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Comparative Study on the Water Quality Status of an Industrialized and a Non-industrialized Area of Bangladesh

Research Article

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Abstract : The adverse effect of industrialization on the water quality status is studied in this paper. Pollution level at different water sources such as tubewell, deep tubewell, pond, canal and river of Shibpur (non-industrialized) and Sonargaon (Industrialized) area was monitored by evaluating the physico-chemical water quality parameters. These parameters include temperature, pH, TDS, COD, DO, EC, salinity and anions (F^-, Cl^-, Br^-, NO_2^-, NO_3^-, SO_4^{2-}). It was found that the average value of temperature, TDS, salinity, F^-, Cl^- and SO_4^{2-}in water sources of all locations were below the permissible level of World Health Organisation (WHO) and Department of Environment (DoE), Bangladesh. However, the value of pH, DO, EC, COD, nitrate, bromide and nitrite in some locations were found higher than the permissible level. The comparative study of the water quality parameters showed that Sonargaon area was more polluted than Shibpur. It can be concluded that the higher pollution of the water in Sonargaon area is due to the release of effluent from various industrial units.

Key words: *Water quality parameters ● Pollution ● Industrial effluent*

1. Introduction

Water plays a crucial role in the survival of living beings on earth. Indeed, contaminated water is harmful to human health as a source of many waterborne diseases. It has been estimated that 80 percent of all diseases and over one-third of deaths in developing countries are caused by the consumption of contaminated water (Halvorson *et al*., 2011). Water can be polluted by both naturogenic and anthropogenic activities (Sarkar *et al*., 2019; Rahman *et al*., 2019, Samad *et al*., 2016). Untreated and partially treated industrial effluents are major sources of water pollution that can deteriorate water quality and causes toxicity. As a case study, there are several industrial units located on the bank of the peripheral rivers of the Dhaka City (Rahman *et al*., 2012; Sarkar *et al*., 2015; Islam *et al*., 2015; Sarkar *et al*., 2018). Among them, Shitalakhya, Meghna, Buriganga, Turag and Balurivers are polluted by around 3072 industrial polluting entities (Mokaddes *et al*., 2013).

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Sonargaon and Shibpur Upazila (part of a district) are two areas near Dhaka city. Sonargaon is an industrial area whereas Shibpur is an agricultural and non-industrial area. Meghna, Shitalakhya and Brahmaputra rivers flow through the Sonargaon area. A number of cottage industries, poultry, dying, leather industries, carbides, and fabric painting, recycling and textile factories are situated on the bank of these rivers. These industries release various organic and inorganic chemicals including heavy metals that alter the water quality parameters like DO, COD, pH, TDS, salinity and concentration of anions and cations. This polluted water causes detrimental effects on the aquatic animal, plant and human life. The continuous increases in concentrations of pollutants within the cells of the organism can finally lead to death. Therefore, the continuous monitoring of the water quality parameters of surface water is essential to know about the contamination level. A number of studies have been reported on the water quality status of various water sources (rivers, canals and lakes). Studied on water quality parameters of 34 different water stations along the Faridpur-Barishal road in Bangladesh, Chowdhury *et al*. (2012) found poor values of the water quality index in most of the stations. From statistical correlation analysis of water quality of Kushiyara and Surma river during 2010 to 2013, Nahar and Chowdhury, (2017) reported that in the winter season, DO value of Kushiyara river decreases due to the high macrobiotic pollution in the riverside. Haque *et al*. (2017) in their investigation on the ground water from different places of Pabna district reported that the quality of water is within permissible limit for irrigation purposes. Critical state of the water of Buriganga river was reported by high values of COD, EC, TDS, salinity, alkalinity, turbidity and low DO indicates unhealthy ecosystem in this river (Akbor *et al*., 2017). Investigating the water quality of Narai canal and Balu river during January to June, 2012, authors reported the risky level of TDS, DO and NH_4^+that it is unsafe for domestic use (Roy *et al*., 2014). Serajuddin and Chowdhury, (2018) investigated the rate of reduction of ammonia in the Shitalakhya river water using the Meteor pilot, a biological pretreatment system. The reduction of ammonia was quite significant on average 73%, while the reduction of COD was in a range from 20 to 60%showed that Belanagar was highly polluted than Drenerghat on the basis of DO value according to river pollution index (RPI) (Bhuyan *et al*., 2018). Islam *et al*. (2018) found very high electrical conductivity and soluble sodium percentage values suggest salinity and sodium hazards in more than 50% of this selected region. Pia *et al*.(2018) monitored the water contamination level of the Shitalakhya River and observed total suspended solids, electrical conductivity and phosphorous were above the standard limit of drinking according to WHO both in pre and post-monsoon season. However, the study of water quality parameters in industry rich area like Sonargaon of Narayangonj district and non-industrial area such as Shibpur of Narsingdi district is not reported yet.

This study aims to evaluate a comparative study on the level of pollution in Sonargaon and Shibpur areas of Bangladesh with respect to temperature, pH, TDS, COD, DO, EC, salinity and anions (F^-, Cl^-, Br^-, NO_2^-, NO_3^-, SO_4^{2-}). A number of poultry, dying, leather, carbides, fabric painting, recycling and textile industries are situated in Sonargaon upazilla that are continuously pouring toxic effluents into the water systems. On the other hand, there is no notable industry in the study area of Shibpur.

