Status of Water Quality in the Tista River at Kaunia Point and its Impact on Aquatic Environment

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Abstract

The study was conducted to investigate the surface water quality of the Tista River at Kaunia point in wet (September to November) and dry season (December to February) during the period from September 2013 to February 2014. The water samples were collected from five different sampling stations of Tista River mentioned as Station 1 (St-1), 2 (St-2), 3 (St-3), 4 (St-4) and 5 (St-5). The analysis of the study showed that the average transparency was 13.28 and 32.31 cm in wet and dry season, respectively, while the temperature was observed 25.86 and 18.18^{o}C in wet and dry season, respectively. The observed electrical conductivity (EC) was 84 and 145.67 µs cm^{-1}, pH was 7.72 and 8.03, dissolve oxygen (DO) was 5.35 and 5.37 mg l^{-1}, biochemical oxygen demand (BOD) 1.64 and 1.89 mg l^{-1} in wet and dry season, respectively. In wet season, the total dissolved solid (TDS) was measured 53.2 mg l^{-1}, while 73.86 mg l^{-1} in dry season. The alkalinity was found 40.94 and 43.4 mg l^{-1} in wet and dry season, whereas, the hardness was found 98.47 and 102.46 mg l^{-1} in the following seasons. The study showed that most of the water quality parameters of the Tista River were suitable for aquatic organisms as well as fishes. However, the agricultural runoff and waste materials generated from anthropogenic sources could be the main causes of degradation of water quality and aquatic organisms.

Key words: Tista River, Water quality, Wet-dry season

Introduction

Water is essential for the survival of any form of life. About 80 % of the earth surface covers by water and out of the estimated 1011 million km^3 of the total water present on the earth, only 33400 m^3 of water is available for drinking, agriculture, domestic and industrial consumption (Dara, 2007). Thus, the surface water is essential for keeping the environmental balance of the total region, particularly in the estuaries to the south and at the mouth of the rivers. Surface water monitoring is essential for aquatic resources management and flood forecasting (Haque, 2008). Aquatic life requires water as a support system and in the case of animals such as fish, a medium in which it moves and obtains oxygen in dissolved form (Ali *et al.,* 2004). Water quality generally means the component of water which must be present for optimum growth of aquatic organisms (Ehiagbonare and Ogunrinde, 2010). Water quality refers to anything in the water, be it physical, chemical or biological factors that affects the production of fish (Cobble and Huffinan, 1999). The productivity depends on physicochemical characteristics of the water body (Ehiagbonare and Ogunrinde, 2010). The population of natural fish species has declined considerably due to increased fishing pressure, and various anthropogenic activities leading to siltation, aquatic pollution, and loss of natural habitat for spawning and growth (Akhteruzzaman *et al.,* 1998). These factors not only destroyed the breeding grounds but also caused havoc to the availability of brood fish including fry and fingerlings (Hussain and Mazid, 2001). Recently the fish is considered as one of the most endangered species in Bangladesh (IUCN, 1998). The quality of aquatic environment generally depends on four kinds of factors such as physical, chemical, biological and meteorological factors (Stanitski *et al*., 2003). Water quality is controlled and determined by the combinations of all kinds of factors in various ways and intensities (Rahman, 1992). Water quality focuses on the various aspects of physicochemical parameters that detect the status of pollution and suitability of a particular water body for various aquatic organisms. Seasonal or annual variation in the availability of fresh water may at times cause water quality degradation (Islam *et al*., 2010). The Tista River is the most important trans-boundary and a silt carrying, flooding and eroding River of Bangladesh (Haque, 2008). Due to over use of fertilizers and pesticides in the surrounding cultivable lands that washed out through surface runoff and river bank erosion which degrade the quality of the Tista River water as well as destroy the natural soundness of the aquatic environment of the river. The present study was undertaken to assess the physicochemical parameters such as DO, pH, temperature, EC, TDS, BOD, transparency, hardness and alkalinity of water in the Tista River are very essential for the fish production, irrigation, to identify the problems of the farm for survival, production and growth. The objectives of the study were as follows: (i) to investigate the physicochemical parameters of Tista River water, and (ii) to find out the suitability of water for aquatic life.

