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RESEARCH ARTICLE

PHYSICO-CHEMICAL LIMNOLOGY OF DAL LAKE

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ABSTRACT

The valley of Kashmir abounds in large number of fresh water bodies including lakes, rivers and springs which are contaminated with different kinds of pollutants resulting from increasing population, urbanization and also due to various other factors. The present study was done at 4 stations in the Dal Lake viz., Telbal Nallah, Hazratbal basin, Gagribal basin and Nigeen basin. The water samples collected during the study period from May, 2010 to April, 2011 showed that water temperature was almost same at all the stations. Transparency values were higher in winter. Water showed pH above 7.5 at all the stations throughout the working period. Alkalinity was also same at all stations. Chloride and conductivity were higher at site IV (Gagribal). Nitrogenous compounds like ammonia, nitrate were higher in the Gagribal basin. Total phosphorus also showed the similar trend.

INTRODUCTION

About 3% of the worlds water being fresh is found mostly in rivers, lakes and streams. These water bodies provide a multitude of uses and are prime regions for human settlement and habitat. Due to the ever increasing human population, urbanisation and a number of other factors the water quality of these fresh waters is deteriorating fast. This problem has attracted the attention of large number research workers since the resources are limited. The valley of Kashmir has been blessed with large number of fresh water resources and many low lying lakes,springs and wetlands are facing the threat of pollution. Lakes occupy a special importance here because they serve as a prime attraction that draws tourists to this place. Not only this but are also of great cultural, ecological and socio-economic importance to the people of this valley.

Dal lake situated between 340 5'-3406' N latitude and 740 8'-740 9'E longitude's ,lies in the floodplains of river Jhelum and is the main focal point of locals as well as non-local people because of its socio-economic value. It comprises of five basins the Hazratbal, Bod Dal, Gagribal, Nigeen and Brarinambal. A perennial inflow channel known as Telbal enters the lake from the north and supplied about 80 percent of the water from a high altitude lake called Marsar lake (Qadri and Yousuf, 1980), but due to the abnormal climatic conditions for the past few decades there has been a drastic reduction in the inflow to the lake .Within the lake basin itself there exist a number of springs (Kundangar *et al*., 1995) which act as a permanent source to the lake. Besides this fifty one peripheral springs have been identified to maintain the volume of the lake (Abubakr and Kundangar, 2005). Due to the extreme diversity of its catchment area the hydrology of this lake is too complicated. Disposal of domestic sewage, illegal encroachments and various other factors are causing undesirable changes in the physico-chemical and biological characteristics of its waters. Keeping in view the ecological significance of this lake, the present investigation was undertaken to study the physico-chemical characteristics of this water body.

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MATERIAL AND METHODS

The present investigation was carried out at the four sites which include the Telbal Nallah, the Hazratbal basin near the shrine, the Nigeen basin near the Ashaibagh bridge and the Gagribal basin.

Site I:- This study site is located in Telbal Nallah which is towards the north-west of the lake and the main source of inflow to the lake. The main macrophytes found here are Potamogeton crispus, Potamogeton natans, Ceratophyllum demersum.Site IV:-. This study site is located in Gagribal basin of the lake. The macrophytic associations comprised of Ceratophyllum demersum, Nymphaea sp., Myriophyllum spicatum, Potamogeton natans, Potamogeton crispus

Site II:- This study site is located near Hazratbal shrine about 10 meters away from the shore. The main macrophytes found here are Azolla sp. which formed blooms there. Others present are Nymphaea maxicana, Myriophyllum spicatum, Ceratophyllum demersum, Potamogeton crispus, Potamogeton natans.

Site III:- This study site is located in the Nigeen basin of the lake. The macrophytic community includes Nymphaea sp. Potamogeton crispus, Potamogeton natans, Ceratophyllum demersum, Hydrilla spThe total of 13 physico-chemical characteristics were studied from May (2010) to April (2011).Water samples were collected on monthly basis with the necessary precautions in plastic bottles of 2 ltr capacity.The collected samples were brought to laboratory for analysis of various parameters except temperature and transparency which were recorded on spot. The water sample for determination of oxygen was also fixed on spot. The water samples were analysed for other physico-chemical characteristics as per the standard methods given by APHA (1995), Mackereth *et al.* (1978), CSIR (1978) and Welch (1948).

