CHARACTERIZATION OF NUTRIENT AND ORGANIC CONTENTS OF WATER IN THE PERIPHERAL RIVERS OF DHAKA CITY

Submitted by

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DECLARATION

I hereby certify that the research work embodied in this study report has been performed by the author under the supervision of Dr. Md. Mafizur Rahman, Professor of the Department of Civil Engineering, BUET. Neither this thesis nor any part of it has been submitted or is being currently submitted elsewhere for any other purpose (except for publications).

August, 2011 **Showkat Mahmood**

The thesis titled "**CHARACTERIZATION OF ORGANIC AND NUTRIENT CONTENTS OF WATER IN THE PERIPHERAL RIVERS OF DHAKA CITY"** submitted by Showkat Mahmood, Roll No. 100704106P, Session : October, 2007 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Master of Science in Civil & Environmental Engineering on 5th August, 2011.

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ABSTRACT

Dhaka city is surrounded by rivers. Ever increasing pollution level in peripheral rivers is causing huge problems for the environment of Dhaka city and jeopardizes the use of the river water for drinking and other useful purposes. Increasing trends of pollution level demands the study of water quality of peripheral rivers around Dhaka city. This study covers analysis and characterization of organic and nutrient contents of water in peripheral rivers around Dhaka city. Under this study water sample was collected from 7 (seven) locations of 6(six) peripheral rivers of Dhaka city, DND canal and several locations of different rivers. The parameters that have been examined in BUET laboratory are pH, DO, NH_3-N, NO_3-N, NO_2-N, PO_4, TDS, TSS, BOD_5 and COD. All the data have been analyzed and monthly variation have been observed. The results of water quality analysis under this study have been compared with the previous data and trend of variation has been shown. A geospatial assessment has been made with spatial features using GIS tools.

pH in peripheral river water was found in normal range and seasonal variation of pH was not significant except in Balu river, where pH was found high in the month of January, 2010 but below the permissible limit of 8.5. In all the peripheral rivers pH measured was within the allowable limit of 6.5-8.5 (Standard for Drinking Water, ECR,1997). Dissolved Oxygen measured in three locations of peripheral rivers namely Chandighat, Intake point of Sayedabad Water Treatment Plant at Sarulia and DND canal was below the standard value for inland surface water (ECR,1997). NH_3-N content in these three points were found within limit in consideration of standard for inland surface water (<15 mg/l, agriculture, DoE,1991). But in consideration of standard for inland surface water for recreation (<2.0 mg/l, DoE,1993) some value is higher. In Tongi, Balu, Shitalakhya river the measured NO_3-N contents were within the permissible limit of 10 mg/l (Standard for inland surface water for pisciculture, agriculture, DoE,1993) but in the Buriganga and Turag river NO_3-N content exceeded this allowable limit. In DND canal the measured value of NO_3-N was found within allowable limit. Except Turag, Shitalakhya river and DND canal, NO_2-N contents in all the peripheral rivers were found high and increased as dry season progressed. Except the river Tongi PO_4 contents in all other peripheral rivers and in DND canal were found within the normal range of 10.0 mg/l (Standard for inland surface water for pisciculture and agriculture, DoE,1993) and in the Tongi river the excess PO_4 content was found only in the month of January, 2010. TDS contents in all peripheral rivers were found within the maximum allowable limit of 1000 mg/l (Standard for Drinking Water, ECR,1997). Almost all TSS content in the peripheral rivers and DND canal were found to exceed the allowable range of 25 mg/l (Standard for inland surface water for fishing, DoE, 1991). Except in Rupgonj Ferry ghat location of Shiatalakhya river, high BOD and COD values were measured in all the peripheral rivers including DND canal.

All the nutrient and organic contents in the water of peripheral rivers around Dhaka city are increasing day by day and pollution level in river water is also increasing. The water of peripheral rivers around Dhaka city is not only unsuitable for drinking but appears to be not usable for any other purposes.

