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TEMPORAL VARIATIONS IN ABIOTIC FACTORS OF A TROPICAL FLOODPLAIN LAKE, UPPER ASSAM (N. E. INDIA)

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INTRODUCTION

Floodplain lakes, locally called 'beels', comprise an integral component of the Brahmaputra and the Barrak river basins of Assam (N. E. India) and cover over 93% of total fish-prone lentic area of this state. Information about their abiotic parameters, a pre-requisite for scientific management, is till now confined to fewer published reports (Dey and Kar, 1987 ; Yadava *et al.* 1987 ; Kakati and Bhattacharya, 1989 ; Yadava and Dey, 1990 ; Dutta *et al.* 1995) from lower Assam.

The present study, first of its kind in floodplain lakes of Upper Assam, deals with temporal variations in abiotic factors of Samuajan beel and ecological correlations between these parameters. The results obtained are discussed in comparison with works in beels of Assam as well as those elsewhere in India.

MATERIAL AND METHODS

The observations were undertaken from March, 1994-February, 1995 in Samuajan beel (Longitude : 94° 56' E ; latitude : 26° 75' N) located in the Dhemaji district, Upper Assam region of the Brahmaputra basin. This ox-bow lake (area : 54 ha, depth : 0.7-2.4 m) was covered with luxuriant growth of *Eichhornia crassipes, Hydrilla, Potamogeton, Nymphaea* etc. Water samples were collected from this beel at regular monthly intervals. Air and water tempertures were noted with a thermal proble ; pH and specific conductivity were noted with pH and conductivity metres respectively ; disssolved oxygen was estimated by modified Winkler's method and other chemical parameters were analyzed following APHA (1985). Rainfall data was collected from local meterological laboratory. Ecological relationships were established by computing correlation coefficients (r) between various factors.

REMARKS AND DISCUSSION

Temporal variations in abiotic factors of Samuajan beel are indicated in Table : 1 ; their salient features and ecological correlations are discussed hereunder :

Rainfall : Total monthly rainfall (0-486 mm) is distinctly influenced by South-west monsoons. It registered a significant direct correlation with water temperature ($r = 0.815$) which apparently resulted due to concentration of precipitation during warmer months. Besides, the rainfall depicted

inverse correlations with important parameters namely specific conductivity (r = –0.509) alkalinity (r = –0.743), total hardness (r = –0.615), Calcium (r = –0.584) and Magnesium (r = –0.590) and, hence, it exercised significant dilution impact in the present study.

Table 1. Monthly variations in abiotic factors of Samuajan beel

	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Rainfall (mm)	22.0	50.5	190.0	389.0	476.0	302.4	156.0	360.0	18.0	0	16.0	34.5
Air temperature (°C)	21.0	24.0	30.0	33.0	38.0	28.0	26.0	25.0	25.0	21.0	15.0	20.0
Water tmperature (°C)	22.5	23.0	28.0	28.0	31.0	30.0	30.0	27.0	23.0	18.0	17.0	22.0
Transparency (cm)	79.0.	81.0	84.0	60.0	15.0	16.0	12.0	23.0	47.0	83.0	45.0	55.0
Specific Conductivity (µS/cm)	186.0	174.0	123.0	85.0	112.0	80.0	70.0	142.0	148.0	160.0	120.0	108.0
pH	7.5	7.5	7.1	7.1	6.5	6.5	6.5	6.5	6.5	7.2	7.2	7.2
Dissolved oxygen (mg/l)	5.6	7.2	5.6	4.0	4.8	7.2	6.4	7.2	6.4	11.2	6.0	10.4
Free Carbon dioxide (mg/l)	4.0	6.0	8.0	6.0	8.0	4.0	4.0	4.0	6.0	6.0	6.0	6.0
Total Alkalinity (mg/l)	100.0	90.0	70.0	44.0	56.0	38.0	36.0	40.0	70.0	92.0	70.0	90.0
Total Hardness (mg/l)	110.0	120.0	80.0	60.0	66.0	50.0	48.0	90.0	102.0	95.0	90.0	80.0
Calcium (mg/l)	48.3	52.5	44.1	31.5	35.1	25.2	23.0	50.4	54.6	54.6	50.4	44.1
Magnesium (mg/l)	14.9	16.4	8.7	6.9	7.3	6.0	6.0	9.6	11.5	9.8	9.6	8.7
Sodium (mg/l)	38.0	20.0	22.0	22.0	12.0	16.0	15.0	20.0	28.0	34.0	35.0	40.0
Potassium (mg/l)	2.0	3.0	4.0	4.0	7.0	3.0	2.0	3.0	6.0	4.0	2.0	2.0
Chloride (mg/l)	9.4	9.4	10.9	12.5	14.0	15.6	14.0	15.6	15.6	7.8	7.8	12.5
Sulphate (mg/l)	10.0	12.2	5.2	4.2	33.1	29.4	29.4	11.6	7.5	13.6	12.7	9.6
Phosphate (mg/l)	0.01	0.05	0.05	0.06	0.29	0.28	0.27	0.04	0.04	0.03	0.04	0.05
Nitrate (mg/l)	1.40	1.40	1.30	1.70	1.80	1.80	1.60	1.56	1.20	1.30	1.36	1.66
Silicate (mg/l)	4.08	1.28	1.21	3.23	1.82	1.68	1.68	2.41	5.10	5.10	3.39	4.07

