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Name of the Presenter	: Mohammad Kamrul Hasan
Author (s) Affiliation	: Kim Kyehyun, Syed Zakir Hossein
Mailing Address	: GIS Lab, No. 319, Dept. of Geoinformatic Eng., Building 4, INHA University, #253, Yongh Yun-Dong, Nam-Ku, Incheon, 402-751, South Korea
Email Address	: kamrul@inhaian.net
Telephone number (s)	: +82-32-875-4413
Fax number (s)	: +82-32-863-1506

Water Quality and Risk Assessment in Peripheral Rivers of Dhaka City, Bangladesh

Mohammad Kamrul Hasan*, Kyehyun Kim, Syed Zakir Hossein*****

Abstract

This study examines the present status of surface water pollution and a statistical comparison of the quality of water in different seasons at different locations of the major river around Dhaka city. Water samples have been collected from a part of rivers along different points and analyzed for various water quality parameters during dry and wet periods (2008).A simple ANOVA and Box-Cox study was also conducted to detect the variation of water quality in the major rivers. Comparisons of abundance values demonstrated high significance ($p < 0.05$) between the upstream and downstream at different locations. The study indicates that most of the elements were generally higher during the dry season especially in the month of January to March. Water quality in the Tongi Railway Bridge and Hagaribagh areas was significantly exceeded the standard limit because of the largest amounts of toxic chemicals are released here by the tanneries and leather industries (raw and processed). The result revealed that river Buriganga and Tongi Khal could be treated as polluted because of the present point sources that directly discharge effluents without any treatment.

Keywords: Water Quality, Risk, ANOVA, Peripheral Rivers, Dhaka City.

INTRODUCTION

Water resources of Dhaka city is the most important and is the burning issue in terms of extreme degradation of water quality of the surrounding water bodies. The surface water along these peripheral rivers is known to be highly polluted due to municipal and industrial untreated wastewaters that are discharged into these rivers (Subramanian 2004; Karn and Harada 2001; Kamal et al. 1999).The banks of the rivers Buriganga, Turag, Tongi khal and Balu have turned into unauthorized industrial districts. The river Buriganga passed in the southern side of Dhaka City through the more populated and industrial area. Domestic and industrial wastes of Dhaka City discharged into the river Buriganga by four main discharge pathways. These are Hazaribagh tanneries, City drain along the river, Dholaikhal, and Pagla sewage treatment plant outfall. In addition, some major drainage khals drain the industrial and domestic wastes from the city center also discharged into the river Buriganga. The Turag and Tongi khal flow the eastern and northern side of Dhaka City and around the industrial town of Tongi and Savar. Lots of Tanneries, dying

* Inaha University, Dept. of Geoinformatic Engineering, PhD course. E-mail: kamrul@inhaian.net
** Inaha University, Dept. of Geoinformatic Engineering, Professor. E-mail: kyehyun@inha.ac.kr
*** University of Incheon, Dept. of Civil and Environmental System Engineering, PhD course. E-mail: szhchembd@incheon.ac.kr

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 Turag and Tongi khal. The industrial area effluent falls on the river Turag and Tongi khal directly and through numerous distribution channels without any treatment. Industry generated liquid and solid waste, most of the human excreta directly goes down the rivers through underground pipelines as nearly 70 percent houses are not connected to the excrete treatment plant (DWASA). Waste from these industries is connected with the sewerage system that directly goes into the Rivers around the city. In fact, the rivers have become a dumping ground of all kinds of solid, liquid, and chemical waste of bank side population.

Thus finally water quality of the rivers deteriorates increasingly and these pose a significant threat to our limited water supply by changing taste and odor, growth of aquatic weeds, aquatic life and wild life. This study aims to analyze the present status of surface water pollution and a statistical comparison of the quality of water in different seasons at different locations of the peripheral river of Dhaka city.

