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Seasonal variation of water quality parameters of the Surma River in Sylhet region, Bangladesh

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Abstract
The Surma River is one of the most important river in Bangladesh, which is located in the north eastern region of Bangladesh. The study was conducted to assess physico-chemical parameters such as water temperature, pH, Dissolved Oxygen (DO), Carbon Dioxide (CO_2) and Total Hardness of this river in two different seasons (wet and dry season). Samples were collected during December 2017 to May 2018 from three different sampling sites. The result revealed that mean values of water temperature: 21.07 ^{0}C in wet season and 25.08^{0}C in dry season, pH: 7.31 in wet and 7.21 in dry season, DO: 6.88 mgL-1 in wet and 6.85 mgL-1 in dry season, CO_2: 16.11 mgL-1 in wet where 15.53 mgL-1 in dry season and Total Hardness: 105.24 mgL-1 in wet and 107.56 mgL-1 in dry season respectively. Evaluated values were found within the standard limit set by FAO, WHO and DoE etc. But in some sampling sites, it has exceeded the safe limit which may become alarming in future. So, the proper authority should take necessary steps to maintain the acceptable water quality of the Surma River.

Keywords: Surma river, physico-chemical parameters, dry season, wet season

1. Introduction

Water is the fluid of life not only for human beings but also for any living organism. The fresh liquid water sources on land surfaces and in the ground constitute only 1% of the total water on earth [18]. The main sources of water in Bangladesh are surface waters in rivers, reservoirs, lakes, canals and ponds and the ground water in deep and shallow aquifer [2]. Today, nearly 40 percent of the world's food supply is grown under irrigation, and a wide variety of industrial processes depends on water [8].

Bangladesh is a land of rivers and the rivers are the main source of surface water. Around 230 rivers flow through the country including 53 international rivers [28]. Most of the big cities and settlements have developed near the rivers and urbanization becomes the main reason for contamination for these rivers [13]. The surface water quality of the rivers of the country had been deteriorating further and further due to continuous pollution. For Bangladesh the concerns over water quality are due to (i) industrial pollution + near major urban centers (ii) faecal contamination throughout the country (iii) contamination by agro-chemicals, though still not so severe (iv) saline intrusion in coastal areas (v) suspended sediments, largely from the upper catchments outside Bangladesh [23].

The Surma River is one of the major river in Bangladesh which originated from northeast India when Barak River divided into Surma and Kushiyara River after entering the Bangladesh boarder. It is the major part of Surma-Meghna River system. It ends in Kishoregonj district above Bhairab bazar when another river joins with it to form Meghna River [30]. It covers eastern parts of Bangladesh and contains at least eight million people making important river basin to the Bangladesh [4]. This river supported a great diversity fish species which plays a significant role to the fisheries communities as well as other community’s livelihood of this area [19]. A total 34 fish species belonging to 7 orders has been identified in Shatghari point of the Surma river by the reference [7]. Another reference [11] were also found 51 fish species belonging to 16 taxonomic families only at Sylhet Sadar area of the Surma river. Along with agricultural activities, the Surma River has significantly take part on drinking or safe water supply. However, introduction of human activities and industrial effluents have put more threat to water quality of Surma River [22].

Water quality is a term which is used to describe the physical, chemical and biological properties of a particular waterbody. The water quality assessment provides a clear knowledge about the subsurface geologic environments in which the waterbodies are present [25]. However, the water quality of this Surma river is gradually deteriorated by direct or indirect disposal of municipal waste and surface run-off from agricultural field to river [3, 1]. Surma River is receiving these pollutants through a number of small and big canals. There are total nine canals were identified in Sylhet city which convey these waste materials to the Surma river [22]. This type of environmental pollution is a serious and growing problem, which have led to various deleterious effects on aquatic organisms. Aquatic organisms, including fish, accumulate pollutants directly from contaminated water and indirectly via the food chain [16], [21]. Although concentrations of the pollutants are still rather low, many of these compounds are toxic to human or animal life; some of them are carcinogenic or have serious ecological implications [17].

