Society & Change
Vol. V, No.1, January-March 2011
ISSN 1997-1052

Water Quality Aspects of Dhaka City's Peripheral Rivers: A Case Study on Tongi Canal and Balu River

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Abstract

Dhaka city's peripheral rivers are Buriganga, Dhaleshwari, Sitalakhya, Turag, Tongi canal and Balu. All these peripheral rivers are known to be highly polluted. Like other rivers the water quality of Tongi canal and Balu (north-eastern part of Dhaka's peripheral rivers) are vulnerable to pollution from sedimentation, illegal encroachment, and disposal of solid waste, untreated industrial effluents and municipal wastewater, runoff from various chemical, fertilizer and pesticides, and oil and lube spillage in and around the operation of river transportation. The present study has been conducted to evaluate the important physical, chemical and biological water quality parameters and scenarios of the Tongi canal and Balu river of Dhaka city through a field survey during monsoon and pre-monsoon in 2009. The investigation results have been compared with the Bangladesh and WHO standard for surface water. The parameters namely pH, Dissolve Oxygen (DO), Biological Oxygen Demand (BOD) Chemical Oxygen Demand (COD), Total Dissolve Oxygen (TDS), Electrical Conductivity (EC), Nitrate-Nitrogen (NO_3_N), Phosphate (PO_4), Ammonium-Nitrogen (NH_4+-N), Turbidity, Lead, Cadmium and Zinc were tested in this research. The test results indicate that all the water quality of Tongi canal and Balu river are highly polluted because disposal of industrial waste and various effluents without any treatment in the river. The study indicates that most of the elements were generally higher during the pre-monsoon. Water quality at the some points in the both Tongi canal and Balu river are significantly exceeded the standard limit because of the largest amounts of toxic chemicals are released here by the various industries (raw and processed).

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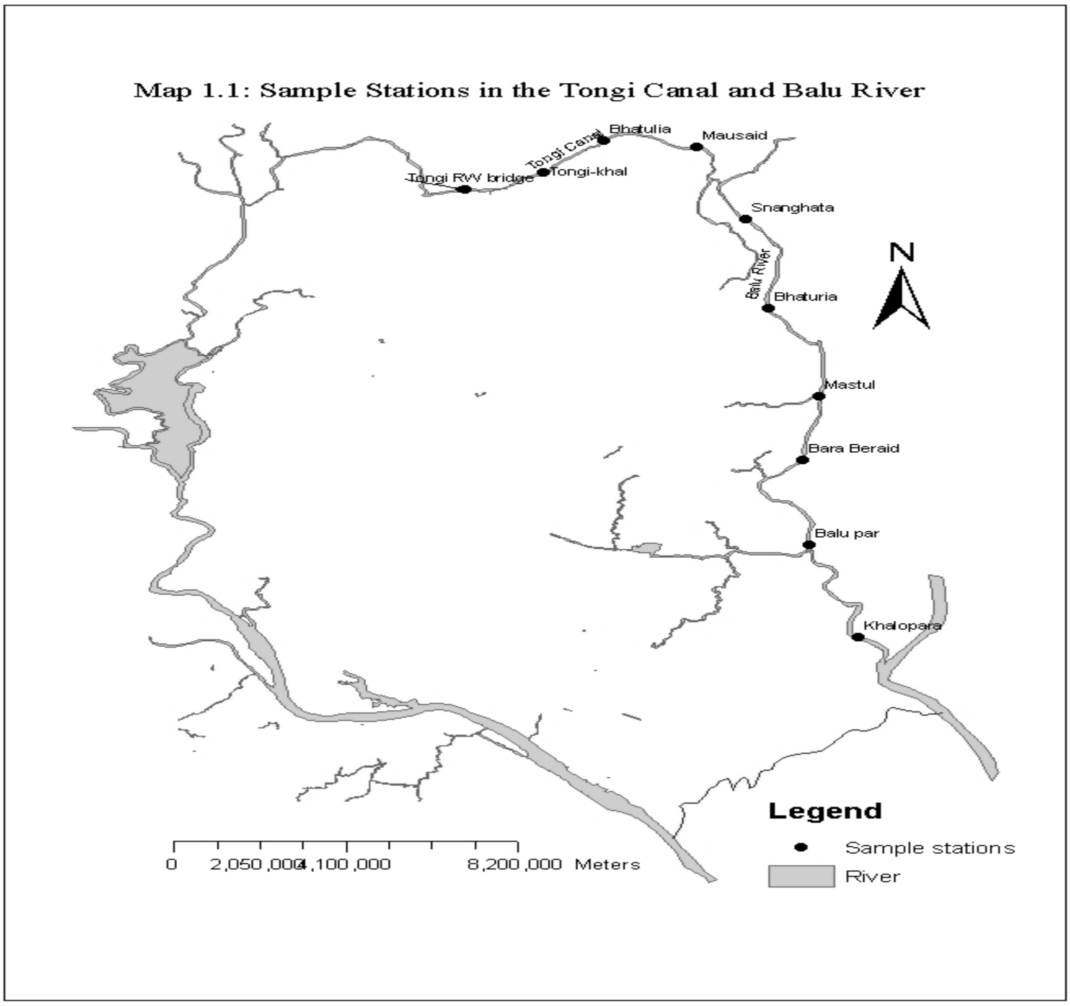
Introduction



Map 1.1: Sample Stations in the Tongi Canal and Balu River

Water quality assessment is the overall process of evaluation of the physical, chemical and biological nature of the water. The water quality of the surrounding rivers of Dhaka city is deteriorating day by day. City's surface water resources are having an inherent problem of pollution. Ground water table is depleted for over withdrawn of water, which may jeopardize its lives and developments. It is very crucial to diversify the sources of water supplied for the city population. Diminution of dependency on the groundwater and make provision to meet demand of the city from surface water is now very essential. The water bodies located in the periphery of the city comprise ample water even in the dry season. Domestic and industrial wastes generated by the city dwellers are deteriorating the water bodies gradually and even are jeopardizing their sustainability. So an assessment of water quality in the peripheral rivers is essential for their sustainability and also to rescue the city water supply from possible catastrophe.