MATERIALS AND METHODS

Study Area

Dhaka, along with its metropolitan area, has a population of over 12 million; making it the largest city in Bangladesh (SYB, 2007). Dhaka is located in central Bangladesh at 23°42′0″N 90°22′30″E to 23.7°N 90.375°E, on the upper alluvial deposits upstream of the confluence of two major rivers, the Brahmaputra and Meghana, and covers a total area of 153.84 square Km (BBS, 2001). The Greater Dhaka urban area is surrounded by a chain of rivers—Turag, Buriganga and Dhaleshwori in the west and southwest, Balu and Lakhya in the east, and Tongi Khal (a drainage channel) in the north connecting River Balu and Turag (Figure 1). Within the urban area, there also exists an about 20 drainage channel (locally named as *khals*) that carries all the drainage and wastewater of the urban areas and discharge into the peripheral rivers

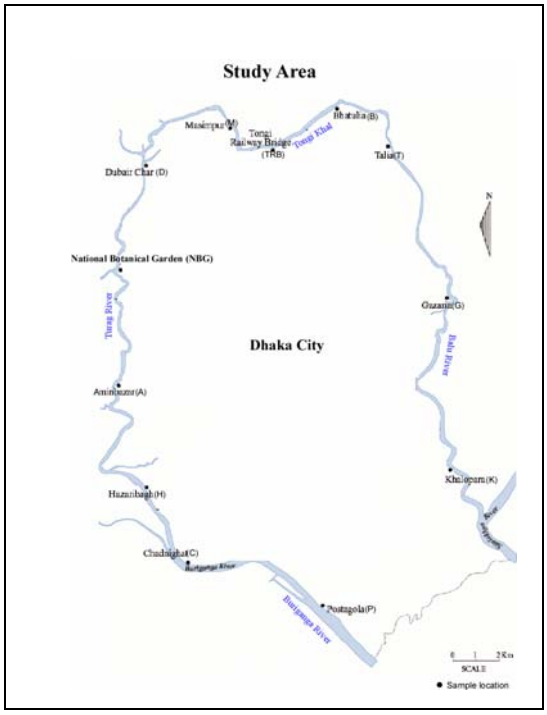


Figure 1: Base map of the peripheral rivers of Dhaka City depicting sample location

Sampling

Surface water samples of the rivers were collected from three different stations of each river in four seasons during the period of January 2008 to December 2008 covering dry and wet periods. The definite points of the downstream Buriganga river were Postagola, Chadnighat and Hazaribagh; the Turag river were Amibazar, National Botanical Garden and Dubair Char whereas the Tongi Khal were Masimpur, Tongi Railway Bridge and Bhatulia and the Balu river were Talia, Gazaria and Khalopara identified as upstream. To determine the extent of pollution of the surrounding rivers of Dhaka city, various water quality parameters were monitored and a detailed field survey has been conducted within the study area. The following parameters were assessed using standard methods for examination of water and wastewater (APHA, 1998): Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Total suspended solids (TDS) and Total phosphate (TP).