Temperature : Air temperature (15-33°C, 21.5±9.5°C) and water temperature (13-31°C, 24.4 ± 4.7°C) followed identical annual trends ; the former significantly influenced the latter (r = 0.861). The recorded tropical ranges corraborated with other Indian floodplain lakes (Dey, 1981 ; Dey and Kar, 1987 ; Vass, 1989 ; Yadava and Dey, 1990 ; Singh and Roy, 1990 ; Sinha *et al.* 1994 ; Sharma, communicated). Mean water temperature is noticed to be higher than mean air temperature and it is evidently attributed to heating caused due to shallow nature of the sampled beel and thick growth of aquatic macrophytes.

Transparency : Samuajan beel reflected low transparency (12-84 cm, 50.0 ± 28.2 cm) with broadly bimodal pattern ; annual range, however, remained lower than other beels of Assam (Lahon, 1983 ; Goswami, 1985 ; Dey and Kar, 1987 ; Yadava and Dey, 1990) but mean transparency coincided with the observations by Dey (1981). Further, relatively lower transparency (12-23 cm) noticed during rainy season (July-October) is corraborated by its general inverse relationship with rainfall (r = –0.521) and also with water temperature (r = –0.565). It, however,

registered positive correlations with pH (r = 0.841), alkalinity (r = 0.792), hardness (r = 0.668), Calcium (r = 0.561), Magnesium (r = 0.632) and Sodium (r = 0.566).

pH : It depicted slightly acidic to slightly alkaline nature (pH : 6.6-7.5, 6.8 ± 0.4) ; mean and annual values corresponded with the works of Dey and Kar (1987) and Yadava *et al.* (1987). Acidic nature (pH : 6.5) indicated presently from July-October (monsoons) can be assigned to influx of Carbonic acid with rainwater while the lake water is noticed to be nearly circumneutral during the remaining study period. This aspect is corraborated by inverse correlation between hydrogen-ion concerntration and rainfall (r = -0.557).

Specific conductivity : Samuajan beel is characterised by relatively low ionic concentration (Conductivity: 70-186 µS/cm, 125.6 ± 37.2 µS/cm) which, in turn, can be attributed to predominant effects of abundant rainfall, weathered and leached nature of surrounding rocks and soils and the lowered buffering capacity of demineralized waters (Steinitz-Kannan *et al.* 1983 ; Sharma, 1995). Impact of rainfall is further ascertained by inverse correlation (r = –0.508) between the two parameters. Mean conductivity value is notably lower than the floodplains from Kashmir (Khan, 1987), West Bengal (Vass, 1989) and Bihar (Singh and Roy, 1990) but agreed with the reports from Deepar beel (Dey, 1981) as well as Sone beel (Dey and Kar, 1987) of Assam State. Further, specific conductivity registered inverse correlation with water temperature (r = -0.579) and direct relationships with transparency (r = 0.644), pH (r = 0.598), alkalinity (r = 0.763), total hardness (r = 0.952), Calcium (r = 0.848) and Magnesium (r = 0.925) in the present study.