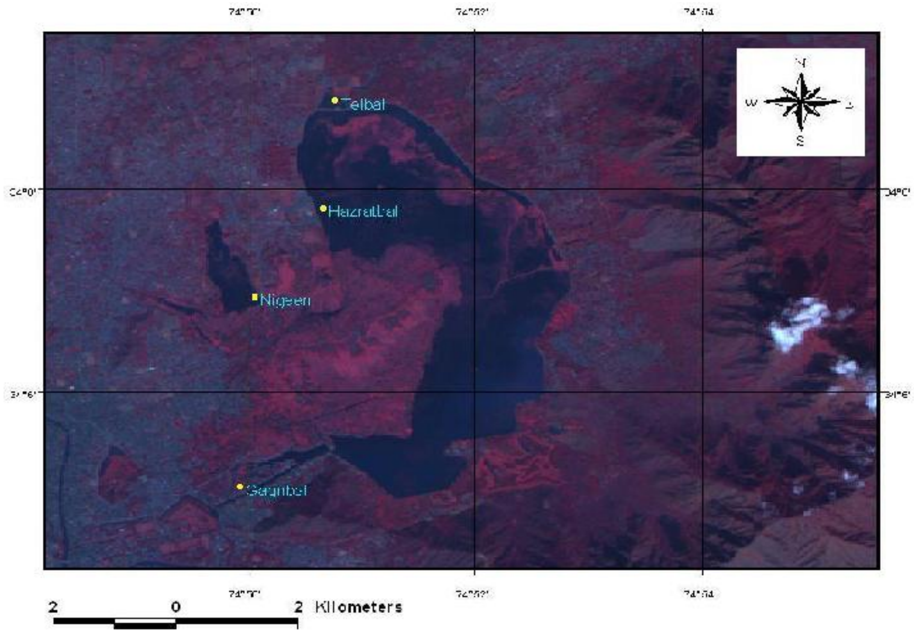
RESULTS AND DISCUSSION

The range and mean of various physico-chemical parameters of the lake are presented in Table 1.

The water temperature was found to follow the air temperature closely with only a slight difference. According to Welch (1952) smaller bodies of water react more rapidly to changing atmospheric temperature. The water temperature remained minimum during the winter season (around 3.5°C). It increased during the summer months to maximum (around 26°C) due to the increased period of solar radiation and high air temperature. During the present study higher values for transparency were observed during the winter period. The lowest value of 0.4m was obtained in the month of August at Site I. This site has comparatively more turbid water which is due to the entry of silt from the upper reaches. The highest of 2.8m was observed in the month of January at Site III. High transparency during winter period is attributed to different factors like low plankton population (Zutshi and Vass, 1970), settling of materials in calm weather (Spurr, 1975), suspension of phytoplankton in water column (Zutshi *et al*., 1980). Site III is having rich growth of macrophytes which help in maintaining clear water state by providing surface for settling of suspended materials. (Blindow *et al*., 2002).

Table 1. Range of variation, mean and standard deviation of various Physico-chemical variables at four sites in Dal lake during 2010-2011