For this reason, it is therefore of vital importance to monitor and assess the water quality regardless if the water is still suitable for various uses. The primary objective of this study is to assess the seasonal changes in water quality parameters such as Water temperature, Dissolved Oxygen (DO), Carbon Dioxide (CO_2), pH, Hardness and compare them with the water quality standards set by FAO, DoE and WHO etc. for suitability. This will be facilitated to evaluate the potential risks as well as to balanced and comprehensive management of water quality for accurate usage and sustainability of important and vulnerable water resources.

2. Materials and Methods

2.1 Study Area

This study was conducted on the Surma River within in Sylhet region of Bangladesh. For this, total three sampling stations were selected namely Kushighat (Site-1), Chalibondor (Site-2) and Kanishail (Site-3) which are almost 5 km away from each other. Selected locations are showed on Figure-2. The sampling sites were selected on the basis of the usage of water for drinking, domestic purposes and the distance between the location of the industry and the water body.

Fig 1: The Surma River

Fig 2: Map showing three sampling stations

2.2 Sampling Procedures

The water quality parameters were grouped in two different periods namely wet season (December to February) and dry season (March to May). Three samples were collected from each sampling site in every month in a diagonal mode (n=27) in one season to ensure uniformity in water samples. Water samples were collected from the first 20-30 cm of the water column along the Surma River from upstream to downstream during two seasons at each site. Mainly water samples were collected between 7 am to 12 pm. A pre-sterilized 250 ml plastic bottles were used for water collection. Before sample collection these bottles were repeatedly washed with distilled water and rinsed again with water from those sites and tested for some water quality parameters which are required for this study. Water quality parameters were assessed by the using of HACH Water Quality Test Kit (Model FF-1A) in which along with several test kit such as Thermometer, pH meter etc. was presented and a working protocol book was also supplied to analyzed the parameters accurately.

2.3 Processing and Statistical Analysis of Data

The collected data were accumulated, tabulated and analyzed in proper arrangement subjected to statistical analysis. Statistical analysis and interpretations of raw data was done by using the computer software like Microsoft Excel (2010) and SPSS etc. Finally, the analyzed data were integrated and presented in different charts and tabular forms. One way of variance (ANOVA) was also carried out to characterize the sites and seasons according to the physicochemical parameters of the water.

3. Results and Discussions

3.1 Water Quality Analysis

Recorded water quality parameters of the Surma River in wet and dry seasons are summarized in Table-I.

Table 1: Recorded water quality parameters of the Surma River and dry seasons are summarized

Parameters	Sampling Sites	Wet Season (December-February)		Dry Season (March-May)		Standards
		Average (N=27)	Range	Average (N=27)	Range	
Water Temperature (^{0}C)	Site-1	20.41	17.6 to 25.1	25.3	24.1 to 26.3	20 to 30 ^{0}C (DoE, 2016) [12]
	Site-2	21.27		25.17		
	Site-3	21.54		25.15		
	Mean ± SD	21.07±0.48		25.21±0.17		

pH	Site-1	7.45±0.12	6.9 to 7.6	7.17±0.19	6.8 to 7.5	6 to 8.5 (FAO, 1992) [15] 6.5 to 8.5 (WHO, 2008) [31]
	Site-2	7.24±0.17		7.28±0.12		
	Site-3	7.24±0.19		7.17±0.17		
	Mean ± SD	7.31±0.11		7.21±0.06		
DO (mgL^{-1})	Site-1	6.2±0.7	5.5 to 8.5	6.88±0.45	5.5 to 7.5	≥ 5.0 (DoE 2016) [12] > 4 (FAO, 1992) [15]
	Site-2	7.83±0.56		6.61±0.49		
	Site-3	6.6±0.44		7.05±0.56		
	Mean ± SD	6.88±0.69		6.85±0.18		
CO_2 (mgL^{-1})	Site-1	16.66±2.35	13. 87 to 18.02	15±4.08	14.11 to 18.57	-
	Site-2	17.22±4.15		15.55±3.3		
	Site-3	14.44±3.68		16.04±3.96		
	Mean ± SD	16.11±1.20		15.53±0.43		
Total Hardness (mgL^{-1})	Site-1	101.33±14.6	76.95 to 119.7	110.2±6.3	94.05 to 119.7	30 to 180 (Santhosh and Singh, 2007) [26] 50 to 150 (Stone and Thomforde, 2004) [28]
	Site-2	109.25±6.71		104.18±8.06		
	Site-3	105.13±14.43		108.3±6.45		
	Mean ± SD	105.24±3.23		107.56±2.51		

