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PHYSICOCHEMICAL STATUS OF WATER AND DISTRIBUTION OF CHLOROPHYLL *a* IN JAMUNA RIVER

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Abstract

The Physicochemical and biological characteristics of a river ecosystem depict its health and status of sustenance of life. Towards appraisal of water quality, physicochemical parameters, (i.e. water temperature, pH, DO and TSS), water nutrients (nitrate, phosphate and ammonium) and concentration of Chlorophyll *a* were determined. Samples were collected from five stations of different locations with their special feature. The study revealed a slight spatial variation in physicochemical parameters of river water. The water of the river was found slightly alkaline (7.75 ± 0.14). The transparency was found (14.86 ± 1.54 cm) followed by temperature (34.04 ± 0.5 ºC), TSS (0.03 ± 0.038mg/L), DO (2.59 ± 0.22 mg/L), Nitrate (0.16 ± 0.35 mg/L), Phosphate (1.13 ± 0.37 mg/L) and Ammonium (0.32 ± 0.25 mg/L). Chlorophyll *a*, which represents the biomass of phytoplankton, was estimated (0.009 ± 0.004 mg/L). Some physicochemical parameters demonstrated interaction between each other where there was negative correlation between DO and Ammonium ($r = -0.911$, $p = 0.05$). The present status of the Jamuna River seems suitable for all aquatic lives, domestic and agricultural uses.

Key words: Water quality, nutrients, chlorophyll *a* and Jamuna River

Introduction

Water is undoubtedly the most precious natural resource that exists on the planet. It is required essentially for the survival and health of living organisms and also for any developmental activity (Kumar *et al*., 2011; Suresh *et al.,* 2013). Water quality of the freshwater habitats provides substantial information about the existing resources which depend on the influences of physicochemical parameter and biological features (Sivakumar and Karuppasamy, 2008). The physical and chemical properties of fresh water body are characterized by the climatic, geochemical, geomorphologic and pollution conditions (Ishaq and Khan, 2013). Clean, safe and adequate freshwater is important for all living organisms and the functioning of ecosystems, communities, and economies and

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the quality of the world's water is increasingly threatened as human populations grow, industrial and agricultural activities expand, and as climate change threatens to cause major alterations of the dydrological cycle. The degradation threatens the health of people and ecosystems, reduces the quality of availability of safe drinking water and other uses, and limits economic productivity and development opportunities.

The term "water quality" is used here to express the suitability of water to sustain various uses or processes. Any particular use will have certain requirements for the physical, chemical or biological characteristics of water; for example, limits on the concentrations of toxic substances for drinking water use or restrictions on temperature and pH ranges for water supporting invertebrate communities. Consequently, water quality can be defined by a range of variables which limit water use. Although many uses have some common requirements for certain variables, each use will have its own demands and influences on water quality (Meybeck *et al.*, 1989).

The environmental quality is greatly focused on water because of its importance in maintaining the human health and health of the ecosystem. Various kinds of pollutants and nutrients flowing through the agency sewage, industrial effluents, agricultural runoff etc. into the water bodies bring about a series of changes in the physicochemical characteristics of water, which have been the subject of several investigations (Maheshwari *et al.,* 2011).

This water is also important for irrigation purposes. Contamination of these industrial and sewerage waste deteriorates the water quality parameters such as pH, DO, NH_4 etc. and alters natural processes and natural resource communities. Due to having no central ETP plants or lowering of unit individual ETP plants, pollution concentration is increasing hazardously and threats for environment is also increasing day by day. Though there were some research work done previously on this study area by Rahman *et al.* (2010) but regular monitoring of those parameters are necessary for estimating the up-to-date level of pollution by which we can be aware of the threats and the problems.

In this study, existing water quality parameters are emphasized for aquatic organisms including fishes in the Jamuna River. The investigated water parameters are compared with relevant standard levels to know the present status of the water quality of the river. The present study is looking at the following specific objectives in order to achieve the broader goals mentioned above. The objectives of the study were to observe the physicochemical characteristics including water nutrients of Jamuna River and to determine chlorophyll *a* content in the water of the river.

