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Assessment of Quality Parameters of a Pond Water: A Limnological Case Study in Bareilly District

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ABSTRACT

The manuscript herewith presents the assessment of water quality parameters in the samples drawn in year 2014-15 from Akshar Vihar pond, located centrally in district Bareilly (U.P.), India. Analysis of check parameters chosen, was performed by employing standard procedures laid down in APHA. The minimum to maximum values recorded in each month of the experimental year for pH, total hardness, DO, BOD, COD, calcium and magnesium were 7.2-8.8, 380 - 486mg/L, 4.2-10.6 mg/L, 1.0-1.6 mg/L, 3.8-8.4 mg/L, 52.97-74.84 mg/L and 56.74-72.98 mg/L respectively. Significant correlation was observed for COD with pH (0.816), carbonate (0.875) and bicarbonate (0.927); that of total hardness with magnesium (0.954) as well as of DO inversely with water temperature (-0.821).

KEYWORDS: Physical and chemical parameters, water quality, DO.

INTRODUCTION

Water is one of the key essential constituents in living beings on this globe, without which life is impossible. Water sources like ponds, rivers, dams and even lakes comprise of around 1% of the total water present on this earth. The usage of this water for industry, domestically and by agriculture practices is well known these days. Pond water is being used today in widespread ways and it supports the life in aquatic ecosystem, which solely depends on the quality of water collectively on physical, chemical and biological scales. This water quality indicates and lays a benchmark that how suitable the water is for human consumption and reflects towards the need today for its sustainable management.

Several studies have been made on the physico-chemical characteristics of fresh water bodies in recent years. Kumar (1992, 1995), Pandey et al. (2000), Gupta and Shukla (2006), Anitha Kumari and Aziz (1989), Maya et al. (2001), Santhi et al. (2014), Lohar and Korekar (2012).

The data obtained depend on its utilization goals, type of samples and the sampling area covered. In the present project an objective was laid to get an assessment of water quality parameters in samples drawn from Akshar Vihar, an urban area pond in Cantonment premises of district Bareilly.

Study area: Studies for water quality assessment was done in Akshar Vihar pond situated in heart of the District Bareilly (U.P.), on the border of Cantonment premises and civil area. Physio graphics of the pond show it at coordinate of latitude $28^0$20'19" N and longitude $79^0$25'39" E. The Akshar Vihar pond comprises of an area roughly in a circular shape with in span of 1.8 sq. km. The mean rainfall of the experimental area is found to be 106.4 cm. The grassy bed and motorable roads are found around the circumference of the Akshar Vihar.

MATERIALS AND METHODS

The samples of pond water were collected in early time between 9.00 AM to 11.00 AM, in sterilised dry 1L capacity polyethylene bottles employing all standard sampling procedures. Immediately after drawing samples, reading for on-spot determination of temperature, pH, transparency etc. were determined. The samples were then preserved, brought to laboratory for analysis of other water quality parameters following standard methods laid down in APHA (2011) as well as Trivedy & Goel (1987). The experimental values for

physical parameters air temperature, water temperature, transparency (Trp.) and pH; for demand parameters viz. chemical oxygen demand (COD), biochemical oxygen demand (BOD), dissolved oxygen (DO); and for chemical parameters i.e. free carbon dioxide (FCO_2), carbonates, bicarbonates, total hardness (TH), chloride (Cl^-), total dissolved solid (TDS), calcium and magnesium were determined and compared to permissible limit of drinking water for a safer approach to aquatic living beings. The data obtained, presented in Table 1, was further subjected to calculate various statistical parameters in order to arrive at significant results computed in Table 2 and 3.

RESULT AND DISCUSSION

Air Temperature: Air temperature recorded in all the months of the experimental year is mentioned in Table-1. It varied from 17^0C (December) to 38^0C (June) value. The minimum value observed in month of December 2014 and the maximum in the month of June 2015(Fig.1). It is in accordance with findings of Kumar (1992). Besides this, recording of air temp. in Wyera reservoir by Mohmmad *et al.* (2015) also showed similar type results in same months of January (22.8) and June (33.7^0C) respectively. Maximum air temperature in Akshar Vihar pond was 38^0C as because its geographical location is in North India plains. Highest temperature in summer season and lowest one in winter season were also on same stream as the results of Baruah and Kakati (2012) for an Indian fresh water pond, Yadav et al. (2012), Santragachi and Joypur Jheel and Patra et al. (2010) for a pond located in semi arid zone.

