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Seasonal Variation In Ionic Fluxing In The Fresh Water Bodies Of Lucknow City Of U.P. (India)

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Abstract
Surface water of natural wetlands of Lucknow city was monitored as a part of comprehensive study of natural imbalance of nutrient ions such as PO_4, NO_3, Cl and NH_4. The common seasonal changes were recorded and statistically analyzed exhibiting a correlation of parameters and also the dependency of one on another. In summer where there is a loss of water due to evaporation results in more ionic concentrations, however, the rainy and winter seasons receives a different chemistry after a average spell of rain. Overall study presents a seasonal variation in the ionic species in water and its impact on the water chemistry.

Keywords: *Seasonal variation, Nutrients, correlation of parameters*

Introduction
All natural water contains dissolved ionic constituents. The distribution of these species in water vary with geographic location and the residence time. Nitrate is present in small amount in fresh waters having higher values of oxygen. Nitrogen is a complex element that can exist in seven states of oxidation. For the water quality standpoint nitrogen containing compounds such as ammonia (NH_3), Nitrate (NO_3-) and Nitrite (NO_2-) are of great importance. Bacterial life within the water largely affects the nitrogen cycle in water (Water quality, 1985). Phosphates enter waterways from several different sources. An average human body excretes about 1 pound i.e., 454 grams per year as Phosphates (Quality Criteria, 1975). Phosphorus is an essential element for the growth of algae and other aquatic organisms, there fore eutrophication of lakes and ponds and even estuaries may occur if the phosphorous content exceeds 0.015 g/m^3. Eutrophication decreases the O_2 content and increased the NH_4+ availability in fresh waters. These changes may affect carbon and nitrogen transformation processes and the production of CH_4 and N_2O (Liikanen & Martikainen, 2003).
The ionic species and their properties in water depend on the geographical and topographical conditions. The closed systems (Ponds, Lakes and Pools) entirely depend upon annual average precipitation. The ionic strength of water is also determined by the conductivity, which is the capability of electrical conductance (Quality Criteria, 1975). It has been reported that about the change in the ion chemistry of the water considerably with the change of climatic conditions on regional scale. The ion concentration in the lakes has also been reported more due to the excessive evaporation (Yang and Williams, 2003).
In the present work the emphasis has been given to the ionic fluxing of the ions of biological importance such as chloride, nitrate, ammonia and phosphate along with other parameters like bicarbonates, pH and conductivity. The Ion fluxing study and the dilution factor is considered here as a major water quality-affecting phenomenon.

Materials & Methods
Three water bodies belonging to the municipal corporation of Lucknow city were selected for the present

study. Water samples were collected in different seasons of summer i.e., March - June, rainy i.e., July -October and winter i.e., in month of November to February, in iodide washed white plastic containers. To avoid the loss of dissolved oxygen it was fixed after collecting it in a glass bottles using fixing reagent. The pH and electrical conductivity were recorded at the site itself with help of a portable pH and EC meters however, both the parameters were also tested in the lab conditions too. All the test parameters were performed as per the Standard Method of APHA (1991).

Ions were analyzed with the help of an Ion Selective Electrode meter provided by Thermo Orion model 920 A Plus and heavy metals were analyzed on the Atomic absorption spectrophotometer Perkin Elmer model 5100. Water samples were collected from the different sites from ponds. The statistical calculations were made with the help of computer-aided software SPSS 13.0 version. SPSS 1997.

Results & Discussion

The results are based on the regular analysis of water collected in different seasons from different water bodies. Table 1 shows the value of water quality parameters of the waters collected from the shore, showing higher values of ionic concentrations in almost all the ponds viz., D, F & G. pH ranges between <6 in D and reaches up to > 8.76 in G water body Liikanen *et al* (2003) found similar trend. Parameters of water quality were showing a tendency of dependence on each other. For which correlation matrix was obtained by the help of computer-aided software SPSS see Table 3 & 4. Two-tailed significant value was considered showing a negative correlation between the parameter sets such as pH - EC, PO_4, NO_3 and HCO_3 - EC, pH. The negative correlation values showing the reciprocal changes in the nature of chemicals i.e., the increase in one will cause the decrease in the other. Bi carbonate ions are negatively correlated with electrical conductivity with a significant value of - 0.980 that is also confirmed by the correlational value of EC and pH. NO_3 is significantly correlated with the dissolved oxygen with a value of 0.999 showing the perfect relation of simultaneous increase of each parameter. Similarly phosphate and ammonium ions have been found to be correlated with the same value of 0.999 Yang and Williams (2003) reported same correlation . Table 2 represents the value of quality parameters of water collected from 2 meters away from the shores. Table 5 & 6 represents the correlation matrix of each parameters season and water body wise. The results show almost the same correlational values. However, in the waters collected from 2 meters away from the shores shows a variable trends.

