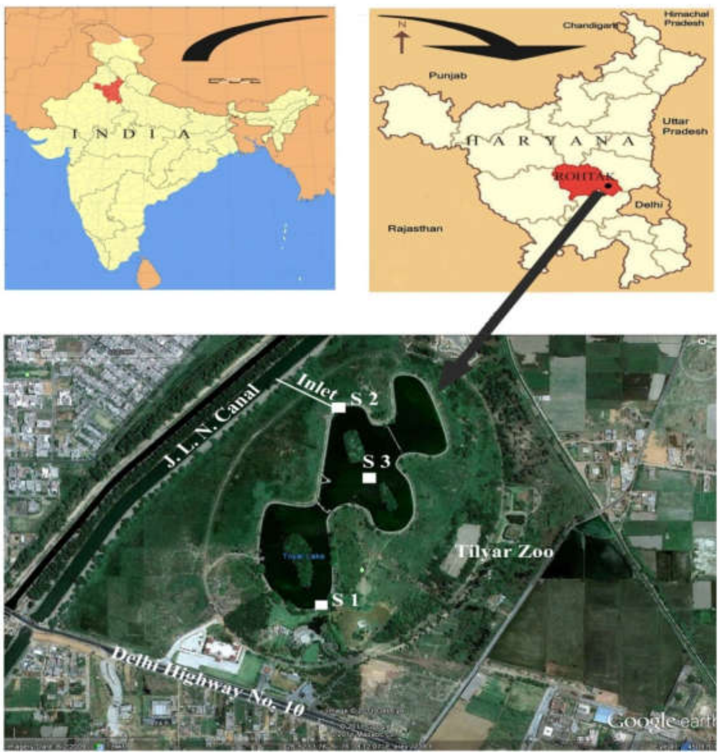
MATERIALS AND METHODS

The lake was sampled from January 2010 to December 2010. Three sampling sites were established, S1 (shore of the lake), S2 (water inlet of the lake) and S3 (middle of the lake) (Fig.1). The samples were collected monthly from a depth of one foot using plastic cans of three liters. The sample collection was done between 8:00 and 10:00 am. Different water quality parameters (pH, temperature, Dissolved oxygen, BOD, COD, total alkalinity, total hardness, calcium hardness, magnesium hardness, acidity, CO_2, chloride, TDS, TSS, TKN, sulphate, phosphate, Net Primary Productivity) were analyzed by following the standard methods of (APHA, 1995). The onsite measurement of pH, temperature and fixation of DO measurement was carried out on sampling time. DO measurement was carried out by Modified Winkler's Method and Net Primary Productivity by light-dark bottle technique.
Samples for phytoplankton cell density were fixed with acidified formaldehyde solution (1:1 ratio of 20% formaldehyde and 50% glacial acetic acid solution). Phytoplankton cell density was analyzed by Haemocytometer counting chamber method (APHA, 1995).

Statistical Analysis

The interrelationships between physicochemical parameters and phytoplankton cell density were examined, using Pearson correlation coefficient. The significance of the correlation coefficient, mean value, standard deviation and standard error was computed with SPSS 16.0 software.

Fig. 1. Geographical location of Tilyar lake



RESULT AND DISCUSSION

Physicochemical Parameters

The mean concentration of the main chemical and biological variables in the Tilyar Lake basin is shown in Table 1. At all the three sampling sites all the parameters were found nearly same but they show a significant seasonal variation throughout the study period of one year. The mean value of pH was estimated 9.04, showing the alkaline nature of the lake water. Maximum pH 9.24 was observed in the month of March and minimum pH 8.75 in the month of September (Fig 2). pH favors the phytoplankton growth and significantly correlated with phytoplankton cell density (r= 0.656, P= 0.05). Temperature is basically important for its effect on certain chemical and biological reaction taking place in water and aquatic organisms (Saksena *et al*., 2008). The mean value of water body temperature observed was 24.78°C. Water temperature showed its maximum (32.67°C) and minimum (13.5°C) values in the month of July and January respectively (Fig. 2). Dissolved oxygen is a regulator of metabolic activities of organism and thus governs metabolism of the biological as a whole and also acts as an indicator of trophic status of water body. DO is generally reduced due to respiration, decomposition of organic matter, temperature rise, oxygen demanding wastes and inorganic reductants such as H_2S, NH_3, NO_2^- etc (Saksena *et al*., 2008). The mean value of dissolved oxygen was estimated to be 3.02 mg/l with maximum (5.13 mg/l) and minimum (1.80 mg/l) values in December and July respectively (Fig 2). DO concentration was found much low which is harmful for aquatic life. DO showed a negative correlation with temperature (r= -0.273) (Table 2) and a close relationship with temperature pattern as dissolution of gases decrease with increase in temperature (Lourantou *et al*., 2007).