Water temperature: The effect of water temperature and seasonal fluctuations on both the thermal features and productivity of the water body is a well-known fact. The temperature of water in body reflects an inverse relationship for solubility of gases in it (Bhouyain, 1979). The minimum and maximum values of water temperature recorded is 18^0C in December and 37^0C June respectively (Fig.1). Though standard required range of water temperature is 20-30^0C yet data for all 8 months lied well within it, except in 3 extreme hot months of May, June and July (>30^0C) and one extreme cold month of January (19^0C). This difference is mainly on account of prevalent climate condition in North Indian plains and the ambient air temperature. Comparable result was obtained from studies of Mohmmad *et al.* (2015) in Wyera reservoir as well as from those of Islam and Choudhary (2013) who worked on Trimohini Beel of Rajshahi. The biotic organisms in aquatic ecosystem are affected with water temperature variation (Sahni and Yadav, 2012). Higher temperature observed in pre-monsoon season while lowest one in extreme chill times in month of January. Results from Tidame and Thakare (2014) are on same lines to present studies.

Transparency: Transparency in water bodies is also a key parameter which affects the aquatic organisms. The range of transparency found in the experimental pond is from 16 cm. (Nov., 2014) to 46 cm. (Feb., 2015) (Fig.2), which is reflecting lesser transparency as compared to those observed by Nath et al. (2015) on pond located at Trivendrum and also by Verma and Pandey (2013) on an Indian pond. The less transparency in the Akashar Vihar pond might be due to dumping of wastes and dissolution of muddy sediments. Furthermore, this is also observed in pre and post monsoon months. Lower transparency in pre monsoon may be attributed to higher temperature leading to more evaporation, consequently a fall in water level and also because of wastes materials, thereby, entering into experimental pond water. Also in the post monsoon time, the low value of transparency is due to excessive rainfall and subsequent silt laden water and as well as dissolved particulates. It is supported by findings from both Sahni and Yadav (2012) as well as Verma and Pandey (2013).

pH: The pH value indicates the nature of water viz. either alkaline or acidic which plays a very important role in survival of living beings. The pH value observed during the entire experimental year was found to be between 7.2 and 8.8, which shows that all water samples were alkaline in nature (Fig.2). Studies of Sayeswara et al. (2011) for Hosahalli pond (India) and of Jipsa et al. (2013) for lentic water body in India, were almost similar to current findings in Akshar Vihar, Bareilly. All the pH values were well within the range (6.5-8.5) set by WHO (2011) except for months of Feb-May of the year. Low values were observed in monsoon months of July to Sept. Similar trend was observed in Wyera reservoir (Mohammad et al., 2015) and in different ponds in India (Sayeswara et al., 2011 and Tidame and Thakre, 2014).

Dissolved Oxygen (DO): It is true that oxygen in atmosphere, rainfall and aquatic plants are important source of oxygen for aquatic beings. DO value assessed in all annually drawn water samples ranged to 10.6 mg/L in month of Jan, from 4.2 in July (Fig.3). Results from Devi and Antal (2013) for a temple pond were in accordance all our findings. In addition, our finding was more or less similar to those of Patra et al. (2010) in water of two Jheels, and Surana (2010) in a lake. DO level of 6mg/L in water rendered suitable for drinking, a standard laid for Bangladesh (WHO, 2011). Observable low values in summer season and high in

winter season of the experimental tenure was interestingly noticeable.

Free CO_2, Carbonate and Bicarbonates: Just like DO, the respiration in aquatic animals, the atmosphere and also the rainfall are the key factors for presence of free CO_2 (FCO_2) in pond water samples. The minimum value (8mg/L) was obtained in July while it ranged to a maximum value of 30mg/l in January. It is further to mention that the free CO_2 was absent in July 2014 and thereafter also in five consequent months *i.e.* February to June 2015 (Fig.3).