3.1.1 Water Temperature (^{0}C)

Temperature is one of the most important factors in aquatic system as biological activities and growth of aquatic animals is dependent on it. The fluctuation in river water temperature usually depends on the season, geographic location, sampling time and temperature of effluents entering the stream [5]. The temperature of three sampling sites was ranged from 17.6 to 25.1 ^{0}C in wet season and 24.1 to 26.3 ^{0}C in dry season (Table-I). Highest and lowest value both were observed in site-1 during dry season and wet season respectively. Mean water temperature were found as 21. 07 ^{0}C in wet season and 25.21 ^{0}C in dry season. In case of river water temperature, the DoE standard for sustaining aquatic life is within 20 to 30^{o}C in both dry and wet season [12]. The estimated mean water temperature was found within the DoE standard both in two seasons. Figure-III graphically shows the water temperature at three different sites in wet and dry season.

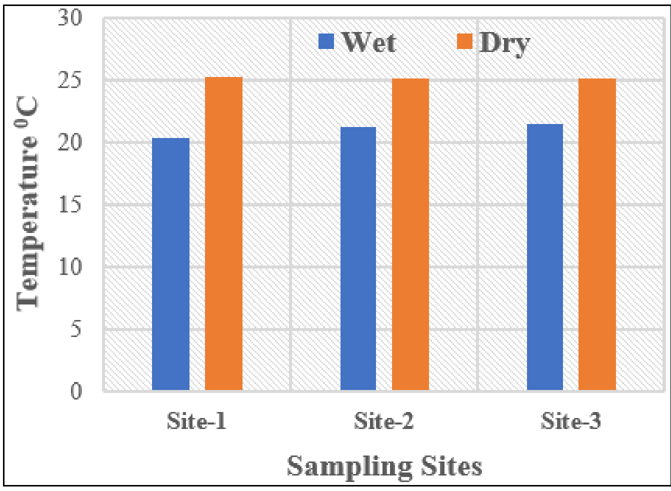

Fig 3: Variation of Temperature (^{0}C) at different sampling sites and seasons

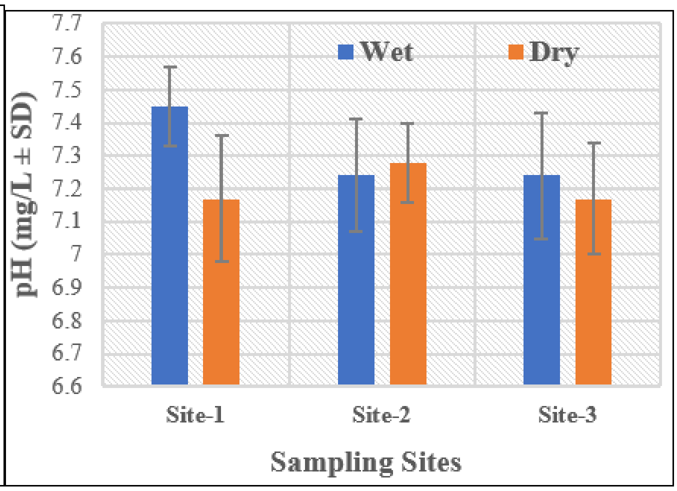

Fig 4: Variation of pH at different sampling sites and seasons

