SCENARIO OF BANGSHI RIVER WATER OF SAVAR POURASHAVA AND PLANNING FOR A SUSTAINABLE MANAGEMENT

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ABSTRACT

A study was carried out on the Bangshi river near Savar Pourashava in Dhaka. The study was aimed to determine the present condition of surface water source, seasonal variation of water pollution and to find out the causes and mitigation measures for pollution. A Total of 7 samples were collected in each season September 2016 and January 2017 from Bangshi river and Karnapara canal connected with the river. Major physical parameters to evaluate water quality were pH, Dissolve Oxygen (DO), Biochemical Oxygen Demand (BOD), Total Dissolve Solids (TDS), Faecal Coliform, Turbidity, concentration of PO_4, NO_3-N and NH_4-N. 'River Pollution Index' by EPA and 'National Sanitation Foundation Water Quality Index' were also used to evaluate the water quality. Highest value of turbidity, total solid and BOD_5 of the river water were found to be 223 NTU, 691 mg/L and 2.72 mg/L respectively, lowest DO was 3.18 mg/L, highest concentration of NH_4-N, PO_4 and NO_3-N were 2 mg/L, 2.54 mg/L and 1.9 mg/L, respectively. The 'River Pollution Index' was found 'Moderately polluted' during dry season where in the rainy season it was 'Slightly polluted'. Similarly NSF-WQI showed that the water quality was 'Medium' and 'Bad' in September 2016 and January 2017, respectively. The main causes found for the pollution were untreated industrial waste, solid waste and untreated sewerage. Establishing effluent treatment plant (ETP) for every industry, sewage water treatment, proper solid waste management and strict law enforcement by Municipality authority can overcome the problem of pollution of Bangshi river.

Keywords: *River Pollution Index, Savar Pourashava, Seasonal variation, Water management*

1. INTRODUCTION

Everything originated in the water, and everything is sustained by water. All life on earth depends on water (Gupta, 2007). Water is the primary source of life on earth. Two third of the earth's surface is covered with water and the rest is land (Fry, 2005). But today pollution of water sources around the world has become a major problem. The environment is heading towards a potential risk due to unsafe disposal of industrial and domestic waste water. Water pollution affects drinking water, rivers, lakes and oceans all over the world. In many developing countries, it is usually a leading cause of death, by people drinking from polluted water sources. Polluted drinking waters are a problem for about half of the world's population. Each year there are about 250 million cases of water-based diseases, resulting in roughly 5 to 10 million deaths (Expedition, 2014). More than 80% of sewage in developing countries is discharged untreated, polluting rivers, lakes and coastal areas. Many industries – some of them known to be heavily polluting (such as leather and chemicals) – are moving from high-income countries to emerging market economies. Although rural populations in Asia are projected to remain stable over the next 20 years, urban populations are likely to increase by 60% before 2025, which affect prospects for water scarcity (Fry, 2005). Water pollution by different chemicals and toxic metals is a worldwide issue. All countries have been affected, though the area and severity of pollution vary enormously. In Western Europe, 1400000 sites were affected by different chemicals agents and heavy metals (McGrath, 2001), of which, over 300000 were contaminated, and the estimated total number in Europe could be much larger, as pollution problems increasingly occurred in Central and Eastern European countries (Gade, 2000). Water pollution is also severe in India, Pakistan and Bangladesh, where small industrial units are pouring their untreated effluents in the surface drains, which spread over near agricultural fields. In recent time, the environment has become hostile, posing threat to health and welfare due to release of pollutants from industries and urban sewage (Ntengwe, 2006). In Bangladesh, there is a progressive increase in industrial wastes and due to the rapid industrialization such waste products have been causing severe contamination to the air, water and soils, thus polluting the environment. Rivers surrounding Dhaka city are mostly affected by pollution. Several studies have been done about the Buriganga, Turag, Dholeshwari, Shitalakhya, Balu and Bangshi river. These rivers are in the most affected area. Surface water of Bangladesh is polluted in various ways. The important sources of surface water pollution are industrial wastes, agricultural inputs including fertilizers and pesticides, sewage slugs and domestic wastes etc. (Dara, 2006). Polluted water cannot be used for drinking, domestic and agricultural purposes because it has inherent health risk (Goel, 2006). Savar is known as a rapid growing industrial city near Dhaka. Most of the garment factories of the country are situated here. Besides countries largest tannery processing zone has also recently been transferred to Savar. These industries are generating a large amount of waste water every day. The dumping source of the waste water is mainly the nearby rivers. So this is contributing to the pollution of the river water. The study is aimed to determine the water quality parameters and compare these parameters with standard ones to evaluate the pollution status of Bangshi river. Seasonal variations of the parameters are also observed. The final objective is to find out the possible sources of pollution and to propose for mitigation measures to improve the present condition.