However, a similar range of free CO_2 was observed in findings of Sayeswara *et al.* (2011) (9.9-25.2mg/L) in Hosahali pond India. Furthmore Surana *et al.* (2010) observed similar findings in a pond and a lake water in India. Highest value of FCO_2 in October and February noticed might be due to entrance of waste material in the pond during monsoon and other seasons as well only because of absence of well protected dyke. Joshi *et al.* (1995) has also reasoned an increase in CO_2 in water bodies for the addition of drainage as one of the key factors.

Carbonates were nil in initial seven months except in August of experimental year, while thereafter the value ranged from 24 to 76 mg/L. On the other hand, bicarbonates values ranged from 164.7 to 488 mg/L through out the experimental year. It is also noticed the value of bicarbonates were greater than 300 mg/L in six consequent months from January to June *i.e.*, pre monsoon timing.

Chloride: Higher chloride content imparts salty taste to water and is even objectionable in consumption. The estimated values of Cl^- in all the annual experimental samples ranged from 3.99 as min value to 5.79mg/L as maximum one.

Calcium and Magnesium: The growth and population dynamic of fresh water flora & fauna gets affected due to both calcium and magnesium. The values determined for calcium and magnesium in water samples taken in this project ranged 52.97 to 74.84 and 56.74 to 72.98 mg/L respectively. The overall values of calcium were above 60mg/L and that of magnesium above 50 mg/L (Fig.4).

The lowest value noticed in the month of March might be due to calcium deficiency in sandy bottom of the pond and the surrounding pond soil. The calcium content in fresh water of lakes and ponds vary between 7.21 to 41.68 m/L (Surana et al. 2010). The higher values of calcium were reported in monsoon season. Lower value of calcium and magnesium recorded in ponds, in post monsoon season. Likewise in the current project findings may be due to pond water dilution taking place in rainy season and thereby decrease in Ca and Mg is observed in the said season. This view is supported by citation from Boyden et al. (1978).

Total hardness: Total hardness in general is a sum of calcium and magnesium solubles in water. It is expressed in terms of $CaCO_3$ equivalent. The range of total hardness determined was 380-486 mg/L across the year. The higher values might suggest usage of locally manufactured soaps by local and poor communities in our experimental pond as a result of washing and bathing. A helpful classification benchmark laid by Kiran (2010) for water body as soft (0-75 mg/L), moderate (75-150), hard (150-300mg/L) and as very hard (>300 mg/L) serves as a guide for assessing water quality. The Akshar Vihar pond water is very hard in all 12 months of the experimental year, though it is less than 600mg/L a value which act as a permissible limit by WHO (2011). Relatively higher value of total hardness was observed in winters might be due to high evaporation and lower volume of water in water body. Mohmad et al. (2015) had remarked an inverse relationship of hardness to water volume but a direct one with evaporation rate.

BOD: The values of BOD in samples under study was found to be in range 1.0-1.6 mg/L (Fig.5). Relatively higher values of BOD were found from November to March. BOD is a quantity of oxygen required by various micro-organisms like bacteria etc in biochemical degradation and transformation of organic compounds under aerobic conditions. The categorization of water quality as per BOD values laid by Ekubo and Abowei (2011) are as clean (1.0-2.0 mg/L), fairly clean (2-3 mg/L), doubtful (3-5mg/L) and heavily polluted (5-10mg/L). So, along the whole experimental year the water stands as clean water body, except in tenure of 6 months viz. from November to April, rest of the year the water is much clean in post monsoon season Yadav et al. (2013) and Patra et al., (2010) also reported similar type of findings in their studies on some ponds and Jheel respectively. The lower BOD values obtained may be attributed to low water temperature which leads to lower microbial activity and algalblooms.

COD: COD is another demanding parameter measuring the quality of water. If reflects the amount of chemicals present in water which require oxygen to oxidise the chemicals. The range of estimated COD is 3.8-8.4 mg/L in which higher COD was found in post monsoon and winter season. The moderate to higher values of COD may be due disposal of chemicals and other waste material being dumped in the experimental site, Akshar Vihar pond, by local community as the

pond premises is not restricted in perspective to various such practices.