Materials and Methods

The study area included downstream of Jamuna River were divided into 5 stations namely, Hard Point (St-1: 24°28.728N to 89°42.753E), Matishaheber Ghat (St-2:

24°27.53N to 89°43.266E), Kata Wabda (St-3: 24°26.92N to 89°42.969E), Belutia (St-4: 24°24.895N to 89°44.702E) and Bangabandhu Bridge (St-5: 24°23.816N to 89°43.897E). Distance between each station was about 2 km. Water sample was collected in triplicate in pre-washed polyethylene bottle from five sampling stations from downstream of Jamuna River. Samples were kept in ice box and were transferred to the laboratory of Environmental Science and Resource Management Department, Mawlana Bhashani Science and Technology University for analysis.

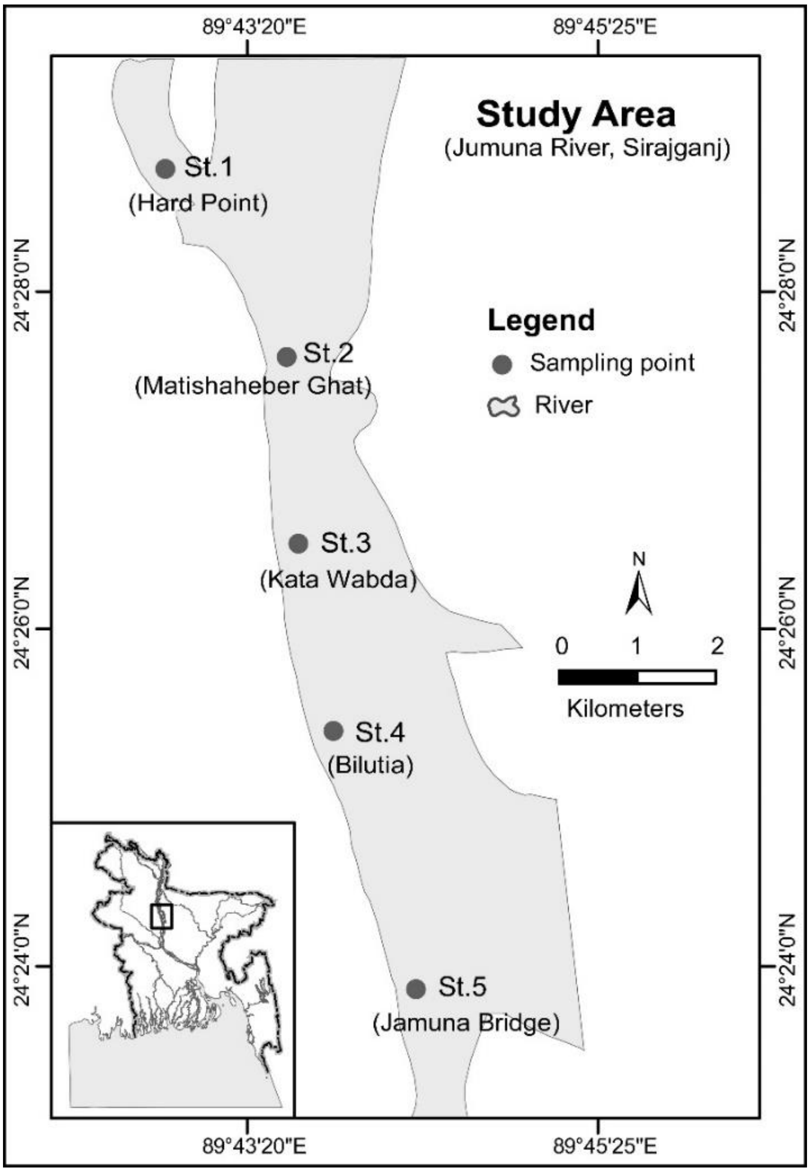

Fig. 1. Map of the study area and the location of different sampling stations

The water quality parameters such as surface water temperature and pH were determined using the digital thermometer (Model: SH-113V1) and digital pH meter (Model: Adwa Ad 1000) respectively. Buffer solution containing pH 7.0 was used to calibrate the digital pH meter. Transparency, Electric conductivity (EC) and Total dissolved solids (TDS) were determined by Secchi Disc method, EC meter (Model: HM digital, Germany) and digital TDS meter (Model: HM digital Germany) respectively. Dissolved nutrients in water were determined for the purpose of relating those to chlorophyll *a* abundance as well as to characterize the water quality. The water samples were filtered using Millipore filtering system (MFS) and analyzed for dissolved inorganic phosphate, nitrate and ammonium following the methods described by Parsons *et al.*1984; Kitamura *et al.* 1982and Weather burn, 1967 respectively. Chlorophyll *a* content of water was estimated following Coombs and Hall's (1982) method. The experimental data were analyzed using Microsoft Excel and Pearson correlation (two tails) was conducted using SPSS. The Arc GIS (Version 10.3) was used to map the spatial distribution of physicochemical and chlorophyll-a of the study area.

Results and Discussion

Physicochemical parameters

The surface water temperature ranged between 32.6°C to 36.5°C with mean 34.6 ± 0.38°C in the month of September. The maximum and minimum water temperature were found 35.9 ± 0.68ºC and 32.7 ± 0.36ºC at near Jamuna bridge (St-5) during the afternoon and at hard point (St-1) respectively (Fig. 2.a). The temperature of Jamuna River was found quite higher than that of the standard level. The higher water temperature could be influenced by the high air temperature of the following day. Generally, with increasing water temperature, the solubility of oxygen is reduced causing deoxygenating (Swingle, 1967) which is also evident from negative correlation between water temperature and dissolved oxygen ($r = -0.897$, $p < 0.01$) (Table 1). However, a positive correlation was found between surface water temperature and the atmospheric temperature ($r = 0.999$; $p < 0.01$) (Table 1).