2. Materials and methods

2.1 Chemicals

All the chemicals used in the experiments were analytical grade and no further treatment was made before use. The chemicals used were Sulfuric Acid (Merck, Germany), Nitric Acid (Merck, Germany), Silver Sulfate (Merck, Germany), Mercuric Sulfate (Merck, Germany), Potassium Dichromate (AnalaR England), Ferrous Ammonium Sulfate (Merck, Germany), Ferroin (Merck, India), Sodium Hydroxide (AnalaR England).

2.2 Sampling location

The surface and groundwater samples were collected from the different points at the Shibpur and Sonargaon areas (Fig. 1) from March 2013 to May 2014. Surface water was primarily collected from rivers, ponds and canals. Groundwater was obtained from tube wells used by the local people whose depth ranged from 90 to 150 ft and depth for deep tubewells is around 350 to 400 ft. Shibpur is 59 km and Sonargaon is 20 km from the capital city, Dhaka (in the south-east side). Sonargaon area consists of 11 unions (administrative area consisting of some villages) including one city corporation. Centrally located unions (Aminpur, Baidyer Bazar, Mugrapara, Baradi, Noagaon and Jampur) are primarily selected for sampling. In addition, two samples were collected from Shitalakhya river near Kachpur bridge. These 6 unions are surrounded by 3 Rivers (Meghna, Shitalakhya and Brahmaputra) and the river water is used as a major source of irrigation. On the other hand, Shibpur Upazila consists of 9 unions and there is only one small river named Koyra in this area. Population livelihood is based on agriculture where groundwater is primarily used for irrigation purposes. Five villages (Ashtani, Joynagar, Ajkitola, Sujatpur and Shimarbag) of

centrally located Joynagar union of Shibpur were selected for sampling. The detail information on sampling area, location and sampling size are provided in Table 1.

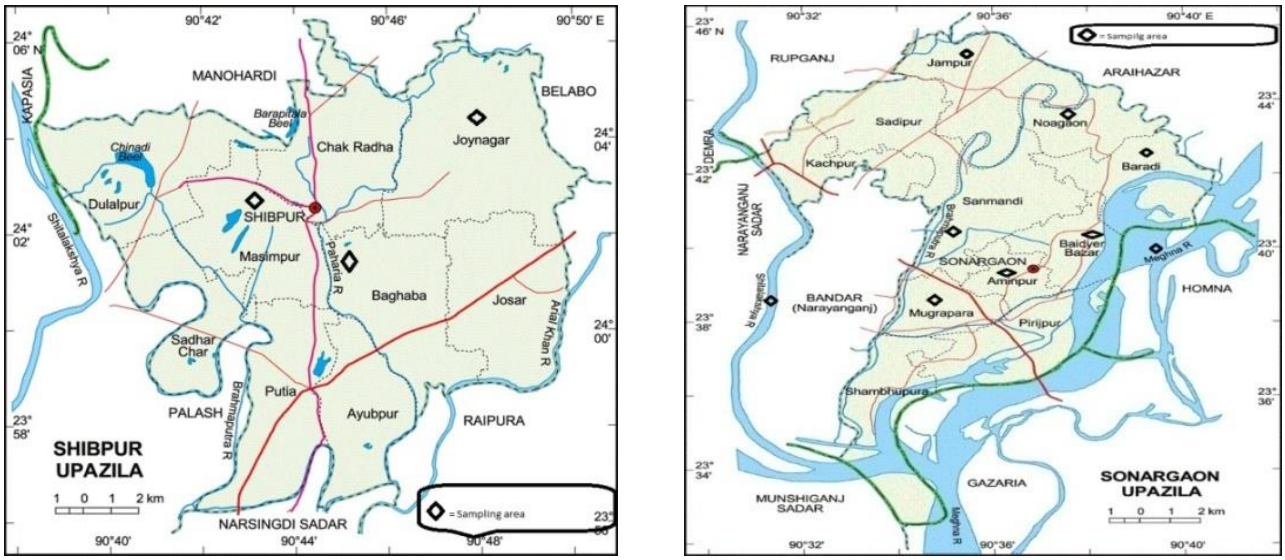

Figure 1. Study area and the sampling stations in the (a) Shibpur (b) Sonargaon Upazila.

Table 1. Information of sampling area, location and sampling size.

Name of Union	Upazila (Area)	Area of Union (sq. km)	Location	No. of sample
Joynagar (sampling villages were Ashtani, Joynagar, Ajkitola, Sujatpur and Shimarbag)	Shibpur (206.98 sq. km)	36.71	Latitude: 24° 22' 30.00" N Longitude: 90° 44' 15.00" E	100
Aminpur	Sonargaon (171.66 sq. km)	9.05	Latitude 23° 38' 40.1280" N Longitude 90° 35' 54.3624" E	17
Baidyer Bazar		9.57		12
Mugrapara		7.81		13
Baradi		13.56		15
Noagaon		12.36		16
Jampur		22.00		17
River (04 sample from Brahmaputra, 04 sample from Meghna and 02 sample from Shitalakhya river)				10

2.3 Water sampling

Samples were collected by the grab method. Polypropylene bottles of 1000 mL were used for collecting samples. Before collecting the samples, the bottles were washed with 5% nitric acid and then deionized water followed by drying. During sampling, bottles were rinsed with water from the sampling point. Sample bottles were marked with different identification numbers and tightly screwed after collecting water. Finally, the samples were carefully transported to the laboratory in an ice carrier until further analysis. The analysis of samples was performed at room temperature.