Parameter	Site I		Site II		Site III		Site IV	
	Range	Mean±S.D	Range	Mean±S.D	Range	Mean ±S.D	Range	Mean±S.D
Air Temp (^{0}C)	4.9-32.3	19.6(±8.7)	7.2-32.5	21.0(±8.5)	7.4-31.8	20.7(±8.2)	8-31.3	20.8(±8)
WaterTemp (^{0}C)	3.5-24.5	15.1±6.9	5.3-25.8	16.7(±6.9)	4.9-25.7	16.4(±6.9)	6-24.8	16.7(±6.6)
Transp.(m)	0.4-1.9	1.1(±0.5)	0.8-2	1.3(±0.4)	1-2.8	1.6(±0.5)	0.6-1.9	1.2(±0.4)
pH	7.8-8.8	8(±0.1)	8-9.3	8.5 (±0.4)	8-9.6	8.5 (±0.5)	8-9.3	8.5 (±0.4)
Conduct.(µS/cm)	164-235	196.5(±27.5)	193-348	277.4(±40.3)	196-350	266.2(±58.7)	200-375	282.6(±61)
DO.(mg/l)	4.9-9.8	7.3±(1.5)	5.4-9.2	7.2(±1.3)	8-10.1	8.1(±1.2)	6-9.9	7.9(±1.3)
FreeCO_2(mg/l)	4.1-18.1	11.4(±4.7)	0-16.3	6.3(±5.9)	0-15.1	6.4(±5.8)	2.2-16.1	8.1(±4.8)
Alkalinity (mg/l)	98.7-148	121.2(±15.7)	103.5-145.1	121.9(±14.2)	104.3-145	123.0(±14.4)	114.8-144.8	129.4(±16.3)
Chloride (mg/l)	12.3-23.6	18.8(±3.2)	12.8-30.6	21.2(±5.7)	12.1-30.5	20.7(±4.5)	15.3-30.6	22.2(±4.3)
Ammo. Nitro (µg/l)	100.5-300.6	213.5(±76.5)	150.6-255.3	217.3(±32.1)	142.6-301.1	221.6(±57)	189.2-315.6	251.8(±44.6)
Nitrate Nitro (µg/l)	316.9-765.4	478.6(±131.2)	423-850.6	599.7(±124.6)	312.1-928.5	596.2(±151)	410.8-1052.3	726(±197)
Nitrite Nitro (µg/l)	20-40	30(±7.2)	20-53	36.3(±12.6)	20-59	39.0(±16.9)	20-63	41.1(±16.2)
Total Phosphorus (µg/l)	400.8-559.6	446.4(±83.9)	432.6-755.2	582.1(±90.9)	430.5-802.6	638.7(±100.8)	547-823.7	666.1(±99.1)



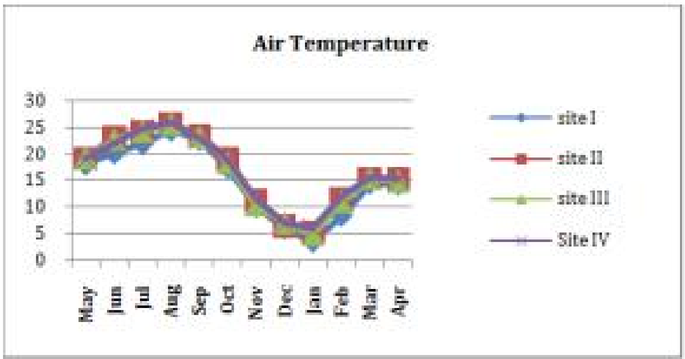
Satellite image of Dal Lake Showing four study sites
Description of study sites

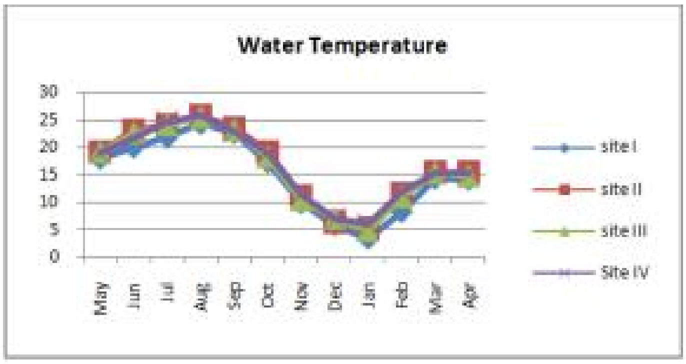
All the four sites were found to be alkaline during the investigation period and pH was highest (9.6) at Site III in June which is due to the phytoplankton maxima in summer (Hutchinson *et al.*, 1929). Phytoplankton takes up CO_2 and thus increases the pH. Since this lake is rich in macrophytes therefore higher photosynthetic activity by them in summer, also increase the value in the same way. Devi and Sharma (2004) also stated that pH value of 9.0 was only the direct outcome of increased photoactivity of macrophytic population. Conductivity values did not show any definite seasonal trend but were high throughout the study period particularly in the Gagribal basin (356µS/cm, August). The greater anthropogenic pressure in this area (Zutshi and Khan, 1988) could contribute to the greater conductivity values. Higher conductivity values also indicate higher nutrient input which is obvious due to the mushroom growth of hotels as well as large number of floating gardens in this portion of the lake.