The observed pH values of five sampling stations in Jamuna River were within the range of 7.45 to 7.79, which is slightly alkaline. The highest pH (7.60 ± 0.17) was found atSt-3 and the lowest pH (7.27 ± 0.22) was found at St-5 (Fig. 2.b). The slight alkalinity of water could be due to soil pH or for domestic and agricultural wastes disposed in the bank of the river. The value of pH is greatly influenced by the presence of carbon-di-oxide, carbonates, bicarbonates and acid rain. Excessive pH is harmful for aquatic life like fish, plants and microorganisms (Huq and Alam, 2005). Most of the water bodies have pH within the range of 6.5 to 8.5 (Das, 1997) which denotes that the water pH of Jamuna River is within the limit.

Table 1. Correlation coefficient among major water parameters of the Jamuna River

	Parameter									
	AT	WT	Trans	TSS	pH	DO	NO_3^-	NH_4^+	PO_4^-	Chl *a*
AT	1									
WT	0.999**	1								
Trans	-0.962**	-0.966	1							
TSS	0.305	0.309	-0.429	1						
pH	0.711**	0.691*	-0.731*	0.146	1					
DO	-0.885**	-0.897**	0.929**	-0.476	-0.609	1				
NO_3^-	0.262	0.277	-0.312	-0.024	-0.050	-0.432	1			
NH_4^+	0.383	0.391	-0.447	0.739*	-0.020	-0.428	0.326	1		
PO_4^-	0.953**	0.959**	-0.902**	0.230	0.618	-0.840**	0.255	0.408	1	
Chl *a*	-0.848**	-0.859**	0.919**	-0.285	-630	0.820**	-0.467	-0.437	-0.836	1

AT = Atmospheric temperature; WT = Water temperature; Trans = Transparency; TSS = Total Suspended Solids; NO_3 = Nitrate; NH_4^+ = Ammonium; PO_4^- = Phosphate; Chl *a* = Chlorophyll *a*
* Correlation is significant at 0.01 level (2-tailed)
** Correlation is significant at 0.05 level

The water transparency of five stations of Jamuna River were found between 12.3 to 16.0 cm. Comparing all the values of transparency, the maximum and minimum were found 16.0 ± 0.15 cm and 12.5 ± 0.05 cm at St-3 and St-2 respectively (Figure 2.c). Transparency or light penetration of water depends on the intensity of sunlight, suspended solid particles, turbid water received from catchment area and density of planktons (De, 2007). Water transparency between 20 to 40 cm is acceptable for fish culture and indicates optimal plankton production. Other study depicts that the transparency of the fresh water is ranging from 35 to 45 cm is suitable for aquatic environment (Saifullah *et al.,* 2016).

