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Water Quality Assessment of Shitalakhya River

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Authors' contributions

This work was carried out in collaboration among all authors. Authors AASMZ and MHR designed the study. Author MMA performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript and managed the analyses of the study. Author MKEZ managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Water quality is the key of environmental concern because of its important provision of water for drinking and domestic purpose, irrigation and aquatic life including fish and fisheries. The present study was conducted to assess the surface water quality of the Shitalakhya River from January, 2017 to December, 2018. Temperature, pH, EC, TDS, TSS, BOD_5, Alkalinity, Total Hardness, Calcium Hardness, Magnesium Hardness, Chloride, Dissolved Silica, Total Iron concentration and Turbidity in water samples have been found in the ranges 24 - 33°C, 6.5 - 7.6, 108 - 478 µS/cm, 54 - 245 ppm, 8 - 118 mg/l, 6 - 12 mg/l, 36.6 - 231.8 mg/l, 30 - 190 mg/l, 20 - 120 mg/l, 10 - 80 mg/l, 3.54 - 9.91 mg/l, 16 - 51 mg/l, 0.10 - 1.5 mg/l, 2.09 - 120 NTU in the year 2017 and 21 - 32.5°C, 6.7 - 7.3, 101 - 424 µS/cm, 55 - 212 ppm, 10 - 154 mg/l, 7 - 16 mg/l, 42.7 - 219.6 mg/l, 35 - 180 mg/l, 25 - 115 mg/l, 10 - 70 mg/l, 4.96 - 16.99 mg/l, 19 - 84 mg/l, 0.10 - 2.50 mg/l, 2.73 - 214 NTU in the year 2018 respectively. Obtained results of the present study area shows that most of the parameters were within the permissible limit except Turbidity, Total Suspended Solid (TSS), Dissolved Silica (SiO_2) and Biological Oxygen Demand for five days (BOD_5). Use of river water can pose serious problems to human health and aquatic ecosystem via biological food chain. The present research suggests special preference for better management of the river water to protect the health of aquatic ecosystem of the river.

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Keywords: Water quality assessment; biological oxygen demand; Shitalakhya River; surface water quality.

1. INTRODUCTION

Bangladesh known as land of river, is filled with 700 rivers including tributaries [1]. Water is the most vital element among the natural resources, and is crucial for the survival of all living organisms including human, food production, and economic development. Moreover, in Bangladesh, the environment, economic growth, and developments are all highly influenced by water - its regional and seasonal availability and the quality of surface and groundwater [2]. Water quality of big rivers such as Padma, Meghna, Jamuna, Brahmaputra is still good and has been within water quality standards set in the environment conservation rules, 1997 [3]. The government has already declared four rivers Buriganga, Turag, Balu and Shitalakhya as ecologically critical areas to improve the quality of river water [4]. However, water quality is being degraded unceasingly due to haphazard industrialization [5]. The major polluting industries such as tanneries, pulp and paper, sugar, fertilizer, pharmaceuticals, metal, and chemical industries are mostly located in and around the major cities in Bangladesh [6]. Some of these are also located on the banks of major rivers and lakes [7]. River pollution is a matter of concern all over the world [8,9,10]. At first polluted river affect its chemical quality of water, then destroy the community structure steadily, disrupting the subtle food web [11]. Surface water quality of the rivers of Bangladesh is highly polluting day by day [[12,13]. Trustworthy information on the characteristics of water quality is directly needed to control pollution effectively and manage sustainable water resource. The river Shitalakhya is one of the most prominent rivers in the flood plain region of Bangladesh. The river is originated from the river of old Brahmaputra in Bangladesh. This flows south, touching the eastern part of Dhaka city and flowing through Narayanganj and meets Meghna river at Kolagachia of Munshiganj. The river is about 110 kilometers (68 mi) long, 300 meters (980 ft) width near at Narayanganj, maximum depth is 21 meters (70 ft) and average depth is 10 meters (33 ft). The river flows 74 cubic meters per second (2,600 cu ft/s) at Demra [14,15]. In recent years, the Polash area of Narsingdi has become one of the rapidest developing regions in Bangladesh. The Shitalakhya River receives effluents from five jute mills, two fertilizer factories, one sugar mill, one cement industry, one textile industry, one dairy plant, two food processing industries, one hardboard mill, one paper mill and one of joint thermal power plant within 13 km range of its flow in Ghorashal region. Shitalakhya River is the main source of industrial and drinking water in this region. Surface water is used in industry for cooling, process, steam generation, safety and miscellaneous purposes. Moreover, the river is the route of the communication with Chandpur, Chittagong as the port of cargo. Besides these, the people live on and around the Shitalakhya River utilizing its water for their household washing, bathing and other necessary daily works. Therefore, the risks of pollution impact are rising upwards sequentially. As a consequence, it is really necessary to assess river water quality. The present study has been conducted systematically to assess the water quality of Shitalakhya River through all seasons of the year 2017 & 2018 and provide the baseline data of the area, which will be useful to measure any anthropogenic pollution level.