3.1.2 pH

pH is the indicator of acidic or alkaline condition of water status. Very high pH (pH>9.5) or very low pH (pH<4.5) values are unsuitable for most aquatic organisms. Aquatic organisms are extremely sensitive to pH levels below 5 and may die at these low pH values. High pH levels (9-14) can harm fish due to the fact that ammonia will turn to toxic ammonia at high pH (>9) [24]. pH value was found to ranged from 6.9 to 7.6 in wet season and 6.8 to 7.5 in dry season (Table-I). Highest pH value (7.45) was observed at site-1 during wet season and lowest pH value (7.17) at site-1 and site-3 during dry season (Figure-IV). The estimated mean pH value in wet season was 7.31±0.11 and in dry season was 7.21±0.06 (Table-I), which indicates slightly acidic water according to FAO [15] and WHO [31] standards.

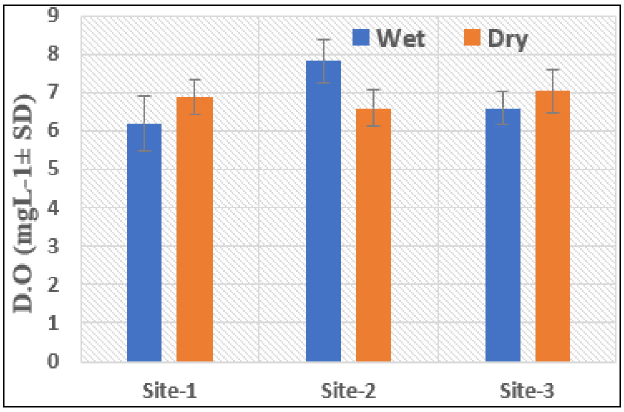

Fig 5: Variation of DO (mgL^{-1}) at different sampling sites and seasons

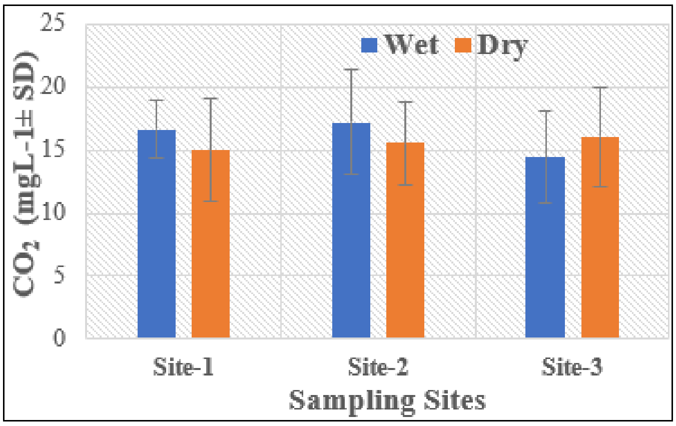

Fig 6: Variation of CO_2 (mgL^{-1}) at different sampling sites and seasons

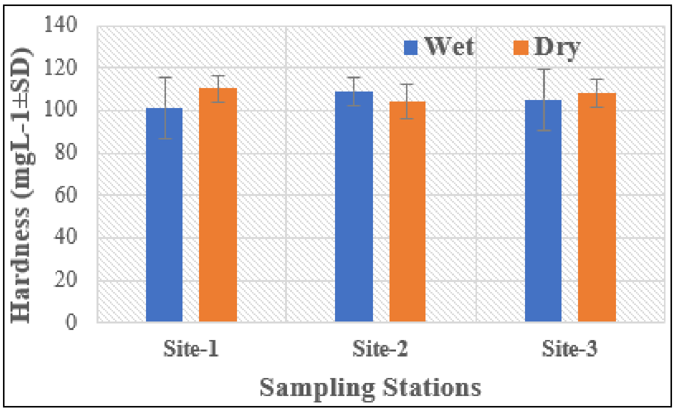

Fig 7: Variation of Total Hardness (mgL^{-1}) at different sampling sites and seasons