Dissolved Oxygen (DO) in the study area ranged from 2.26 to 2.86mg/L with the highest (2.76 ± 0.11 mg/L) at St-4 and the lowest (0.24 ± 0.10 mg/L) at S^{-2} (Fig. 2.d). According to Bhatnagar and Singh (2010) and Bhatnagar *et al.* (2004), DO level > 5ppm is essential to support good fish production. Oxygen depletion in water leads to poor feeding of fish, starvation, reduced growth and more fish mortality, either directly or indirectly (Bhatnagar and Garg, 2000). Dissolved Oxygen in the study area revealed lesser than the prescribed value (Table 2) which could hinder the growth and sustenance of fishes in the river. The principal source of oxygen in water is atmospheric air and photosynthetic planktons. Obtaining sufficient oxygen is a greater problem for aquatic organisms than terrestrial ones, due to low solubility of oxygen in water. The solubility decreases with factors like — increase in temperature, increase in salinity, low atmospheric pressure, high humidity, high concentration of submerged plants, phytoplankton blooms.

Table 2. Comparison of water quality parameter of the Jamuna River with standard values

Parameter	Sampling station	Mean ± SD	Standard value
Temperature (ºC)	Hard point (St 1)	32.7 ± .36	20-30 (EQS, 1997)
	Matishaheberghat (St 2)	33.3 ± .11	
	Kata wabda (St 3)	34.8 ± .64	
	Bilutia (St 4)	33.5 ± 1.1	
	Bangabandhu bridge (St 5)	35.9 ± .68	
pH	Hard point (St 1)	7.45 ± .29	6.5-8.5 (Das,1997)
	Matishaheberghat (St 2)	7.47 ± .16	
	Kata wabda (St 3)	7.60 ± .17	
	Bilutia (St 4)	7.34 ± .29	
	Bangabandhu bridge (St 5)	7.27 ± .22	
TSS(mg/L)	Hard point (St 1)	0.03 ± .01	5.0 (De, 2007)
	Matishaheberghat (St 2)	0.06 ± .01	
	Kata wabda (St 3)	0.02 ± .006	
	Bilutia (St 4)	0.02 ± .01	
	Bangabandhu bridge (St 5)	0.02 ± .11	
DO (mg/L)	Hard point (St 1)	2.63 ± .23	5(EQS, 1997)
	Matishaheberghat (St 2)	2.4 ± .10	
	Kata wabda (St 3)	2.56 ± .30	
	Bilutia (St 4)	2.76 ± .11	
	Bangabandhu bridge (St 5)	2.6 ± .34	
Transparency (cm)	Hard point (St 1)	15.7 ± .7	35-45 (Hossain *et. al.*, 2011)
	Matishaheberghat (St 2)	12.3 ± .05	
	Kata wabda (St 3)	16.0 ± .15	
	Bilutia (St 4)	14.1 ± .53	
	Bangabandhu bridge (St 5)	14.7 ± .45	
Chl-*a* (mg/L)	Hard point (St 1)	0.009 ± .001	0.24-3.00 (Rahaman *et al.* 2013)
	Matishaheberghat (St 2)	0.014 ± .004	
	Kata wabda (St 3)	0.0117 ± .02	
	Bilutia (St 4)	0.003 ± .003	
	Bangabandhu bridge (St 5)	0.007 ± .001	
NO_3^- (mg/L)	Hard point (St 1)	0.118 ± .002	0.1 (De, 2007)
	Matishaheberghat (St 2)	0.137 ± .87	
	Kata wabda (St 3)	0.164 ± 0.41	
	Bilutia (St 4)	0.186 ± 0.41	
	Bangabandhu bridge (St 5)	0.182 ± .06	
PO_4^- (mg/L)	Hard point (St 1)	0.87 ± 0.06	0.1 (De, 2007)
	Matishaheberghat (St 2)	0.94 ± 0.19	
	Kata wabda (St 3)	1.68 ± 0.87	
	Bilutia (St 4)	0.96 ± 0.09	
	Bangabandhu bridge (St 5)	1.23 ± 0.60	
NH_4^+ (mg/L)	Hard point (St 1)	0.22 ± 0.35	0.5 (De, 2007)
	Matishaheberghat (St 2)	0.50 ± 0.39	
	Kata wabda (St 3)	0.40 ± 0.34	
	Bilutia (St 4)	0.31 ± 0.14	
	Bangabandhu bridge (St 5)	0.16 ± 0.02	