2. MATERIALS AND METHODS

Shitalakhya River water samples used in this research were collected from Palash near at Ghorashal Power Station in Narsingdi. Two liter polypropylene bottles were used for water sample collection. Prior to sample collection, all bottles were washed with very dilute hydrochloric acid followed by demineralized water. All samples were collected from the middle point of the river and a depth of 40 to 50 cm from the water surface. Before taking final water samples, the bottles were rinsed several times with the water sample to be collected. The sample bottles were then sealed & labeled with date immediately and transported to the laboratory for quality analysis. Water temperatures were recorded using calibrated laboratory thermometer (Made in Japan) at the sampling location. Electrical conductivity (EC), total dissolved solids (TDS), pH and Turbidity were measured using calibrated conductivity meter (WTW, Germany), TDS meter (Hanna, Romania), pH meter (Hanna, Romania) and Turbidity meter (WTW, Germany) respectively according to standard testing method by APHA [16]. Total suspended solid (TSS) was determined gravimetrically [17]. Total hardness, calcium hardness, total alkalinity and chloride ions were measured using titrimetric method according to the analytical standard testing methods [18,19,20,21] for the examination of surface waters. Magnesium hardness were calculated from calcium hardness and total hardness. Dissolved silica concentration and Total iron concentration were determined by using UV spectrophotometer (HACH DR 6000, USA). Biological oxygen demand on five days (BOD_5) at 20°C was determined by respirometric method followed by nitrification inhibitor using digital OxiTop pressure measuring heads (WTW, Germany).

3. RESULTS AND DISCUSSION

Temperature is one of the most important parameter for aquatic environment because of all physical and chemicals activities, the DoE standard for sustaining aquatic life is within 20°C to 30°C [3]. The temperature of Shitalakhya River water was in between 24°C to 33°C in the year 2017 and 21°C to 32.5°C in the year 2018 respectively. Lowest temperature 24°C and 21°C recorded on 14 December, 2017 & 15 January, 2018 respectively while the highest temperature 33°C and 32.5°C recorded on 17 April, 2017 and 10 September, 2018 respectively, that's are shown in the Fig. 1. In a previous study, Kabir [22] reported that the temperature of Shitalakhya River water at Narayanganj ranged from 19.7°C to 32.2°C. Azam et al. [23] studied the water quality parameters of the four river systems in the Sundarbans and found the temperature seasonally varied from 23.3°C to 30.3°C. Islam et al. [24] found the temperature of water ranged from 28°C to 32°C in Shitalakhya River in June-July, 2007. The obtained results indicate that the temperature of Shitalakhya River water are within acceptable limit.

The acidic or alkaline condition of water is expressed by pH and DoE standard of this parameter is 6.5 to 8.5 for sustaining aquatic ecosystem. The optimum limit of pH for fish culture is from 6.5 to 8.0 [25,26]. The results showed in Fig. 1 that pH of the river water was in between 6.5 to 7.6 in the year 2017 and 6.7 to 7.3 in the year 2018, which indicates that the river water was characterized as neutral from acidic or alkalinity point of view. DoE reported that pH of Shitalakhya river water varied 6.31 to 8.80 in 2013 [27], 6.80 to 7.80 in 2014 [4], 6.66 to 7.97 in 2015 [28] and 6.66 to 7.98 in 2016 [29]. Water with pH ranging from 6.0 to 9.0 is generally regard as suitable for organism`s growth and aquatic animals [14]. The pH values were generally found to be constant due to the strong buffering capacity of water [30]. Similar ranges of pH were obtained by other researchers on Shitalakhya River [31,32]. The obtained result showed that pH values were within the EQS (6.5 to 8.5) range for inland surface water.