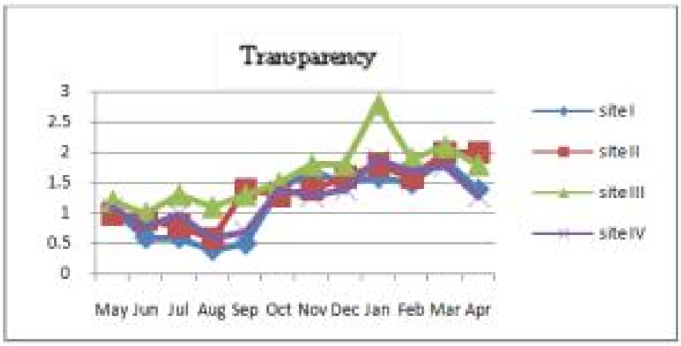
The dissolved oxygen levels in aquatic systems probably reveal more about their metabolism than any other single measurement. Its concentration in the lake was found to be highest in April at SIII (10.1 mg/l). Rejuvenation of aquatic plants and phytoplankton in spring season leads to the increase in its concentration. Lower concentration in autumn could be due to higher rate of decomposition of organic matter (Singh *et al.*, 2002; Kumar *et al.*, 2004) and decaying process of the macrophytes which are widely distributed in this lake, thus results in consumption of large quantities of dissolved oxygen. Free carbon dioxide of most waters is not present in large quantities because of its reaction in the carbonate equilibrium and exchange with atmosphere (Wetzel, 2001). It was absent at sites II and III for four consecutive months from May to August due to the vigorous growth of macrophytes which take it up for carrying out their process of photosynthesis. However its concentration gradually increased and reached its maximum (16.1mg/l) in January at Site IV. The increase in colder period may be due to the dormant phase of plants as well as phytoplankton.

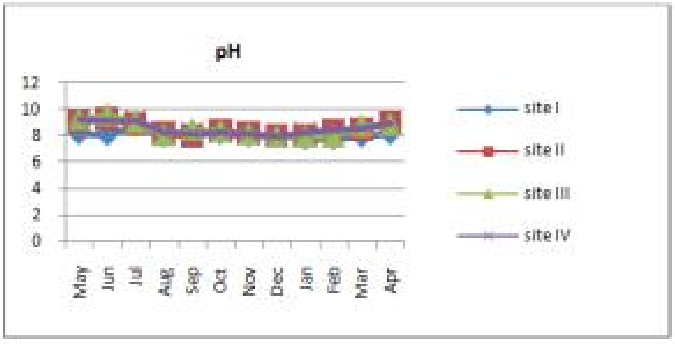
Calcium rich rocks in the catchment area contribute to the alkalinity of lake water (Zutshi *et al*., 1980). The alkalinity values did not show any marked difference between the different sampling sites. It gradually increased and reached the peak value (144mg/l) in January at site IV. The colder period maximum could be attributed to lower pH values (<8.4) as a result of which insoluble carbonate gets changed into bicarbonate which is readily soluble in water. According to Jumppanen (1976) the first changes resulting from pollution in water are an increase in the concentration of chlorides, sulphates, phosphorous and nitrogen. The chloride concentrations fluctuated from 12.1mg/l in the month of July at site III to the highest value of 30.6mg/l in February at SII. Metabolic utilization does not cause significant changes or variations in the seasonal and spatial distribution of chloride in a lake (Wetzel, 1983).

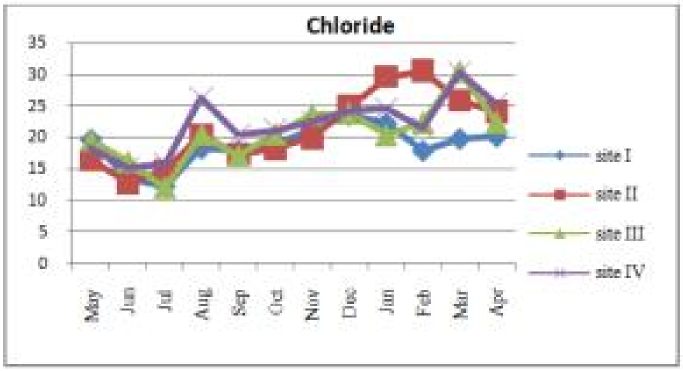
In freshwater systems nitrogen is available in inert state and in several combined forms such as nitrates, ammonia compounds and nitrites. The nitrogenous compounds come from outside through rains, surface runoff, ground water and biological processes. Commercial fertilizers, manures and sewage are the other sources of nitrogen in the water bodies. Ammonical nitrogen concentration ranged from 100.5 µ g/l at site I in the month of December to 315.6 µ g/l at site IV in the month of June. High values at SIV may be due to the entry of domestic sewage, use of fertilizers in the catchment area as well as on the floating gardens in the lake for increasing the yield of vegetables. Nitrate is the main form of inorganic nitrogen in the lakes**.** The concentrations in surface water ranged from 312 µ g/l at site III in May to 1052.3 µ g/l at Site IV in the month of september which could again be related to the agricultural activities in the above mentioned areas. Nitrite nitrogen was found to be in very low quantities as nitrite concentrations in freshwaters is negligible (Stanley and Hobbie, 1981; Paul and Clarke, 1989) due to its unstable nature. It fluctuated from 20µ g/l at site I and II in May to the highest value of 69 µg/l in January at site IV. Total phosphorous concentration in the present study ranged from a mean value of 446.4µg/l±83.9 to 666.1µg/l ±99.1 at site IV. Phosphorus is regarded as a key element in the eutrophication process and its higher values indicate contamination with sewage or other effluents. Its concentration during the present study did not reveal any definite trend. The higher values at site IV indicate greater contamination with sewage and agricultural run-off from the floating gardens and the surrounding area.