Total Suspended Solids (TSS) values were found between 0.02 mg/L to 0.06 mg/L. The highest value (0.06 ± 0.01mg/L) was found at St-2 and the lowest value (0.02 ± 0.11mg/L) at St-5 (Fig. 2.e). The standard value of total suspended solids is 5 mg/L (De, 2007; DoE, 2007) (Table 2).

Water nutrients

Nitrate concentrations were found within the range 0 – 0.186 mg/L. The highest concentration (0.19 ± 0.041 mg/L) was found at St-4 and the lowest (0.12 ± 0.003 mg/L) was found at St-1 (Fig. 3.a). According to Bhatnagar *et al.* (2004), concentration of nitrate 0.02-1.0 ppm is lethal to many fish species, > 1.0 ppm is lethal for many warm water fishes and < 0.02 ppm is acceptable (OATA, 2008). Thus, the nitrate concentration in the present study was within the acceptable limit (Table 2). The higher amount of contamination from fertilizers, municipal wastewaters, feedlots, septic systems in water increase the concentration of Nitrate, it refers that the higher (NO_2 and NO_3) the deviation the lower the quality of water for fish and other aquatic life and for common uses. The amount of nitrate could also be influenced by the growth of plankton (Qureshimatva *et al.*, 2015).

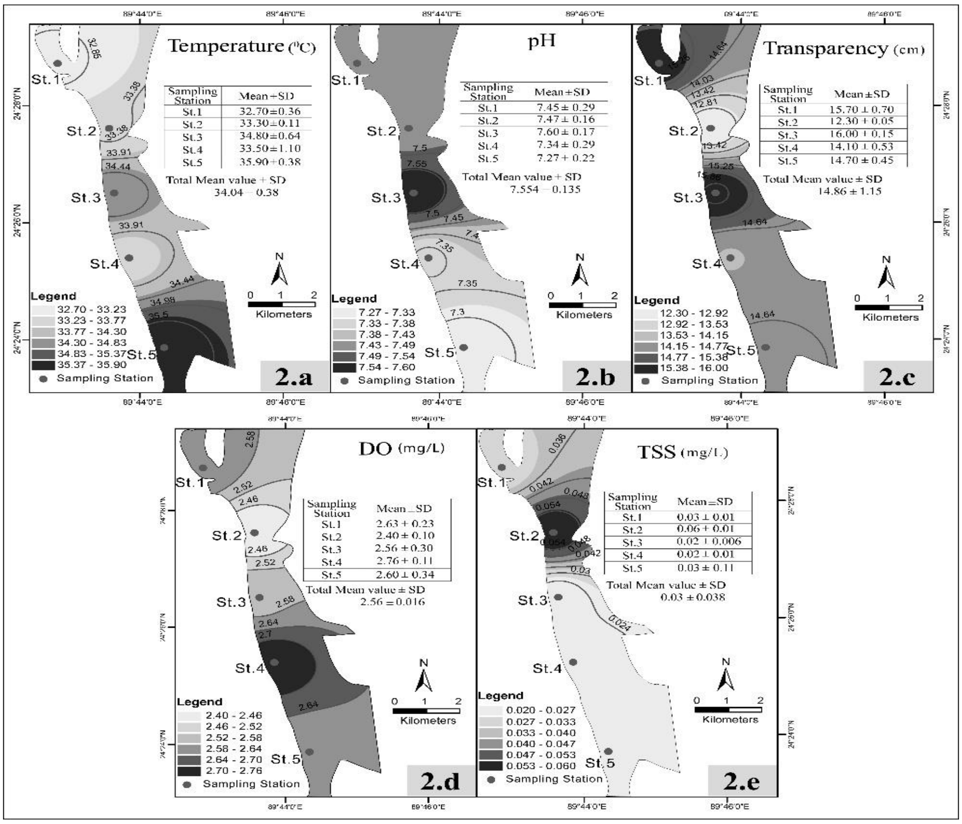

Fig. 2(a-e). Spatial distribution of physical parameters in different sampling stations in Jamuna River