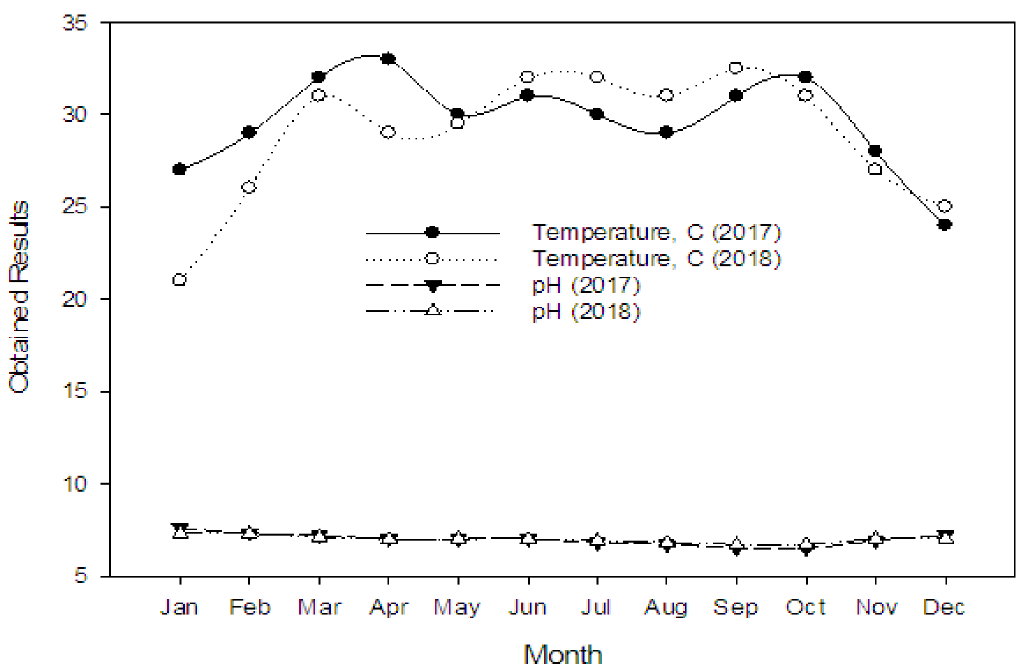

Fig. 1. Temperature (°C) and pH of the year 2017 and 2018 respectively

Table 1. Physical parameters of Shitalakhya River water during the year 2017 and 2018

Parameter	Month	Obtained result 2017	Obtained result 2018	Bangladesh standard DoE, 1997	Bangladesh standard EQS, 1997
Temperature (°C)	Jan	27	21	20 - 30	20 -30
	Feb	29	26		
	Mar	32	31		
	Apr	33	29		
	May	30	29.5		
	Jun	31	32		
	Jul	30	32		
	Aug	29	31		
	Sep	31	32.5		
	Oct	32	31		
	Nov	28	27		
	Dec	24	25		
EC (µS/cm)	Jan	396	348	N/A	≤ 1200
	Feb	412	370		
	Mar	478	398		
	Apr	320	374		
	May	152	101		
	Jun	112	126		
	Jul	110	128		
	Aug	108	138		
	Sep	110	168		
	Oct	140	220		
	Nov	252	405		
	Dec	317	424		
Turbidity (NTU)	Jan	2.75	11	≤ 10	N/A
	Feb	4.89	4.13		
	Mar	6.15	4.08		
	Apr	2.09	2.73		
	May	30.15	39.4		
	Jun	42.02	26.4		
	Jul	115	152		
	Aug	120	214		
	Sep	39.75	206		
	Oct	48.1	61		
	Nov	11.9	4.2		
	Dec	11.5	3.24		

Parameter	Month	Obtained result 2017	Obtained result 2018	Bangladesh standard DoE, 1997	Bangladesh standard EQS, 1997
pH	Jan	7.6	7.3	6.5 - 8.5	6.5 - 8.5
	Feb	7.3	7.3		
	Mar	7.2	7.1		
	Apr	7.0	7.0		
	May	7.0	7.0		
	Jun	7.0	7.0		
	Jul	6.8	6.9		
	Aug	6.7	6.8		
	Sep	6.5	6.7		
	Oct	6.5	6.7		
	Nov	6.9	7.0		
	Dec	7.2	7.0		
TDS (mg/L)	Jan	201	174	≤ 1000	≤ 2100
	Feb	211	185		
	Mar	245	199		
	Apr	157	187		
	May	74	55		
	Jun	56	63		
	Jul	55	64		
	Aug	54	69		
	Sep	55	84		
	Oct	70	110		
	Nov	126	202		
	Dec	158	212		
TSS (mg/L)	Jan	10.0	16.0	≤ 10	≤ 150
	Feb	8.0	10.0		
	Mar	30.0	20.0		
	Apr	60.0	13.0		
	May	55.0	65.0		
	Jun	80.0	60.0		
	Jul	102.0	123.0		
	Aug	118.0	121.0		
	Sep	59.0	154.0		
	Oct	46.0	110.0		
	Nov	26.0	40.0		
	Dec	20.0	14.0		

Table 2. Chemical parameters of Shitalakhya River water during the year 2017 and 2018

Parameter	Month	Obtained result 2017	Obtained result 2018	Bangladesh standard DoE, 1997	Bangladesh standard EQS, 1997
Total Hardness (mg/L)	Jan	170.0	130.0	200 - 500	N/A
	Feb	180.0	150.0		
	Mar	190.0	180.0		
	Apr	100.0	130.0		
	May	60.0	35.0		
	Jun	40.0	45.0		
	Jul	30.0	50.0		
	Aug	50.0	50.0		
	Sep	40.0	65.0		
	Oct	50.0	100.0		
	Nov	120.0	160.0		
	Dec	120.0	175.0		
Calcium Hardness (mg/L)	Jan	100.0	100.0	≤ 75	N/A
	Feb	100.0	115.0		
	Mar	120.0	110.0		
	Apr	60.0	85.0		
	May	40.0	25.0		
	Jun	30.0	30.0		
	Jul	20.0	40.0		
	Aug	35.0	40.0		
	Sep	30.0	55.0		
	Oct	30.0	70.0		
	Nov	80.0	100.0		
	Dec	85.0	120.0		
Chloride Concentration (mg/L)	Jan	5.66	10.62	150 - 600	≤ 600
	Feb	7.08	12.04		
	Mar	9.91	13.10		
	Apr	9.91	16.99		
	May	7.08	9.91		
	Jun	4.96	7.08		
	Jul	4.25	6.02		
	Aug	3.54	7.08		
	Sep	3.54	4.96		
	Oct	5.66	6.37		
	Nov	6.37	9.20		
	Dec	8.50	11.33		
Iron Concentration (mg/L)	Jan	0.10	0.30	0.3 - 1.0	N/A
	Feb	0.10	0.20		
	Mar	0.10	0.10		
	Apr	0.10	0.20		
	May	0.40	2.50		
	Jun	0.50	0.50		
	Jul	1.50	1.00		
	Aug	0.50	1.30		
	Sep	0.50	1.50		
	Oct	0.50	1.00		
	Nov	0.50	0.30		
	Dec	0.30	0.30		