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LIST OF ABBREVIATIONS

APHA	American Public Health Association
ATP	Adenosine triphosphate
BGB	Border Guard of Bangladesh.
BIWTA	Bangladesh Inland Water Transport Authority
BOD	Biochemical Oxygen Demand
BTM	Bangladesh Tranverse Mercantor
COD	Chemical Oxygen Demand
DND	Dhaka Narayangonj Demra
DO	Dissolved Oxygen
DoE	Department of Envrionment.
DTW	Deep Tube Well
DWASA	Dhaka Water Supply and Sewerage Authority
ECR	Environmental Conservation Rules
EPA	Environmental Protection Agency (EPA)
EQS	Environmental Quality Standard
ETP	Effluent Treatment Plant
EU	European Union
GIS	Global Positioning System
GPS	Global Positioning System
IWM	Institute of Water Modelling
JICA	Japan International Co-operation Agency
MCL	Maximum Concentration Level
MOEF	Ministry of Environment and Forest
NO_3-N	Nitrate Nitrogen
NO_2-N	Nitrite Nitrogen
NTA	Nitriloacetate
OECD	Organisation for Economic Co-operation and Development
PAN	Peroxy Acetyl Nitrate
PPM	Parts Per Million
PSTP	Pagla Sewage Treatment Plant.
STP	Sewage Treatment Plant
SWTP	Surafce Water Treatment Plant
TDS	Total Dissolved Solids
TP	Treatment Plant
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
WHO	World Health Organization
WWTP	Waste Water Treatment Plant
WQ	Water quality

CHAPTER 1

INTRODUCTION

1.1 General

Bangladesh is a land of river. Many river, khal, channel have gone through the heart of this riverine country. Bangladesh has been a land of green trees, crops, fruits and vegetables due to the blessings of these abundant water resources. These river, khal and channel are gifting the water sources to the citizens of this country for hundreds of years. But due to tremendous population growth, pressure has been created on these water resources. Some rivers are narrowing by encroaching, some are widening due to demolition of shoreline by the turbulent current of rivers especially in rainy season and some are loosing their appearance by excess pollution level. The city Dhaka is surrounded by rivers. These rivers became the blessing of this city for many reasons, especially water supply, transportation, recreation and disposal of waste water. Disposal of waste water is becoming a subject of attention for the environmentalist. Because tanneries, industries, garments, dyeing, washing plant have been developed on both sides of the rivers along the periphery of Dhaka city. Domestic and industrial sewage are coming freely to these rivers. As a result the quality of water of the peripheral rivers of Dhaka city is worsening every year. A number of studies has been carried out by different research group and observed the deteriorating condition of water quality of these rivers.

Dhaka is located in central Bangladesh on the lower reaches of the Ganges Delta and it is surrounded by the distributaries of the two major rivers, the Brahmaputra and the Meghna. The city covers a total area of 153.84 km^2 (BBS, 2008) and its population is growing with an estimated rate of 4.2% per annum (Hossain, 2008), one of the highest amongst asian cities. Considering present birth rate and rural-urban population migration, it is estimated that with a growth rate of over 5.6 %, Dhaka will be the 2nd largest city of the world by the year of 2015 (BCEOM,1994). With this huge population Dhaka city is facing severe difficulties with the emergency utility services like gas, electricity & water supply. Although Dhaka city is surrounded by a circular river system, only 13-15% of water supply comes form these peripheral rivers. Excess pollution level in peripheral rivers of Dhaka city forced the engineers concerned to look for alternative sources of raw water for surface water treatment plant (Rahman, 2007).

Dhaka city having a population of more than 10 million and over 7000 industries, factories and workshops generates large volume of waste water and industrial effluent. There is only one sewage treatment plant at Pagla which has the capacity to treat only 20 % of total sewage

CHAPTER 2

LITERATURE REVIEW

2.1 Background

Dhaka City is located between 23°35 to 23°54 North Latitude and 90°20 to 90°33 East Longitude and is encompassed by six water ways, five rivers and one canal (Karn and Harada, 2001). These waterways constituted the following routes :

1. Tongi Canal–Balu river
2. Tongi Canal–Turag river–Buriganga river–Dhaleshwari river
3. Shitalakhya River

The rivers around Dhaka do not get any flow from the upstream Jamuna during the peak period. During this period the Bramhaputra carries between 6,000 and 8,000 cubic meters of water per second through Jamuna, of which 'nothing flows' into the Turag, Balu or the Buriganga due to silt formation at the mouths of the tributaries whereas, in the monsoons around 87,000 cubic meters of water per second flow in the Jamuna. There is enough water flowing through the Brahmaputra and the Meghna, but this cannot be used as the country is unable to build a barrage due to the flat surface of the delta and also because of fund constraints.