2.4 Analysis of water sample

Samples were analyzed in the Inorganic Research laboratory, Department of Chemistry, Jagannath University, Dhaka. The temperature, salinity, conductivity, TDS, pH and DO were measured instrumentally. Salinity, EC and TDS were measured by “CTS-406K” model meter, pH was measured by “Twin

B-221" and DO was measured by "YK-22" model DO meter. COD was measured chemically by potassium dichromate oxidation. Anion analysis was performed by "DIONEX ICS-3000" model I on Chromatography in the Chemistry division, Atomic Energy Centre (AEC), Dhaka. A high precision electrical balance "KERN, ABS 220-4" was used for weighing.

3. Results and discussion

3.1 Temperature

Water temperature plays a significant role in hydrochemistry. According to DoE, the permissible limit of temperature for sustaining aquatic life is 20 to 30 ºC (Sarwar *et al*., 2010). The temperature recorded in the present study are plotted in Fig. 2(a) and 2(b). From March, 2013 to May, 2014 on spot measurement of the temperature of the surface and groundwater at different sources of Shibpur and Sonargaon areas varied from 24.0-30.8 ºC and 28.9-31.5 ºC, respectively. The highest temperature was recorded as 31.5 ºC at the pond water in Sonargaon and the lowest one was 24 ºC at the river water in Shibpur area. The mean water temperature at different water sources of Shibpur and Sonargaon areas varied from 28 ± 3 ºC and 30 ± 1 ºC, respectively ($p<0.001$).

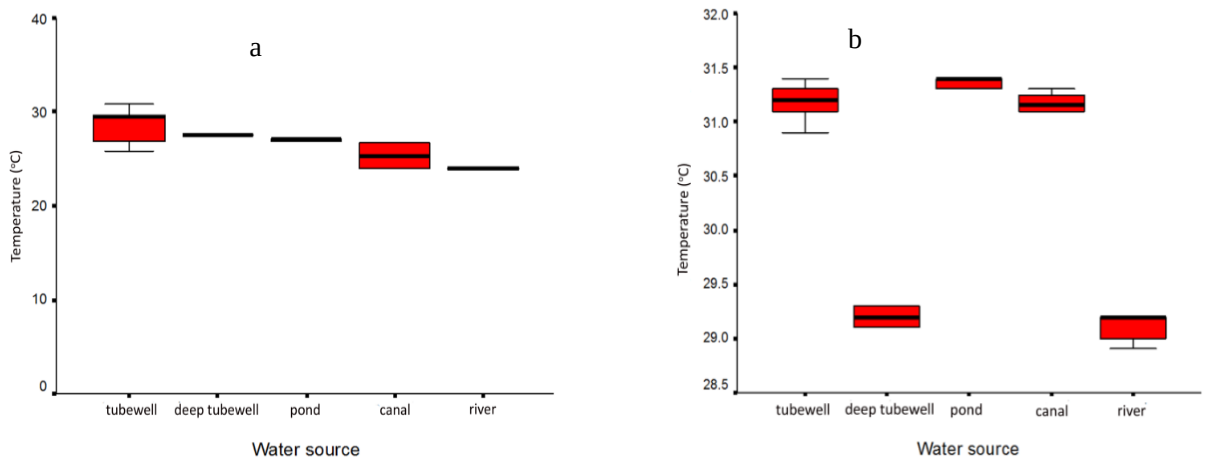

Figure 2. Variation of temperature at different water sources of (a) Shibpur (b) Sonargaon area.

3.2 pH

pH is the indicator of the acidic or alkaline condition of the water. It is the most important factor in determining the corrosive nature of water. Lower pH value indicates the higher corrosive nature of water (Langelier, 1946, Samad *et al.,* 2010). The DoE, Bangladesh endorse the value of pH for the freshwater is 6.5 to 8.5. The results of pH measurement in the present study are shown in Fig. 3(a) and 3(b). The following figures demonstrate that the pH of surface and groundwater at different water sources of Shibpur and Sonargaon areas ranged from 5.4 to 7.8. The mean pH at different sources of Shibpur and Sonargaon area varied from 6.9 ± 0.7 and 6.3 ± 0.6, respectively ($p<0.001$). Fig. 3(a) depicts that in Shibpur area, majority of the tubewell and deep tubewell water is slightly alkaline and Fig. 3(b) shows that the canal water is slightly alkaline while river water is slightly acidic in Sonargaon area. The slight alkalinity of groundwater is the result of dissolution of carbonate rich minerals in ground water whereas slight acidity is due to the absence of calcite minerals or infiltration of slightly acidic surface water into ground aquifer (Saha *et al.,* 2019).However, the slight alkalinity in canal water of Sonargaon area is due the release of alkaline industrial waste water.