2. METHODOLOGY

Different locations of the Bangshi river were visited to observe the pollution scenario and to find out the sources of pollution. Pictorial views of pollution scenario were collected from different disposal point, sewage point and industrial area which were adjacent to the Bangshi river to find out the causes and sources of pollution of the river water and observe the present pollution scenario of the river. The water samples were collected in two seasons. First time samples were collected in September 2016 after the monsoon. Second time samples were collected from the same place in January 2017 during winter season. Sampling location has been selected from this initial survey with the help of GPS shown in Table 1.

Table 1: GPS location of the sampling points

Sampling points	Latitude	Longitude	Locations
Point 1	23°48'9"N	90°14'45"E	Rajfulbaria
Point 2	23°49'5"N	90°15'28“E	Bank Town
Point 3	23°49'14"N	90°14'56"E	Bank Town
Point 4	23°49'46"N	90°14'52"E	Ulail
Point 5	23°50'17"N	90°14'40"E	Genda
Point 6	23°50'48"N	90°14'30"E	Monughat
Point 7	23°51'50"N	90°14'15"E	Savar Nama Bazar

The depth of the sampling was fixed at 1 ft for avoiding the surface interference. The water samples were collected from 7 different points along the Bangshi river and Karnapara canal at a regular interval of 1.0 km between each sampling point except from point 1 and point 7 which are taken 2 km away from adjacent points. The GPS position were taken from each point and it was shown in the google map in Figure 1. The samples were taken in plastic containers of 1000 ml capacity and prior sampling the bottles were washed with distilled water. The containers were completely filled with sample water to the brim. Later the containers were labelled and sealed carefully.

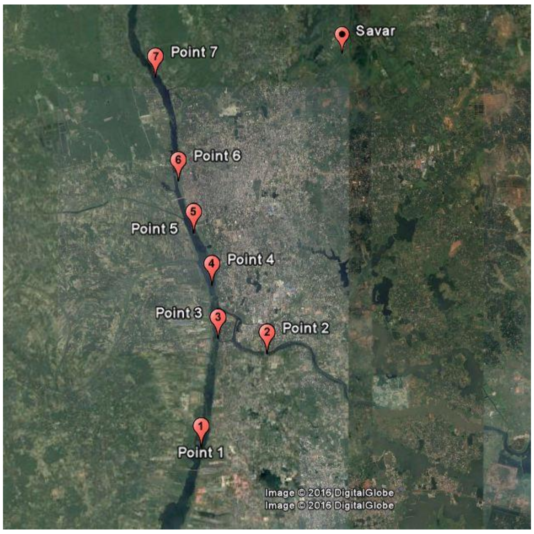

Figure 1: Sampling points shown on google map

The temperature of the sample was measured in the field with a thermometer. Water pH was measured by a pH meter (Model- SensIon: 156). Turbidity was measured by a digital turbidimeter (Model- Hack 2100p). Biochemical oxygen demand of water samples were determined in the lab by DO meter five days after sampling; the water sample was stored in incubator for 5 days. This standard method is recognized by U.S. EPA, which is labelled Method 5210B in the Standard Methods for the examination of water and wastewater. Nitrate and phosphate were measured using a Hack Spectrometer (Dr/4000). Nitra Ver 5 Nitrate Reagent Powder Pillow was used to measure nitrate content and Potassium Persulfate Powder Pillow was used to measure phosphate content. Concentration of ammonia was measured in 'Indophenol Blue Method'. Reagent Set for Water Analyser No.17A Ammonium, model LR-NH_4-A. Standard method was adopted for finding total solid and suspended solid content in water.

