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STATUS OF MAJOR NUTRIENTS IN THREE LENTIC ECOSYSTEMS OF EASTERN KOLKATA, WEST BENGAL

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ABSTRACT

In the present study an attempt has been made to study the seasonal variation of nutrient concentration in three selected lentic ecosystems of Eastern Kolkata. The study was carried out for three seasons namely winter, summer and monsoon. Both water and sediment samples were collected fortnightly. Nitrate-nitrogen & phosphate-phosphorus in water and organic carbon, available nitrogen & available phosphorus in sediment were estimated as, they are considered as the most important nutrients in freshwater ecosystems. The results indicated that the nitrate-nitrogen in water was maximum during monsoon followed by summer and winter whereas available nitrogen in sediment was maximum in summer followed by monsoon and winter. Phosphate-phosphorus in the water was maximum in summer followed by monsoon and winter as such available phosphorus in sediment was maximum during monsoon followed by winter and summer in P-1 and P-2, but in P-3 it was maximum during winter followed by monsoon and summer. Organic carbon of the sediment was maximum in summer followed by monsoon and winter in P-2, whereas in P-1 and P-3 it was maximum during monsoon followed by winter and summer. All the parameters showed significant fortnight variation in all ponds. Nutrient concentration of all ponds lies below the level of eutrophication. This nutrient study will help in the effective management of lentic ecosystems which in turn augments the aquatic productivity. concentration of all ponds lies below the level of eutrophication. This nutrient study will help in the effective management of lentic ecosystems which in turn augments the aquatic productivity.

KEY WORDS
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INTRODUCTION

The increased awareness and valuing of wetlands over the past fifty years has been in a large part due to people experiencing and connecting with these areas. The East Kolkata Wetlands are stretching over 12,500 ha. of area which includes around 254 sewage fed fisheries, agricultural land, some built up area *etc*. Around 45.93% area of East Kolkata Wetlands is manmade water area used to be a buffer zone. But, later on sewage started to be dumped here due to increased urbanization. Consequently the practice of sewage fed pisciculture and agriculture made this area a natural waste recycling region. So, this wetland system is popularly known as the kidney of the city and has been included under Ramsar Convention during the year of 2002 (Kundu *et al*., 2008). Sewage may contain high levels of the nutrients especially nitrogen and phosphorus. The abiotic processes of pond ecosystems are dominated by three nutrient cycles namely carbon, nitrogen, and phosphorus.

Management of these nutrient levels is very much essential to avoid eutrophication of the wetlands. Information about seasonal variations of the major nutrients is essential for the effective management of these wetlands. The dynamics and seasonal cycles of the nutrients – nitrate, nitrite, phosphate, silicates and sulphates were controlled most of the biological activities in an aquatic ecosystem (Ludwig *et al.,* 2005). Diurnal variability in nitrate concentrations has been attributed to denitrification rates, resulting in higher concentrations during periods of daylight (Harrison *et al*., 2005).

Studies on the distribution, variation and transfer processes of nutrients are therefore vital in assessing the water pollution problems and study of ecology in the area (Thilaga *et al.,* 2005). For the present study three ponds have been selected to obtain a clear understanding of the role of nitrogen and phosphorus dynamics in ponds which has extensive, social and financial implications.

MATERIALS AND METHODS

The study was conducted on three selected lentic water bodies of East Kolkata Wetlands, and is denoted as P-1, P-2 and P-3. All the ponds are used for fish culture as well as domestic purpose. The study was conducted during the period from November 2015 to July 2016. To obtain a detailed status of water bodies, three sampling sites from each water body were randomly selected. Both the water and sediment samples were collected fortnightly in the early morning (between 7.00 am and 9.00 am) from selected sites of the water bodies. Collection, preservation and analysis of nutrient parameters like nitrate-nitrogen and phosphate-phosphorus of water, and organic carbon, available nitrogen and available phosphorus of sediment was done according to the standard methods of APHA (2012).

RESULTS AND DISCUSSION

The minimum and maximum nitrate values in three ponds varied from 0.12 ± 0.02 mg/l to 0.43 ± 0.08 mg/l in P-1, 0.14 ± 0.01 mg/l to 0.48 ± 0.03 mg/l in P-2 and 0.32 ± 0.01 mg/l to 1.05 ± 0.06 mg/l in P-3 respectively (Fig:1). Statistical analysis revealed that nitrate among the ponds and months were significantly varying at $P \leq 0.05$ (Table:1). Pearson correlation coefficient (r) revealed that nitrate-nitrogen showed positive correlation with available phosphorus in P-1.