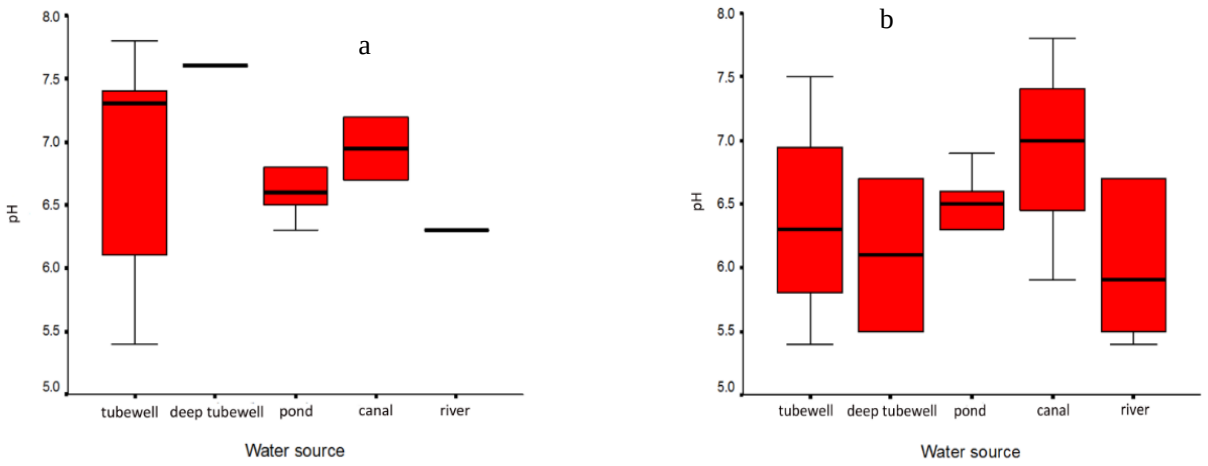

Figure 3. Distribution of pH at different water sources of (a) Shibpur (b) Sonargaon area.

3.3 Salinity

The level of minerals present in water is indicated by salinity. The increase of salinity in the water endangers the aquatic life of freshwater. In the present study, the results of salinity in the Shibpur and Sonargaon area were in the range of 0 - 96 mg L^{-1} and 19 - 693 mg L^{-1}, respectively during the study period as shown in Fig. 4(a) and (b). The mean salinity at different water sources of the Shibpur and Sonargaon area found 43 ± 24 and 288 ± 156 mg L^{-1}, respectively ($p<0.001$). High level of salinity observed at the Sonargaon area which is surrounded by different types of industries like chemicals, textiles, paper, dockyard, and match.

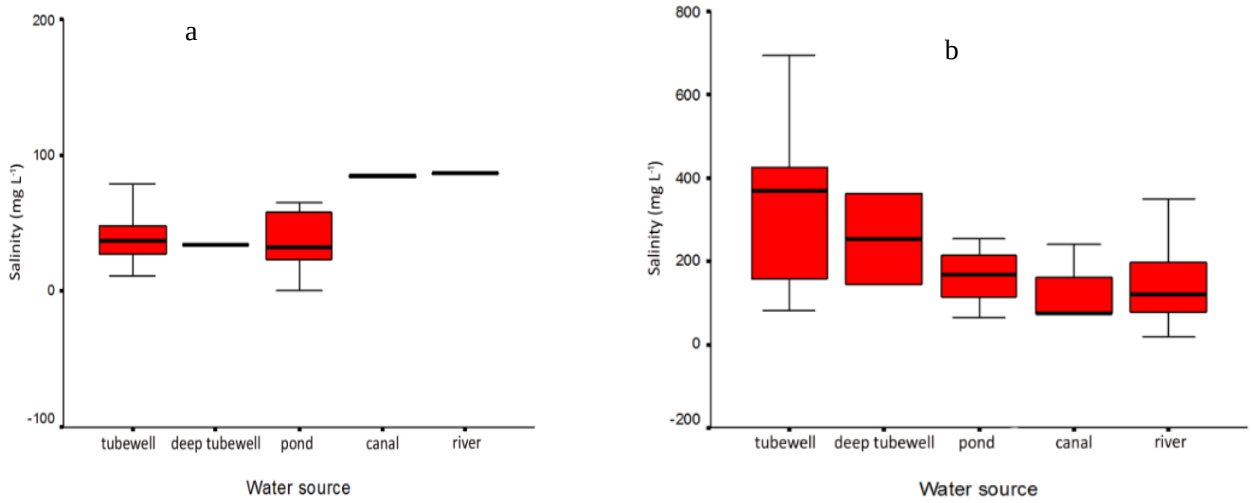

Figure 4. Distribution of Salinity at different water sources of (a) Shibpur (b) Sonargaon area.

3.4 Total dissolved solid (TDS)

Total dissolved solids (TDS) reveal the organic matter, inorganic matter and other materials dissolved in water. According to the Environmental conservation rules (1997), the maximum permissible value of TDS for potable water of Bangladesh is 1000 mg L^{-1}. The measured TDS values at different water sources of Shibpur and Sonargaon areas are plotted in Fig. 5(a) and (b). The mean total dissolved solids in Shibpur and Sonargaon were found to be 60 ± 33 and 402 ± 219 mg L^{-1}, respectively ($p<0.001$) which ranged from 0 to 126 mg L^{-1} at Shibpur and 27 to 943 mg L^{-1} at Sonargaon. The following figures indicate that the level of TDS is

higher at Sonargaon, but still below the maximum tolerable limit. Higher values of the total dissolved solids may be due to the presence of silt and clay particles in the water.