Parameter	Month	Obtained result 2017	Obtained result 2018	Bangladesh standard DoE, 1997	Bangladesh standard EQS, 1997
Total Alkalinity (mg/L)	Jan	207.4	158.6	N/A	≤ 200
	Feb	231.8	183.0		
	Mar	231.8	219.6		
	Apr	134.2	146.4		
	May	73.2	42.7		
	Jun	48.8	54.9		
	Jul	36.6	61.0		
	Aug	61.0	61.0		
	Sep	48.8	79.3		
	Oct	61.0	122.0		
	Nov	146.4	195.2		
	Dec	146.4	219.6		
Magnesium Hardness (mg/L)	Jan	70.0	15.0	30 - 35	N/A
	Feb	80.0	35.0		
	Mar	70.0	70.0		
	Apr	40.0	45.0		
	May	20.0	10.0		
	Jun	10.0	15.0		
	Jul	10.0	10.0		
	Aug	15.0	10.0		
	Sep	10.0	10.0		
	Oct	20.0	30.0		
	Nov	40.0	60.0		
	Dec	35.0	60.0		
Dissolved Silica (mg/L)	Jan	26	19	N/A	N/A
	Feb	26	21		
	Mar	26	23		
	Apr	17	20		
	May	25	19		
	Jun	16	24		
	Jul	27	45		
	Aug	51	35		
	Sep	21	84		
	Oct	24	42		
	Nov	19	31		
	Dec	24	25		
BOD (mg/L)	Jan	6	7	≤ 0.2	≤ 6
	Feb	7	7		
	Mar	7	8		
	Apr	8	7		
	May	8	8		
	Jun	10	10		
	Jul	10	10		
	Aug	9	10		
	Sep	12	16		
	Oct	8	8		
	Nov	8	8		
	Dec	7	7		

Electrical conductance or conductivity is the ability of a substance to conduct an electric current. It measures the salinity of water and depends on the ions present in water. In any water body higher electrical conductivity (EC) means higher pollution. Specific conductance of most natural water generally ranges from about 50 μS/cm to 1500 μS/cm [33]. The results of conductivity of the current study were found ranged from 108 to 478 μS/cm in the year 2017 and 101 to 424 μS/cm in the year 2018 that's are shown in Fig. 2. In 2017, the highest EC (478 μs/cm) was recorded on 16 March, 2017 and Lowest EC (108 μs/cm) on 16 August, 2017 while in 2018, the highest EC (424 μs/cm) was recorded on 20 December, 2018 and lowest EC (101 μS/cm) on 22 May, 2018 respectively. DoE reported in water quality report that EC of Shitalakhya river water varied 120.3 μmho/cm to 1370 μmho/cm in 2014 [4], 108.40 μmho/cm to 930 μmho/cm in 2015 [28], 116.8 μmho/cm to 6147 μmho/cm in 2016 [29]. The obtained values in this study location was within the EQS (1200 μmho/cm) for treated wastewater from industrial units. Therefore it can be said that the water of the Shitalakhya River is suitable for aqua culturing.

Total Dissolve Solids (TDS) refers to the sum of all the components dissolved in water. In natural water dissolved solids are composed of mainly sodium ion, potassium ion, calcium ion, magnesium ion, chloride ion, sulfate ion, phosphate ion, silicate ion, carbonate ion, and bicarbonate ion. TDS in the study area varies from 54 ppm to 245 ppm in 2017 and 55 ppm to 212 ppm in 2018 that's are shown in Fig. 2. DoE reported in water quality report that TDS of Shitalakhya River varied from 70.6 mg/l to 523 mg/l in 2014 [4], 48.5 mg/l to 484.2 mg/l in 2015 [28] and 107.9 mg/l to 498 mg/l in 2016 [29]. Pia et al. [15] reported in contamination level (water quality) assessment and agro-ecological risk management of Shitalakhya River of Dhaka, Bangladesh that the total dissolved solids vary in pre-monsoon season from 111.5 ppm to 113.4 ppm and in post monsoon season from 96.2 ppm to 99.3 ppm. The permissible limit for TDS in the drinking water quality is 500 to 2000 ppm which is announced by WHO in 2008 [34,35]. Water that contains too much dissolved matter is not suitable for common uses. TDS of Shitalakhya river water at the sampling location was within the EQS (2100 mg/l) for wastewater after treatment from industrial units. Therefore the river water is moderately suitable for common uses.

