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Ecological Studies of the River Padma at Mawa Ghat, Munshiganj I. Physico-chemical Properties

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Abstract: Some selected physico-chemical properties were measured in three stations at Mawa Ghat, Munshiganj, of Padma river between February and December, 2002. The pH of the water was slightly acidic to alkaline (6.2 to 7.5). Conductivity ranged from 106.0-209.0 μS cm^{-1}. The values of chloride, alkalinity, free CO_2 were 65.0-85.6, 57.7-110.0 and 2.3-13.4 mg L^{-1}, respectively. The values of dissolved oxygen were 5.1 to 10.3 mg L^{-1}. BOD_5 ranged from 3.4 to 7.2 mg L^{-1}. Total hardness were 2.9 to 6.5 mg L^{-1} and the values were 2.3-4.2 mg L^{-1} in case of permanent hardness. Total solids were 175.5-472.1 mg L^{-1} and 35.5-179.9 mg L^{-1} dissolved solids were recorded. River water did not show any significant pollution during the present study. Free CO_2 showed negative correlations with all other parameters. The relation was highly significance (p=0.01) in case of conductivity and total hardness. The other parameters showed positive correlation among themselves.

Key words: Padma river, correlation, water quality

INTRODUCTION

Much focus has been given on the studies on the life of fresh water and its interrelationships with habitat factors[1,2]. Blum[1] has pointed out that most of the information pertaining to the river ecology has been obtained from investigations in Europe and North America. Livingstone[3] investigated the chemical composition of rivers and lakes. Wong *et al.*[4] examined the effects of nutrients of the quality of shallow rivers. Large number of studies has been done on the ecology of wetlands in Britain, USA and Canada.

Most of the rivers in Bangladesh passes through the landmass and finally fall into the Bay of Bengal resulting in a series of complex changes in sedimentation and erosion patterns. Rivers passing urban centers are invariably used as depositories for untreated domestic waste, sewage and industrial pollutants, all of which can seriously reduce the quality of down stream surface water and grounds waters and adversely affect aquatic life. The rivers of Bangladesh have been scantly investigated from the ecological point of view except few studies on phytoplankton and water chemistry[5-9]. The study of water quality of Buriganga, Sitalakhay and Baloo river system has clearly shown pollution conditions[10]. In the present investigation an attempt was taken to bring information on ecological conditions with reference to water chemistry, of a small segment of the river Padma (6 km) near Mawa Ghat, Munshiganj.

MATERIALS AND METHODS

Rivers are a prominent and important feature of the landscape in Bangladesh. Some rivers are known by different names in various portions of their course. The river Padma also known as river Ganges, is originated from the Himalaya and passes through India and entered in Bangladesh at greater Rajshahi district. A part of the river Padma near Mawa Ghat, Munshigang (23°15′-23°30′N Latitude to 90°15′-90°30′E Longitude), 40 km south of Dhaka City, was selected for study. The stretch of the river under study was divided into 3 stations. For sampling, a total of 5 visits were made in between February and December, 2002. Water samples were collected in replicates from each zone. Water samples were always taken 45 to 60 cm depth from the surface of the water[11]. The samples were brought up to the surface with minimum disturbance. A centigrade thermometer was used and the temperatures were noted at about 8 inches below the surface of water, during the hours of collection. Outside air temperatures were simultaneously recorded. Analysis of free CO_2, dissolved

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Oxygen (DO), chloride, alkalinity and BOD_5 were carried out after APHA[12].

RESULTS AND DISCUSSION

River water quality study is usually required for stabilizing base line conditions, setting quality criteria and standards; monitoring of temporal.

Air temperature of the studied site varied from 21.4 to 33.8°C. Maximum air temperature was recorded in June, 2002 (summer season), whereas the minimum temperature was recorded in February, 2002 (winter season) (Table 1). During summer, the water temperatures increased due to clear atmosphere and greater insolation from the sun. The average water temperature 29.4°C was similar to that obtained for the river Buriganga[5]. Safi *et al.*[7] observed average temperature 25.8°C of the river Meghna near Daudkandi. In the Karnafully estuary, the value was 27.52°C[6]. However, the average temperature in the river Halda was 2 to 3°C lower than the above mentioned values[8].