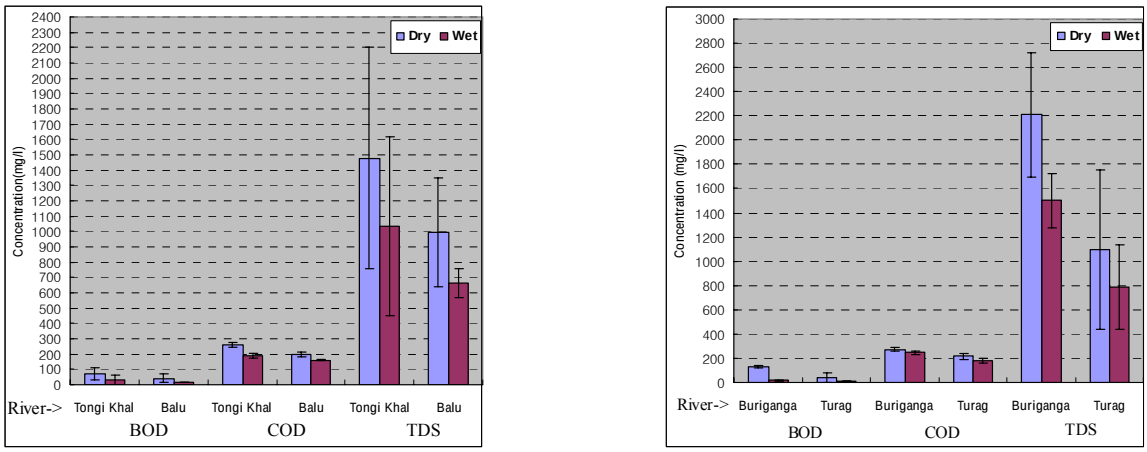
Statistical analysis

The data thus obtained were computed and subjected to statistical analysis. The significance of differences between seasons and locations were compared. NCSS statistical software has been used for the analysis of variance (ANOVA) with Tukey Kramer (Hsu, 1996, Kleinbaum et al., 1998) and Duncan's multiple comparison tests (NCSS, 2007) with the standard value of water quality parameters proposed by Department of Environment, Bangladesh (DOE) and United States Environmental Protection Agency (USEPA). The Tukey-Kramer multiple-comparison test is based on the assumption that the data are normally distributed, random, and independent and that they have common variance. It is an exact alpha level test if the sample sizes are the same, and slightly conservative for unequal sample sizes (Rebecca and others, 2004). An alpha level of

0.05 was used to judge significance of all tests discussed in this study. On the basis of these tests, it was determined that Box-Cox transformations (Box and Cox, 1962; Peng et al., 2007) of concentrations of DO, COD BOD and TP were necessary to meet the normality assumption using Maximum likelihood value (lambda = -0.05). The mean values were also compared with water quality standards of DOE and USEPA.

RESULTS AND DISCUSSION

The Buriganga River is the branch river of the Dhaleswari River. It has a large drainage area. This river flows through the most heavily industrialized and old urban areas of Dhaka city. Many industrial plants utilize river water as a water source and as a final dump for their waste water. The river Turag and Tongi khal is also flow by the side of industrialized areas of Tongi. The industry disposed their pollutant effluent in these rivers but Balu has no such kind of source. But the lake passing over Rampura, Dhaka is connected with this river. Municipal wastewater and garbage are mixed with the river water. So the color and odor of the river Buriganga and Tongi Khal water is objectionable. A good seasonal and spatial variation in BOD concentration is found in four of the rivers. The lowest value was found in Turag River at Aminbazar station in January-March (dry period).



(a) Upstream (b) Downstream

Fig. 2. Seasonal variation of water quality of peripheral rivers of Dhaka City

Season. The BOD value was more in Balu River in all seasons compare to the river Buriganga, Turag and Tongi Khal because Balu River have flown through the agricultural land and in the less polluted area.

The chemical oxygen demand (COD) and biological oxygen demand (BOD) was higher in the Buriganga River because these rivers have flown through the densest urbanized and big or small industrialized area. Most of the leather industries are situated near the bank of this river. Their waste materials directly dumped into this river. More over municipal waste materials directly or within the sewerages dumped into the Buriganga River. The concentration was found higher in dry season and lower concentration was observed during wet period in the four rivers.

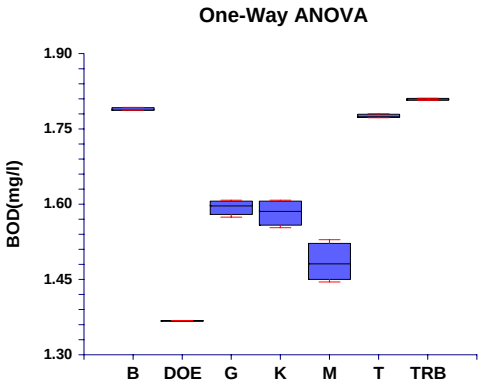
From all the data analysis the polluted area was the Hazaribagh in Buriganga and Tongi Railway Bridge in Tongi Khal. The less polluted area was Dubair Char in Turag River and Gazaria in Balu River. In the rainy season the DO level of the river quite near to the standard value but not well enough for life support. In the point sources the value of DO are 0.8-3.3 mg/L from dry to wet season. But at the non point source the DO level also very low as ranges from 2.9-5.8 mg/L from dry to wet seasons respectively. The figure 3 shows that the concentration of DO is low where the industries are present and high in the non-agricultural areas. When BOD is too high, the DO content of water become too low to support all the life in water. In wet season the value were 100 to 175 mg /L means the biodegradation of organic matter in a liter of sample consumes 100 to 175 mg of O_2 and in dry season the value were 190-2430 mg/L. So in dry season the bio degradation of organic matter is higher than in wet season. But the standard value of BOD up to 250 mg/L. One of the most serious effects of human and industrial waste is to increase the BOD of natural water supplies.