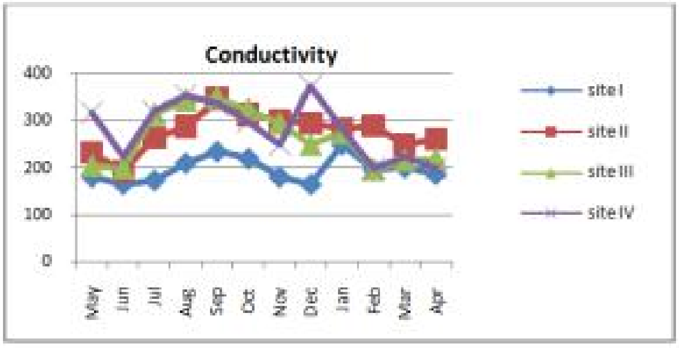


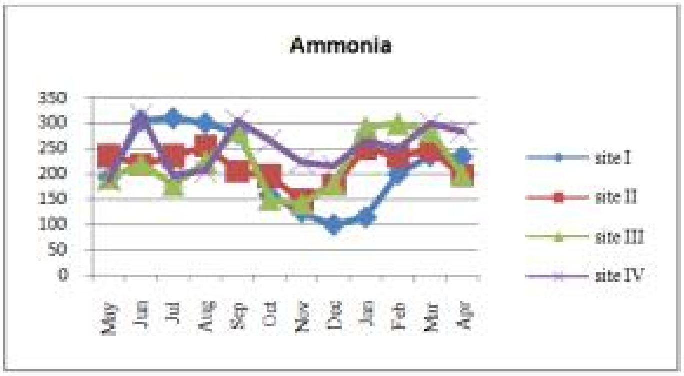


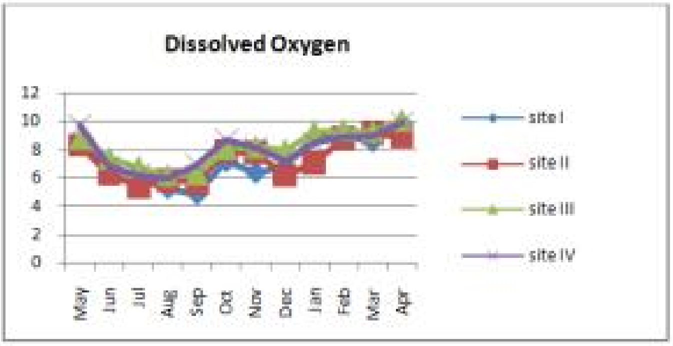


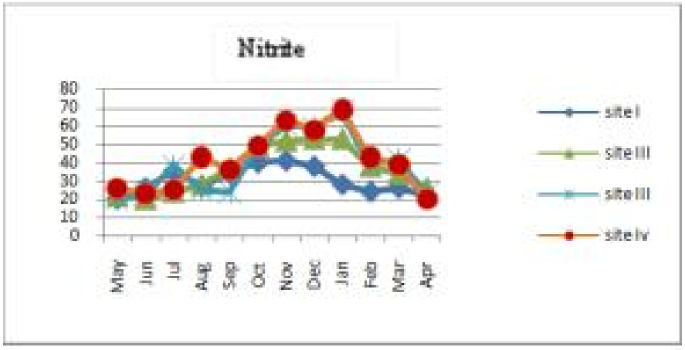

pH
12
10
8
6
4
2
0
May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr
site I
site II
site III
site IV

