Water Quality Assessment of the Buriganga River, Dhaka, Bangladesh.

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Abstract—This study deals with evaluating the surrounding environment at some selected locations (Hazaribagh, Mitford Ghat, Sadarghat and Postogola) around Buriganga River, to evaluate the river’s water quality in terms of some very fundamental water quality parameters (such as pH, temperature, alkalinity, turbidity, iron, chloride and BOD). To do this assessment for the Buriganga River, the study area was chosen to find out the water quality parameters such as the pH of water of river Buriganga was shown a variation from 7.4 to 6.8. The right bank of the river holds higher pH value from the left bank and middle. The colour of the river water was shown a variation from 322 to 756 mg/l. The turbidity of the river water was shown in a variation of 7.2 NTU to 55 NTU. The chloride of water of the river Buriganga was found in a range of 55 mg/l to 178 mg/l. Alkalinity of water of the river Buriganga was found to vary from 370 mg/l to 471 mg/l. Among them 370 mg/l was shown in Hazaribagh and 471 mg/l was showed in Postogola. Iron of water of the river Buriganga was found in a range of 0.38 mg/l to 0.91 mg/l. Biochemical Oxygen Demand (BOD) is not actually a water quality parameter but it is the most commonly used indicator of the general health of a surface water body which varies from 71.67 to 87.5 mg/l (BOD₅) during the test. The mean values for the parameters were compared with the surface water quality standards as set by the Department of Environment (DOE) in Bangladesh. The water quality test results have also been summarised and presented through box and graphs.

Keywords—Biological Oxygen Demand, Buriganga River, Nephelometric Turbidity Units, Tannery, Tributaries.

I. INTRODUCTION

Bangladesh is situated at the southern part of the Asia that is a low-lying riverine country. About seven hundred rivers including tributaries flow through the country creating a waterway of overall length about 15,000 miles (Akhter et al. 2001). Dhaka is one of the megacities of World and the capital of Bangladesh and it was established about four hundred years ago on the northern bank of the river Buriganga (Old named Ganges). This flows past the southwest outskirts of the capital. Dhaka is spreading over an area of about 1.5 to 1.7 square kilometer near the connection of the Postogola and Buriganga River (Akhter et al. 2001).

Buriganga River is a tide-dominated river passing through west and south of Dhaka. In ancient times one of the courses of the Ganges used to touch the Bay of Bengal through Dhaleshwari. This course gradually shifted and eventually lost its connection with the main channel of the Ganges and was changed the named as the Buriganga. The course of the Padma, as the main course of the Ganges, changed considerably during the period 1600 to 2000 AD. It is difficult to trace precisely the various channels through which it flowed. In the 18th century, the lower course of the river flowed further south. Its average depth is 7.5 meters and its maximum depth is 18 meters and only 27 km long (Imam, 2013). The Turag has linked the Buriganga at Kamrangirchar of Dhaka City. In fact, the main flow of the Buriganga comes from the Turag. It meets with the Dhaleshwari at Munshiganj. The downstream junction with the Dhaleshwari fluctuates from time to time according to changes in the position of the end river; at present it lies about 3 km southwest of Fatullah. Its course by Dhaka is stable, fixed by the resistant clays marking the southern edge of the Madhupur tract.

The Buriganga is of great economic importance to Dhaka and a large portion of the country’s 150 million people rely on them for an accommodations and for transportation. This is now one of the most polluted rivers in Bangladesh due to extensive dumping of industrial and human waste. The most significant source of pollution appears to be from tanneries in the Hazaribagh area. In the dry season, the dissolved oxygen level becomes very low or non-existent and the river becomes toxic. The study has been showed to find out the current condition of Buriganga and to find out some solutions to protect the river.

II. OBJECTIVES

- Studying the adjacent environment at some designated locations around Buriganga River.
- Measuring the river water quality in terms of some very key water quality parameters such as PH, alkalinity, turbidity, chloride, iron and temperature.
- Examining the reasons behind this dangerous water pollution.
• Making available some recommendations to improve the present condition.

III. METHODOLOGY

• To identify the suitable locations of water collection, the whole area in and around the river was preliminarily surveyed.
• To collect water samples such that the samples represent the characteristics of river water.
• To find out the water quality parameters in water samples were tested in the laboratory of University of Dhaka and North South University, Bangladesh.
• Then necessary consequences and relevant suppositions & recommendations were made.
• To measure pH using the pH meters Turbidity was measured turbid meter. Titration method was used for determination of Alkalinity, Hardness and Chloride. For measurement of colour, Spectrophotometer was used.