Dissolved oxygen : Its concentration ranged between 4.0-11.2 mg/l (6.8±3.3. mg/l) and dissolved oxygen depicted 64.0-118.2% saturation. The recorded annual range broadly coincided with the works of Lahon (1983), Yadava *et al.* (1987), Vass (1989), Yadava and Dey (1990), Singh and Roy (1990) and Sinha *et al.* (1994) while its mean value agreed with Yadava *et al.* (*loc cit.*). This dissolved gas did not depict any definite annual pattern but its higher concerntration and supersaturation level particularly during winter months are corraborated by its inverse correlation with water temperature (r = –0.653) which, in turn, is in confirmity with the results of Lahon (*loc cit.*), Goswami (1985), Dey and Kar (1987) and Singh and Roy (*loc cit.*).

Free Carbon dioxide : It occurred throughout the present study period in low concentrations (4.0-8.0, 5.6 ±1.4mg/l) but did not follow any definite pattern. The stated range, however, coincided with the works of Lahon (1983), Goswami (1985), Dey and Kar (1987) and Sharma (1995) but is lower than the results of Yousuf *et al.* (1986), Singh and Roy (1990) and Sinha *et al.* (1994).

Total Akalinity : It ranged between 36-100 mg/l (66.3±33.3 mg/l) and mean value reflected marginally 'hardwater' nature of Samuajan beel. Alkalinity is exclusively attributed to bicarbonate ions in this study and this feature is in general conformity with other floodplains of Assam. The observed range and mean value are, however, higher than the reports by Lahon (1983), Dey and Kar (1987), Yadava *et al.* (1987) and Yadava and Dey (1990). Further, alkalinity did not depict any definite pattern but remained low (36-56 mg/l) during the rainy season (June-October) than during rest of the study period (70-100mg/l). This feature is attributed to dilution impact of rainfall and is evident from their inverse correlation (r = –0.743). On the contrary, alkalinity

registered direct correlations with specific conductivity (r = 0.762), pH (r = 0.771), hardness (r = 0.779), Calcium (r = 0.684), Magnesium (r = 0.740) and Sodium (r = 0.749) ; these relationships agreed with Sharma (1995) while that with pH coincided with the works of Lahon (1983), Goswami (1985) and Dey and Kar (1987).

Total Hardness : The present observations (48 –120 mg/1, 82.5 ± 23.1mg/1) reaffirmed hardwater character of Samuajan beel ; the recorded values are, however, higher than the reports by Lahon (1983), Goswami (1985), Yadava and Dey (1990), Singh and Roy (1990) and Sinha *et al.* (1994). Further, total hardness depicted a bimodal annual pattern with low values (48-60 mg/1) during monsoons and high range (80-120 mg/1) in the remaining period. The former feature indicating dilution impact of rainfall is also supported by an inverse correlation (r = –0.615) between the two parameters.

Calcium (42.8±11.2mg/1) > Sodium (25.1±9.g mg/1) > Magnesium (9.6±3.2mg/1) > Potassium (3.0 ± 1.6 mg/1) contributed to hardness ; the stated order corresponded with the observations of Yadava *et al.* (1987) and Sinha *et al.* (1994). First three alkaline earth metals also depicted direct relationships (r = 0.689, r = 0.749, r = 0.710 respectively) with total hardness. Further, Calcium content is distinctly higher than other floodplain lakes of Assam (Lahon, 1983 ; Goswami, 1985 ; Dey and Kar, 1987 ; Yadava and Dey, 1990 ; Goswami, 1997) while Sodium concentration agreed with the report by Sinha *et al.* (loc cit.).

Chloride : Low concentration of this cation (7.8-15.8 mg/1, 12.0 ± 2.9 mg/1) in Samuajan beel corresponded with its range in natural freshwaters (Wetzel, 1983) and, hence, reflected absence of organic pollution. Further, Chloride depicted its general conservative nature while minor variations noticed in the present study are influenced by dilution caused by the rainfall (r =-0.757).