CONCLUSION

Assessment of physico-chemical parameters lead us to conclude that water quality of Akshar Vihar pond is yet safe on WHO benchmark standard in spite the water is being used by local communities without any treatments and discipline, which could lead to further deterioration. Recommendations are suggested for local government authorities to restrict the pond premises for such unhygienic practises. Furthermore, they should also chalk out plans to pave a way for possible fish or shrimp culture practises, there in the pond, an economic footstep ahead.

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Table 1: Monthly variation in water quality parameters recorded in Akshar Vihar pond (July 2014 – June 2015)

Month	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**
AT (^{0}C)	32	29	30	26	24	17	29	24	26	30	37	38
WT (^{0}C)	31	27	27	27	20	18	19	23	25	28	34	37
Trp. (cm)	28	30	22	18	16	24	28	46	34	24	16	18
pH	7.2	7.6	7.7	8.2	8.2	8.3	8.3	8.6	8.8	8.8	8.6	8.4
DO (mg/L)	4.2	6.0	6.8	7.2	8.8	9.4	10.6	10.2	7.4	6.8	6.4	5.6
Free CO_2 (mg/L)	8.0	0	17	23	10	10	30	0	0	0	0	0
CO_3^{2-} (mg/L)	0	18	0	0	0	0	0	24	39	78	96	72
HCO_3^- (mg/L)	207.4	179.99	183.0	183.8	164.7	164.7	323.3	366.0	460.5	488.0	455.3	402.6
Cl^- (mg/L)	5.19	4.99	4.79	4.79	4.59	4.59	5.19	5.39	5.59	5.79	4.99	3.99
Ca^{2+} (mg/L)	64.96	63.36	63.36	64.16	67.37	72.98	64.56	60.15	56.14	64.96	66.57	71.38
Mg^{2+} (mg/l)	52.97	56.86	59.29	60.99	71.93	72.9	68.77	67.07	68.04	58.32	61.72	74.84
TH (mg/l)	380	392	402	411	464	482	444	426	420	402	420	486
BOD (mg/l)	1.0	1.0	1.2	1.2	1.4	1.4	1.6	1.4	1.4	1.3	1.2	1.2
COD (mg/l)	3.8	4.0	4.0	4.4	4.8	5.0	6.0	6.4	7.2	7.8	8.0	8.4

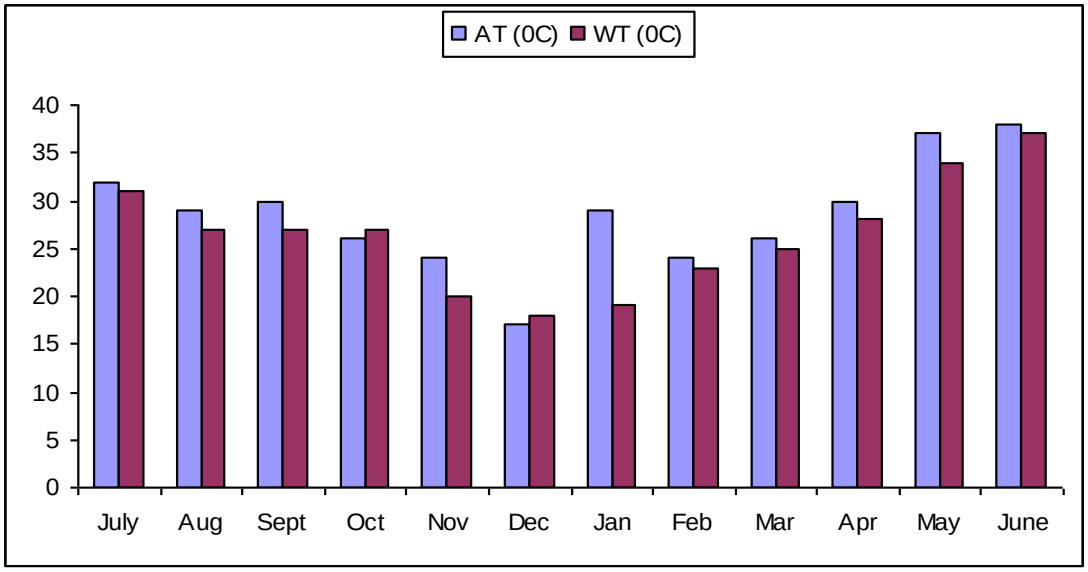
Table 2: Requisite Statistical output related to data assessed for quality parameters