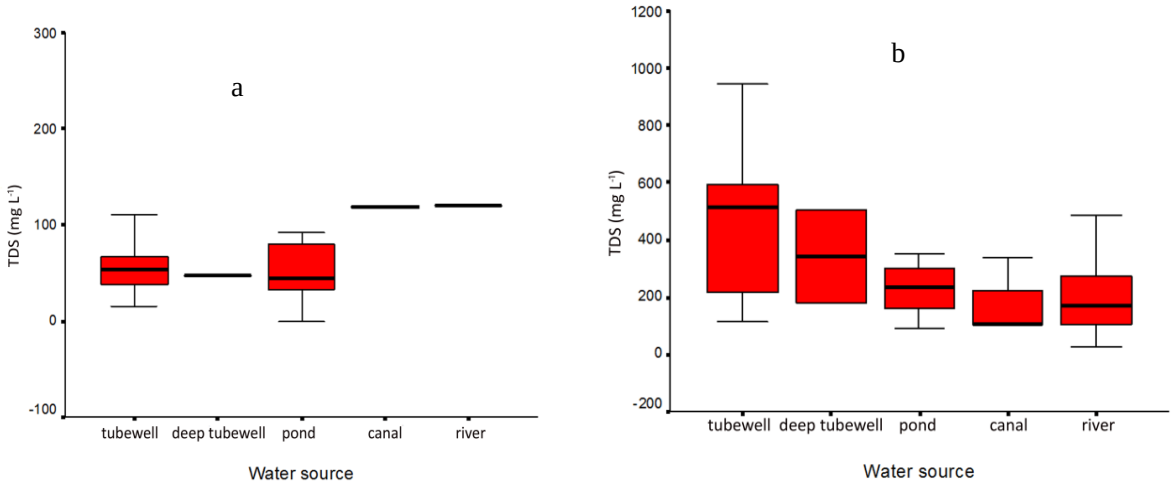

Figure 5. Variation of TDS at different water sources of (a) Shibpur (b) Sonargaon area.

3.5 Electrical Conductivity (EC)

Electrical conductivity (EC) specifies the level of cations and anions present in water. The standard value of EC according to the Food and Agriculture Organization (FAO) is 1000 µS (FAO, 1985; WHO, 2006). The increase of EC in water is not auspicious for aquatic life and agriculture. In the present study, the EC of the Shibpur area at different points varied from 0.0 to 180 µs and in the Sonargaon area from 41 to 1414 µS as shown in Fig. 6(a) and (b), respectively. The average EC values of different water sources of Shibpur and Sonargaon were recorded as 91 ± 50 µS and 598 ± 322 µS, respectively ($p<0.001$). Lowest EC was found in the Shibpur whereas the highest value was in the Sonargaon area. In the Shibpur area, the electrical conductivity value for all the ground and surface water samples were found within the permissible limit. Due to the industrial effluent, EC value of some samples was found above the permissible limit in the Sonargaon area.

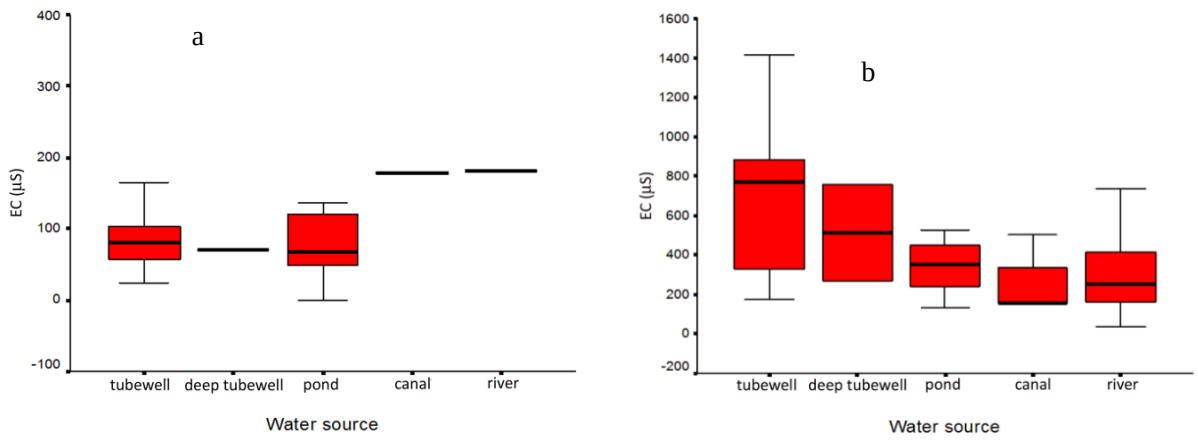

Figure 6. Distribution of EC at different water sources of (a) Shibpur (b) Sonargaon area