The ionic strength remains normally elevated in the summer and get diluted in rainy season. The microbes however, consume the ions in summer the value never goes down. The pH value of natural water depends on the carbonate system which is present naturally and get disturbed in case of the higher levels of biostimulants such as PO_4, NO_3, NH_4 & Cl that causes the growth of algae and other phytoplankton in water that removes almost all the carbonate ions that elevated the pH of water see table 1. The water collected from the 2 meter inside the water body shows a trend of dilution in the concentrations of ions. More water leads to the reduction in the microbial count, as most of the microbes needs substratum to grow. Least microbial activity reduces the demineralization process and hence the reduction in the ionic contents. The run off from the surroundings of the fields nearby the water body let it to get enriched but in the same time most of the phytoplankton grow and remove most of the ions from the water.

Conclusion

The water quality of ponds of different nature were analyzed in different seasons and found to have a correlation in the parameters. The ionic fluxing in the water depends up on the geographical, chemical and biological factors. However, there is a significant impact of each parameter on the water chemistry. Some correlations are naturally occurring such, as the dissolved oxygen is associated with the nitrate and ammonia content.

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Table 1 : Mean and Standard deviation of quality parameters of water in different seasons

Pond	Group (Season)	Parameters							
		pH	EC	DO	HCO_3	PO_4	NH_4	NO_3	Cl^-
D 1	Summer	6.99 (0.10)	1800.0 (172.71)	2.33 (1.45)	543.0 (35.17)	4.0 (1.08)	115.9 (5.99)	17.80 (3.75)	109.30 (14.35)
	Rainy	7.14 (0.59)	719.0 (66.20)	3.40 (1.31)	255.0 (21.80)	0.17 (0.01)	1.92 (1.20)	21.60 (1.22)	96.50 (4.09)
	Winter	7.92 (0.16)	778.0 (58.28)	3.30 (1.66)	603.0 (60.31)	1.95 (0.19)	ND	21.10 (2.87)	136.90 (33.12)
F 2	Summer	8.16 (0.10)	230.0 (25.51)	5.60 (2.08)	568.13 (23.74)	0.99 (0.31)	26.87 (6.12)	17.03 (3.54)	114.80 (66.56)
	Rainy	7.36 (0.16)	688.3 (39.79)	5.90 (1.13)	201.48 (12.3)	0.12 (0.05)	0.70 (0.7)	23.13 (4.96)	37.25 (4.02)
	Winter	8.38 (0.87)	477.0 (9.54)	8.30 (1.48)	433.0 (45.13)	0.06 (0.05)	ND	13.40 (2.72)	21.80 (1.44)
G 3	Summer	8.76 (0.24)	674.33 (42.40)	4.00 (0.17)	266.67 (11.55)	2.74 (0.42)	17.46 (0.77)	39.18 (0.74)	99.57 (1.50)
	Rainy	8.87 (0.32)	537.33 (42.10)	11.60 (0.35)	161.33 (1.26)	0.96 (0.17)	0.07 (0.02)	70.80 (0.20)	27.72 (0.63)
	Winter	8.30 (0.17)	720.0 (92.90)	6.03 (0.12)	336.00 (27.07)	1.48 (0.27)	0.11 (0.01)	68.50 (1.56)	32.21 (1.35)

Table 2. Mean and Standard deviation of quality parameters of water at 2 mt away from the shore in different seasons