Dhaka city is surrounded by four rivers are Buriganga in the south; Turag is the west, Tongi canal in the north and Balu river in the east. All theses rivers are highly polluted. A survey was conducted in 1999 revealed that the water of the rivers Buriganga, Turag, Tongi canal , Balu, Shitalakha and Dhaleshwari had been completely polluted (Subramaniam 2004; Karn and Harada 2001; Kamal et al. 1999).

This study is concentrated only in Dhaka's surrounding two rivers Tongi canal and Balu (map 1.1). The banks of the rivers Tongi canal and Balu have turned into unauthorized industrial districts. There has been unauthorized occupation on the bank sides land and illegal encroachment into the river. Lots of tanneries, dying industries, brick fields, aluminum industries, battery manufacturing industries, pharmaceutical industries, soap industries, match industries, ink manufacturing industries, textile, paint, iron and steel workshops, Pb-Zn melting industries are situated in the EPZ of Tongi area, around the river Tongi canal and Balu. The industrial effluents and untreated agricultural waste fall in Tongi canal and Balu river directly without any treatment. So pollution of the rivers and streams with chemical contamination has become one of the most crucial environmental problems in the 21^{st} century. So these rivers deserve serious attention from the researchers and planners. There are some research on surroundings rivers, but Tongi canal and Balu river need special attentions because the study on these two rivers are few. This justifies a fresh study on Tongi canal and Balu river.

The main objectives of the study are to determine the quality of water basically the concentration of different pollutants in the peripheral rivers Tongi canal and Balu around Dhaka city, which provide a baseline data, that may help in formulation better strategies and guidelines to reduce the pollutants levels and that will be a sustainable solution.

Total 20 samples were collected 10 in monsoon and another 10 in pre-monsoon from Balu river and Tongi canal at various important (taking four points from Tongi canal and six points from Balu river) points. The samples were collected in two seasons during pre-monsoon and monsoon at March and July, 2009. The locations of the stations are: Sample Station-1: Tongi Bridge area, Back side of Bengal Textile; Sample Station-2: Rajabari, Tongi; Sample Station-3: Bhatulia, Tongi; Sample Station-4: Mausaid, Tongi; Sample Station-5: Snanghata, Uttar Khan; Sample Station-6: Bhaturia, Daskhin Khan; Sample Station-7: Mastul, Daskhin Khan; Sample Station-8: Bara Beraid, Badda; Sample Station-9: Balu Par, Badda; Sample Station-10: Khael Para, Badda. On the other hand, secondary data were collected from different books, journals, research papers, and reports (Library of DU, BUET, BANSDOC, CIRDAP) and also from various web sites. Collected data were analyzed at the environmental lab, Departmental of Geography and Environment, University of Dhaka and Department of Civil Engineering, BUET.

Experimental methods

Collected water samples were analyzed by using the instruments mentioned below:

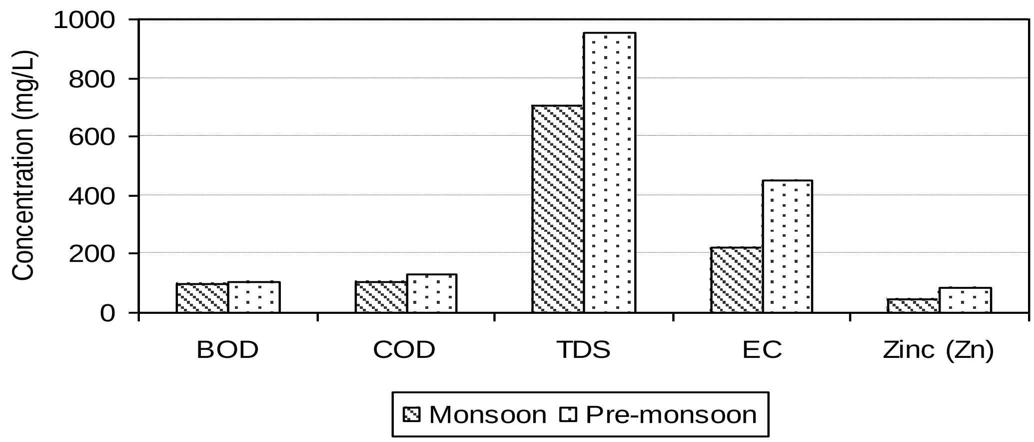
1. pH meter (Glass electrode pH meter calomel reference electrode meter- Model-7, Japan) to determine the pH.
2. Conductivity meter (CM-55 TOA, Japan) to measure Electrical Conductivity (EC), Total Dissolved Solid (TDS) and Total Suspended Solid (TSS).
3. Turbidity meter (HACH Ratio Turbid meter model 18900) to measure turbidity.
4. HACH Test Kit (Model FF-2, USA) to determine the Dissolved oxygen (DO), Biological Oxygen Demand (BOD), Ammonium Nitrogen (NH_4+ -N), Nitrate Nitrogen (NO_3-N), Chemical Oxygen Demand (COD).
5. Atomic Absorption Spectrophotometer (AAS, Model AA-680 Shimadzu, Japan) was used to determine Cadmium (Cd).