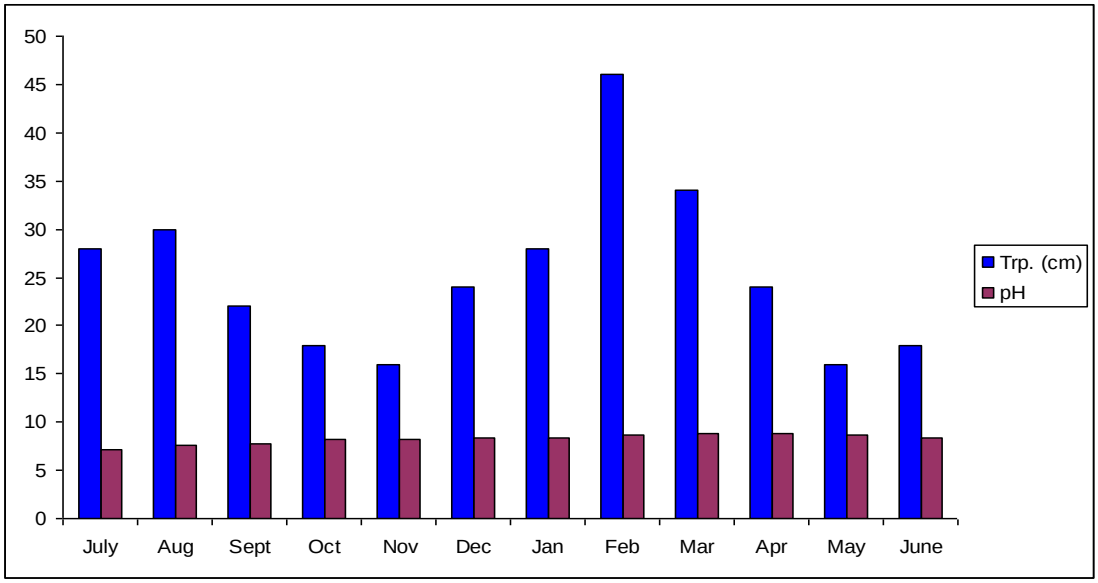
	Min	**Max**	**Mean**	**Median**	**CV**	**SD**	**Confidence level (95%)**
AT (^{0}C)	17	38	28.50	29	0.212	5.76	3.37
WT (^{0}C)	18	37	26.38	27	0.282	5.90	3.90
Trp. (cm)	16	46	25.33	24	0.633	8.71	3.40
pH	7.2	8.8	8.23	8.3	0.183	0.50	0.40
DO (mg/L)	4.2	10.6	7.45	7	0.892	1.94	0.80
Free CO_2 (mg/L)	0	30	8.91	8	1.506	10.53	4.94
CO_3^{2-} (mg/L)	0	96	27.25	9	1.027	35.67	19.00
HCO_3^- (mg/L)	164.7	488	298.21	265.35	1.154	130.59	80.02
Cl^- (mg/L)	3.99	5.79	4.99	4.99	0.880	0.49	0.34
Ca^{2+} (mg/L)	56.14	72.98	65.00	64.76	0.089	4.48	3.34
Mg^{2+} (mg/l)	52.97	74.84	64.48	64.395	0.760	7.05	5.01
TH (mg/l)	380	486	427.42	420	1.022	34.64	20.83
BOD (mg/l)	1.0	1.6	1.28	1.25	0.735	0.18	0.12
COD (mg/l)	3.8	8.4	5.82	5.5	0.293	1.71	1.10