3.6 Dissolve Oxygen (DO)

Dissolved oxygen (DO) is the indication of the level of oxygen dissolved in water. High DO value indicates the healthy condition of the water body. The permissible limit of DO in the potable water of Bangladesh is 6 mg L^{-1} or above according to the environmental conservation rule (1997). The results of DO value in the Shibpur and Sonargaon area are presented in Fig. 7(a) and (b). The DO values at Shibpur and Sonargaon areas ranged from1.0 to 8.8 mg L^{-1} and 1.2 to 6.5 mg L^{-1}, respectively. The average DO values of different water sources of

Shibpur and Sonargaon areas were recorded 6 ± 1.7 mg L^{-1} and 3 ± 1.4 mg L^{-1}, respectively ($p<0.001$). The lowest DO was recorded in the Sonargaon whereas, the highest DO was found in the Shibpur area. The lower average value of DO at Sonargaon area indicates that water sources of this area are more polluted compared to Shibpur area especially by textile dye and organic compounds related industries.

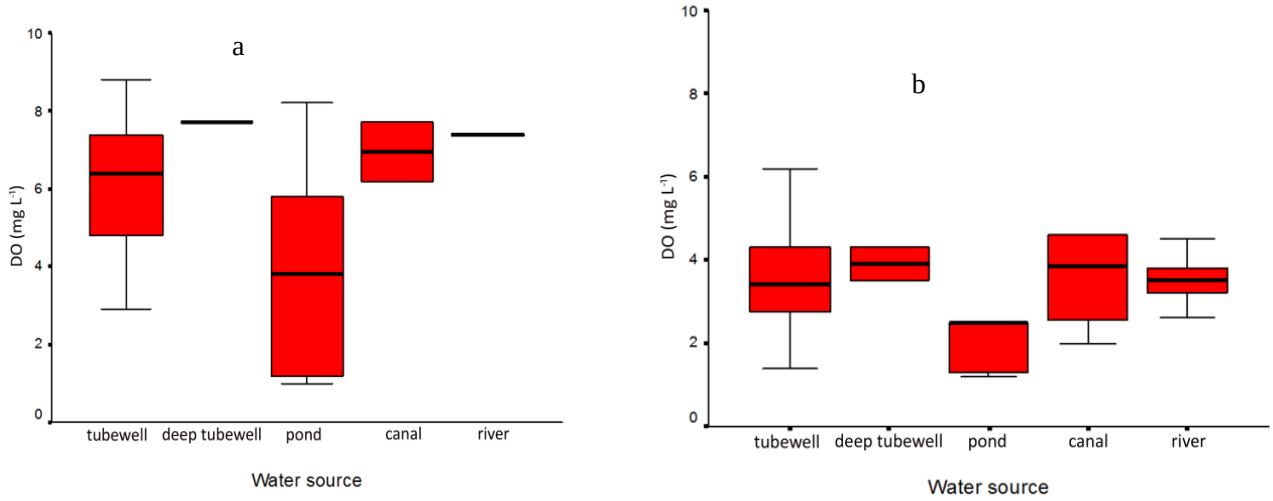

Figure 7. Variation of DO at different water sources of (a) Shibpur (b) Sonargaon area.

3.7 Chemical Oxygen Demand (COD)

COD is the estimation of the microorganism in water. The high COD value indicates the presence of some degree of non-biodegradable oxygen demanding pollutant in water having an injurious effect on the water ecosystem. The Department of Environment (DoE) approves standard value of COD for wastewater should be below 200 mg L^{-1} (DoE, 2008). In this study, the ranges of COD values in the Shibpur and Sonargaon areas were observed 20 - 580 and 20 - 970 mg L^{-1}, respectively as shown in Fig. 8(a) and (b). The mean COD values for different points of Shibpur and Sonargaon were recorded as 179 ± 136 and 394 ± 228 mg L^{-1}, respectively. The lowest COD was found 20 mgL^{-1} in the Shibpur area whereas the highest COD was recorded as 970 mg L^{-1} in the Sonargaon area. The average value of COD in the Shibpur area lies in the permissible limit by DoE whereas in the Sonargaon area; it is significantly higher than the acceptable limit. The high value of COD in Sonargaon is the indicative of higher organic pollutant in water which is the result of organic rich industrial pollutants released from different industries located in this area.