Everyday Dhaka city is generating about 3200 tones of solid waste (DCC, 2005) in addition to huge liquid waste 90 % of what is coming directly or indirectly to the peripheral rivers. In this way the peripheral rivers around Dhaka city are assimilating the huge waste load everyday and the quality of river water is thus deteriorating every year. There are about 3000 industries on both sides of the river and inside the Dhaka city. These industries are generating huge industrial sewage that are toxic and needs treatment before disposal to the surrounding rivers. Although Department of Environment (DoE) has many Environmental Conservation Rules for industries for treatment of industrial effluent, most of the industries don’t care for the laws. During field survey under this study, effluent treatment plant had been discovered in many industries but the authorities were not operating it. Either the plants are out of order or they deliberately don’t run it. The consequence is terrible in the context that water quality is deteriorating gradually. The chapter details the peripheral river system, the topography, environmental parameters that are responsible for deterioration of water quality of peripheral rivers. Six water sample from six location of peripheral rivers around Dhaka city have been collected. And an a sample have been collected from DND canal for having an idea about the water quality of that canal from which raw water is extracted for treatment in Syedabad Water Treatment plant. In addition to these 7 (seven) points samples have been collected from Chandighta, Hazaribagh, Pagla on Burignga River, Goran Chatbari sluice gate point on Turag

CHAPTER 3

METHODOLGY AND DATA ANALYSIS

3.1 Introduction

This thesis work aims at finding an statistical evaluation of the organic and nutrient contents in the water of peripheral rivers around Dhaka city. To achieve the goals study on the existing peripheral rivers of Dhaka city is important. Methodology is very important to put forward the findings from the thesis work. Dhaka city is not only overcrowded by huge population, but also overburdened by the huge solid & sanitary waste generated within the city. The city is surrounded by five rivers and one khal. These rivers and khals are receiving the flows from the upstream rivers. The water quality of all these rivers and khals is deteriorating rapidly due to pollution from industrial and municipal waste and the situation turns particularly alarming during the dry season. In this thesis works, evaluation of water quality parameters of the peripheral rivers have been set target in consultation with the supervisor. Among the water quality parameters, the organic and nutrients contents would be analysed and statistical characterization would be made for water quality variables (organic and nutrient contents) of peripheral rivers around Dhaka city.

3.2 Evaluation of water quality parameters

The analysis of the water quality parameters of rivers, surrounding Dhaka city is extremely important as it contains a large number of impurities or pollutants which are necessary to be checked out before the water is used for any specific purpose. For example to use the water for drinking purpose, it is most essential to determine colour, turbidity, dissolved solids, hardness, alkanity or acidity, iron, manganese, fluoride, free chlorine etc. In addition a complete mineral examination as well bacteriological examination is also necessary. As the water of the river Buriganga and Lakhya is used as potential source of raw water for water treatment plants of Dhaka WASA, monitoring the water quality of these two rivers is extremely important. Under this study the organic and nutrient contents of peripheral river water of Dhaka city have been examined and trend of variation have been observed in comparison to previous data of water quality variables.