The current assessment of river quality by the E.P.A (The United States Environmental Protection Agency) is based on a comprehensive index known as "River Pollution Index", or RPI for short. RPI is an integrated indicator used to determine the level of pollution of a river. The index value is calculated using the concentration of 4 parameters in water quality: Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD_5), Suspended Solids (SS) and Ammonia Nitrogen (NH_3-N). Another commonly-used water quality index (WQI) was developed by the National Sanitation Foundation (NSF) in 1970. The NSF WQI was developed to provide a standardized method for comparing the water quality of various bodies of water. Nine water quality parameters were selected to include in the index. These parameters are dissolved oxygen, faecal coliform, pH, biochemical oxygen demand, temperature, phosphate, nitrate, turbidity and total solids.

3. RESULTS AND DISCUSSION

The location of sampling points was surveyed thoroughly before collecting samples. During the assessment of water quality of Bangshi river different point and non-point pollution sources have been identified. Pollutants are mainly generated in and around the city through domestic, commercial and industrial activities. Wastewater and sewage generated in the city are carried into the river system through numerous outlets. There were dumping points of solid waste near the river banks shown in Figure 2. These waste were directly in contact with river water.

Figure 2: Municipal waste dumping site at river side

Domestic waste are high in organic content and they increase the BOD of the water and decrease DO level. Industrial waste gets dissolved in water and also some of it remain as suspended solid. A lot of drains running through the municipality end at the river. So almost all the domestic waste and runoff generated inside Savar Municipality is carried by the Bangshi river. A number of industries were situated near river side. The waste generated in some of those industries were directly dumped into river without any treatment. Several locations were spotted where sewerage water and Industrial waste water were falling into river shown in Figure 3.

Figure 3: Sewerage water and Industrial waste water falling into river

The data regarding the pH of the sites shows almost invariance maintaining neutrality of water through the period. The pH values of water samples of the study area varied between 6.80 and 7.20 in January and in September it varied between 7.70 and 7.80 Shown in Figure 4. Although the pH values of water samples were found within the standard limits for drinking, irrigation and aquaculture, it dropped down significantly in the dry season. Because in dry season the discharge of the river decreases, but the amount of waste disposed to the river remains same. So it slightly lowers the pH of the river water in dry season.

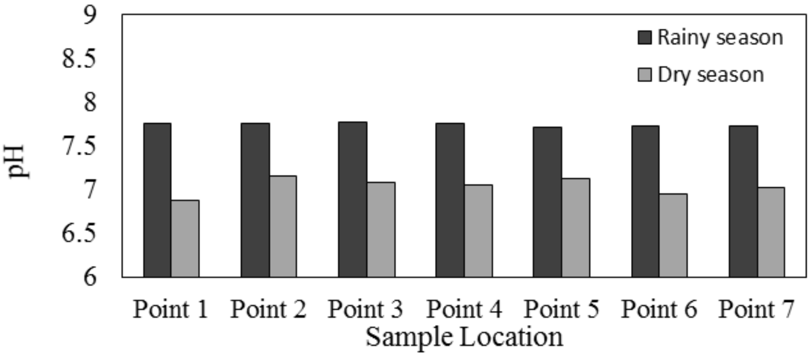

Figure 4: pH variation of Bangshi river at two seasons

The turbidity value varied from 70 to 145 NTU in January and from 132 to 223 NTU in September shown in Figure 5. The turbidity level was higher than the standard limit 10 NTU set by ECR, 97 throughout the year. The turbidity of the sampling area was found unsuitable for drinking, domestic, irrigation and industrial purposes.