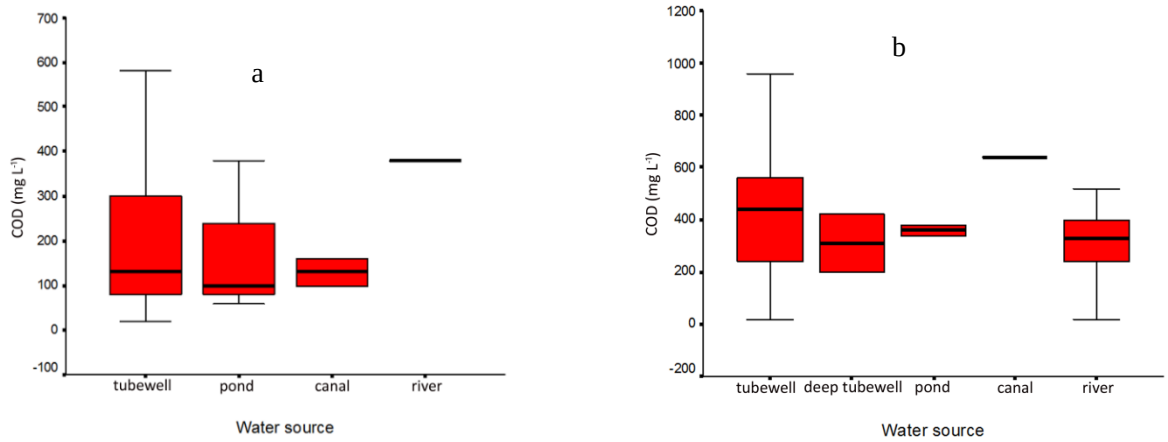

Figure 8. Variation of COD at different water sources of (a) Shibpur (b) Sonargaon area.

3.8 Concentration of anions

Various anions level of the Shibpur and Sonargaon areas were measured during the month of August, 2014. The different types of anions such as fluoride, chloride, bromide, nitrite, nitrate and sulphate etc. were analyzed. For every anion analysis, 10 samples were collected from each area and the results are presented in Table 2.

Table 2. Concentration of anions from different water sources of Sonargaon and Shibpur

Sample ID	F^- (mg L^{-1})	SD (±)	Cl^- (mg L^{-1})	SD (±)	Br^- (mg L^{-1})	SD(±)	NO_2^- (mg L^{-1})	SD (±)	NO_3^- (mg L^{-1})	SD (±)	SO_4^{2-} (mg L^{-1})	SD (±)
SB-1370	0.12	0.01	3.10	0.31	1074	107	0.59	0.05	0.31	0.03	0.39	0.04
SB-1407	0.18	0.02	6.88	0.69	849	84.9	0.61	0.06	0.30	0.03	0.55	0.06
SB-1410	0.16	0.02	5.33	0.53	523	52.3	0.74	0.05	0.33	0.03	0.53	0.05
SB-1419	0.22	0.02	4.30	0.43	499	49.9	0.63	0.06	0.46	0.05	0.50	0.05
SB-1422	0.14	0.01	5.27	0.53	0.30	0.03	0.70	0.07	156.55	15.7	0.34	0.03
SB-1441	0.15	0.02	3.52	0.35	364	36.4	0.68	0.07	0.31	0.03	0.31	0.03
SB-1455	0.13	0.01	3.49	0.35	0.30	0.03	0.69	0.07	64.63	6.46	0.46	0.05
SB-1502	0.25	0.02	24.9	2.49	1570	157	0.67	0.07	0.47	0.05	0.58	0.06
SB-RCW	0.28	0.03	9.20	0.92	680	68.0	0.67	0.07	1.00	0.10	2.22	0.22
SB-KRW	0.24	0.02	14.6	1.46	657	65.7	0.65	0.06	0.42	0.04	12.7	1.27
SG-1608	0.08	0.01	54.3	5.43	1363	136	0.47	0.05	0.17	0.02	0.41	0.04
SG-1641	0.10	0.01	43.2	4.32	1378	138	0.49	0.05	0.24	0.02	0.45	0.05
SG-1663	0.16	0.02	38.5	3.85	1734	173	0.53	0.05	0.24	0.02	0.52	0.05
SG-1664	0.12	0.01	32.2	3.22	2313	231	0.56	0.05	0.31	0.03	0.42	0.04
SG-1746	0.12	0.01	22.0	2.20	813	81.3	0.56	0.05	0.20	0.02	1.01	0.10
SG-1752	0.10	0.01	13.3	1.33	1540	154	0.59	0.06	0.26	0.03	0.30	0.03
SG-1784	0.12	0.01	47.9	4.79	3235	323	0.63	0.06	0.24	0.02	0.54	0.05
SG-1794	0.14	0.01	100	10.0	1017	102	0.42	0.04	0.31	0.03	1.29	0.13
SG-BRW	0.18	0.02	20.0	2.00	1284	128	0.66	0.06	0.24	0.02	9.38	0.94
SG- SRW	0.21	0.02	42.1	4.21	1456	146	0.67	0.07	0.27	0.03	15.6	1.56

SB = Shibpur, SG = Sonargaon, KRW= Koyra River Water, RCW = Ramganga Canel Water, BRW = Brahmaputra River Water, SD = Standard Deviation, SRW = Shitalakhya River Water

3.8.1 Fluoride (F^-)

Fluoride plays an important role as anticaries when applied topically to the teeth (Horst et al. 2018). However, it is not necessary for the development of healthy teeth and bones (Tsiros et al. 1998; Chouhan and Flora 2010). Excessive F^- intake may have an adverse effect on human health such as dental fluorosis, skeletal fluorosis, etc (Everett, 2011). In the present investigation, fluoride content in the water samples varied from 0.08 to 0.28 mg L^{-1}. The variation of fluoride in the Shibpur area ranged from 0.12 to 0.28 mg L^{-1} as illustrated Table 2 whereas in the Sonargaon area ranged from 0.08 to 0.21 mg L^{-1}. The minimum value was recorded at Aminpur (SG-1608) of Sonargaon while the maximum value was recorded at Ramganga canal water (SB-RCW) of Shibpur area. All the values observed lower than the WHO standard.