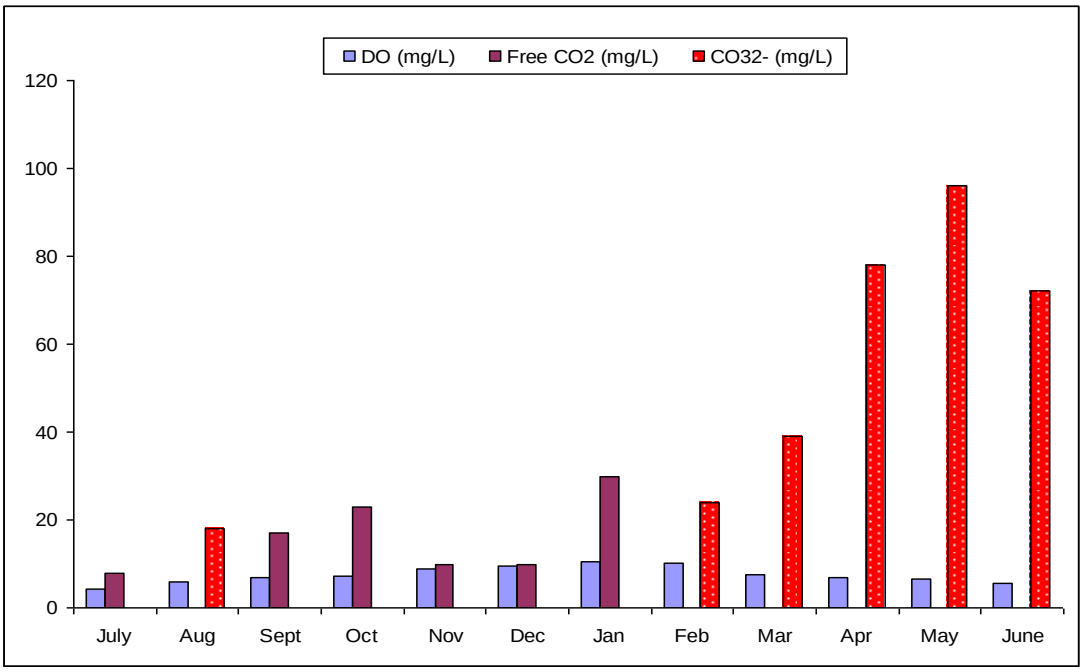
Table 3: Correlation matrix among the assessed quality parameter in pond water.