Results and discussions

Different parameters of river water quality were measured at different points (table 1 & 2). Both pre-monsoon and monsoon data are also compared in the light of different guideline value (e.g. DOE, USEPA, WHO and Bangladesh).

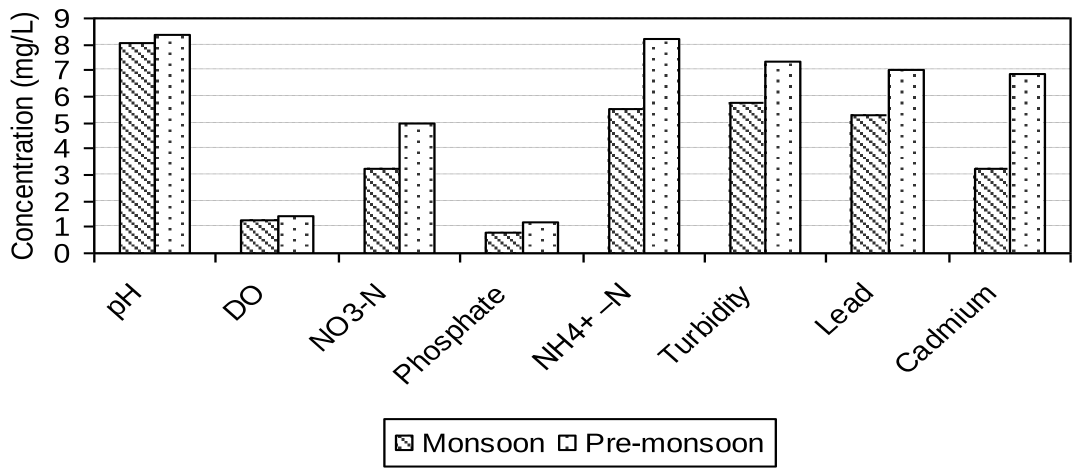
pH: The pH of water is a measure of the hydrogen ion concentration on a scale of 0 (very acidic) to 14 (very alkaline) with pH 7 being the neutral point (Stirling, et al. 1990). Several other variables of water depend on it. For most species, a pH between 6.5 and 9 is ideal. Below pH 6.5 species experience slow growth (Lloyd 1992). At lower pH, the species ability to maintain its salt balance is affected (Lloyd 1992) and reproduction ability will be hampered. At approximately pH 4 or below and pH 11 or above, most species die (Lawson 1995) and the high pH values promote the growth of algae (George, 1961). The pH can also indirectly affect fish and shellfish through its effects on other chemical parameters.

Fig. 1: Concentration level in Tongi Canal



The standard value for pH is 6.5-8.5 mg/L, which is tolerable for fishing and drinking. The present value of pH in Tongi canal is 8.33 mg/L and 8.08 mg/L at pre-monsoon and monsoon seasons (fig.2). The present pH value in Balu river is 7.47 mg/L and 7.22 mg/L at pre-monsoon and monsoon (fig. 3, table1 & 2). The study shows that the two stations 3 and 4 at Tongi canal are not suitable for fishing, bathing and drinking because of their alkaline conditions (table1 & 2).

Fig.2: Concentration level in Tongi Canal

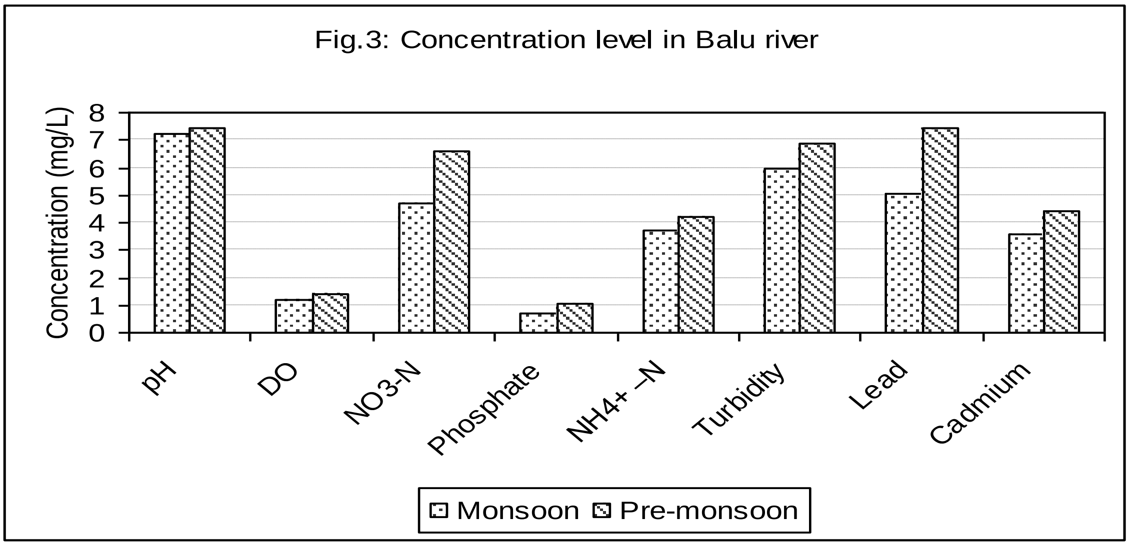


Shahjahan, 2006 carried out a study on Tongi canal and Balu river but the study did not show the seasonal fluctuation. But in the present investigation the pH fluctuations was shown, the range was 7.0 to 8.6 in the different sampling stations. According to DoE survey (2004) the pH level of Jamuna, Buriganga, Shitalaksma, Meghna and Padma rivers of Bangladesh were 6.91 mg/L, 7.1 mg/L, 7.14mg/L, 7.1 mg/L, and 7.1 mg/L, which were comparatively low then the study rivers.