In the present investigation, seasonally, nitrate was maximum during monsoon followed by summer and winter in three ponds. Similar fluctuations were also observed by Sivakumar and Karuppasamy (2008) ranging from 0.90 mg/l (November) to 0.70mg/l (July) from reservoirs of Tamilnadu and Manjare *et al*. (2010) reported the nitrate values of 37.5 mg/l (July) to 4.40mg/l (November) from the reservoirs of Maharashtra. According to Anderson *et al*. (1998), higher concentration may be due to influx nitrogen rich flood water and bring about large amount of sewage. The rainy season was period with the highest nitrate-nitrogen concentration which is known to support the formation of blooms. Minimum values were recorded during winter might be due to lower rate of oxidation (Sayeswara *et al.,* 2011). Nitrate-nitrogen showed direct relation with phosphate-phosphorus and the same relation was also reported by Sharma *et al*. (2012).

The minimum and maximum phosphate values in three ponds varied from 0.17 ± 0.04 mg/l to 0.81 ± 0.05 mg/l in P-1, 0.41 ± 0.02 mg/l to 0.74 ± 0.05 mg/l in P-2 and 0.25 ± 0.03 mg/l to 0.76 ± 0.02 mg/l in P-3 respectively (Fig:2). Statistical analysis revealed that phosphate among the ponds and months were significantly varying at $P \leq 0.05$ (Table:2). Pearson

Table1: Two-way ANOVA (with replication) for nitrate- nitrogen

ANOVA						
Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Ponds	2.952404	2	1.476202	937.0874	5.74E-69	3.080387
Months	3.486356	17	0.20508	130.1838	9.89E-64	1.718165
Interaction	3.819507	34	0.112338	71.31203	1.29E-59	1.538002
Within	0.170133	108	0.001575			
Total	10.4284	161				

Table 2: Two-way ANOVA (with replication) for phosphate-phosphorus.

ANOVA						
Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Ponds	1.532912	2	0.766456	495.0793	4.06E-55	3.080387
Months	1.638803	17	0.0964	62.26806	9.37E-48	1.718165
Interaction	2.847399	34	0.083747	54.09497	1.52E-53	1.538002
Within	0.1672	108	0.001548			
otal	6.186314	161				

Table3: Two-way ANOVA (with replication) for Sediment organic carbon

ANOVA						
Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Ponds	0.066411	2	0.033206	17.12607	3.47E-07	3.080387
Months	10.455	17	0.615	317.192	7.1E-84	1.718165
Interaction	4.8731	34	0.143326	73.92196	2.05E-60	1.538002
Within	0.2094	108	0.001939			
Total	15.60391	161				

Table 4 :Two-way ANOVA (with replication) for Available Nitrogen

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Ponds	8314.158	2	4157.079	19833.63	2.7E-139	3.080387
Months	579.5564	17	34.09155	162.6525	1.05E-68	1.718165
Interaction	1205.269	34	35.4491	169.1294	4.1E-79	1.538002
Within	22.63653	108	0.209598			
Total	10121.62	161				

Table 5: Two-way ANOVA (with replication) for Available phosphorus

ANOVA						
Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Ponds	65.6192	2	32.8096	2293.586	3.43E-89	3.080387
Months	26.91278	17	1.583104	110.6684	3.86E-60	1.718165
Interaction	10.93855	34	0.321722	22.49028	3.12E-35	1.538002
Within	1.544933	108	0.014305			
Total	105.0155	161				

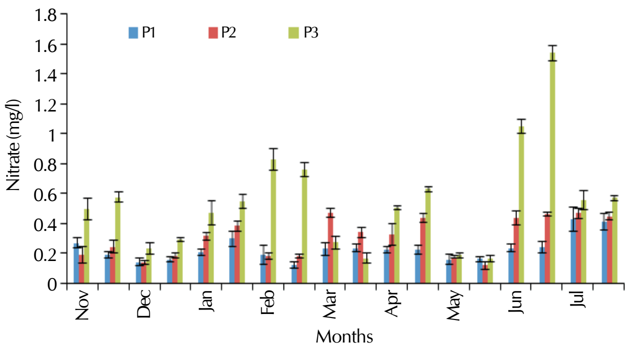

Figure 1: Average fortnight variation of nitrate- nitrogen (mg/l) with SD in three ponds during 2015-2016