The pH of the river water was found to be slightly acidic to slightly alkaline and varied between 6.2 and 7.5. Highest values (7.5) were recorded in the month of

Table 1: Physico-chemical properties of the water of the river Padma near Mawa ghat, Munshiganj

Measurements dates of collection	Zones	Temperature (°C) Air	Water	pH	Conductivity µS cm^{-1}	Chloride mg L^{-1}	Alkalinity mg L^{-1}	Free CO_2 mg L^{-1}	DO mg L^{-1}	DO% saturation	BOD_5
01.02.2002	U	21.4	22.8	7.1±0.39	187.5±12.1	77.0±4.6	81.3±3.9	5.7±0.5	10.3±0.9	118.1±10.5	4.9±0.9
	M			6.7±0.17	191.0±2.5	70.4±7.1	71.1±3.9	5.6±0.7	9.5±1.7	108.6±6.9	5.1±1.1
	D			7.1±0.40	191.0±2.4	65.0±5.1	71.0±7.6	5.3±0.5	8.7±1.3	99.5±6.5	4.2±0.6
14.04. 2002	U	30.1	31.0	6.9±0.20	160.0±28.4	83.3±5.8	92.1±9.9	9.6±1.4	7.7±0.5	103.3±7.7	6.5±1.1
	M			6.9±0.30	159.0±11.2	85.0±5.1	87.5±5.2	8.6±1.5	7.5±0.4	100.5±7.7	5.7±1.3
	D			7.0±0.10	169.5±3.5	85.6±9.5	85.2±7.1	10.2±1.1	8.0±0.3	107.3±11.4	5.8±1.0
30.06. 2002	U	33.8	34.4	6.3±0.40	106.0±9.4	72.0±9.2	57.7±4.3	13.2±2.3	7.3±0.6	102.9±9.3	6.6±1.4
	M			6.3±0.10	111.0±7.6	66.1±8.9	63.3±3.4	13.4±2.9	8.0±0.6	112.9±12.1	7.2±1.4
	D			6.2±0.10	121.3±2.5	70.4±9.2	67.4±3.4	12.9±2.1	7.0±0.4	98.7±9.7	6.5±0.7
15.09. 2002	U	32.9	34.0	7.4±0.30	165.2±11.8	77.4±5.7	110.0±7.8	2.3±0.8	5.4±0.4	76.2±5.6	5.4±0.8
	M			7.5±0.30	177.9±15.4	79.9±8.8	93.4±6.1	2.7±0.7	5.4±0.7	75.7±5.5	3.4±0.5
	D			7.3±0.30	167.6±12.6	77.5±4.4	101.1±9.7	2.9±0.5	5.1±0.6	72.4±4.1	3.8±0.7
1. 12. 2002	U	26.5	27.1	7.2±0.40	182.6±6.8	84.9±5.7	85.4±4.3	9.3±0.9	6.3±0.8	76.1±6.3	4.6±0.9
	M			7.3±0.20	209.0±9.7	79.2±5.0	81.0±6.2	9.0±1.3	6.1±0.7	76.9±7.1	4.7±0.4
	D			7.3±0.40	182.3±8.1	79.2±3.9	77.2±6.1	10.1±0.8	6.1±0.7	76.3±6.8	4.6±0.7

Table 2: Fractions of hardness and solids of water of the river Padma at Mawa Ghat, Munshiganj

Measurements dates of collection	Zones	Hardness (mg L^{-1}) Total	Permanent	Temporary	Fractions of solids (mg L^{-1}) Total solids	Total dissolved solids	Total suspended solids
01.02.2002	U	4.7±0.7	2.6±0.30	2.10±0.60	289.0±27.1	82.6±7.5	210.4±18.8
	M	4.8±0.4	3.6±0.50	1.60±0.30	238.7±38.4	80.6±5.5	152.1±11.6
	D	4.5±0.6	3.9±0.50	0.60±0.10	240.5±29.2	70.3±5.9	177.2±10.4
14.04. 2002	U	3.8±0.4	2.8±0.30	1.10±0.20	320.7±21.5	93.0±6.1	230.7±15.1
	M	4.0±0.3	2.9±0.35	0.98±0.30	350.3±29.7	113.3±8.7	239.9±19.3
	D	4.0±0.3	3.4±0.30	0.60±0.10	310.0±22.9	102.8±6.4	202.9±10.7
30. 06. 2002	U	3.5±0.5	2.3±0.30	1.20±0.20	472.1±35.2	179.9±11.2	298.2±21.1
	M	3.3±0.5	2.9±0.20	0.40±0.10	377.5±25.9	161.7±9.3	221.0±14.5
	D	2.9±0.3	2.6±0.20	0.30±0.00	334.3±27.1	129.4±6.8	211.3±9.7
15.09.2002	U	5.3±0.8	3.6±0.50	1.70±0.30	443.6±31.5	163.2±11.6	265.3±15.9
	M	5.0±0.8	2.9±0.20	2.10±0.60	445.5±29.7	158.4±8.3	273.0±12.7
	D	5.4±0.5	3.9±0.40	1.50±0.30	452.0±38.1	169.2±8.9	292.5±14.1
01.12. 2002	U	4.9±0.4	3.5±0.20	1.40±0.30	209.3±22.1	35.5±4.9	161.7±12.4
	M	6.5±0.7	4.0±0.50	2.50±0.40	229.3±18.8	45.1±3.4	159.0±10.8
	D	5.7±0.6	4.2±0.30	1.50±0.04	175.5±19.3	38.1±3.7	147.1±14.1