Materials and Methods

Study area

The study area was located at the Tista River at Kaunia in Rangpur district which was approximately within latitude 24.11920-25.46745^{0}N and longitude 89.59224-89.26841^{0}E.

The Tista is the most important river in northwest region Bangladesh and originates in the Sikkim valley of the Himalayan Range. It enters Bangladesh near Tin Bigha in Lalmonirhat district. The Tista River is flashy and eroding during monsoon. Total length of the river is 315 km out of which 129 km is inside Bangladesh. The Bangladesh Water Development Board (BWDB) constructed a barrage on this river at Gaddimari of Lalmonirhat district. At Kaunia railway cum road bridge in Rangpur district, there is a water level and discharge measuring stations for the Tista River (Haque, 2008).

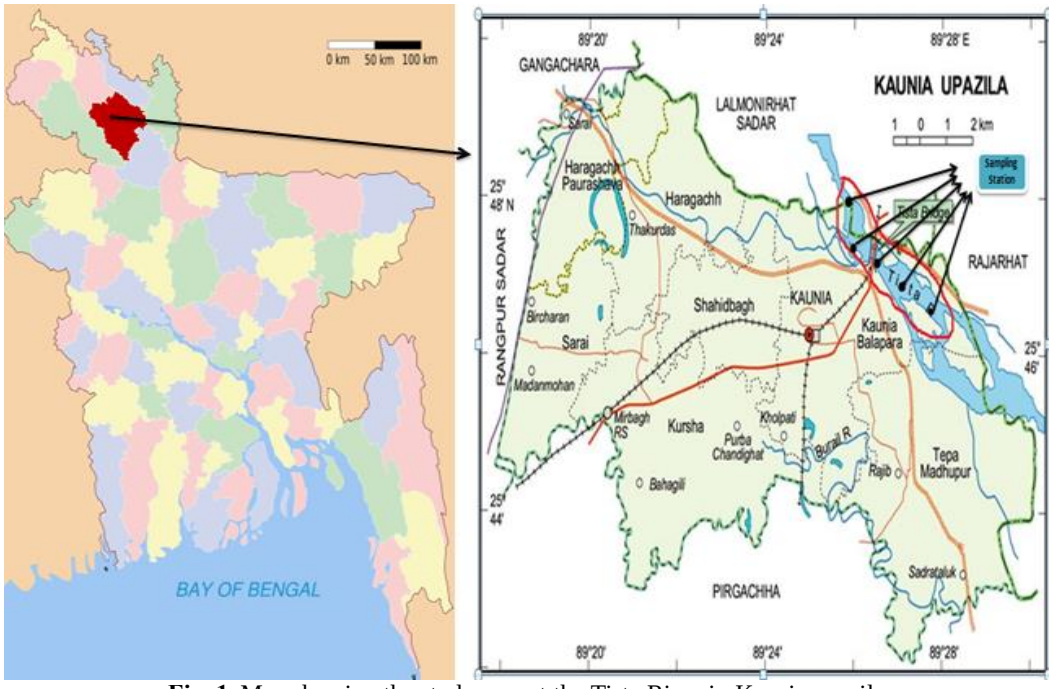

Fig. 1. Map showing the study area at the Tista River in Kaunia upazila

Sample collection

The study was executed in five different sites at the distance of 1.5 km from each station of Tista River. From each site, samples were collected from five different points of the river. Water samples were collected for physicochemical analysis from those sites in dry season (September to November 2013) and wet season (December 2013 to February 2014). Water sample was collected by plastic bottles with double stoppers. Before the sampling the bottles were proper cleaned and finally rinsed with de-ionized water and dried. After sampling the bottles were screwed and marked with the respective identification number. The different instrumental techniques employed for water quality parameters.