COD is used as a measure of oxygen equivalent to organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant. For example from specific source, COD can be related empirically to BOD. BOD values are correlated to COD values. The experiment found the COD level from 155-310 mg/L in the wet and dry season respectfully. The COD level is high (more than 300 mg/L) in Hazaribagh and Tongi Railway Bridge area because this area is surrounded by the industrial zone and mixed area. The COD level is low in Balu River and in the Turag river at the stations National Botanical Garden and Dubair Char because these area are surrounded by the agricultural land.

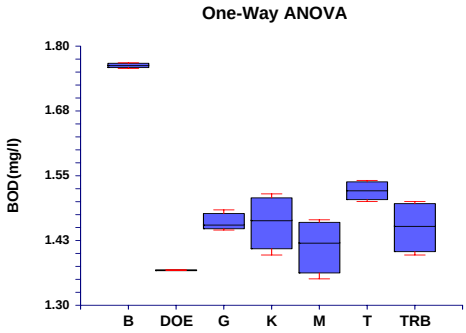
The maximum concentration of phosphate ranged 0.54-5.98 mg/L in the surface water of the river Buriganga, Turag and Tongi Khal. The concentration of phosphate in the river exceeds the permissible level of DOE standard of. Both the highest and lowest value of phosphate is much higher than the standard limit at all the locations in all the seasons. The high values are probably due to fertilizer run-off from agricultural lands. Phosphate fertilizer is used in rice harvesting in monsoon (March-August). Other sources may be organic wastes, soaps and detergents etc.

Sample in wet season the solids that dissolved in water are lower than that of dry season. For point source TDS value was found 520-3320 mg /L in wet and dry season respectively and observed significant difference. Based on the fig.- 2., it could be stated that the station Buriganga and Tongi khal are the mostly polluted area than others. -

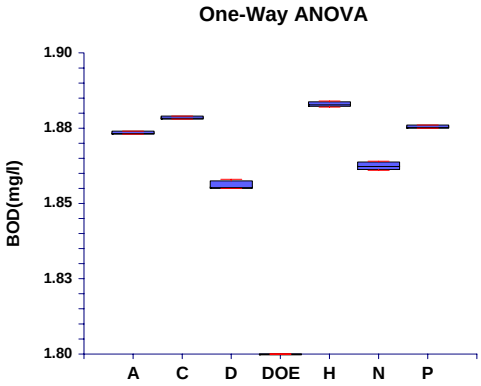
One way analysis of variance (ANOVA) was used to detect differences between watersheds. Because of the severe "skewness" of the data, common in water quality data affected by non point and point sources of pollution, ANOVA's were run on rank-average transformed data for comparison of mean concentration distributions. An alpha value of 0.05 was used as the threshold for statistical significance. If a significant difference among group mean was detected, Tukey's multiple comparison test was used on the rank transformed data to determine where differences were located. The computed F- ratio of 1312.08(dry) and 12.86 (wet) with 6 and 18 dehree of freedom, is seen to be significant ($p < 0.05$).