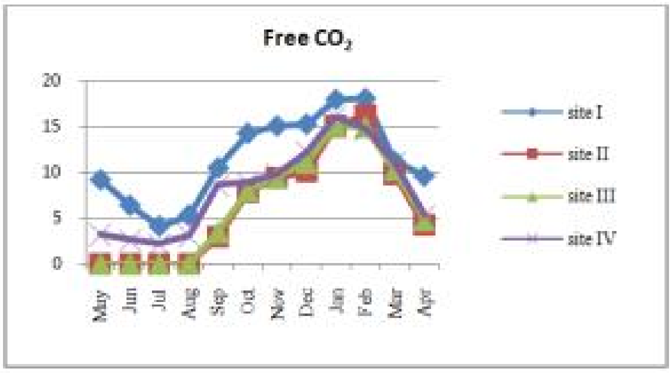

Chloride
35
30
25
20
15
10
5
0
May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr
site I
site II
site III
site IV

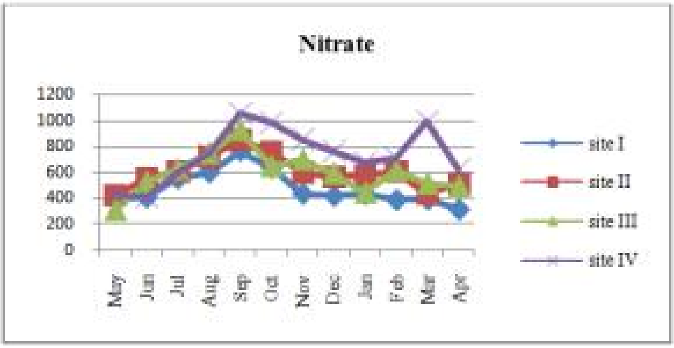

Conductivity
400
300
200
100
0
May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr
site I
site II
site III
site IV

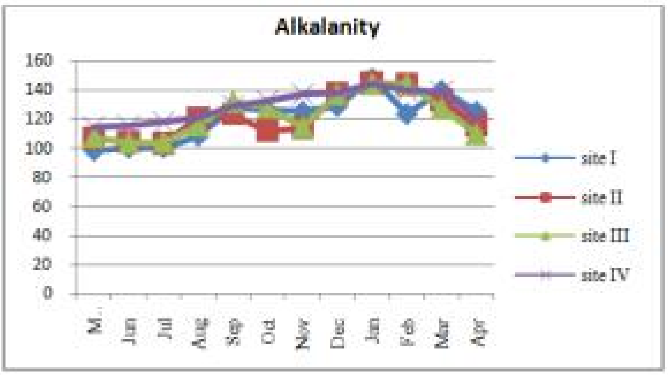

Ammonia
350
300
250
200
150
100
50
0
May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr
site I
site II
site III
site IV

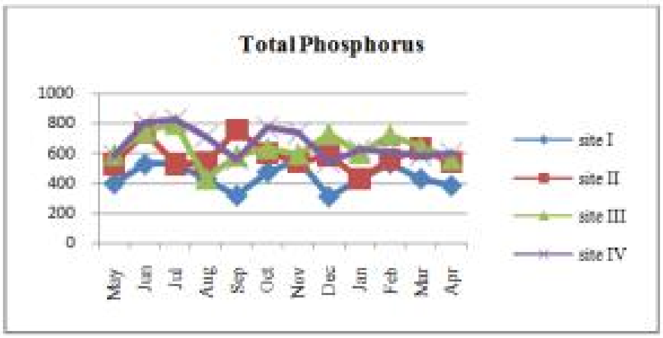

Dissolved Oxygen
12
10
8
6
4
2
0
May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr
site I
site II
site III
site IV


Nitrite
80
70
60
50
40
30
20
10
0
May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr
site I
site III
site III
site iv


Free CO2
20
15
10
5
0
May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr
site I
site II
site III
site IV


Nitrate
1200
1000
800
600
400
200
0
May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr
site I
site II
site III
site IV


Alkalanity
160
140
120
100
80
60
40
20
0
M.. Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr
site I
site II
site III
site IV


Total Phosphorus
1000
800
600
400
200
0
May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr
site I
site II
site III
site IV

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