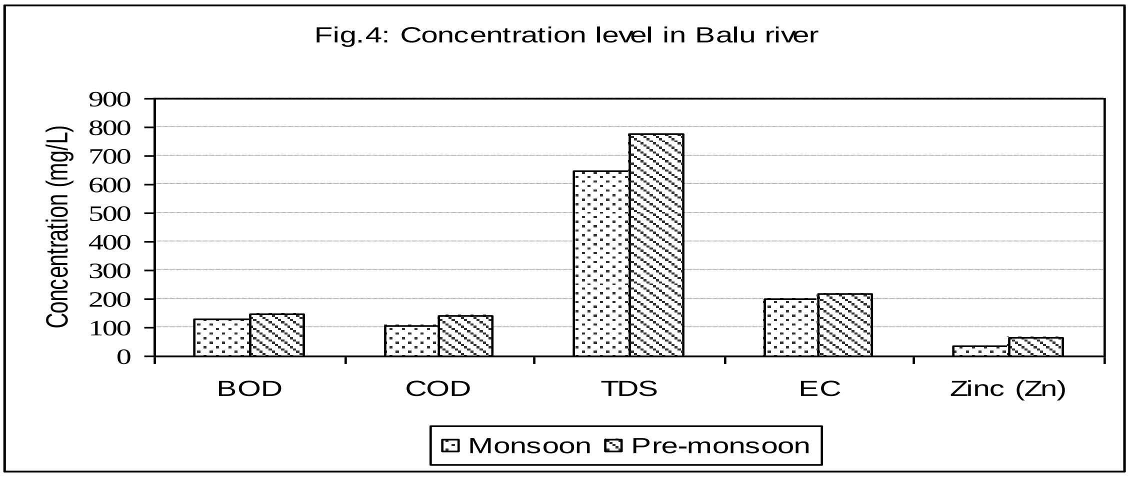
Table 1: Different parameters conditions at the monsoon in the Tongi canal and Balu river

		Sample stations												Monsoon average
		Tongi canal				Avrg.	Balu river						Avrg.	
Parameters	Units	1	2	3	4		5	6	7	8	9	10		
pH	mg/L	7.8	7.72	8.5	8.3	8.08	7.25	6.9	7.15	6.89	7.2	7.9	7.22	7.561
DO	mg/L	1.2	1.3	1.1	1.3	1.23	1.25	1.31	1	1.2	1.5	0.98	1.21	1.214
BOD	mg/L	100	105	108	86	99.8	135	110	110	145	130	135	128	116.4
COD	mg/L	85	110	125	92	103	145	80	110	105	95	90	104	103.7
TDS	mg/L	620	680	805	730	709	510	700	840	690	530	600	645	670.5
EC	µS/cm	289	221	210	158	220	310	205	184	140	202	165	201	208.4
NO_3-N	mg/L	2.2	3.2	4.25	3.35	3.25	6.82	5.64	3.98	3.4	2.5	5.88	4.7	4.122
Phosphate	mg/L	1.15	0.45	0.84	0.69	0.78	1.2	0.82	0.84	0.32	0.25	0.86	0.72	0.742
NH_4+ –N	mg/L	8.5	3.5	4.15	6	5.54	7.26	1.8	5.05	4.2	2.2	1.8	3.72	4.446
Turbidity	mg/L	5	6	6.2	5.9	5.78	7	5.9	5.9	6	5.95	5.2	5.99	5.905
Lead	mg/L	5.2	4.2	5.65	6.12	5.29	6.26	4.87	3.98	5.08	6.1	3.8	5.02	5.126
Cadmium	mg/L	2	3	4	4	3.25	3.5	3	3.5	5	3.5	3	3.58	3.45
Zinc (Zn)	mg/L	56	43	39	52	47.5	28	22	42	54	36	21	33.8	39.3

Source: Field survey 2009



Dissolved Oxygen (DO): Dissolved oxygen (DO) is one of the significant parameter in water quality, pollution control, and several treatment processes. Dissolved oxygen measurements are vital for maintaining aerobic conditions in natural waters that receive pollutants in the water. Dissolved oxygen is the factor that determines whether the biological changes are brought by aerobic or by anaerobic organisms. If DO levels drop below 4 to 5 mg/L then it is risk to survive for aquatic life (Devis and Cornwell, 1991).



In the present study, concentration of DO value fluctuates in two seasons of various point of Balu River and Tongi canal. The average value of DO in Tongi canal at pre-monsoon is 1.4 mg/L and monsoon is 1.23 mg/L (fig. 2, table1 & 2). The average value of DO in Balu river is 1.37 mg/L at pre-monsoon and 1.21 mg/L at monsoon (fig. 3, table 1 & 2). On the other hand, the average DO in the both rivers in the pre-monsoon and monsoon were 1.38 mg/L and 1.21 mg/L respectively. An irregular seasonal variation was observed for DO in both the seasons at different stations in Balu river and Tongi canal.