(U= Upper reach, M= Middle reach and D= Down reach)

Table 3: Matrix of correlation among physical and chemical parameters of the river Padma at Mawa Ghat, Munshiganj

	pH	Conductivity (µS cm^{-1})	Chloride (mg L^{-1})	Alkalinity (mg L^{-1})	Total hardness (mg L^{-1})	Free CO_2 (mg L^{-1})	DO (mg L^{-1})	Total residue (mg L^{-1})
pH	1.0	0.86***	0.54	0.67*	0.87***	-0.75**	0.68**	0.67*
Conductivity (µS cm^{-1})		1.00	0.30	0.55	0.90***	-0.89***	0.74**	0.55
Chloride (mg L^{-1})			1.00	0.86***	0.21	-0.51	0.09	0.76**
Alkalinity (mg L^{-1})				1.00	0.39	-0.41	0.21	0.87***
Total hardness (mg L^{-1})					1.00	-0.88***	0.77**	0.38
Free CO_2 (mg L^{-1})						1.00	-0.85**	-0.39
DO (mg L^{-1})							1.0	0.05
Total residue (mg L^{-1})								1.00

* = Significance at 5% level, ** = Significance at 1% level, *** = Significance at 0.01% level

September. The pH generally maintained a buffering capacity of the river Padma. Roy[13] observed the pH of the river Hoogly to be more or less stable within the range of 8.3 to 8.4 which is another example of high buffering capacity. No significant difference in pH was observed during the study period except June when the pH dropped to an acidic range (6.2-6.3). In the river Meghna, pH values obtained by Shafi *et al.*[7] ranged from 6.79 to 8.41. Talukdar *et al.*[9] found pH value of 8.1 in their study of the river Padma near North Western region of Bangladesh. Nile water in Egypt showed a pH range of 7.4-8.4[14]. Very high pH (9.7) was recorded in a small stream of New Zealand[15]. Blum[1] observed that removal of carbon dioxide was affected by photosynthesis and may result in an annual variation of pH as in the river Thames[16], where pH attained a value of 8.5 in spring at the time of phytoplankton maximum and was relatively low in summer, fall and winter. Similarly, in the river Padma, the water maintained relatively higher values of pH in the winter season, when the phytoplankton was generally high[17]. In the rainy season, highest values of pH were recorded. This may be due to the river's enormous size and constant water movements, which are expected to bring changes in the levels of carbon dioxide and hence a increase in the rise in the pH value.

Conductivity varied from 106.0 to 209.0 $\mu S\ cm^{-1}$. The highest values were recorded in September and the lowest in June, 2002 (Table 1). The mean value is 177.1 $\mu S\ cm^{-1}$. A low conductivity (94.18 $\mu S\ cm^{-1}$) was recorded in the river Halda by Patra and Azadi[8]. African river Nourouri[18] and a stream in New Zealand[15] had a higher conductivity (278 and 234 $\mu S\ cm^{-1}$, respectively).

Chloride content of the water of Padma River varied from 65.0 to 85.6 mg L^{-1} during the study period, highest being in April and lowest in February. In the other rivers of Bangladesh, chloride varied between 4 and 14 mg L^{-1}[9]. It is apparent that chlorides can be taken as one of the indices of water pollution from sewage and drains in the vicinity of the towns within the drainage basin. The chloride in the Potomac waters appears to be mainly due to sewage contamination[19,20]. In the river Moosi the chloride reached their maximum during summer when the water level was considerably low and reached minimum during the monsoon and winter seasons with comparatively high water levels[21]. Such a condition was also observed by Lakshminarayana[11] in the river Ganges. But in the present study, a considerable high chloride level was recorded during the lean period (April).

Alkalinity of the river water ranged from 57.7 to 110.0 mg L^{-1}. The highest value was found in the month of September whereas the lowest was in the month of June. Highest free CO_2 (13.4 mg L^{-1}) was found in June and the lowest value (2.3 mg L^{-1}) was found in the month of September. The higher values of carbon dioxide recorded in summer might have been due to deoxygenation in a lesser extent, a feature observed also by Talling[22] while investigating the White Nile. The raise in temperature in the river water could be correlated with the increase in carbon dioxide levels[22] but when the water-level increased with commencement of the monsoon, its levels decreased sharply.