3.3 Selection of site for sample collection

In order to achieve the best results seven points on surrounding six rivers have been selected for water sample collection considering importance, level of pollution (based on the past data) and scope of analysis. These seven points as shown in Figure 3.1 are located on six

CHAPTER 4

RESULTS AND DISCUSSION

1.1 Introduction

The organic and nutrient content data of the peripheral rivers around Dhaka city have been analyzed in Chapter- 3. Total forty nine samples have been collected from the peripheral rivers of Dhaka city during the period starting from September,2009 to March,2010 and September-October,2011. In addition to selected seven locations on peripheral rivers, sample have been collected from Chandighat, Hazaribagh, Pagla Sewage Treatment Plant, DND canal and Intake point of Sayedabad Water Treatment Plant at Sarulia. The statistical characterization and visualization of seasonal variation of organic and nutrient contents in peripheral river water is the principal goal of this project. At the final stage of this thesis work nine additional samples have been collected from Chandighat, Sarulia intake point and DND canal to measure the dissolved oxygen and NH_3-N in addition to other nutrient and organic contents in peripheral river water. These thesis data have been compared with the previous data collected from different sources such as IWM, DoE, BUET, DWASA, BWDW, BIWTA, JICA etc. This historical data series would help to determine how the river pollution has been worsened over the years. It is worthwhile to mention here that some historical data series have been collected from previous thesis and journal and the authenticity have been verified. Under this study sample has been collected in the months starting from September,2009 to March, 2010. The variation of organic and nutrient contents of peripheral rivers of Dhaka city could have been better understood if the data had been obtained for a whole year.

1.2 Trend of Variation of pH over the years

The variation of pH at Turag river in different months of the year over a last few years including this study period (2009-2011) have been shown in Figure 4.1. In all the years it is seen that an increasing trend of pH from September to December have been observed. Although in the month of September in all the years, the variation of pH was not significant. Minimum pH - 6.7 have found in the month October, 2000 and highest pH- 7.8 have been recorded in December 2009. In lean period during December, January, high alkaline waste from garments and dying cause pH of river water increased. Textile mills waste contains as high as 11.8 - pH value (Rao M.N. and Datta A.K., 2007)

The variation of pH at Sadarghat on Buriganga river from the year 2000 to 2009 have been shown in Figure 4.2. It is observed from Figure 4.2 that the highest pH 7.72 have been recorded in December, 2009 under this study. This may be due to the ever increasing trends of industrialization on both sides of Buriganga river. And in December, January the river water decreases and concentration of pollution load in river water increases. The trend of variation of pH at Hazaribagh area of Buriganga river in the month of February in different

CHAPTER - 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Review of data and conclusion

Under this study water sample has been collected from seven locations of peripheral rivers around Dhaka city. In addition to these seven points sample have been collected from intake point of Sayedabad Water Treatment Plant, DND canal, Chandighat, Hazaribagh, outfall of Pagla Sewage Treatment Plant and Goranchatbari. Data collection were started from September, 2009 and ended in March, 2010 in first phase and in the last stage of this thesis work nine additional samples have been collected from three points of peripheral rivers namely Chandighat, Sarulia intake point of SWTP and DND canal. The findings and conclusion from this study can be summarized in the following paragraphs.

- In all the peripheral rivers of Dhaka city, BOD values were high. Maximum 56 mg/l of BOD have been measured in Tongi Khal in January, 2010 and minimum 0.1 mg/l of BOD have been measured in Shitalakhya river in November, 2009. Almost all the BOD values have exceeded the allowable limit for inland surface water used as source of drinking water supply, recreation, fisheries and even for agriculture. Comparatively high BOD values have been measured in the rivers Balu, Tongi and Buriganga and comparatively low BOD values were recorded in Turag and Shitalakhya river. High COD values have also been measured in all the peripheral rivers. Maximum 144 mg/l of COD have been found in Tongi river in January, 2010. And minimum COD values measured was 3 mg/l in Shitalakhya river in December,2009. All these COD values are beyond the admissible limit in respect of standard for inland surface water used for recreation (DoE,1991).

- Dissolved Oxygen was measured only at three locations of peripheral rivres. These three locations are Chandighat, Intake point of Sayedabad Water Treatment Plant at Sarulia and DND canal. At Chandighat maximum dissolved oxygen measured was 0.50 mg/l on 27th October,2011. At intake point of SWTP maximum 3.70 mg/l of DO has been measured on 6th September,2011. And in DND canal maximum 4.45 mg/l of DO has been measured on 6th September,2011. All these values of DO are less than the minimum allowable limit of DO in inland surface water (recreation and irrigation, ECR,1997).

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