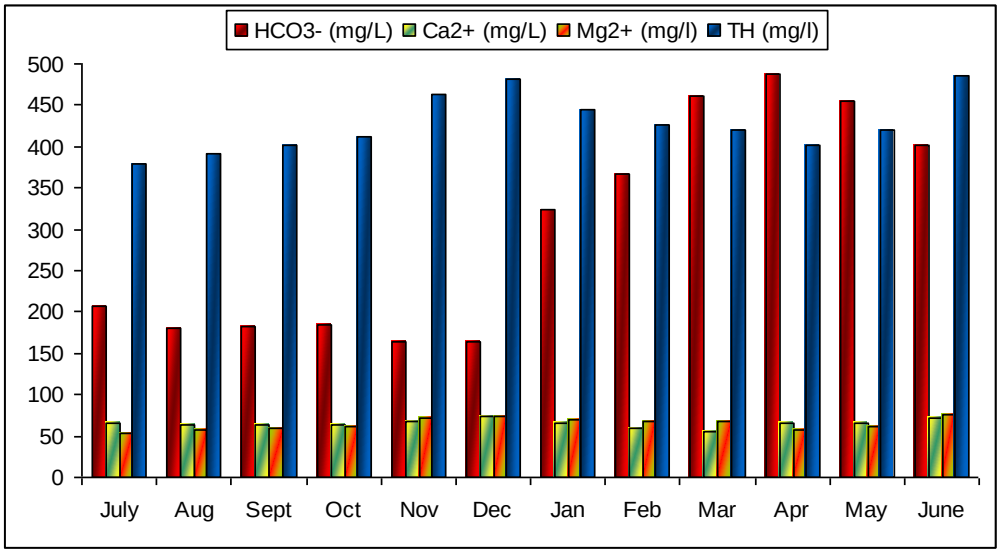
	AT	WT	Trp.	pH	DO	FCO_2	CO_3^-	HCO_3^-	Cl^-	Ca^{++}	Mg^{++}	T.H.	BOD	COD
AT	1.000													
WT	0.878	1.000												
Trp.	-0.330	-0.315	1.000											
pH	-0.088	-0.084	0.080	1.000										
DO	-0.645	-0.821	0.336	0.459	1.000									
FCO_2	-0.227	-0.463	-0.199	-0.408	0.346	1.000								
CO_3^-	0.629	0.669	0.584	0.584	-0.325	-0.701	1.000							
HCO_3^-	0.458	0.400	0.180	0.745	-0.034	-0.601	0.844	1.000						
Cl^-	-0.135	-0.201	0.579	0.255	0.119	-0.155	0.122	0.443	1.000					
Ca^{++}	0.049	0.095	-0.625	-0.114	-0.054	0.058	0.066	-0.275	-0.721	1.000				
Mg^{++}	-0.283	-0.326	-0.074	0.531	0.582	-0.055	0.024	0.115	-0.478	0.361	1.000			
T.H.	-0.221	-0.242	-0.264	0.408	0.470	-0.026	0.041	0.008	-0.633	0.625	0.954	1.000		
BOD	-0.452	-0.676	0.189	0.642	0.888	0.271	-0.112	0.250	0.168	-0.059	0.682	0.552	1.000	
COD	0.434	0.398	-0.026	0.816	0.042	-0.612	0.875	0.927	0.117	0.035	0.398	0.345	0.322	1.000

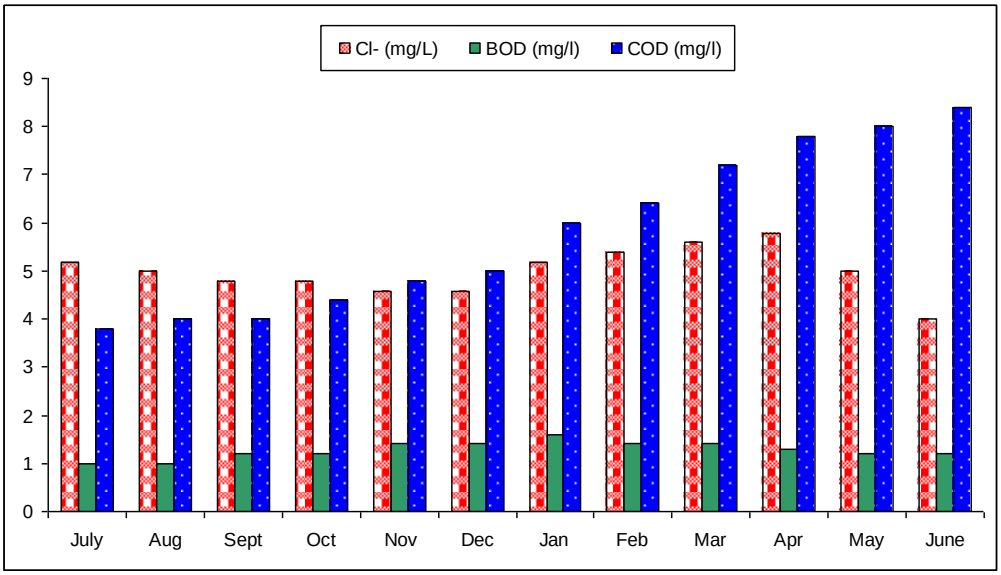
Fig.1-5: Monthly variation in water quality parameters recorded in Akshar Vihar pond (July 2014 – June 2015)








HCO3- (mg/L)
Ca2+ (mg/L)
Mg2+ (mg/l)
TH (mg/l)
500
450
400
350
300
250
200
150
100
50
0
July
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
June


Cl- (mg/L)
BOD (mg/l)
COD (mg/l)
9
8
7
6
5
4
3
2
1
0
July
Aug
Sept
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
June