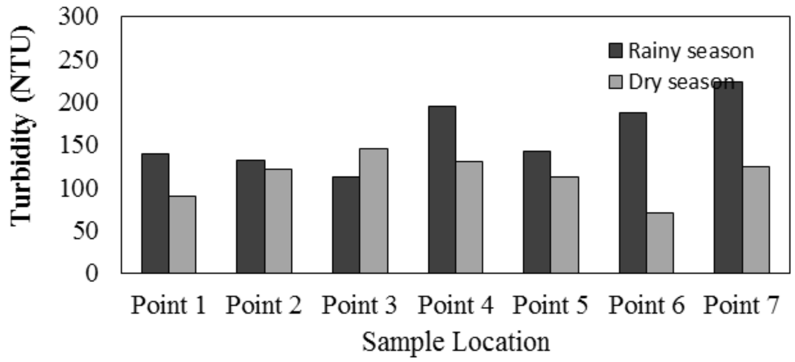

Figure 5: Turbidity of different points at two seasons

The DO value varied from 3.18 to 4.25 mg/L in January and from 6.00 to 7.05 mg/L in September shown in Figure 6. The optimum DO in natural water is 4-6 mg/L, which is essential for supporting aquatic lives. Although the amount of Dissolved Oxygen found in water samples during rainy season was sufficient, the DO level in dry season was too little for well aquatic environment.

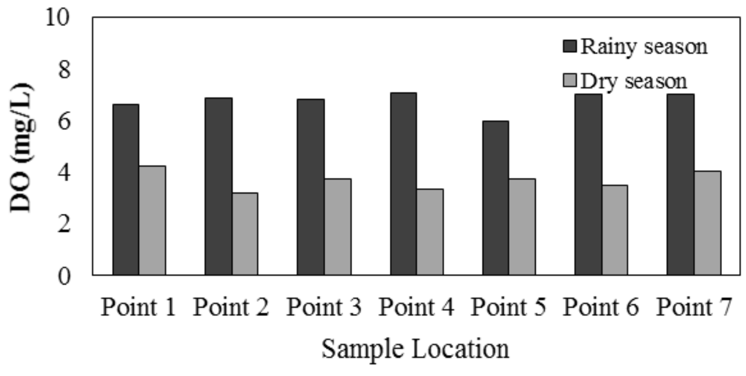

Figure 6: DO concentration in different location at two seasons

The optimum value of BOD_5 for surface water is 6 mg/L or less (ECR, 97). Higher values indicate water pollution. The BOD_5 of the study areas varied from 0.48 to 1.09 mg/L in the month of September and from 2.06 to 2.72 mg/L in the month of January shown in Figure 7.

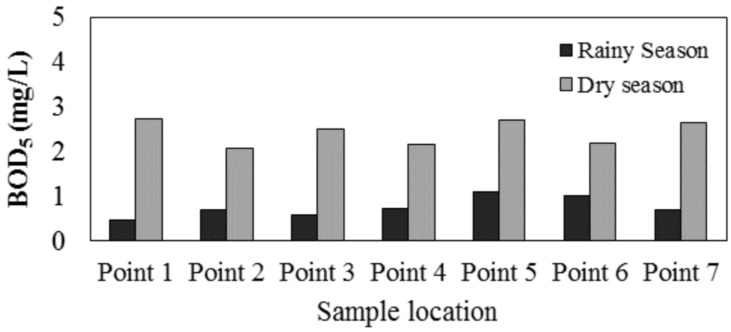

Figure 7: BOD_5 concentration of different points at two seasons

The phosphate concentration increase significantly during dry season shown in Figure 8. The average phosphate concentration during rainy season was 0.60 mg/L where the average rises up to 1.57 mg/L during dry season that is almost 3 times than the result found during September. It is very high than the allowable limit 0.1 mg/L (USEPA, 2000).