IV. STUDY AREA AND SELECTION OF LOCATIONS FOR SAMPLE COLLECTION

The Buriganga River flowing by the side of the Dhaka City, the capital of Bangladesh, is one of the most polluted rivers in Bangladesh. Many industries have established in and around the Dhaka city during the last decade, and the number of new industries are rapidly increasing. The Buriganga River is increasingly being polluted with the city’s thousands of industrial sectors and sewerage lines dumping huge volumes of toxic wastes, tanneries discharge and land grabbing which contain lots of heavy metal, toxic chemical into it day and night (Islam et al., 2006).

For collecting sample were sensibly chosen to correctly measure the water quality parameters.
• The samples are selected on the river Buriganga from upstream to downstream i.e. Hazaribagh, Mitford Ghat, Sadarghat and Postogola [Fig 1, 2].
• Water samples were collected from three chosen points (Left, Middle and Right Bank) of each selected locations.
• Water samples were collected from some other sub-points such as Zinzira Ghat, Ali Ghat, Chandina Ghat, Kamrangirchar, Badamtoli Ghat and to submerge the main selected location [Fig 1, 2].
• The samples were then tested for a varied range of water quality parameters included pH, turbidity, alkalinity, color, chloride, iron, and BOD.

V. WATER QUALITY PARAMETERS

pH, temperature, turbidity, alkalinity, color, hardness, chloride, BOD and iron are commonly used parameters to confirm the quality of water. Most of these parameters have certain environmental study impacts and some of them can be dangerous to human and animal if their existence in water is beyond the tolerable limits.


\textbf{pH:} pH is an amount of the acidity (0 to 6.9) or alkalinity (7.1 to 14) of water. It is determined by using a colorimetric test - litmus paper fluctuations color with increased acidity or alkalinity. pH contrasts naturally within streams as a product of photosynthesis. Higher in pH can make a river unpleasant to life. Lower in pH is especially hurtful to immature fish and insects. Acidic water also hustles the leaching of heavy metals hurtful to fish.

A pH range of 6.5 – 8 is best for freshwater. A range of 8 – 9 is ideal for estuarine and sea water (Water Watch, 2011).

\textit{Temperature:} Temperature is significant parameter because it disturbs the amount of dissolved oxygen in the water bodies. The amount of oxygen that will dissolve in water rises as temperature losses. Water at 0°C will hold up to 14.6-15.5 mg of oxygen per liter, while at 30°C it will hold only up to 7.6-8.5 mg/L (Water Watch, 2011).

Temperature of the waterway affects the photosynthesis rate of plants, the metabolic rate of aquatic organism, the rate of development, the time and success of reproduction, migration patterns, mobility and the sensitivity rate of organisms to toxins, diseases and parasites. Life cycles of aquatic organisms are often interrelated to changes in temperature.

\textit{Alkalinity:} The alkalinity of water is the amount of its ability to neutralize acids. The alkalinity of natural waters is due primarily to the salts of weak acids, though weak or strong bases may also contribute. A few organic acids, that is quite resistant to biological oxidation, from salts that ass to the alkalinity of natural waters.

Highly alkaline waters are usually unpalatable. Chemically treated waters sometimes have rather high pH values which have met with some objection on the part of users. For this reasons, standards are sometimes recognized on chemically treated waters.

\textit{Color:} Color affected by dissolved and colloidal form of impurities is called true color and that triggered by suspended matter. In addition to dissolved and colloidal matters, is called apparent color. Surface waters may appear highly colored because of colored suspended matters when in reality they are not. Surface waters may become colored by pollution with highly colored wastewaters such as wastes from dyeing operation in textile industry and pulping operations from paper industry. Ground water may show color due to the presence of iron compounds.

\textit{Turbidity:} Turbidity is an amount of the capability of light to pass through water. This is also an amount of the water’s fogginess. To evaluate fogginess gives an assessment of suspended solids in the water. Turbidity is dignified in Nephelometric Turbidity Units. Turbidity is an important consideration in public water supplies. Again materials causing turbidity may range from purely inorganic to those that are largely organic in nature. Consumers of public water supplies expect and have a right to demand turbidity free water. Any turbidity in the drinking water which takes from river is automatically associated with possible waste water pollution and the health hazards occasions by it. Turbidity in water can harbor and transport bacteria and other harmful pathogenic organisms and absorbed contaminants which is highly risky for river water life.

Category NTU’s:

- Excellent ≤ 10 NTU’s, Fair 15-30 NTU’s, Poor > 30 NTU’s (Water Watch, 2011).

\textit{Chloride:} Chlorides occur in all natural water in widely varying concentration. The chloride content normally increases as the mineral content increases. Mountains supplies usually are quite low in chlorides, whereas river and ground waters usually have a considerable amount. Sea and ocean waters represent the residues resulting from partial evaporation of natural waters that flow into them, and their chloride levels are very high.