Table 2: Different parameters conditions at the pre-monsoon in the Tongi canal and Balu river

Parameters	Units	Sample stations												Pre-monsoon average
		Tongi canal				Avrg.	Balu river						Avrg.	
		1	2	3	4		5	6	7	8	9	10		
pH	mg/L	7.7	7.7	9	8.9	**8.33**	7.5	7.5	7.3	7.5	7.5	7.5	**7.47**	7.81
DO	mg/L	1.5	1.4	1.3	1.4	**1.4**	1.3	1.8	1.1	1.3	1.4	1.3	**1.37**	1.38
BOD	mg/L	108	120	100	95	**106**	150	130	125	170	150	155	**147**	130.3
COD	mg/L	103	140	160	110	**128**	180	120	137	145	130	120	**139**	134.5
TDS	mg/L	790	1060	830	1125	**951**	810	752	852	750	753	752	**778**	847.4
EC	μS/cm	260	450	740	360	**453**	289	221	210	158	235	186	**217**	310.9
NO_3-N	mg/L	3.02	5.3	6.2	5.5	**5.01**	10.5	8.25	4.1	3.1	5.13	8.5	**6.6**	5.96
Phosphate	mg/L	1.9	0.95	1.03	1	**1.22**	1.5	0.9	1.05	0.85	0.79	1	**1.02**	1.097
NH_4+ –N	mg/L	12.8	5.2	6.31	8.5	**8.2**	10.2	2.1	4.1	5.1	1.7	2.1	**4.22**	5.811
Turbidity	mg/L	7.11	7.2	7.9	7.1	**7.33**	8.5	6.9	7	7.2	5.48	6.4	**6.91**	7.079
Lead	mg/L	6.1	8.05	6.5	7.5	**7.04**	8.1	7	7.5	7.14	6.9	8.1	**7.46**	7.289
Cadmium	mg/L	2.25	11	7	7.2	**6.86**	4.2	5	3	4.5	4.5	5.2	**4.4**	5.385
Zinc (Zn)	mg/L	85	79	76	90	**82.5**	65	45	76	90	63	52	**65.2**	72.1

Source: Field survey 2009

Banerjee (1967) noted that the water body should have dissolved oxygen concentration above 5.0 mg/L for average or good production. Gupta et al. (1983) reported that above 5.0 mg/L dissolved oxygen provides a favorable productive condition of water bodies. According to DOE, 2004 the standard value of DO for fishing is 5 mg/L and drinking is 6 mg/L. On the basis of this standard, every station of Tongi canal and Balu river is not fit for drinking and fishing. Whereas the averages DO level of Jamuna, Buriganga, Shitalaksma, Meghna and Padma rivers are respectively 6.8, 1.8, 5.2, 6.2 and 6.1mg/L (DOE, 2004).

Biochemical Oxygen Demand (BOD): Biological oxygen demand is the most commonly used parameter to define the strength of wastewater (Singh, 2000). When BOD is too high the DO content of water become too low to support all the life in water. According to DoE the standard value of BOD range is 5 to 250 mg/L. (DoE, 1997).The present study shows that the average BOD in the pre-monsoon at the Tongi canal and Balu river are 106 mg/L and 147 mg/L (fig. 1 & 4, table 1 & 2). On the other hand, the average BOD in the monsoon at the Tongi canal and Balu river are 99.8 mg/L and 128 mg/L (fig. 1 & 4). The BOD in the both river at monsoon and pre-monsoon are 130.3 mg/L and 116.4 mg/L, which are with the range of the given standards, while this is not suitable for drinking.

Chemical Oxygen Demand: Chemical oxygen demand (COD) is a measure of the capacity of water to consume oxygen during the decomposition of organic matter and the oxidation of inorganic chemicals such as ammonia and nitrite. COD measurements are commonly used for waste water and natural water those are contaminated by domestic or industrial wastes.

The present study shows that, the average Chemical Oxygen Demands (COD) are 103 mg/L and 103.7 mg/L at the Tongi canal and Balu river in the monsoon and in the pre-monsoon the levels are 128 mg/L and 134.5 mg/L (fig. 1 & 4, table 1 & 2). According to the standard value set by DoE (Table 3) for COD, these values were in the acceptable ranges for use in agriculture and release in inland surface water while this water is not suitable as good drinking water.

Total Dissolved Solid (TDS): TDS is the most important parameter for water quality especially for irrigation water since it controls the availability of water to plants through osmotic pressure regulating mechanisms (ADB 1994). A limit of 500 mg/L dissolved solids is desirable for drinking water (DoE 1999). Highly mineralized water is unsuitable for many industrial applications.

According to the study, the average TDS in the Tongi canal and Balu river are 951 mg/L and 778 in the pre-monsoon, but the average value are 709 mg/L and 645 mg/L in the monsoon. According to this data the average TDS value is low in the Balu river than in the Tongi canal (fig. 1 & 4, table 1 & 2). According to standard value of this parameter set by DoE (Table 3), this water could not be used for agricultural purposes but could be released into the surface water, while according to EPA (1985) standard maximum TDS of 500 mg/L is the acceptable range for diverse fish population and aquatic life. So, the values of TDS in sample waters were not suitable for fish and other aquatic fauna.