3.8.2 Chloride (Cl^-)

Chloride is a major anion in potable and industrial water which has an effect on health and imparts bad taste to drinking water. Chloride exerts a harmful effect on human health include the risk of cancer, cell damage,

increase risk of asthma, etc (Bilal and Iqbal, 2019). Table 2 shows that the chloride concentration is in the range of 3.10 mg L^{-1} to 100.0 mg L^{-1}. Similar chloride concentration was observed by Islam and co-authors (2018) in the surface water of Turag river. The variation of chloride in the Shibpur area ranged from 3.10 to 24.9 mg L^{-1} whereas in the Sonargaon area ranged from 13.3 to 100.0 mg L^{-1}. The minimum value was recorded at Joynagar (SB-1370), Shibpur while the maximum value was noted at Aminpur (SG-1794), Sonargaon. However, all the values detected were lower than the WHO standard (1996).

3.8.3 Bromide (Br^-)

Bromide concentration was found in the range of 0.30 to 3235.0 mg L^{-1} in the present assessment (Table 2). The variation of bromide in Shibpur area ranged from 0.30 to 1570.0 mg L^{-1} and in the Sonargaon area ranged from 813.0 to 3235.0 mg L^{-1}. The minimum value was recorded at Ajkitola (SB-1455), Shibpur while the maximum value was recorded at Aminpur (SG-1784), Sonargaon. The abnormally high bromide (3235.0 mg L^{-1}) was observed at the Sonargaon area due to the effect caused by agricultural and industrial effluent.

3.8.4 Nitrite (NO_2^-)

Nitrite is used for the curing of meat products due to its inhibiting effect on the growth of bacteria (Wójciak *et al.*, 2019). Unfortunately, it can also stimulate the growth of bacteria when introducing in high levels into the water body (Sharma & Bhattacharya, 2017). High levels of nitrites are toxic to humans and animals, especially infants (Ward *et al*., 2018). Nitrite concentration ranged from 0.42 to 0.74 mg L^{-1} in the present study. The variation of nitrite in the Shibpur area ranged from 0.59 to 0.74 mg L^{-1} and in the Sonargaon area ranged from 0.45 to 0.67 mg L^{-1} (Table 2). The minimum value was recorded at Aminpur (SG-1794), Sonargaon while maximum value was recorded at Austoani (SB-1410), Shibpur. All the values noted higher than the WHO standard (WHO 2004). The maximum value of nitrite was observed in the river water because of the percolation of nitrite component to the river water from the dumping of garbage, sewage leakage, etc.

3.8.5 Nitrate (NO_3^-)

Nitrate concentration was found in the range of 0.17 to 156.55 mg L^{-1}. The variation of nitrate in the Shibpur area ranged from 0.30 to 156.55 mg L^{-1} and in the Sonargaon area ranged from 0.17 to 0.31 mg L^{-1}(Table 2). The minimum value was recorded in Aminpur (SG-1608), Sonargaon while the maximum value was recorded in Austoani (SB-1422), Shibpur. The nitrate values of the samples lie within the permissible limits of WHO (10 mg L^{-1}) in the Sonargaon area but some samples found above the permissible limits in the Shibpur area due to the leaching of nitrate salt present on the surface with percolating water (Sharma, 1994).

3.8.6 Sulphate (SO_4^{2-})

The results of sulphate concentration are illustrated in Table 2. The observed concentration of sulphate was in the range of 0.30 to 15.6 mg L^{-1}. The variation of sulphate concentration in Shibpur area ranged from 0.31 to 12.7 mg L^{-1} and in the Sonargaon area ranged from 0.30 to 15.6 mg L^{-1}. The minimum value was recorded in Aminpur (SG-1752), Sonargaon while the maximum value was recorded in Shitalakhya river water (SRW) near Kachpur Bridge, Sonargaon. The sulphate value of the entire sample was observed within the permissible limits of WHO (400 mg L^{-1}) (Kaur and Singh, 2009).

4. Conclusion

Among the water quality parameters evaluated, some of them were found below the permissible level of WHO and Department of Environment, Bangladesh (DoE) except pH, DO, EC, COD, nitrate, bromide and nitrite. The lower value of DO (minimum 1.0 mg L^{-1}, average 3±1.4 mg L^{-1}) in Sonargaon area indicates that the water bodies are not suitable for fish and living organisms. The higher value of COD observed 970 mg L^{-1}(with a mean value of 394 ± 228 mg L^{-1}) in Sonargaon area was due to the discharge of different kinds of industrial and municipal waste. The abnormally high value of bromide (3235 mg L^{-1}) is the direct consequence of the release of chemicals from industries. It can be concluded that the level of water pollution in Sonargaon area is more than that of Shibpur area which can be attributed to the discharge of effluent from various industries. Therefore, in order to improve the water quality, industries should use effluent treatment plant (ETP) before releasing effluent to the water bodies. Government authority should strictly monitor the practice of ETP by relevant industrial units. Planned industrial area with central effluent treatment plant (CETP) can be a viable option. This study will also provide the database for the government to understand the level of water pollution and to take necessary steps regarding water pollution control.

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