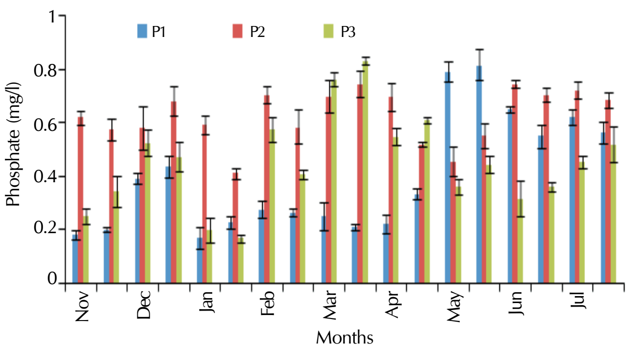

Figure 2: Average fortnight variation of phosphate-phosphorus (mg/l) with SD in three ponds during 2015 -2016

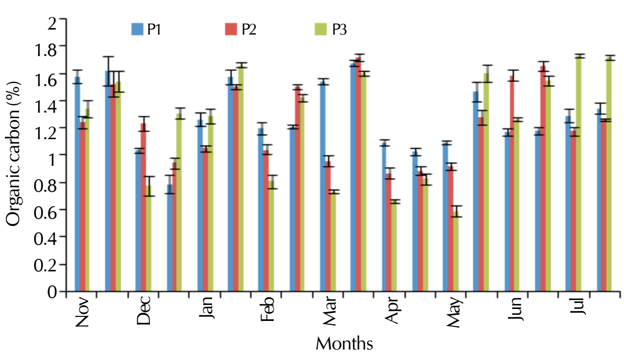

Figure 3: Average fortnight variation of Sediment organic carbon (%) with SD in three ponds during 2015 -2016

correlation coefficient (r) revealed that phosphate-phosphorus showed negative correlation with available nitrogen in P-2 and it showed positive correlation with nitrate-nitrogen in P-2. In P-3, it showed negative correlation available phosphorus. In the present investigation, seasonally, phosphate-phosphorus was maximum in summer followed by monsoon and winter. This correlates with the findings of various workers like Hulyal and Kaliwal (2011). Verma *et al.* (2012) also reported lowest levels during winter. Phosphate ranged from 0.21 mg/l (May, November) to 0.42 mg/l (February, July) in Danteshwar pond, Gujarat was reported by Pathak and Mankodi (2013), whereas 0.14 to 0.92 ppm phosphate was recorded from a dam of Aurangabad (Shinde *et al.*,2010) which is in agreement with the present findings.

The minimum and maximum values of organic carbon in three ponds varied from 0.8 ± 0.06 % to 1.7 ± 0.02 % in P-1, 0.86 ± 0.04 % to 1.65 ± 0.03 % in P-2 and 0.59 ± 0.04 % to 1.71 ± 0.02 % in P-3 respectively (Fig:3). Seasonally, sediment organic carbon was maximum in summer followed by monsoon and winter in P-2. In P-1 and P-3 sediment organic carbon was maximum during monsoon followed by winter and summer. Statistical analysis revealed that organic carbon among the ponds and months were significantly varying at $P \leq 0.05$ (Table:3). The Pearson correlation coefficient (r) revealed that sediment organic carbon showed positive correlation with available phosphorus in P-2 and P-3 while it showed a negative correlation with available nitrogen in P-3.

Seasonally, higher organic carbon was found during monsoon and lower during summer. Almost similar type of observations were made by Das and Bandyopadhyay (1998), who reported that in Kole beel of West Bengal, the organic carbon content was higher in monsoon (0.68%) as compared to winter (0.45%) and summer (0.38%). Natural processes and human activities have resulted in elevated content of organic carbon in sediment which includes diverse input from inappropriate animal waste applications and disposals, forest clear cuttings, agricultural practices and changes in land uses (Kamaruzzaman *et al.*, 2009). The observed peak value of organic carbon in monsoon is due to the influx of land run off containing considerable amount of terrigenous organic matter such as dead planktonic matter which settles at the bottom and get oxidized and decomposed releasing high level of organic carbon in the sediment (Martin *et al.,* 2010).