Chlorides in reasonable concentrations are not harmful to humans. At concentrations above 250 mg/L, they give a salty taste to water, which is distasteful to many people. High concentrations of chlorides are corrosive to metal.

\textit{Iron:} Iron (manganese) generates serious problems in public water supplies. The problems are most serious for ground water. Iron exists in soils and minerals as insoluble ferric oxide/hydroxide and iron sulfide. In some areas it also occurs as ferrous carbonate, which is very slightly soluble.

\textit{BOD:} Biological Oxygen Demand (BOD) is, the capability of water to absorb and hold oxygen is vital to human health and the health of fishes and other water inhabitants and this is one of the most common measures of pollutant organic material in water. BOD indicates the amount of putrescible organic matter existing in water. Thus, a low BOD is a pointer of good quality water, while a high BOD indicates polluted water.

Dissolved Oxygen (DO) is the amount of the volume of oxygen dissolved in a body of water as an indication of the grade of health of the water and its ability to upkeep a stable aquatic ecosystem.
DO is the actual amount of oxygen available in dissolved form in the water. When the DO drops below a certain level, the life forms in that water are unable to continue at a normal rate.

The test of BOD serves a significant function in watercourse pollution-control activities. It is a bioassay process that determines the amount of oxygen consumed by living organisms while they are using the organic matter present in waste, under conditions similar in nature. In other words, this test measures the oxygen requirements of the bacteria and other organisms as they feed upon and bring about the decomposition of organic matter.

For outcomes of the BOD test to be accurate, much care must be taken in the actual method. For example, additional air cannot be introduced. Temperature must be 20°C, which is the normal temperature of bodies of water in nature. A five-day BOD test is used in environmental study observing. This test is applied as a means of stating what level of contamination from pollutants is entering a body of water.

VI. RESULTS AND DISCUSSIONS

This study was measured on the overall water quality in the Buriganga River. This was measured the probable range of values for each water quality parameter, whether they are surpassing the recommended limit, etc. this study also determined the expected shape of variation of water at different sections of the Buriganga River.

A. Overall Water Quality Changes from Hazaribagh to Postogola

The pH of water in the Buriganga River has shown a variation from 6.8 to 7.3 [Graph 1]. The right bank of the river comprises higher pH value from the left bank and middle. Photosynthesis uses up dissolved carbon dioxide which acts like carbonic acid (H₂CO₃) in water. CO₂ removal, in effect, reduces the acidity of the water and so pH rises. In contrast, respiration of organic matter yields CO₂, which dissolves in water as carbonic acid, thereby dropping the pH. For this purpose, pH may be greater during daylight hours and during the growing season, when photosynthesis is at an extreme. Respiration and decomposition processes lesser pH. Like dissolved oxygen concentrations, pH may variation with depth in a lake, due again to variations in photosynthesis and other chemical reactions. The weighted average values of pH of water in Hazaribagh were 7.3, where in Mitford Ghat were also 7.2 and in Sadarghat were 7.3 and in Postogola intake point were 7.4 [Graph 1].

This indicates that pH is increased from Hazaribagh to Postogola in the direction of water flow.

Graph 1: pH values of samples collected from different locations

The average values of Color of water in Hazaribagh were 756, where in Mitford Ghat were 672 and in Sadarghat were 755 and in Postogola points were 342 [Graph 2]. In the average value, this study showed that the water color is very high in Hazaribagh, because many tanneries, lather industry and dying industry discharges their waste water directly into the river.

Graph 2: Color values of samples collected from different locations

The average values of Turbidity of water in Hazaribagh were 53.5 NTU, where in Mitford Ghat were 55 NTU and in Sadarghat were 18.2 NTU and in Postogola intake point were 8.9 NTU [Graph 3]. From the average value, the study showed that the Turbidity of water is high in Mitford Ghat.
The average values of chloride of water in Hazaribagh were 178 mg/l, where in Mitford Ghat were 62 mg/l and in Sadarghat were 63 mg/l and in Postogola were 165 mg/l [Graph 4]. From the average value, this study revealed that the chloride of water is displayed highly variation in Postogola and Hazaribagh with Mitford Ghat and Sadarghat. So much salt is used in tanneries for processing of lather in Hazaribagh.

The average values of alkalinity of water in Hazaribagh were 391 mg/l, where in Mitford Ghat were 465 mg/l and in Sadarghat were 465 mg/l and in Postogola were 471 mg/l [Graph 5]. From the average value, this study also presented that the alkalinity of water is high in Postogola.

Iron of water in the Buriganga River was found in a range of 0.38 mg/l to 0.91 mg/l. Among them 0.38 was found in Postogola and 0.91 was found in Hazaribagh. The weighted average values of iron of water in Hazaribagh were 0.91 mg/l, where in Mitford Ghat were 0.89 mg/l and in Sadarghat were 0.63 mg/l and in Postogola were 0.40 mg/l [Graph 6]. Weighted average value shows that iron of water was not exceed the limit.