The mean concentration of BOD found to be 1.44 mg/l, fluctuating between 0.73-2.1 mg/l, with maximum in December and minimum in April (Fig 2). Mean COD concentration was 32.51 mg/l showing a high peak in July (62.67 mg/l) and lower peak in April (18.47 mg/l) (Fig 3). The

Fig. 2. Seasonal variation in pH, Temperature, Dissolved Oxygen and Biological Oxygen Demand in Tilyar Lake.

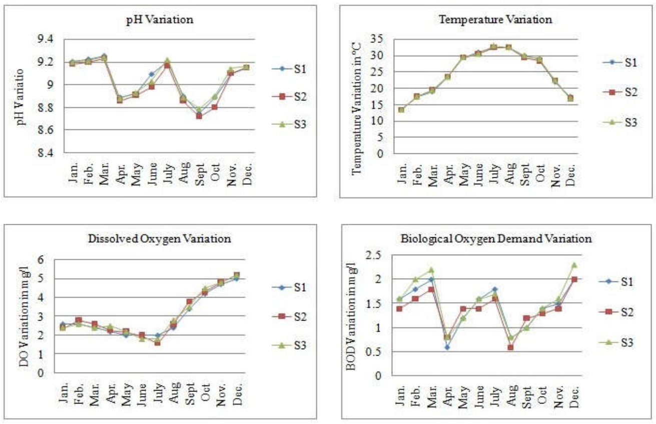


Fig. 3. Seasonal variation in COD, total alkalinity, total hardness and calcium hardness in Tilyar Lake

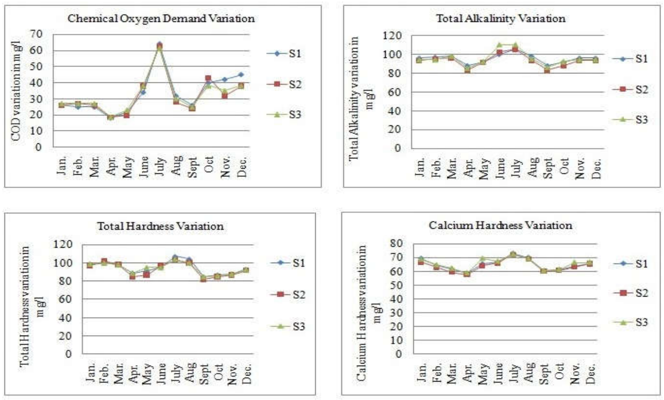


Fig. 4. Variation in Magnesium hardness, Acidity, CO_2 and chloride in Tilyar Lake.

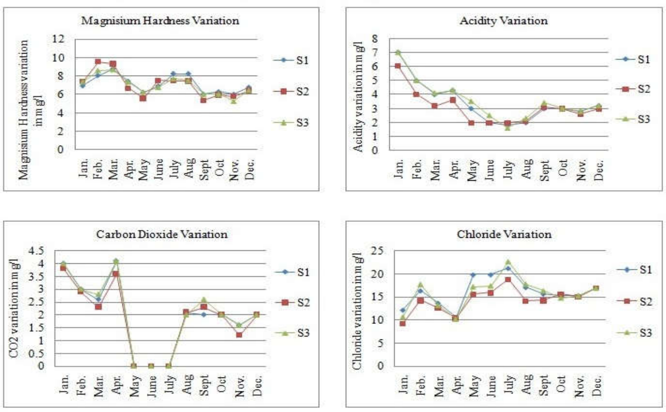
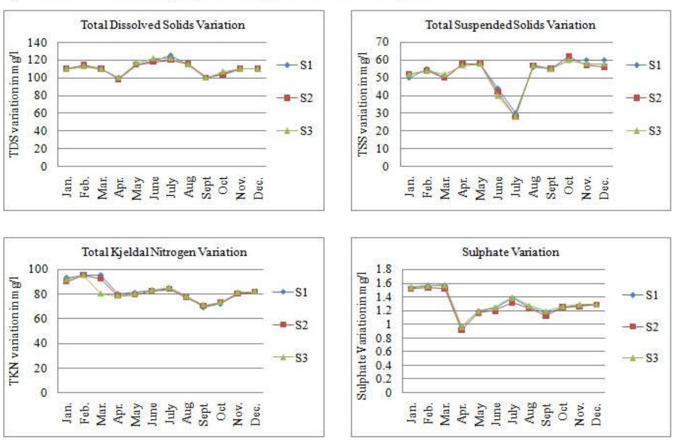