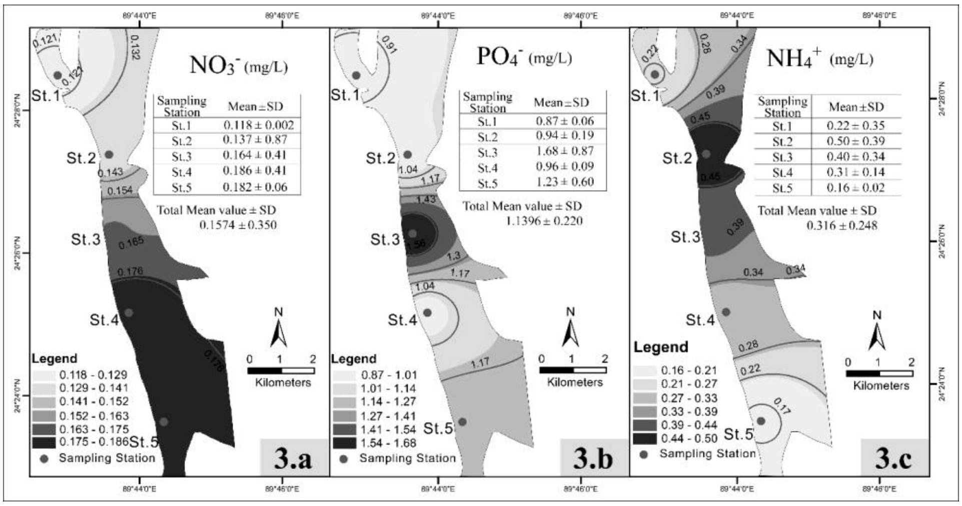

Fig. 3 (a-c). Spatial distribution of water nutrients in different stations in Jamuna River

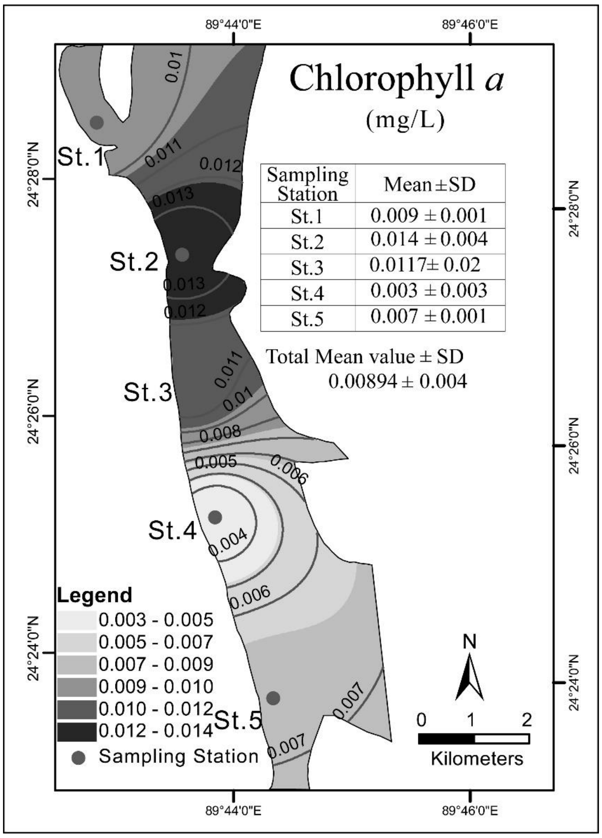

Fig. 4. Spatial distribution of Chlorophyll *a* in different stations in Jamuna River