Total Suspended Solids (TSS) are the solids in water trapped by a filter which include organic and inorganic materials such as silt, sewage, and decaying plants. It also includes animal parts and industrial wastes. Suspended solids in water are easily noticeable other than anything else. From our experimental data total suspended solids varied from 8 - 118 mg/l in 2017 and 10 - 154 mg/l in 2018 that's are shown in Fig. 3. Pia et al. [15] reported that TSS in the Shitalakhya river water ranged from 116 - 119 mg/l in pre-monsoon season (2015), and 101-103 mg/l in the post-monsoon (2016). DoE reported that suspended solid (SS) of Shitalakhya River water varied from 8 mg/l to 124 mg/l in 2014 [4], 12 mg/l to 76 mg/l in 2015 [28], 4 mg/l to 89 mg/l in 2016 [29]. DoE also reported that maximum SS concentration of Shitalakhya River was 89 mg/l in August, 2016 at Demra Ghat and the minimum was 4.0 mg/l in February, 2016 at Ghorashal Fertilizer Factory. Obtained result in 2017 and 2018, TSS of Shitalakhya River water at the sampling location was mostly within the EQS (150 mg/l) except in the month of September, 2018.

Turbidity is the cloudiness or haziness of a fluid caused by insoluble and colloidal compounds of inorganic origin (clay minerals, silicic oxide, hydrated oxide of iron and magnesium, etc.), or of organic origin (organic colloids, bacteria, plankton etc.). Turbidity is a key parameter of water quality, Turbidity readings are somewhat dependent on particle size, shape and color. Turbidity of the study area varied from 2.09 NTU to 120 NTU in 2017 and 2.73 NTU to 214 NTU in 2018. Minimum turbidity was 2.09 NTU and 2.73 NTU in April 2017 and 2018 while the maximum turbidity was 120 NTU and 214 NTU in August 2017 and 2018 respectively that's are shown in Fig. 3. Turbidity of Buriganga River water varied from 4.9 NTU to 250 NTU in 2015 [28] and 3.6 NTU to 120 NTU in 2016 [29] while EQS for drinking water is 10 NTU.

Hardness depends on the presence of magnesium and calcium ions in water. The value of total hardness in the present study was fluctuated from 30 mg/l to 190 mg/l in 2017 and 35 mg/l to 180 mg/l in 2018 that's are shown in fig. 4. In 2017, maximum value (190 mg/l) was recorded in the month of March and minimum value (30 mg/l) in the month of July. In 2018, maximum value (180 mg/l) was recorded in the month of March and minimum value (35 mg/l) in the month of May. High value of hardness can be attributed to decrease in water volume and

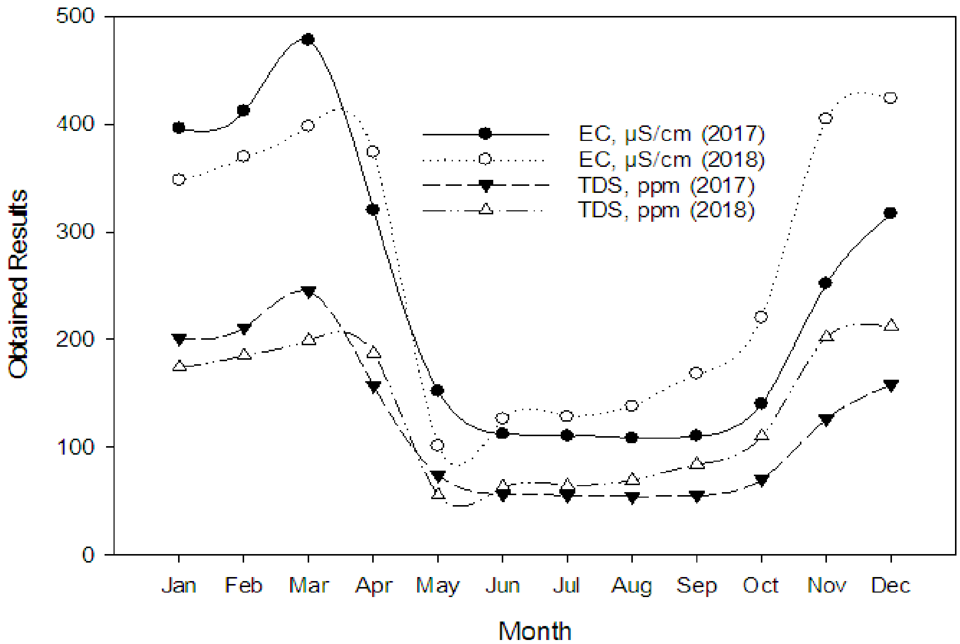

Fig. 2. Electrical conductivity (µS/cm) and TDS (mg/L) of the year 2017 and 2018 respectively