Fig. 5. Seasonal variation in TDS, TSS, TKN and sulphate concentration in Tilyar Lake.



COD values found to be much higher than BOD values, indicating considerable presence of chemically oxidizable matter, most of which should be non-biodegradable (Raja *et al*., 2008). High value of COD indicates the presence of unstable carbonaceous organic matter in the water (Bathusha and Saseetharan, 2007). This creates problems for aquatic life

Fig. 6. Seasonal variation in Phosphate, NPP and Phytoplankton cell density in Tilyar Lake.

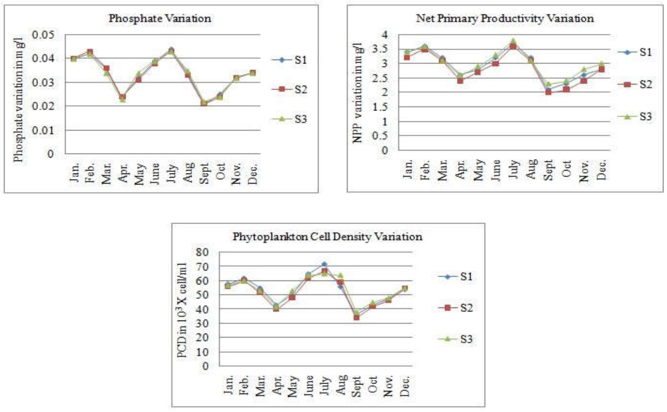


Table 1. Average of sampling station (S1, S2, S3) and Mean value (± standard error of mean, standard deviation) of physical, chemical and Biological parameters in Tilyar Lake

Param.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug	Sept	Oct	Nov.	Dec.	Std. Error	Mean±SD
pH	9.19	9.21	9.24	8.88	8.92	9.03	9.2	8.88	8.75	8.86	9.11	9.15	0.05	9.04± 0.17
Temp.	13.5	17.5	19.33	23.5	29.5	30.67	32.67	32.5	29.83	28.83	22.33	17.17	1.93	24.78± 6.72
DO	2.47	2.67	2.47	2.33	2.13	1.93	1.8	2.6	3.57	4.33	4.77	5.13	0.33	3.02± 1.14
BOD	1.53	1.8	2	0.73	1.27	1.53	1.7	0.73	1.07	1.37	1.5	2.1	0.13	1.44± 0.44
COD	26.33	26.33	26	18.47	21.67	36.67	62.67	30	25	40.33	36.33	40.33	3.44	32.51± 1.19
TA	94.33	95.33	97.33	85.33	91.67	104	106.67	95.33	85.67	90.67	94.33	94.33	1.81	94.58± 6.27
TH	98	100.67	98	87.67	91	95.67	104.67	101.33	84	86	87.67	92.67	1.95	93.94± 6.75
CaH	68.17	63.7	61.17	58.2	66.23	66.57	72.47	69.43	60.13	60.9	64.23	65.63	1.21	64.74± 4.19
MgH	7.25	8.74	8.94	7.16	6.02	7.07	7.82	7.75	5.8	6.09	5.69	6.57	0.32	7.08± 1.09
Ac.	6.67	4.67	3.77	4.07	2.83	2.17	1.8	2.13	3.17	3	2.73	3.13	0.38	3.34± 1.33
CO_2	3.93	2.97	2.57	3.93	0	0	0	2.07	2.3	2	1.47	2	0.40	1.94± 1.38
Cl^-	10.67	16.07	13.13	10.37	17.53	17.7	20.87	16.29	15.38	15.2	15.16	16.88	0.85	15.43± 2.96
TDS	110	113.67	110	99.33	115.67	120	122.33	115.33	100	105	110	110	2.05	110.94± 7.10
TSS	51.33	54.33	50.67	57.67	58	42	28.67	56.67	55	60.67	58.33	58	2.61	52.61± 9.03
TKN	91.5	95	89	78.93	80	82.67	84.2	77.73	70.17	72.9	80.7	81.67	2.08	82.04± 7.19
SO_4^-	1.53	1.55	1.55	0.95	1.18	1.23	1.36	1.25	1.16	1.25	1.27	1.29	0.05	1.29± 0.18
PO_4^-	0.043	0.04	0.031	0.023	0.032	0.039	0.043	0.034	0.021	0.024	0.032	0.034	0.02	0.039± 0.02
NPP	3.33	3.57	3.13	2.53	2.8	3.17	3.7	3.13	2.13	2.27	2.6	2.87	0.14	2.94± 0.49
PCDx10^3	57	60.67	53.33	41.67	50.33	63.67	68	59.67	36	43.33	47	54.67	2.77	52.94± 9.61