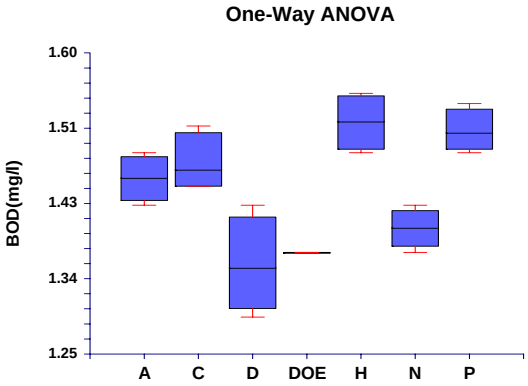
(a) Dry (upstream)



(b) Wet (upstream)



(a) Dry (downstream)



(b) Wet (downstream)

Fig.-3. Results of ANOVA on BOD with DOE standard

BOD was in the range of 1.3 – 1.9 mg/l .in the twelve stations sampled and was not significantly different ($p > 0.05$) (Table 1) compared to DOE. The mean BOD concentration was also different in all the particular stations ($p > 0.05$) for upstream and downstream during the dry and wet periods (Fig- 3). The Multiple comparison using Tukey-Kramer and Duncan's multiple range test revealed that compared to DOE standard, the stations Hazaribag in the Buriganga (Downstream) river and Tongi railway bridge in the Tongi khal (down stream) were the most significantly different($p > 0.05$).

Most of the variables, that is dissolved oxygen, chemical oxygen demand (COD), phosphate-phosphorus and Total dissolve solids (TDS) were significantly different among the various stations sampled ($p < 0.05$). Multiple comparison using Tukey- Kramer and Duncan's multiple range test showed that most of the stations differ from the standard value of DOE and USEPA during the dry season whereas few stations were significantly found during wet season. Table (1).

Table 1: Multiple comparison test of ANOVA for BOD

		Turkey				Duncuns			
		Dry		Wet		Dry		Wet	
		Mean	*DFG	Mean	*DFG	Mean	*DFG	Mean	*DFG
Upstream	DOE	1.368	M, K, G, T, B, TRB	1.368	T, B	1.368	M,K,G,T,B, TRB	1.368	TRB, G, T, B
	USEPA	1.553	T, B, TRB	1.553	M, B	1.553	M, T, B, TRB	1.553	M, TRB, G, K, B
Downstream	DOE	1.8	D, N, A, P, C, H	1.368	P, H	1.8	D, N, A, P, C, H	1.368	A, C, P, H
	USEPA	1.789	D, N, A, P, C, H	1.553	D, N	1.789	D, N, A, P, C, H	1.553	D, N, A

CONCLUSION

The disposal of industrial waste effluent into riverine system has given rise to heavily localized pollution and threatens seriously to the environment. 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 maximum concentration of BOD, COD, Turbidity and Total Dissolved Solids found in the Buriganga River, in the Tongi Khal at the location Tongi Railway Bridge and in the Turag river at the location Aminbazar is much higher than the standard permissible limit. DO concentration is alarmingly lower than the standard level of the river Buriganga and Tongi Khal. The pollution level of Balu river is less than compare to the river Buriganga, Turag and Tongi Khal because it is pass through non industrialize and less urbanized area. The pollution level of the river Buriganga, Turag and Tongi Khal is increasing sharply and can cause serious problem in near future. From this study, the surface water quality of the major rivers around Dhaka City , it can be concluded that the water of those 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.

ACKNOWLEDGEMENT

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Brief Biography

	**Mohammad Kamrul Hasan** 2001 - Bachelor of Science - Department of Geography and Environmental Science, University of Dhaka. Bangladesh 2002 - Master of Science - Department of Geography and Environmental Science, University of Dhaka. Bangladesh 2008~present - Ph.D Student - Department of Geoinformatic Engineering, Inha University, S.Korea
	**Kyehyun Kim** 1982 - Bachelor of Engineering - Department of Resources Engineering, Hanyang University, S.Korea 1989 - Master of Engineering - Department of Hydrology Engineering, Arizona University (Tucson), USA 1993 - Ph.D of Engineering - Department of Civil and Environment Engineering, Univ. of Wisconsin (Madison), USA 1995~present - Professor - Department of Geoinformatic Engineering, Inha University, S.Korea
	**Syed Zakir Hossein** 1999 - Bachelor of Science - Dept. of Chemistry, National University of Bangladesh 2000 - Master of Science - Dept. of Chemistry, National University of Bangladesh 2006~present - Ph.D Candidate - Department of Civil & Environmental Engineering, Incheon University, S.Korea