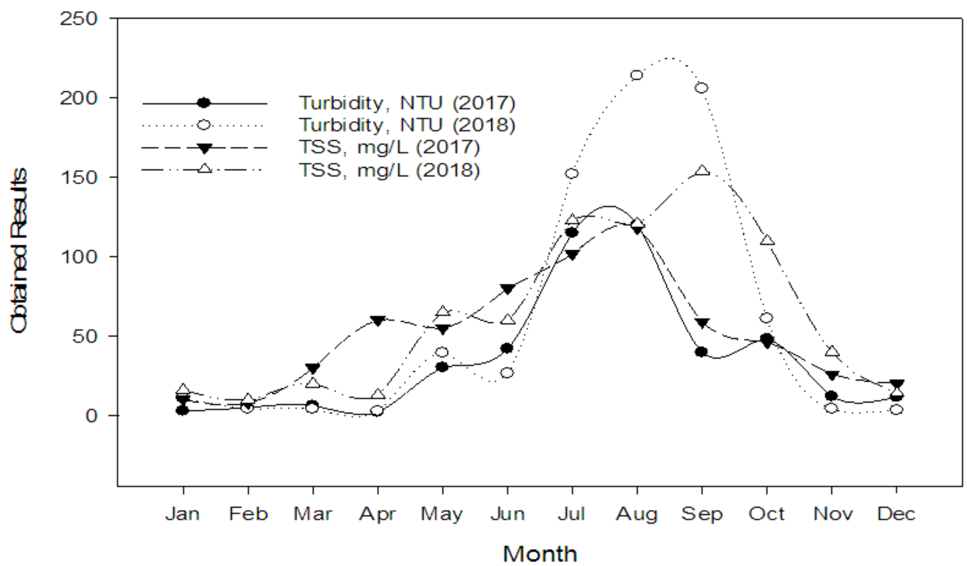

Fig. 3.Turbidity (NTU) and TSS (mg/L) of the year 2017 and 2018 respectively

increase of rate of evaporation of water. Similar results were obtained in the present study.

Total alkalinity level varied from 36.6 - 231.8 mg/l in 2017 and 42.7 - 219.6 mg/l in 2018 that's are show in Fig. 4. DoE reported that total alkalinity of Shitalakhya River water varied from 1.8 mg/l to 190 mg/l in 2014 [4], 32 mg/l to 170 mg/l in 2015 [28], 22 mg/l to 164 mg/l in 2016 [29]. For fishing purpose maximum recommended range of alkalinity is 200 mg/l [36]. Therefore the Shitalakhya river water is suitable for aquatic ecosystem.

Calcium concentration of Shitalakhya River water ranged between 20 mg/l to 120 mg/l in 2017 and

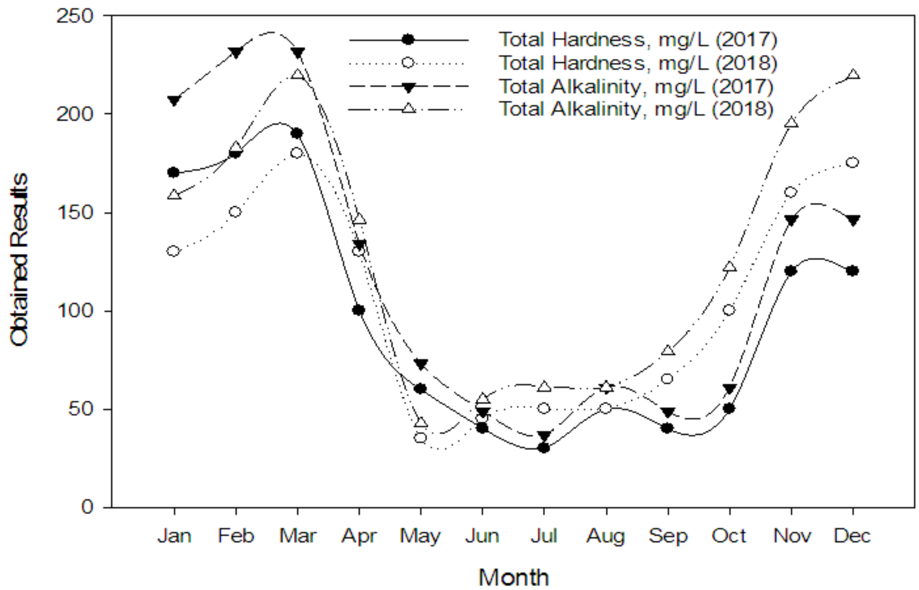

Fig. 4. Total hardness (mg/L) and total alkalinity (mg/L) of the year 2017 and 2018 respectively