Electrical Conductivity (EC): Electrical conductivity is usually used for indicating the total concentrations of the ionized constituents of water. It is closely related to the sum of the actions as determined chemically, and it usually correlates closely with TDS (Rouse, 1979). According the study, the average EC in the Tongi canal and Balu river are 453 μS/cm and 217 μS/cm in the pre-monsoon, but the average value are 220 μS/cm and 201 μS/cm in the monsoon (table 1 & 2, fig. 1 & 4). The average values are 310.9 μS/cm and 208.4 μS/cm in the pre-monsoon and monsoon in the both rivers (table 1 & 2, fig. 1 & 4). According to standard value of this parameter set by DoE (Table 3) it showed lower value and this water would not need treatment to reduce EC.

The EC level of Jamuna, Buriganga, Shitalaksma, Meghna and Padma rivers in Bangladesh were 200, 546, 230, 152 and 120 μS/cm respectively which was studied by DOE in 2004. The standard value of EC for Bangladesh is 800-1000 μS/cm for fishing and 2250 μS/cm for irrigation.

Table 3: Standard values of various water qualities parameters

Parameters	Standard Value of Bangladesh in Agriculture (DoE)	Standard for Good Drinking Water (DoE)	Standard of Waste from Industrial Units or Projects Waste (DoE)		
			Inland Surface Water	Public Sewerage system connected to treatment at Second Stage	Irrigated Land
BOD	250	0.2	50	250	100
COD	200	4	200	400	400
DO	4.5 – 8	6	4.5-8	4.5-8	4.5-8
EC	500		1200 micro mho/cm	1200 micro mho/cm	1200 micro mho/cm
NH_4+ –N	0.5	0.5	5	5	15
NO_3-N	<10	10	10	-	10
pH	6.5-8.5	6.5-8.5	6-9	6-9	6-9
TDS	500	1000	2100 micro mho/cm	2100 micro mho/cm	2100 micro mho/cm
TSS	100	10	150	150	150
JTU	10	10			
Cd	0.05	0.005	0.05	0.5	0.5

Source: Bhuiyan et. al, 2009

Nitrate Nitrogen (NO_3 –N): NO_3 –N leaching depends on a number of variables including quantity of NO_3 water holding capacity of soil, evaporation etc. Nitrate can be expressed as either NO_3 (nitrate) or NO_3-N (nitrate-nitrogen). Nitrate levels above the EPA maximum contaminant level of 10mg/L NO_3- N or 45 mg/L NO_3-N may cause methemoglobinemia in infants.

According the study, the average NO_3 –N in the Tongi canal and Balu river are 3.25 mg/L and 4.7 mg/L in the monsoon, but the average value are 5.01 mg/L and 6.6 mg/L in the pre-monsoon (table 1 & 2, fig. 2 & 3). On the other hand, the average values are 4.122 mg/L and 5.96 mg/L in the monsoon and pre-monsoon in the both rivers (table 1 & 2, fig. 2 & 3). According to standard value of this parameter set by DoE (Table 3) it showed that all sample stations within the acceptable range for agricultural use, drinking purposes, while some stations exceed drinking quality level and for releasing in the inland surface water. But fish grow and survive at 0.5 mg/L NO_3 –N (Boyd et al, 2008), which indicates that all the sampled water lost their suitability for fish survival. High concentrations of NO_3 –N may cause excessive plant growth leading to phytoplankton bloom leading to more toxification of the water system vulnerable for the survival of aquatic organisms (Stirling 1990). Sensitive crops may be affected by nitrogen concentrations above 5 mg/l. Most other crops are relatively unaffected until nitrogen exceeds 30 mg/L (FAO 1985). High nitrogen levels may be beneficial during early growth stages but may cause yield losses during the later flowering and fruiting stages. Less than 5 mg/L NO_3 –N has little effect, even on nitrogen sensitive crops, but may stimulate nuisance growth of algae and aquatic plants in streams, lakes, canals and drainage ditches (FAO, 1985).

Phosphate: Phosphate is one of important parameters of water quality. The average phosphate in the Tongi canal and Balu river were 1.22 mg/L and 1.097 mg/L in the pre-monsoon and 0.78 mg/L and 0.72 mg/L in the monsoon respectively. The level of phosphate is high at monsoon and low at pre-monsoon season (table 1 & 2, fig. 2 & 3).

The concentration of phosphate in the both rivers exceeds the permissible level of USPH standard of phosphate for drinking water (0.10 mg/L). Both the highest and lowest value of phosphate is much higher than the standard limit at all the locations in all the seasons. The high values are probably due to fertilizer run-off from agricultural lands. The sources of phosphate may be organic wastes, soaps and detergents. So the water of these two rivers is not suitable for various purposes.

Ammonium-Nitrogen (NH_4+ –N): Ammonium measurement is an important water quality parameter used to indicate water pollution. Ammonium is produced in water bodies naturally by some industrial process such as paper mills, garbage and drainage waste. It is also influenced by temperature and salinity.