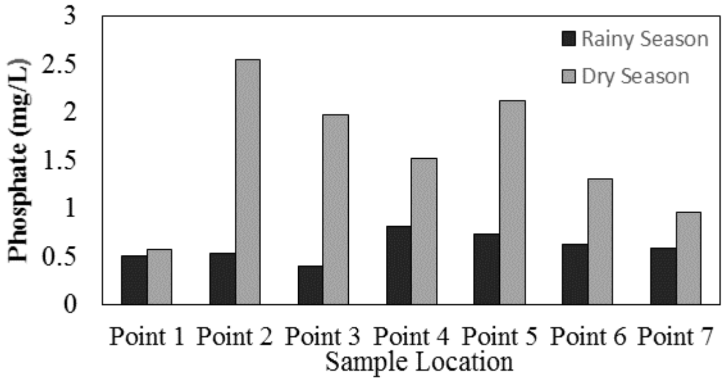

Figure 8: Phosphate concentration in different location at two seasons

The highest nitrate concentration found during dry season and rainy season was 1.9 mg/L and 0.3 mg/L, respectively. The allowable limit for nitrate concentration is 10 mg/L stated in ECR, 97. So the nitrate concentration was under acceptable limit. The current USEPA recommendations for faecal coliform for body-contact recreation is fewer than 200 colonies/100 mL; for fishing and boating, fewer than 1000 colonies/100 mL; and for domestic water supply, for treatment, fewer than 2000 colonies/100 mL (USEPA, 2000). The drinking water standard is less than 1 colony/ 100ml. The highest number of faecal coliform was found during dry season 73 N/100ml. So the water is safe for all purposes except drinking. The highest amount of total solid is observed during dry season which is 693 mg/L. The EPA standard for total solid is 1000 mg/L, so the result is favorable. The ammonia nitrogen concentration increase significantly during dry season shown in Figure 4.22. The average ammonia nitrogen concentration during dry season was 1.40 mg/L where it has been reported toxic to freshwater organisms at concentrations ranging from 0.53 to 22.8 mg/L.

There are water quality standards for surface water for water supply stated by ECR, 1997. As we can see in Table 2 all the four parameters during September 2016 were inside standard limit. But during January 2017 all the parameters excluding pH crossed the standard limit for surface water for water supply by disinfection process. So costly treatment is needed to use the river water for supply during dry season.

Table 2: Comparison between test result and Bangladesh water quality standards for surface water for water supply (ECR, 1997)

Water quality parameters	**(ECR, 97) values for water supply by**		**Bangshi river water**	
	Disinfection only	**Conventional treatment**	**September 2016**	**January 2017**
pH	6.5-8.5	6.5-8.5	7.77	7.15
BOD (mg/L)	2 or less	3 or less	1.09	2.72
DO (mg/L)	6 or more	6 or more	6	3.18
Total Coliform (N/100 mL)	50 or less	5000 or less	20 (Faecal Coliform)	73 (Faecal Coliform)

The seasonal variation of RPI is shown in Table 3. In rainy season the pollution status of the river was found 'lightly polluted' but in dry season the pollution status degraded to 'moderately polluted'. This happened primarily because in rainy season the discharge of river water was very high. So the amount of waste discharged into the river was little compared to the discharge of the river. But in dry season the river carry relatively less discharge so the amount of waste water discharged to the river can't be washed away by the slow moving current of the river.