3.1.3 DO (Dissolved Oxygen)
Dissolved oxygen is the single most important gas for most aquatic organisms; its needed for respiration. The DO levels below 1 ppm will not support fish; 5 to 6 ppm are usually required for most of the fish population [6]. DO level was found to be ranged between 5.5 to 8.5 mgL^{-1}in wet season and 5.5 to 7.5 mgL^{-1} in dry season respectively (Table-I). In the Surma River fairly similar DO level was observed in two seasons. The mean DO level in wet season as 6.88±0.69 mgL^{-1} and in dry season 6.85±0.18 mgL^{-1} was recorded (Figure-V). In this study, estimated DO level were remain within the permissible value by DoE [12] and FAO [15] standard. Comparison between mean value and standard value of DO is closely related (Table-I), so that it represents the higher quality of river water for fish and other aquatic animals life.

3.1.4 Carbon Dioxide (CO_2)
Carbon dioxide is highly soluble gas in water. When dissolved in water it forms carbonic acid which decrease the pH of any system and this pH drop can be harmful for aquatic organisms [9]. Highest (16.04) and lowest (14.44) CO_2 were found at site-3 during dry and wet season respectively (Figure-VI). CO_2 content ranged from 13.87 to 18.02 mgL^{-1} in wet season and 14.11 to 18.57 mgL^{-1} in dry season (Table-I). Mean CO_2 level was found as 16.11±1.20 mgL^{-1} in wet season and 15.53±0.43 mgL^{-1} in dry season.
According to reference [14], tropical fishes can tolerate CO_2 levels over 100 mgL^{-1} but the ideal level of CO_2 in fishponds is less than 10 mgL^{-1}. Reference [10] suggested 5-8 mgL^{-1} is essential for photosynthetic activity; 12-15 mgL^{-1} is sublethal to fishes and 50-60 mgL^{-1} is lethal to fishes. So, the measured levels of CO_2 are more or less remain in suitable condition for aquatic animals, but special care should be needed in this river water to keep the CO_2 level in ideal condition in future.

3.1.5 Total Hardness (mgL^{-1})
Total hardness is a measurement of the mineral content in a water sample that is irreversible by boiling. The recommended ideal value of hardness for fish culture is at least 20 mgL^{-1} [29] and a range of 30-180 mgL^{-1} [26]. According to Bhatnagar *et al.* (2004) [10] hardness values less than 20 mgL^{-1} causes stress, 75-150 mgL^{-1} is optimum for fish culture and >300 ppm is lethal to fish life as it increases pH, resulting in non-availability of nutrients. However, some euryhaline species may have high tolerance limits to hardness. Water containing calcium carbonate at concentrations below 60 mgL^{-1} is generally considered as soft; 60–120 mgL^{-1}, moderately hard; 120–180 mgL^{-1}, hard; and more than 180 mgL^{-1}, very hard [20].
In this study, total hardness varied from 76.95 to 119.7 mgL^{-1} in wet season and 94.05 to 119.7 in dry season (Table-I). Highest value (109.22) and lowest value (101.33) were found during wet season at site-3 and site-1 respectively (Figure-VII). However, mean value of Hardness was found within the aforementioned recommended value as 105.24±3.23 mgL^{-1} in wet season and 107.56±2.51 mgL^{-1} in dry season. According to the reference [10, 20] and [29], the estimated hardness values indicate the water of the Surma river remains in optimum ranges for aquatic animals especially for fishes and water is safe for aquaculture practicing.

4. Conclusion
The Surma River is an important river in Sylhet region, as well as in Bangladesh. Most of the people depends on this river directly or indirectly. Like other rivers, the Surma River is losing its water quality day by day. At present the river is under severe pollution threat. The physico-chemical analysis of the water samples show that the water quality of the Surma River is of medium category and it is not suitable for drinking but fit for other purposes like non sensitive pisciculture, livestock drinking, irrigation and recreation. Although, the mean value of all parameters remains within the recommended level but in some the sites it has exceeded the permissible limit and may it will become more dangerous in future. So, the proper authority should take necessary steps to maintain the acceptable water quality and ensure the flow of the Surma River. People should be aware of the possible threats on water pollution in the river.

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