Table 2. Pearson correlation coefficient between all the physical, chemical and biological parameters attributes (= Correlation is significant at the 0.01 level; *= Correlation is significant at the 0.05 level)**

Param.	pH	T	DO	BOD	COD	TA	TH	CaH	MgH	Ac	CO2	Cl	TDS	TSS	TKN	SO4	PO4	NPP
T	-.611*																	
DO	-.083	-.273																
BOD	.822**	-.517	.221															
COD	.331	.324	.117	.398														
TA	.636*	.170	-.368	.518	.701*													
TH	.646*	-.057	-.560	.330	.359	.762**												
CaH	.392	.218	-.310	.184	.588*	.744**	.734**											
MgH	.584*	-.265	-.545	.307	.002	.448	.797**	.177										
Ac	.307	-.816**	-.058	.133	-.514	-.341	.021	-.236	.232									
CO2	.023	-.666*	.146	-.159	-.553	-.584*	-.133	-.501	.251	.788**								
Cl	.072	.592*	-.051	.259	.694*	.612*	.318	.589*	-.060	-.758**	-.869**							
TDS	.493	.267	-.438	.357	.540	.900**	.764**	.852**	.347	-.380	-.694*	.711**						
TSS	-.426	-.298	.574	-.291	-.665*	-.815**	-.633*	-.600*	-.395	.263	.466	-.508	-.654*					
TKN	.873**	-.655*	-.363	.585*	-.032	.467	.694*	.299	.727**	.546	.220	-.126	.433	-.304				
SO4	.792**	-.531	-.085	.707*	.159	.476	.626*	.328	.604*	.428	.140	.027	.388	-.260	.774**			
PO4	.364	-.338	-.121	.276	-.118	.099	.367	-.003	.490	.306	.200	.104	.187	.009	.602*	.470		
NPP	.758**	-.187	-.561	.438	.341	.780**	.961**	.709**	.757**	.127	-.141	.302	.781**	-.657*	.819**	.653*	.463	
PCD	.656*	.012	-.469	.424	.505	.899**	.922**	.817**	.607*	-.123	-.370	.498	.907**	-.685*	.642*	.530	.320	.937**