Pond	Group (Season)	Parameters							
		pH	**EC**	**DO**	**HCO_3**	**PO_4**	**NH_4**	**NO_3**	**Cl^-**
D 4	**Summer**	7.02 (0.27)	1720.0 (160.93)	5.40 (1.25)	588.0 (59.43)	3.62 (0.91)	49.50 (12.42)	33.30 (2.86)	131.13 (46.12)
	Rainy	7.91 (0.18)	706.0 (56.67)	3.00 (0.35)	280.0 (69.46)	0.10 (0.04)	4.03 (2.61)	19.0 (2.78)	98.0 (4.36)
	Winter	7.83 (0.22)	765.0 (59.81)	3.96 (1.80)	614.0 (118.7)	2.23 (0.52)	ND	18.30 (1.86)	118.1 (30.64)
F 5	**Summer**	8.20 (0.05)	225.0 (29.51)	5.97 (2.14)	615.0 (195.2)	1.04 (0.13)	9.15 (1.56)	15.60 (4.91)	72.60 (19.63)
	Rainy	7.59 (0.46)	590.0 (134.3)	7.37 (0.90)	319.0 (68.94)	0.19 (0.14)	ND	19.92 (2.18)	23.30 (3.24)
	Winter	8.27 (0.23)	480.0 (2.65)	8.60 (1.40)	423.0 (15.4)	0.06 (0.05)	ND	14.50 (1.65)	20.80 (1.04)
G 6	**Summer**	8.04 (0.09)	537.0 (41.73)	6.23 (0.12)	286.3 (5.69)	2.07 (0.10)	9.56 (0.68)	43.99 (3.40)	109.4 (9.35)
	Rainy	7.68 (0.33)	480.0 (8.0)	9.43 (0.80)	152.6 (8.3)	1.29 (0.3)	0.14 (0.03)	68.83 (2.32)	92.4 (2.7)
	Winter	7.62 (0.29)	587.3 (24.34)	8.17 (0.06)	207.6 (13.28)	1.69 (0.25)	0.13 (0.05)	63.73 (3.86)	88.03 (6.27)

EC = electrical conductivity in µmhos/cm, DO = dissolved oxygen in mg/l, HCO_3 = bi-carbonates in mg/l, PO_4 = phosphate in mg/l, NH_4 = ammonium in m g/l, NO_3 = nitrate in ppm, Cl = chlorides in mg/l. Values in parenthesis are std. dev

Table 3 : Correlation coefficient between water quality parameters

	Group 1 ?							
	pH	**EC**	**DO**	**HCO_3**	**PO_4**	**NH_4**	**NO_3**	**Cl^-**
pH		-0.585	0.556	0.509	-0.190	-0.635	0.525	0.893
EC	-0.714		-0.999*	0.398	0.907	0.998*	-0.997*	-0.159
DO	0.577	0.158		-0.431	-0.921	-0.995*	0.999*	0.123
HCO_3	0.836	-0.980*	0.036		0.747	0.340	-0.464	0.841
PO_4	0.256	-0.859	-0.640	0.743		0.878	-0.935	0.271
NH_4	0.290	-0.876	-0.876	0.766	0.999*		-0.990*	-0.221
NO_3	-0.985*	0.584	-0.708	-0.730	-0.087	-0.122		0.086
Cl^-	0.160	-0.805	-0.712	0.674	0.995*	0.991	0.010	
	Group 2 ?							

Significant at 0.05 probability level

Table 4. Correlation Coefficient between water quality parameters

	pH	EC	DO	HCO_3	PO_4	NH_4	NO_3	Cl^-
pH		-0.812	0.431	-0.896	0.052	0.332	-0.271	0.281
EC			-0.875	0.986*	0.538	0.279	-0.339	0.330
DO				-0.786	-0.878	-0.707	0.751	-0.744
HCO_3					0.395	0.120	-0.182	0.173
PO_4						0.959	-0.975	0.973
NH_4							-0.998*	0.998*
NO_3								-0.999*
Cl^-								

*Significant at 0.05 probability level

Table 5. Correlation Coefficient between water quality parameters (2mt away from shore line)

	Group 4 ?							
	pH	**EC**	**DO**	**HCO_3**	**PO_4**	**NH_4**	**NO_3**	**Cl^-**
PH		-0.999	-0.946	-0.509	-0.845	-0.988	-0.992	-0.844
EC	-0.665		0.937	0.484	0.829	0.992	0.995	0.827
DO	0.056	0.707		0.759	0.972	0.886	0.900	0.971
HCO_3	0.705	-0.998	-0.667		0.890	0.371	0.400	0.891
PO_4	0.302	-0.912	-0.934	0.888		0.753	0.773	0.999
NH_4	0.416	-0.955	-0.884	0.938	0.992		0.999	0.751
NO_3	-0.995	0.587	-0.155	-0.631	-0.206	-0.324		0.772
Cl^-	0.377	-0.942	-0.903	0.922	0.996	0.999	-0.283	
	Group 5 ?							

*Significant at 0.05 probability level

Table 6. Correlation Coefficient between water quality parameters (2mt away from shore line)

	pH	EC	DO	HCO_3	PO_4	NH_4	NO_3	Cl^-
pH		-0.094	-0.860	0.850	0.783	0.991	-0.946	0.998
EC			-0.425	0.443	0.544	0.036	-0.231	-0.156
DO				-0.999	-0.990	-0.920	0.978	-0.827
HCO_3					0.993	0.912	-0.974	0.815
PO_4						0.858	-0.941	0.743
NH_4							-0.980	0.981
NO_3								-0.924
Cl^-								
	Group 6 ?							