The minimum and maximum values of available nitrogen in three ponds varied from 10.6 ± 0.2 mg/100g of soil to 17.0 ± 0.5 mg/100g of soil in P-1, 18.2 ± 0.3 mg/100g of soil to 25.9 ± 0.7 mg/100 g of soil in P-2 and 28.9 ± 0.6 mg/100g of soil to 35.6 ± 0.4 mg/100g of soil in P-3 respectively (Fig:4). Statistical analysis revealed that available nitrogen among the ponds and months were significantly varying at $P \leq 0.05$ (Table:4). The Pearson correlation coefficient (r) revealed that available nitrogen was insignificant among the ponds and months.

Seasonally, available nitrogen was maximum in summer followed by monsoon and winter in three ponds. Higher amount of available nitrogen, during summer might be due to increased temperature and light intensity, which accelerates the rate of mineralization process. Similar observations were made by Vijayakumar *et al.* (2000) and Saravanakumar *et al.* (2008) as concentration of nitrogen was highest during pre-monsoon season which could be attributed to oxidation of organic matter which has settled on the top layer of sediment.

The minimum and maximum values of available phosphorus in three ponds varied from 1.0 ± 0.01 mg/100g of soil to 2.7 ± 0.06 mg/100g of soil in P-1, 2.6 ± 0.05 mg/100g of soil to 4.6 ± 0.05 mg/100g of soil in P-2 and 2.3 ± 0.05 mg/100g of soil to 4.3 ± 0.04 mg/100g of soil in P-3 respectively (Fig:5). Statistical analysis revealed that available phosphorus among the ponds and months were significantly varying at $P \leq 0.05$ (Table:5). The Pearson correlation coefficient (r) revealed that available phosphorus was insignificant among ponds and months.

Phosphorus is a key nutrient found in soil. Phosphorus content

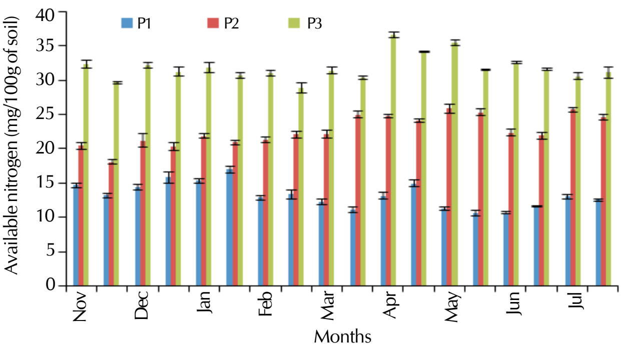

Figure 4: Average fortnight variation of available nitrogen (mg/100g of soil) with SD in three ponds during 2015 – 2016.

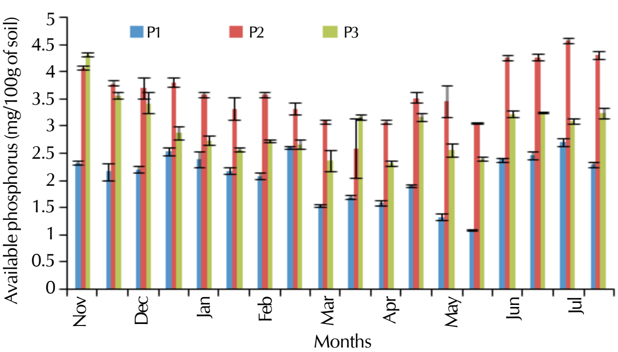

Figure 5: Average fortnight variation of available phosphorus (mg/100g of soil) with SD in three ponds during 2015-2016

of water in aquatic systems is greatly influenced by the bottom sediments. Sediments often play an important role in the uptake, storage and release of dissolved inorganic phosphorus in aquatic systems (Haggard *et al.*, 2004). In the present investigation, available phosphorus was maximum during monsoon followed by winter and summer in P-1 and P-2 where as in P-3, maximum available phosphorus was recorded during winter followed by monsoon and summer. Mahajan and Mondloi (1998) stated that the available phosphorus values were higher during monsoon (10.73 mg/100g of soil) from a pond in Madhya Pradesh which correlates with the present findings from three study ponds. The higher values of available phosphorus during monsoon might be due to allochthonous input of nutrients during rain water.

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