by consuming much oxygen. Total Alkalinity occurs due to carbonate, bicarbonate and hydroxide in the water body. Alkalinity ranges between 85.33-106.67 mg/l during the study period with maximum in July and minimum in April (Fig 3). Mean value of total hardness was found to be 93.94 mg/l with maximum (104.67 mg/l) and minimum (84 mg/l) in the month of July and September respectively (Fig 3). This may be due to low water level in July by high rate of evaporation. Same trend was observed in case of magnesium hardness and opposite in case of calcium hardness. Calcium hardness ranged between 58.2-72.74 mg/l (Fig 3) and magnesium hardness ranged between 5.69-8.94 mg/l (Fig 4). Acidity ranged between 1.8-6.67 mg/l with a mean value of 3.34 mg/l. Minimum value was recorded in September (1.8 mg/l) and maximum in January (6.67 mg/l). CO_2 values were observed between nil to 3.93 mg/l (Fig 4) with mean value of 1.94 mg/l. CO_2 was found significantly correlated with acidity (r= 0.788, P= 0.01). More uptake of CO_2 by primary production increase the pH which affect adversely on biological processes resulting in deterioration of whole water chemistry. The mean value of chloride was found to be 15.43 mg/l with minimum (10.30 mg/l) in April and maximum (20.87 mg/l) in July (Fig 4). TDS was observed to be high (122.33 mg/l) in the month of July and minimum (99.33 mg/l) in April (Fig 5). Mean value of TSS was found to be 52.61 mg/l and ranged between 28.67-60.67 mg/l (Fig 5). TSS act as limiting factor for phytoplankton growth and negatively correlated with phytoplankton density (r= -0.685, P= 0.05) and net primary productivity (r= -0.657, P= 0.05). TKN concentration in lake remained fairly constant throughout the study. TKN ranges between 70.17-95 mg/l with mean value of 82.04 mg/l. It acts as a fertilizer for the algal growth. Maximum concentration of TKN was found in February due to deposition and decomposition of high organic waste of plants and minimum concentration was found in September due to dilution (Fig 5). Same trend was observed in case of sulphate concentration which shows its high peak in the month of February (1.55 mg/l) and minimum in April (0.95 mg/l) as shown in (Fig 5). The most important single element which regulates aquatic productivity is phosphate, though it is one of the most limiting factors of production in Indian reservoirs (Das, 2000). The higher values of phosphate recorded in July and January (0.043 mg/l) and minimum concentration was recorded in September (0.021 mg/l) (Fig 6).

Net Primary Productivity and Phytoplankton Cell Density

Primary production is controlled by a combination of temperature, light and nutrients. When nutrient availability is high, overall production varies with water temperature (Fee *et al*., 1992). Mean value of primary productivity was estimated to be 2.94 mg/l. High peak for NPP was observed in the month of July (3.7 mg/l) and minimum was found in September (2.13 mg/l) as shown in (Fig 6). NPP shows a significant correlation with pH (r= 0.758, P= 0.01), total alkalinity (r= 0.780, P= 0.01), total hardness (r= 0.961, P= 0.01), calcium hardness (r= 0.709, P= 0.01), magnesium hardness (r= 0.757, P= 0.01), TDS (r= 0.781, P= 0.01), total nitrogen (r= 0.819, P= 0.01), sulphate (r= 0.653, P= 0.05) summarized in Table 2.

Mean phytoplankton density was observed to be 52.94 x 10^3 cells/ml. Two higher peaks were observed during study i.e. one in July (68 x 10^3 cells/ml) and another in February (60.67x 10^3 cells/ml) (Fig 6). Cell density significantly correlated with total alkalinity (r= 0.899, P= 0.01), total hardness (r= 0.922, P= 0.01), calcium hardness (r= 0.817, P= 0.01), TDS (r= 0.907, P= 0.01), net primary productivity (r= 0.937, P= 0.01), pH (r= 0.656, P= 0.05), magnesium hardness (r=0.607, P= 0.05) and total nitrogen (r= 0.642, P= 0.05)Table 2. Net primary productivity and phytoplankton cell density influenced by seasonal variations in light intensity, and availability of nutrients such as nitrogen, phosphorous (Breton *et al*., 2009). NPP and phytoplankton cell density were found high in the month of July and then show a sudden fall due to the decrease in concentration of nutrients and grazing by zooplanktons (Sommer *et al*., 1986)**.** Saha and Choudhary (1988) obtained the maximum density of phytoplankton during the month of July and minimum during January. Atici and Olcay (2006) reported increased phytoplankton density during the dry season, rather than the rainy season.