Phosphate concentration was found 1.14 mg/L where the highest concentration (1.69 ± 0.37mg/L) was found in St-3 and the lowest (0.89 ± 0.05mg/L) in St-1 (Fig. 3.b) while the standard value of phosphate in water is 0.1 ppm (De, 2007). According to Stone and Thomforde (2004), the phosphate level of 0.06 mg/L^{-1} is desirable for fish culture. Bhatnagar *et al.* (2004), suggested 0.05-0.07 ppm is optimum and productive; 1.0 ppm is good for plankton and shrimp production. Phosphorus in soil (P_2O_5 per 100gm of soil) level below 3 might be considered indicative of poor production, between 3 and 6 of average production and ponds having available phosphorus above 6 are productive (Banerjea, 1967). According to Stone and Thomforde (2004) the phosphate level of 0.06 mg/L is desirable for fish. Phosphate is a liming factor in almost all water bodies because in water, it remains in a very small amount, in most cases less than 0.1 ppm. Almost all of the phosphorus present in water is in the form of phosphate (PO_4^-) and in surface water mainly present as bound to living or dead particulate matter and in the soil is found as insoluble $Ca_3(P0_4)_2$ and adsorbed phosphates on colloids except under highly acid conditions (De, 2007). It is an essential plant nutrient as it is often in limited supply which stimulates plant (algae) growth and its role for increasing the aquatic productivity is well recognized.

Ammonium concentration was found 0.32 mg/L with its highest concentration (0.50 ± 0.14 mg/L) at St-2 and the lowest (0.16 ± 0.02 mg/L) at St-5 (Fig. 3.c). Ammonium showed positive correlation with the TSS ($r = 0.739$, $p = 0.01$). According to Swann (1997) and OATA (2008), the levels of Ammonium below 0.02 ppm were considered safe. The safe limit for ammonium is 0.5ppm (De, 2007) and present finding remains within the safe limit. Bhatnagar *et al.* (2004) suggested 0.01-0.5 ppm is desirable for shrimp; > 0.4 ppm is lethal to many fishes and prawn species; 0.05-0.4 ppm has sub-lethal effect and < 0.05 ppm is safe for many tropical fish species and prawns.

Chlorophyll a distribution

The highest content of Chlorophyll *a* was revealed at St-2 (0.014 ± 0.004 mg/L) and the lowest (0.003 ± 0.003mg/L) at St-4 (Fig. 4). Chlorophyll *a* showed significant positive correlation with water transparency ($r = 0.919$; $p > 0.05$) and DO ($r = 0.820$; $p > 0.05$) and negative correlation with both atmospheric temperature ($r = -0.848$; $p = 0.05$) and water temperature ($r = -0.859$; $p > 0.05$) (Table 1). The concentration of Chlorophyll *a* can act as an indicator of phytoplankton abundance in an aquatic ecosystem. One of the major objectives in analyzing photosynthetic pigments (Chlorophyll *a*) in limnology is the estimation of phytoplankton biomass and its photosynthetic capacity. It is natural for levels of chlorophyll *a* to fluctuate over different seasons (Saifullah *et al.*, 2016). It is also reported in other research that chlorophyll *a* concentration remains high during low-water discharges (Devercelli and Peruchet, 2008). In exploiting the fact that algae, like all plants, contain the pigment Chlorophyll *a*, one can measure its concentration in a water sample then calculate algal biomass using an average factor for the Chlorophyll *a* concentration per cell: approximately 1 to 2% of dry weight in planktonic algae (APHA, 1995).

Conclusion

The water quality of an aquatic body largely depends on the interactions of various physicochemical factors. Therefore, a study on some water parameters i.e. pH, TSS, DO; water nutrients like nitrate (NO_3^-), phosphate (PO_4^-), ammonium (NH_4^+) and Chlorophyll *a* of Jamuna River was conducted. The revealed outcomes demonstrate that during the wet season, the river belongs more suitable condition for aquatic organisms than the dry season. In some case, Dissolved Oxygen (DO) in the water body was low which could be alarming. Similarly, during the sampling period the TDS also revealed high which could be the hindering factor for photosynthetic activity as well as primary productivity. The outcome of this study opens window for further intensive study on seasonal variability of water quality parameters and chlorophyll distribution of an aquatic ecosystem.

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