Sample analysis

The water quality parameters such as pH, temperature, transparency, DO, EC and TDS were measured by pH meter (model-pH Scan WP 1, 2, Malaysia), thermometer (Celsius scale), Secchi disk, DO meter, EC meter (model-HM digital, Germany) and TDS meter, respectively. Alkalinity was measured by titration method with 0.1 N HCl after adding 2-3 drops of methyl-orange indicator. The EDTA method was used to determine the hardness of water where Eriochrome Black T was used as indicator and titration with EDTA solution. The Biological Oxygen Demand (BOD) was measured by two steps where initial BOD (BOD_1) was measured immediately after collection and after 5 days BOD (BOD_5) was measured by incubation in the dark condition at 20 ^oC for 5 days. Then the total BOD (BOD_1 - BOD_5) was measured according to Trivedy and Goel (1984), and Huq and Alam (2005). The collected data were compiled and tabulated in proper form and were subjected to statistical analysis. The findings of the study were presented as charts and tabular forms.

Results and Discussion

From the investigation, the mean of transparency was 13.29 cm in wet season and 32.32 cm in dry season. The highest and lowest transparency was found at station 2 (15.87 cm) and station 1 (11.87 cm), respectively (Table 1) that caused by the embankment, surface runoff, river bank erosion and aquatic vegetation. The transparency of productive water bodies should be 40 cm or less (Rahman, 1992). The study observed that the transparency was within the standard limit (40 cm) for the wet and dry seasons. The range of water temperature was found around 25.33 to 26.76^oC in wet season (Table 1) whereas the highest and

lowest temperature was found during the wet season in September at station 5 (31.1°C) and November at station 1 (20°C), respectively. In case of river water temperature, the DoE standard for sustaining aquatic life is within 20 to 30°C both in wet and dry season (Bhaumik *et al*., 2006). Observed the average temperature in the Tista River during wet and dry season was 25.86 and 18.18°C, respectively that caused by the climatic condition which is in the permissible limit and it suitable for aquatic life.

The standard for Electric Conductivity (EC) is 1200 µS cm^{-1} for inland surface water (ECA, 1995). The highest and lowest concentration of EC was found at station 2 (91.33 µS cm^{-1}) and station 4 (76.33 µS cm^{-1}) (Fig. 2), respectively. In this study it was observed that the average value of EC in wet and dry seasons were 84 and 145.67µS cm^{-1}, respectively it conductance values for the wet and dry seasons were within the standard limit (700 µS cm^{-1}). In the wet season, as the flow of the river water increases which may cause the dilution of the salinity of the water and agricultural practices due to use of fertilizers and pesticides which mixed with river water by surface runoff, while in the dry season, the flow of water decreases, as a result the EC decreased than wet season.

The average values of TDS in wet and dry seasons were found 53.7 and 73.87 mg l^{-1} (Table 1), respectively where the standard value 165 mg l^{-1} in wet and dry season. A positive relation between TDS and EC where the EC value slightly increased with increasing the TDS concentration. The pH average values in wet and dry seasons were found 7.73 and 8.03, respectively where the standard value is 6.5 to 8.5 in wet and dry season (Table 1). The study revealed that the pH of Tista River water was within the permissible limit (6.5-8.5).

Table 1. Water quality parameters of the Tista River at Kaunia point in Rangpur (ranges are in parentheses)

Parameters (Unit)	Wet season (Sep-Nov) mean ± SD	Dry season (Dec-Feb) mean ± SD	Standard
Temperature (ęC)	25.86 ± 4.86 (25.30-26.70)	18.18 ± 1.39 (17.0-18.40)	20-30 (EQS, 1997)
Transparency (cm)	13.28 ± 10.80 (11.55-15.86)	36.45 ± 4.89 (0.00-48.23)	40 or less (Rahman, 1992)
TDS (ppm)	53.2 ± 17.02 (51.33-57.00)	73.86 ± 5.07 (67.33-85.33)	165 (Huq and Alam, 2005)
BOD (ppm)	1.64 ± 0.27 (1.36-1.96)	1.89 ± 0.28 (1.73-1.93)	2 or less (EQS, 1997)
pH	7.72 ± 0.17 (7.57-7.92)	8.03 ± 0.12 (7.68-9.01)	6.5-8.5 (Das, 1997)
Alkalinity (mg l^{-1})	40.94 ± 2.95 (34.13-49.73)	43.40 ± 2.88 (36.33-58.56)	>100 (Rahman, 1992)
Total hardness (ppm)	98.48 ± 4.97 (84.33-143.33)	102.46 ± 4.27 (72.33-156.33)	123 (Huq and Alam, 2005)