Conclusion

After the present research investigation it was observed that the lake had poor health condition. DO was found to be much low during most of the study period which is harmful for aquatic life. High pH and low CO_2 cause an adverse effect on biological processes resulting in deterioration of whole water chemistry. The large fish population was observed negligible due to low concentration of dissolved oxygen, net primary productivity and less phytoplankton density indicating very fragile ecosystem balance in the lake. High tourist load exploit the lake ecology unfairly. Unmanaged tourists activities and unplanned management strategies by lake authorities harm the lake in many ways. There should be strict management rules for the tourists in relation to the biodiversity conservation in lake area. So the monitoring of Tilyar Lake is necessary for proper management and conservation.

REFERENCES

Allan, J.D. 1995. Stream Ecology: Structure and function of running waters. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Allan, D. and Castillo, M.M. 2007. Stream Ecology: Structure and Function of Running Waters. Springer Publishing CO., pp. 436.

APHA, 1995. Standard methods for the examination of water and waste water (17thEd.). American Public Health Association, Washington, DC.

Atici, T. and Olcay, O. 2006. Seasonal variations of phytoplankton and value of chlorophyll a in the Sariyar Dam Reservoir (Ankara, Turkey). Turk. J. Bot., 30: 349–57.

Bathusha, M.I. and Saseetharan, M.K. 2007. Assessment of surface water quality in eight major ponds of Coimbtore City and potential risk on ground water quality. Journal of Environmental Science and Engineering, 49(4): 297-308.

Breton, J., Vallieres, C. and Laurion, I. 2009. Limnological properties of permafrost thaw ponds in northeastern Canada. Canadian Journal of Fisheries and Aquatic Sciences, 66: 1635–1648.

Chaurasia, M. and Pandey, G.C. 2007. Study of physico-chemical characteristics of some water ponds of Ayodhya- Faizabad. Indian Journal of Environmental Pollution, 27(11): 1019-1023.

Das, A.K. 2000. Limno- chemistry of some Andhra Pradesh. J Inland Fish Soc 32(2): 37-44.

Fee, E.J., Shearer, J.A., DeBruyn, E.R. and Schindler, E.U. 1992. Effect of lake size on phytoplankton photosynthesis. Canadian Journal of Fisheries and Aquatic Science, 47: 1771-1778.

Lourantou, A., Thome, J.P. and Goffart, A. 2007. Water quality assessment of a recently filled reservoir: the case of Butgenbach Reservoir, Belgium'. Lake and Reservoir: Research and Management, 12: 261-274.

Mathew T., Devi Prasad, A.G. and Hosmani, S.P. 2007. Physicochemical parameters and plankton communities in the wetlands of Mysore District. Journal of Ecotoxicological Environmental Monitoring, 17(1): 91-96.

Raja, P., Amarnath, A.M., Elangovan, R. and Palanivel, M. 2008. Evaluation of physico-chemical parameters of River Kaveri, Tiruchirappalli, Tamil Nadu. Journal of Environmental Biology, 29(5): 765-768.

Saha, L.C. and Choudhary, S.K. 1988. Phytoplankton in relation to abiotic factors of a pond, Bhagalppur. Comp. Physiol. Ecol., 1:91-100.

Saksena, D.N., Garg, R.K. and Rao, R.J. 2008. Water quality and pollution status of Chambal river in National Chambal Sanctuary, Madhya Pradesh. Journal of Environmental Biology, 29(5): 701-710.

Sharma, V., Ridhhi, S., Malera, H. and Sharma, M.S. 2009. Zooplanktonic Diversity and Trophic Status of Mahi Dam in Relation to Physico-chemical Characteristics. Water Poll. Res., 28 (4): 571-576.

Sommer, U., Gliwicz, Z.M., Lampert, W. and Duncan, A. 1986. PEG-model of Seasonal Succession of Planktonic Events in Fresh Waters. Archives of Hydrobiology, 106(4): 433-471.

Sudhira, H.S. and Kumar, V.S. 2000 Monitoring of lake water quality in Mysore City. Symposium on Restoration of Lakes and Wetlands (CSIC Banglore). http://wgbis.ces.iisc.ernet.in/energy/water/proceed/proceedings_text/section6/paper5/section6paper5.htm. Accessed 25 June 2009.

Vannote, R.L., Minshall, G.W., Cummins, K.W., Sedell, J.R. and Cushing, C.E. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences, 37:130-137.

****