Recently, BOD (Biochemical Oxygen Demand) is very high in Buriganga River. This study has displayed that the BOD in Hazaribagh was 87.5 mg/ l, Mitford Ghat were 78.33 mg/l, Sadarghat were also 86.67 mg/l and Postogola were 71.67 mg/l [Tab 1].
Table 1:
BOD values of samples collected from different locations

| Location   | DO_0 | DO_5 | BOD (mg/l) |
|------------|------|------|-------------|
| Hazaribagh | 11.75| 6.5  | 87.5        |
| Mitford Ghat | 11   | 6.3  | 78.33       |
| Sadarghat  | 10.9 | 5.7  | 86.67       |
| Postogola  | 11.5 | 5.8  | 71.67       |

VII. CONCLUSIONS & RECOMMENDATIONS

The results from data analysis show that the Buriganga River water quality is not acceptable from aquatic ecosystem perspectives for the parameters such as P\text{H}, temperature, turbidity, colour, alkalinity, turbidity, chloride, iron, DO and BOD. The overall mean values (average of all the selected locations) of the parameters for the Buriganga River were P\text{H}: 6.8-7.4 Colour: 322-756 TCU Alkalinity: 370-471 mg/l Turbidity: 7.2-55 NTU Iron: 0.38-0.91 mg/l Chloride: 55-178 mg/l and BOD: 71.67-87.5 mg/l. This study indicates that the water of the Buriganga River is being polluted from its adjacent point and non-point sources which include discharge from tannery industries, sewage, municipal and medical wastewater.

As a high growth rate of population in Bangladesh is predictable to have its population more than 300 million by the year 2050, it has turned out to be a regular event that river area is used up by the land grabbers. As a result all the main rivers are becoming narrow day by day that reasons enormous pressure on most of the rivers because maximum drainage outlets and sewerage of this mega city like Dhaka falls into the rivers as Buriganga. Scientists discloses that there are many industries developed on the river bank and those discharges about 1.5 to 2 million cubic meters of unprocessed waste water everyday into the river. This is one of the most vulnerable reasons behind the extreme pollution of the river water. The water quality parameters that are tested for the river water showed that most of the samples were within the standard limit set by ECR, 97. Few samples crossed the limit but still some kingfishers are flying over the river to gather their daily meal from it. It is high time to protect the river from the devastating effect of urbanization and to establish the flora and fauna of this mega city by giving a new life to Buriganga.

Suitable dredging of the existing river and regular deduction of non-degradable matters from the river bed, demolition of illegal establishment on the river bank, to maintain a regular monitoring system against the land grabbers, to provide Effluent Treatment Plant for each and every industrial unit to lessen the pollutant load on the river, to apply law enforcement and to aware public and finally decentralization of some important industries, e.g. tanneries, dying industries etc. from the centre of the city to the periphery will diminish the pollution load on the river and will finally help to re-establish the Green Dhaka.

Few recommendations are proposed to protect the existing river which are as follows:

- To enforce and maintain laws and legislation strictly relating to pollution by all. People should be conscious that loyalty to water laws are in their own concern.
- To dredge of the present river and to eradicate non-degradable matters from the river bed and banks.
- To wreck Illegal establishment on the river bank and to maintain a consistent observing system against the land grabbers.
- To establish mitigation system such as retention basins, infiltration basins, etc. should be in place where effective urban runoff (discharge of polluted storm water into river) takes place. People should not permit to throw wastes into the river water.
- To make available Effluent Treatment Plant for each and every Industrial units to lessen the pollutant load on the river. Industrial units are anticipated to treat its effluent wastes prior to release. Toxic material must be treated chemically and altered into harmless materials. If possible, factories should try to recycle the treated water.
- To remove harmful pollutants in water that flows through the city drainage system before they are introduced into reservoirs. If this water tolerate going into water reservoirs without treatment, it will pollute them.
- To diminish the risk of urban pollutants being introduced into the rivers so that the municipalities of most urban cities should have vigorous waste water management system.
- To decentralize of some important industries, e.g. tanneries, dying industries etc. from the heart of the city to the outside.
• To use massive quantity of water as coolant by various industrial units and power plants which are discharged in water bodies without prior treatment and strangely hot or cool water is released into the natural water bodies. This reason sudden change in the temperature of the water bodies are called as “thermal shock”, and it disturbs the water inhabitants harshly (Ravi, 2014). The water ecosystem can be endangered from thermal pollution, if the water used as coolant is recycled by the industrial units and not released into these natural water bodies.

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