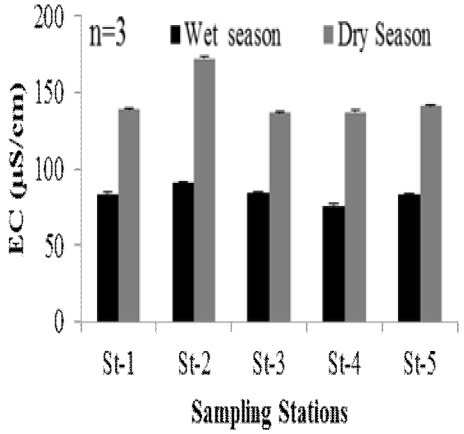

Fig. 2. Mean concentrations of EC in the Tista River during wet and dry seasons

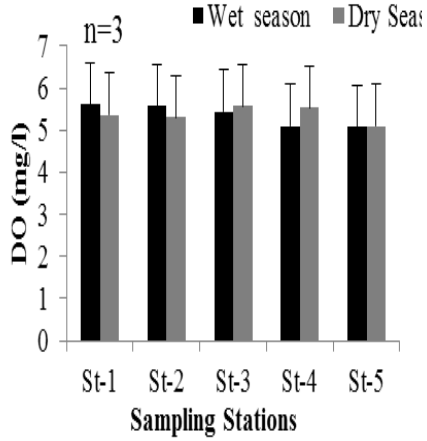

Fig. 3. Mean concentrations of DO in the Tista River during wet and dry seasons

Adequate DO is necessary for good water quality, survival of aquatic organism and decomposition of waste by microorganism (Islam *et al.,* 2010; Rahman *et al.,* 2012). The average DO values in wet and dry season were found 5.35 and 5.37 mgl^{-1}, respectively (Fig 3), where the standard value is 5 mg/l. The comparison between average values of DO is slightly increased than standard level was

observed in Tista River water which are within the permissible limit and suitable for aquatic life. The average BOD values of wet and dry season were found 1.64 and 1.89 mg l^{-1} (Table 1) in wet season and dry season, respectively. The standard value of DO is 2 mg l^{-1} or less.

The average alkalinity values of wet and dry seasons were found 40.94 and 58.57 mg/l, respectively (Table 1), where the standard value for aquatic life is 100 mg l^{-1} (EQS, 1997). So comparison between average values of alkalinity in Tista River water which in within the permissible limit suitable for aquatic life. The hardness average values of wet and dry seasons were found 98.48 and 102.46 mg l^{-1}, respectively (Table 1). The standard value is 123 mg l^{-1} for aquatic life. So comparison between averages values of hardness in Tista River water which in within the permissible limit for all uses like irrigation, domestic, and recreational, according to the standard value and suitable for aquatic life.

Conclusions

The study observed that all the water quality parameters were suitable in all sampling stations of the river during both seasons. However, due to anthropogenic activities and agricultural runoff would be the main causes of the water quality degradation. To maintain the suitable aquatic environment of the river the study suggests the following measures should be taken: (a) regular monitoring the seasonal variations of the water quality parameters of the Tista River, (b) to ensure the control use of fertilizers and pesticides, (c) illegal dredging and sand extraction must be stopped, (d) halt encroachment, and (e) restoration of fisheries habitat and keep records about fish species and their status.

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