The present average observed value of Ammonium-Nitrogen in Tongi canal is 5.54 mg/L at monsoon and 8.2 mg/L at pre-monsoon and in the Balu river this levels are 3.72 mg/L at monsoon and 4.22 mg/L at pre-monsoon (fig. 2 & 3). The average values in the monsoon and pre-monsoon in the both rivers were 4.446 mg/L and 5.811 mg/L (table 1 & 2). Individually the highest NH_4+ –N value is found at Tongi bridge (station 1) area. The standard value of Ammonium-Nitrogen (NH_4+ –N) is 0.5 mg/L for agriculture and drinking (table 3). According to this standard, the water of Tongi canal and Balu river is not suitable for drinking, fishing and living organism for survival.

Turbidity (JTU): Turbidity is important parameters to measure surface water quality. Insoluble particles of soil, organics, microorganisms, and other materials impede the passage of light through water by scattering and absorbing the rays. The present turbidity level of Tongi canal at pre-monsoon is 7.33 JTU and 5.78 JTU at monsoon and in the Balu river this level is 6.91 JTU at the pre-monsoon and 5.99 JTU at the monsoon (table 1 & 2, fig. 2 & 3). The standard value of turbidity is 10 JTU for drinking and agriculture (table 3), which can be acceptable for the both purpose according to this parameter.

Lead (Pb): Lead, a metal found in natural deposits, is commonly used in household plumbing materials and water service lines. The greatest exposure to lead is swallowing or breathing in lead paint chips and dust. But lead in drinking water can also cause a variety of adverse health effects. In babies and children, exposure to lead in drinking water above the action level can result in delays in physical and mental development, along with slight deficits in attention span and learning abilities. In adults, it can cause increases in blood pressure. Adults who drink this water over many years could develop kidney problems or high blood pressure. Acute toxicity of Pb in the invertebrates is reported at concentration of 0.1-10 mg/L (Moore and Ramamoorthy, 1984). The worst lead contamination is in Southeast Asia (ADB, 1997).

The average lead concentration in the Tongi canal is 7.04 mg/L at pre-monsoon and 5.29 mg/L at monsoon and in the Balu river the concentration of lead is 7.29 mg/L and 5.17 mg/L at the pre monsoon and monsoon seasons respectively (table 1 & 2, fig. 2 & 3). The average lead level of Balu river is more than Tongi canal at the season of pre-monsoon and monsoon. According to WHO report (2010), the standard value of lead is 0.01 mg/L and the Department of Environment (DoE, 1991) standardized the lead level is 0.05 mg/L for drinking. According to this value, the lead level of the two rivers is high and the water of Tongi canal and Balu river is not suitable for drinking and fishing.

Cadmium (Cd): Cadmium is one of the heavy metal, which is toxic to animals and plants. The average level of cadmium in Tongi canal is 6.86 mg/L at pre-monsoon and 3.25 mg/L at monsoon and in the Balu river this range is 4.4 mg/L and 3.58 mg/L in the pre-monsoon and monsoon seasons (fig. 2 & 3). But the average cadmium in the pre-monsoon and monsoon are 3.45 mg/L and 5.39 mg/L respectively in the both Tongi canal and Balu river (table 1 & 2). The standard level of cadmium is .005-.05 for drinking and agriculture (table 3). So, the studied rivers water is not suitable for drinking, fishing and even agriculture.

Zinc (Zn): Zinc enters the domestic water supply from the deterioration of galvanized iron and dezincification of brass besides industrial waste. Zinc also discharges form zinc-fertilizer, leather and paint industries. The average value of zinc at the Tongi canal and Balu rivers in the pre-monsoon is 82.5 mg/L and 72.1 mg/L (fig. 1 & 4) and in the monsoon season this is 47.5 mg/L and 33.8 mg/L (table 1 & 2). According to DoE (1999) standard this value is high in the two rivers and the water is not suitable for drinking and fishing. According to Masuduzzaman and Rafiq (2006) the concentration of zinc range is 112-225 mg/L in the Buriganga river and 26-247 mg/L in the surface water of the Turag river and lowest in Balu river, which range is 38-98 in wet and dry season.

Summary Conclusions

The disposal of industrial waste, effluents and byproducts into riverine system caused river water is polluted and threatens seriously to the environment. Many of the chemicals substance are toxic or even carcinogenic. Pathogens can obviously produce waterborne disease in either human or animal hosts. Finally, the area is vulnerable not only for wild and domestic flora and fauna but also for the human. The present data on the status of river water will help to establish water processing plants in future, the requirement of which increases at a tremendous rate due to growth of population, industrialization and arsenic contamination in tube well water.

The concentration of pH, Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Turbidity, Dissolved Oxygen (DO), Total Dissolved Solids (TDS), Electrical Conductivity (Ec), Nitrate-Nitrogen (NO_3-N), Ammonium-Nitrogen (NH_4+ –N), Phosphate (PO_4), Cadmium, Lead and Zinc are 7.22 to 8.33 mg/L, 103 to139 mg/L, 99.8-147 mg/L, 5.9 to 7.07 mg/L, 1.2 to 1.3 mg/L, 670 to 847 mg/L, 209 to 310 µS/cm, 4.12 to 5.96 mg/L, 4.45 to 5.81 mg/L, .742 to 1.097 mg/L, 3.45 to 5.38 mg/L, 5.13 to 7.29 mg/L and 39.3 to 72.1 at the monsoon and pre-monsoon seasons in the Tongi canal and Balu river respectively. According to the data, the level of contamination in Tongi canal and Balu river are severe for the environment in many cases, like drinking, agriculture, fisheries and other uses. It can be concluded that the water of these rivers is a great threat to ecosystem though some parameters may not in the deteriorate level but the condition of the river side urbanization and industrialization may cause all kind of water pollution in the near future. So measures should initiate immediately in the both rivers as like as Dhaka surrounding rivers.