Sulphate : Its concentration (4.2-33.3 mg/1, 14.9±9.9mg/1) coincided with the range in natural freshwaters (Wetzel, 1983) ; mean value corresponded with Yousuf *et al.* (1986). Sulphate content registered a distinct increase (29.4-33.1 mg/1) during monsoon season (July-September) than during rest of the study period (4.2-13.6 mg/1) but did not exhibit significant direct correlation with rainfall thus indicating importance of its release from *in-vitro* decomposition of detritus. Further, it registered inverse correlations with water temperature (r = -0.506), specific conductivity (r = - 0.452), pH (r = -0.534), total alkalinity (r = -0.456) and hardness (r = -0.568) while direct relationships are noticed with phosphate (r = 0.935) and nitrate (r = 0.602).

Phosphate : It fluctuated between 0.01–0.29mg/1 (0.09±0.1mg/1) ; annual range is identical with the results of Yousuf *et al.* (1986), Yadava *et al.* (1987), Vass (1989) and Sinha *et al.* (1994) but is lower than the report by Singh and Roy (1990). Further, it registered unimodal pattern with higher content during monsoon period (0.27-0.29 mg/1), thereby, indicating its influx with rainwater as also supported by direct relationship with rainfall (r = 0.577). In addition, phosphate indicated inverse correlations with water temperature (r = -0.770), specific conductivity (r = -0.669), transparency (r = -0.617), alkalinity (r = -0.629), hardness (r = -0.760), Calcium (r = -0.513), Magnesium (r = -0.623) and Sodium (r = -0.726) while it showed positive relationships with nitrate (r = 0.698), sulphate (r = 0.935) and chloride (r = 0.521). In general, lower phosphate content in water column of Samuajan beel, during most part of the present study period, is attributed to its uptake by luxuriant growth of aquatic macrophytes.

Nitrate : It ranged between 1.2-1.8mg/l (1.5±0.2mg/l and did not depict any definite annual pattern ; annual range and mean value are slightly higher than the reports by Lahon (1983), Yousuf *et al.* (1986), Yadava *et al.* (1987), Vass (1989) and Sinha *et al.* (1990). This micronutrient depicted marginal increase during monsoon and positive correlation with rainfall (r = 0.743) as also noted by Goswami (1985) and Yadava (1987). On the other hand, it registered inverse relationships with water temperature (r = -0.655), specific conductivity (r = -0.667), transparency (r = -0.642), alkalinity (r = -0.569), hardness (r = -0.736), Calcium (r = -0.770), Magnesium (r = -0.519) and Sodium (r = -0.480).

Silicate : Its concentration (1.2-5.1 mg/l, 2.8±1.5 mg/l) is lower than the reports by Dey (1981), Yousuf *et al.* (1986), Yadava *et al.* (1987) and Singh and Roy (1990). Silicate content is relatively higher from November-February and again in March while during the rest of the study period it varied between 1.2-2.4 mg/l. It, however, registered inverse correlations with water temperature (r = -0.689), rainfall (r = -0.534) and phosphate (r = -0.541) while showed positive relationships with alkalinity (r = 0.482), Calcium (r = 0.513) and Sodium (r = 0.770).

SUMMARY

Samuajan beel indicated tropical water temperature (17.0-31.0°C), low transparency (50.0 ± 28.2 cm), slightly acidic to slightly alkaline pH (6.5 - 7.5), low specific conductivity (70-186 µS/cm) and hardwater (alkalinity : 66.3 ± 23.3 mg/l ; total hardness : 82.5 ± 23.1 mg/l, Ca > Na > Mg > K). Dissolved oxygen ranged between 4.0-11.2 mg/l (64.0-118.2% saturation) and very low free Carbon dioxide (4.0-8.0 mg/l) is recorded throughout the study period. This floodplain lake exhibited low Chloride (12.0 ± 2.9 mg/l), Sulphate (14.9 ± 9.9 mg/l), Phosphate (0.09 ± 0.1 mg/l) and Silicate (2.8±1.5mg/l) contents and its nitrate concentration ranged between (1.5±0.2 mg/l). Comments are made on monthly variations in abiotic factors and on ecological correlations between various parameters.

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