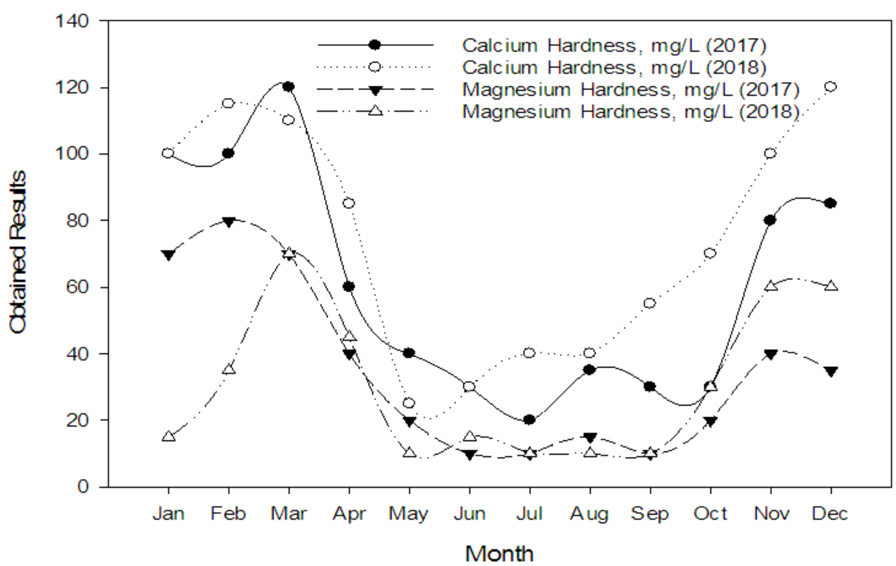

Fig. 5. Calcium hardness (mg/L) and Magnesium Hardness (mg/L) of the year 2017 and 2018 respectively

25 mg/l to 115 mg/l in 2018 that's are shown in Fig. 5. In 2017, maximum value (120 mg/l) was recorded in the month of March and minimum value (20 mg/l) in the month of July. In 2018, maximum value (115 mg/l) was recorded in the month of February and minimum value (25 mg/l) in the month of May.

Magnesium concentration of Shitalakhya River water ranged between 10 mg/l to 80 mg/l in 2017 and 10 mg/l to 70 mg/l in 2018. In 2017, maximum value (80 mg/l) was recorded in the month of February and minimum value (10 mg/l) in rainy season. In 2018, maximum value (70 mg/l) was recorded in the month of March and minimum value (10 mg/l) in rainy season. Mentioned results are shown in Fig. 5.

Chloride is an indicator of salinity in water. Surface water containing significant amount of chloride also tend to have high amount of sodium ions in water. From an environmental standpoint, chloride is basically a conservative parameter and may serve as an index of pollution occurring in natural fresh water from primary sources such as industrial and municipal outlets. The experimented chloride concentrations varied from 3.54 mg/l to 9.91 mg/l in 2017 and 4.96 mg/l to 16.99 mg/l in 2018 that's are shown in Fig. 6. DoE reported that chloride concentration of Shitalakhya River water varied from 0.7 mg/l to 179.5 mg/l in 2013 [27], 3.1 mg/l to 44 mg/l in 2014 [4], 4.0 mg/l to 35.98 mg/l in 2015 [28], 4.0 mg/l to 48.9 mg/l in 2016 [29]. DoE also reported that the maximum chloride concentration (48.9 mg/l) of Shitalakhya River water was found at near ACI factory in April, 2016 and the minimum was 4.0 mg/l at near Ghorashal fertilizer factory in October, 2016. Experimented results in 2017 and 2018, Chloride concentration of Shitalakhya River water was below the EQS (600 mg/l) for wastewater after treatment from industrial units.

Silica concentration of present study varied from 16 - 51 mg/l in 2017 and 19 - 84 mg/l in 2018 that's are presented in the Fig. 6. Dissolved silica concentrations in river water depend on chemical weathering, hydrological cycle in the basin, biological process and dissolution on land and in water [37]. Kennedy [38] explained that, in most cases, dilution and biological uptake by diatoms are the cause of low concentration of dissolved silica in river water. Adsorption of silica on suspended particles could also possibly remove silica from solution in the presence of electrolytes [39]. Silica is the most objectionable parameter in industrial water. Silica fouling and silica scaling of heat exchanger and equipment is a great problem. The problem of silica scaling is exacerbated in presence of low levels of polyvalent ions (i.e., aluminum, iron, calcium, magnesium, etc.) [40]. Maximum allowable limit for silica concentration in boiler feed water is 0.02 mg/l.

Iron concentration of Shitalakhya River water varied from 0.10 - 1.5 mg/l in 2017 and 0.10 - 2.50 mg/l in 2018. In 2017, maximum value (1.5 mg/l) was recorded in the month of July and minimum value (0.10 mg/l) in the month of January to April. In 2018, maximum value (2.50 mg/l) was recorded in the month of May and minimum value (0.10 mg/l) in the month of March. Iron concentration of Shitalakhya River water were presented in the Fig. 7 during the year 2017 and 2018 respectively. From the Fig. 7, it is clear that iron concentration quit good till the month of April in 2017 while rest of the study period it exceed the WHO and DoE standard for drinking water quality. Therefore Shitalakhya River water are not suitable for drinking purpose.