Recommendations

To mitigate the disastrous problem measures should be taken like: (i) Measurement of wastewater flows through different outlets is essential for campaign to compute actual volume of wastewater discharged into the studied rivers. (ii) Water quality monitoring stations are required in the Tongi canal and Balu river for better understanding of the water quality. (iii) Every industry along with Tongi canal and Balu river must follow and apply the DoE environmental guidelines. (iv) Effluent Treatment Plants (ETP) should be set up for all industries in besides Tongi canal and Balu river and every industry should follow it. (v) Continuous measurement of DO throughout whole day, at least twelve hours will be helped to understand the complete diurnal variation. (vi) Finally, public awareness is essential to prevent the serious degradation of water quality.

References

ADB. 1994. The Environment Program: Past, Present and Future. Asian Development Bank, Manila, Philippines.

ADB. 1999. Development Debacles, Marinduque Mining Project: The Worst Mining Disaster in the Philippines, Asian Development Bank, Manila, Philippines.

Banerjee, A. C. 1967. The hydrobiological features, Primary Production of Stanely Reservior Mettur Dam for the year 1958-1965. Madras J. Fisheries 14, 133-144.

Bhuiyan, R. H, Ullah, M. S. and Hossain, M. K. 2009. Quality of Surface Water at the Savar and its Adjacent Areas, *Society and Change*, Vol. III No. 3 July and September 2009, Organization for Social Development and Research.

Boyd, C. A., Puan, P. and Boyd, C. 2008. New Nitrogen Fertilization Recommendations for Bluegill Ponds in the Southeastern United States, *North American Journal of Aquaculture*, 70: 308-313.

Devis, M. L. and Cornwell, D. A. 1991. Introduction to Environmental Engineering, 2nd edition, McGraw-Hill Inc, New York.

DoE 1997. Environmental Water Quality Standard for Bangladesh. Ministry of Environment and Forest, Government of the Peoples Republic of Bangladesh.

DoE 1999. Environmental Water Quality Standard for Bangladesh. Ministry of Environment and Forest, Government of the Peoples Republic of Bangladesh.

DoE 2004. Environmental Water Quality Standard for Bangladesh. Ministry of Environment and Forest, Government of the Peoples Republic of Bangladesh.

EPA (Environmental protection agency, USA) 1985. National interim Primary Drinking Water Standards as given by laws E.A. in Water Pollution and Toxicology. Encyclopedia of Physical Science and Technology 2nd ed; 17, p. 525.

FAO. 1985. Water Quality for Agriculture. Irrigation and Drainage Paper No. 29, Rev. 1. Food and Agriculture Organization of the United Nations, Rome.

George, M.G. 1961. Diurnal variations in two shallow ponds in Delhi, India. Hydrobiologia, 18: 265-273.

Gupta, S., Dalela, R. C. and Saxena P. K.1983. Influence of dissolved oxygen levels on acute toxicity of phenolic compounds to fresh water teleost, *Notopterus notopterus* (PALLAS) , Water, Air, & Soil Pollution, Volume 19, Number 3, 223-228, DOI: 0.1007/BF00599049.

Kamal, M. M., Malmgren-Hansen, A. and Badruzzaman, A. B. M. 1999. "Assessment of pollution of the River Buriganga, Bangladesh, using a water quality model," *Water Science Technology*, vol. 40(2), pp. 129–136.

Karn. S. K, Harada, H. 2001. Surface water pollution in three urban territories of Nepal, India, and Bangladesh. *Environ Manage* 28(4):483–496

Lawson, T. B. 1995. *Fundamentals of Aquacultural Engineering*. New York: Chapman and Hall.

Lloyd, R. 1992. Pollution and Freshwater Fish. West Byfleet: Fishing News Books.

Masuduzzaman, and Rafiq M. H, 2006. "Water Quality Assessment of Four Rivers Surrounding Dhaka City," *B.Sc. Engg. Thesis,* Bangladesh University of Engineering and Technology, pp. 71-76.

Moore, J. and Ramamoorthy. 1984. *Heavy Metals in Natural Water*.Berlin: Springer-Verlag.

Rouse, J. V. 1979. Evaluation and Control of Ground-Water Quality in the Rocky Mountain Area. – In: Argall, G. O. & Brawner, C. O.: Mine Drainage – Proceedings of the First International Mine Drainage Symposium. – p. 154-160; San Francisco (Freeman).

Shahjahan, M. 2006. Quality of Water in the Major Rivers Around Dhaka City, M.Sc. Thesis, Department of Geography and Environment, University of Dhaka.

Singh, N. 2000.A Study on the Performance of "root zone method" for removal of total solid, BOD, total nitrogen and total phosphorus from the Municipal wastewater, Ph.D. thesis, Vikram University, Ujjain (MP).

Stirling, H. P. (Ed.), Beveridge, M.C.M; Ross, L.G. and Phillips, M.J. 1985. *Chemical and biological methods of water analysis for aquaculturists*. Stirling. 119 pp

Subramanian, B.2004. "Water quality in South Asia". *Asian Journal of Water, Environment and Pollution*, 1(1–2):41–54 Statistical year book (SYB), 2007.

WHO. 2010. Water for Health: Guideline for Drinking-water Quality (2010).World Health Organization. Geneva.