The DO concentrations of the river Padma near Mawa ghat, Munshiganj, varied from 5.1 to 10.3 mg L^{-1}. EPA[23] proposed that DO concentrations of less than 5.0 mg L^{-1} are indicative of pollution. The lowest mean value for DO in the present study was 5.1 mg L^{-1}. Periods of high temperatures nearly coincided with those of low oxygen content (Table 1), a feature also observed by Neel[24]. The attainment of maximum levels of dissolved oxygen, during February, 2002 in the river Padma might be due to relatively low temperatures of the waters. The falls in the levels of dissolved oxygen from April, 2002 to September, 2002 were followed by gradual raises in temperature. Shafi *et al.*[7] found almost similar values (6.25 to 10.5 mg L^{-1}) in the river Meghna. Talukdar *et al.*[9] reported DO varied within a normal range (5.4-8.7 mg L^{-1}). Islam *et* al.[25] also reported similar ranges. Venkateswarlu[21] observed range of DO concentration from 2.39 to 8.6 mg L^{-1} in the river Moosi, Hyderabad (India). Low values of DO were usually associated with organic matter[26,27]. DO content, which plays a vital role in supporting aquatic life in running water, is susceptible to slight environmental changes. Oxygen depletion often results during times of high community respiration. For this reason, DO has been extensively used a parameter delineating water quality. Many chemical and physical reactions in water may affect the DO content but the saturation would usually remain close to 100% saturation in the absence of any biological activity. Thus, the diurnal amplitude of DO in aquatic system is, in fact, mainly due to biotic functions[4]. In the present study hypersaturation of DO occurred during the month of February, April and June. During February and April, phytoplankton density was higher[17] and their higher photosynthetic rate might be the reason of hypersaturation. Talukder *et al.*[9] also found hypersaturation in the Bangali river. In a stream of New Zealand, Marshall and Winterbourn[15] observed DO concentration was close to saturation or supersaturated (upto 168%) at most time.

BOD_5 varied from 3.4 to 7.2 mg L^{-1}. The highest value 7.2 mg L^{-1} was recorded in the month of June, whereas the lowest value was found in September. BOD_5 values were lower in February when water level was low and

tends to increase with the rising of water level (June). Talukder *et al.*[9] recorded the BOD_5 values of the river Nandakuja as high as 40 mg L^{-1} whereas the values were 3.0-5.8 mg L^{-1}, 4.0 mg L^{-1} and 2.6 mg L^{-1} in the river Jamuna, Padma and Brahmaputra, respectively[9]. Rai[28] had measured the BOD values in the rivers of Ivory Coast and values ranged between 2.5 and 10.0 mg L^{-1}. Marshall and Winterbourn[15] showed the BOD_5 values between 0.4 to 15.2 g m^{-3}. The BOD and other microbial activities are generally increased by the introduction of sewage[29]. Although BOD is frequently used to monitor wastes loading, enriched river sections other than those exposed to immediate out fall, will not necessarily exhibit BOD problems[29,30].

The range of total hardness was 2.9 to 6.5 mg L^{-1}. There were significance difference (p=0.05) between the values of June and December and between April and December. Permanent hardness values ranged between 2.3 to 4.0 mg L^{-1} whereas the range was 0.3 to 2.5 mg L^{-1} in case of temporary hardness (Table 2).

Total solids varied between 175.5 and 472.1 mg L^{-1}. The lowest values were recorded in December and the values increased gradually with the rainy season to commence which may be responsible for the washed in of material from the catchments areas and erosion of the river banks. Total dissolved solids and total suspended solids ranged between 35.5 to 179.9 and 147.1 to 298.2 mg L^{-1}, respectively (Table 2). This result was supported by the concept of Payne[31].

Free CO_2 showed negative correlations with all other parameters. The relation was highly significant (p=0.01) in case of conductivity and total hardness. The other parameters showed positive correlation among themselves (Table 3). Conductivity showed a very high positive correlation with total hardness. There was also very high correlation between chloride and alkalinity. Alkalinity also showed correlation with total residue.

The present study reveals that water quality of the river Padma near Mawa ghat, Munshiganj, is reasonable. Although the lowest amount of DO in the study area was just above the pollution level as indicated by EPA[23], it may be considered temporary. Comparing the value of DO with the standards for irrigation water quality and drinking water quality for Bangladesh[32], it can be said that the water quality fulfils the irrigation water quality as well as drinking water quality standards for Bangladesh.

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