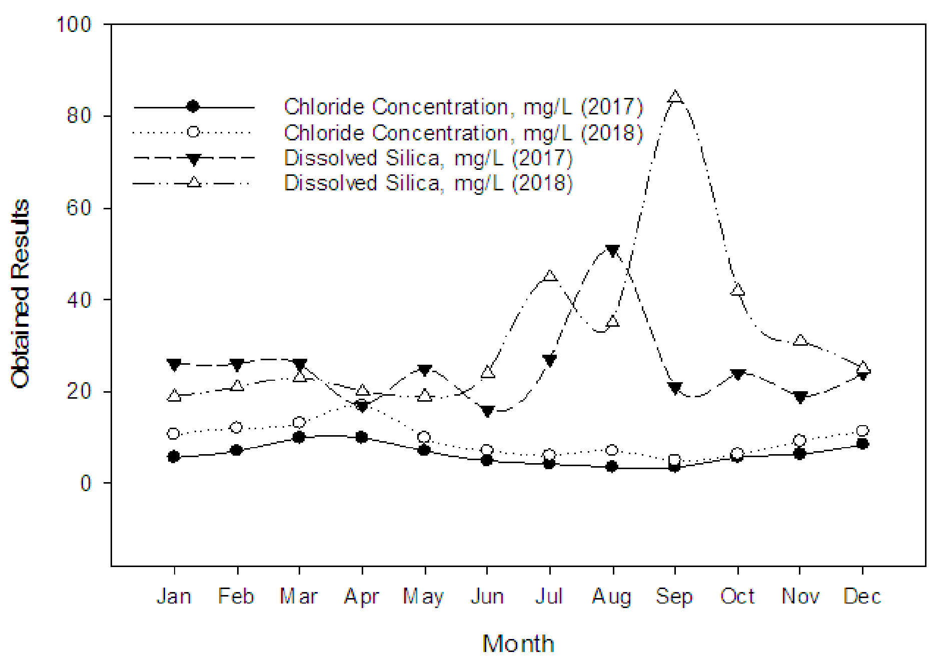

Fig. 6. Chloride concentration (mg/L) and dissolved silica (mg/L) of the year 2017 and 2018 respectively

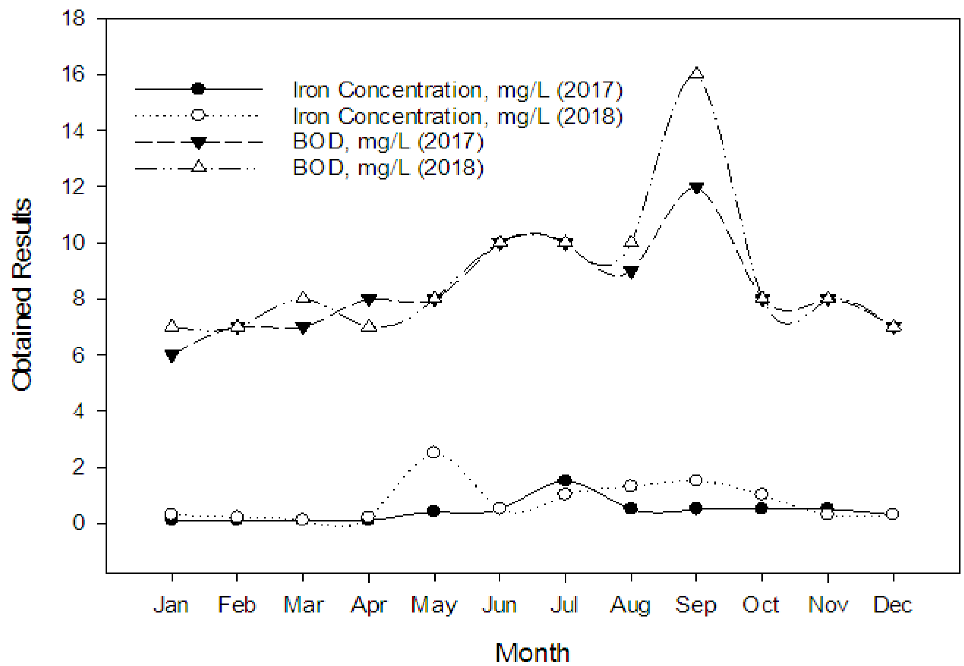

Fig. 7. Iron concentration (mg/L) and BOD (mg/L) of the year 2017 and 2018 respectively

Biochemical Oxygen Demand (BOD) is the amount of oxygen used by microbes to decay carbon-based materials in water within a five-day period [16]. Low BOD in water indicates that the riverside is free from organic pollution [41] while high BOD is detrimental as it reduce the DO [42]. The BOD in Shitalakhya river water varied from 6 mg/l to 12 mg/l in 2017 and 7 mg/l to 16 mg/l in 2018 that's are given in the Fig. 7. DoE reported that BOD concentration of Shitalakhya river water varied from 0.0 mg/l to 47 mg/l in 2013 [27], 0.0 mg/l to 32 mg/l in 2014 [4], 0.8 mg/l to 18 mg/l in 2015 [28] and 0.8 mg/l to 38 mg/l in 2016 [29]. Paul [43] mentioned that river water with a BOD concentration above 10 mg/l is considered to be moderate, while above 20 mg/l is considered highly contaminated water. Therefore Shitalakhya River water can be said as moderately contaminated.

4. CONCLUSION

Among the all tested parameter; Temperature, pH, EC, TDS, are in standard level while Turbidity, BOD5, Silica concentration are much higher than permissible level. The overall test results of the sampling water revel that the water quality of the Shitalakhya River is suitable for aqua culturing, irrigation and all living organism for sustaining aquatic ecosystem but not suitable for drinking and domestic purpose without conventional treatments. Government need to take a proper planning for development and better management of the river to control the pollution of Shitalakhya River water.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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