Table 3: Variation of RPI at two seasons

	Rainy Season (September)		**Dry Season (January)**	
Sample Location	RPI score	Pollution status	RPI score	Pollution status
Point 1	2.25	Lightly Polluted	5	Moderately Polluted
Point 2	2.25	Lightly Polluted	5.75	Moderately Polluted
Point 3	2.25	Lightly Polluted	5.75	Moderately Polluted
Point 4	2.25	Lightly Polluted	5	Moderately Polluted
Point 5	2.75	Lightly Polluted	5.75	Moderately Polluted
Point 6	2.25	Lightly Polluted	5.75	Moderately Polluted
Point 7	2.25	Lightly Polluted	5.75	Moderately Polluted

The same thing happened for NSF-WQI. In rainy season the water was of 'Medium quality' but in dry season the water quality drops down to 'Bad quality' shown in Table 4. A lot of variation in NSF-WQI score is observed between rainy season and dry season. The average score in September was 68 whereas the average score in January was 49. So the water quality degraded in great extant from September to January.

Table 4: Variation of NSF-WQI at two seasons

	Rainy Season (September)		**Dry Season (January)**	
Sample Location	**NSF-WQI Scores**	**Water quality**	**NSF-WQI Scores**	**Water quality**
Point 1	69	Medium	54	Medium
Point 2	68	Medium	48	Bad
Point 3	69	Medium	48	Bad
Point 4	69	Medium	47	Bad
Point 5	66	Medium	47	Bad
Point 6	68	Medium	49	Bad
Point 7	68	Medium	51	Medium

Different types of approaches needed to restore and rehabilitate the river water quality. There are lot of industries already established near the river side. Also waste from industries located inside Savar Municipality are finally dumped into Bangshi river. So effluent treatment plant is a must for these industries. The domestic waste water should be treated properly so that they become environmentally safe. Adequate care should be taken to ensure that effective sewage treatment process is in place and that contaminated water does not get mixed with the environment in order to prevent water pollution. The municipal solid waste dumping site should be moved elsewhere at a distance from river side. Municipality authority can play a vital role in controlling the pollution of Bangshi river. Strict laws should be imposed on violating the Environmental Conservation Rules.

4. CONCLUSIONS

The water quality of Bangshi river was observed polluted not only by laboratory analysis but also by its physical appearance. The pH, BOD, DO and Faecal coliform value of Bangshi river water was found to be 7.77, 1.09 mg/L, 6.00 mg/L and 20 N/100 mL, respectively, which was satisfactory in rainy season but BOD 2.72 mg/L, DO 3.18 mg/L and Faecal coliform 73 N/100 mL was not satisfactory in dry season for inland surface water according to ECR, 97. Highest value of turbidity, total solid, NH_4-N, PO_4 and NO_3-N of river water was observed 223 NTU, 691 mg/L, 2 mg/L, 2.54 mg/L and 1.9 mg/L respectively. From the study, it may be concluded that Bangshi river water contained acceptable pH and concentration of NO_3, NH_4-N, DO and BOD during September 2016, whereas water turbidity, values of FC, TDS, SS and PO_4 exceeded the recommended limit for drinking and irrigation water. But in January 2017 only pH and nitrate were inside acceptable limit. The River Pollution Index and NSF-WQI for rainy season was found to be ‘Lightly Polluted’ and ‘Moderate Quality’ whereas in dry season it was found to be ‘Moderately polluted’ and ‘Bad quality’, respectively. From the results of the experiment it can be clearly stated that the concentrations of studied parameters were proceeding towards impermissible limit with the advancement of months, when the rainfall intensity was getting lower. But these values were generally low and fell within standard levels when rainfall intensity was higher. The scenario indicated that the Bangshi river received a huge amount of untreated sewage, municipal solid waste and industrial waste regularly through direct disposal. As the untreated effluent was directly discharged to the river, its water color was black and having noxious odor. Current pollution will be minimized if necessary approaches are properly implemented. So the authority of Savar Municipality needs to enforce laws and environment standards and regulation on polluting industries as they cause a tremendous threat to river water quality. This may involve identifying the sources of pollution, strict enforcement of laws to setup effluent treatment plant (ETP) in each industry to treat effluents before discharge in respect to recommended standard and also create public awareness about “save life of river”.

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