Study of Sources of Pollution and its Effects on Water Quality and Human Habitat: A Case Study of Bansi River, Savar, Dhaka, Bangladesh

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Abstract—Bansi River catchment is surrounded with different land use activities ranging from urbanization to agriculture and quarrying. The objectives of this study are to establish the number of point and non-point sources pollution of Bansi River and to identify which area source pollutions have the potential to increase the pollution rate in this river with its effects. This study involved both field and laboratory data (secondary data) study. Field study is conducted to establish the number of sources pollution and its effects. The various parameters of the water such as Dissolved Oxygen, Biochemical Oxygen Demand, pH, Chlorine, etc. were examined. Laboratory data was collected from Bangladesh Water Development Board (BWDB) and Department of Environment (DOE). Based on an analysis that has compliance with these standards, it can be concluded that point and non-point sources pollution that toward the station (Nayarhat area) have potential to increase pollution rate in the River.

Key words: Point sources pollution, Non-Point source pollution, Water Quality Analysis.

Introduction

Bansi River is located approximately 20 km far from of the Dhaka city. The Bansi is located within 23°93′ north latitude to 23°81′ north latitude and 90°21′ east longitude to 90°26′ east longitude. Savar area is on the bank of Eastern side and Nayarhat is on the western side of the Bansi River. The river system of Bansi River is spread in Dhaka district and in neighboring areas of Dhaka City. Hydrologically, the river is not separated. Many rivers are interlinked with this river such as Balu River, Dhaleswari River, Pungli River, Sitalakhya River, Tongikhal, Turag River, Karnaparakhal and karnatoli River. These rivers are also tributaries and branches of the Ganga, the Jumana and the Brahmaputra. This River gathers most of the pollutants of Dhaka city, Savar and Dhamrai area (Field

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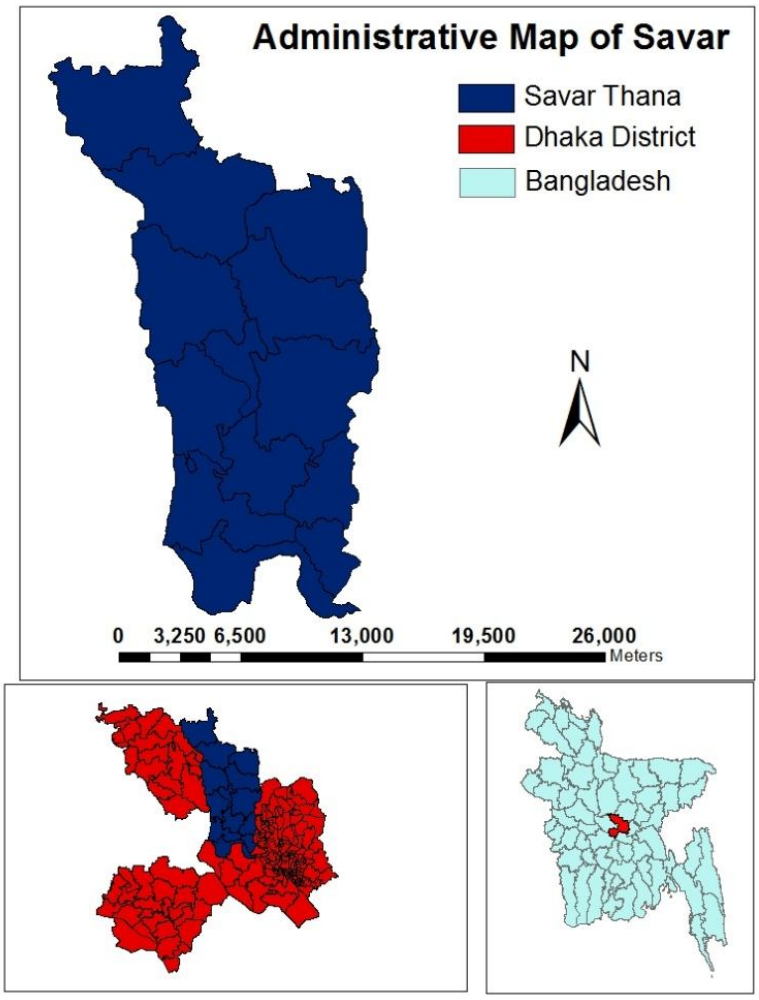
Survey, 2009). For this reason severe complexity is found in the hydrologic characteristics of Bansi River. Major tributaries of the Bansi River are Karnaparakhal. Agriculture area in its upstream catchments such as paddy, sugar cane and jute plantations are surrounding the river. Urbanization and infrastructures development involved land clearing activities in Savar and Nayarhat area. Bansi River can be classified as medium size and shallow waterlevel [1]. The River is an important sources of water and has multiple functions. Bansi River water is mainly use for navigation, household, market area and industrial purposes. Similarly, it is also used for agriculture as well as irrigation and flood control. The river performs important ecological functions with regards to the water quality protection and biodiversity maintenance.

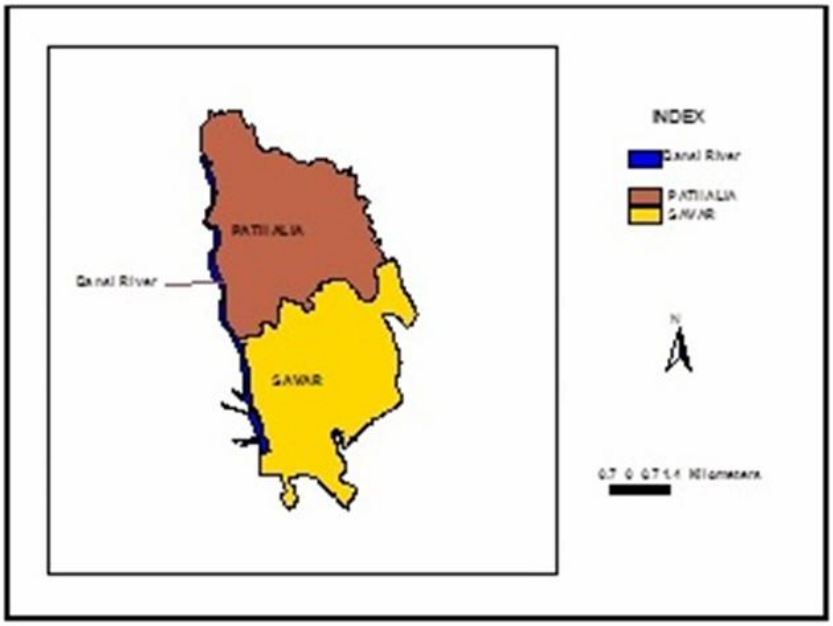
Human activities such as agriculture, housing, Industrialization and recreation contribute to the degradation of water quality of the river. Excessive loadings of pollution into river, lakes, reservoir and estuaries have become major cause of water pollution. Source of pollution can be categorized into two types, point source pollution and non-point source pollution. Point source pollution is a single category source. Point sources are relatively easy to identify, quantify and control. Point sources of water pollution include discharge from municipal sewage treatment plant and industrial plant [1].

While non-point sources are categorized by multiple discharge points, the pollution cannot be traced to a single point of discharge, difficult to monitor and control [2]. Non-point source pollution is water pollution affecting a water body from diffuse sources, such as human land use, land use changes, and pollutes runoff from agricultural areas draining into a river [2], [3]. Use of intensive mineral fertilizers associated with contamination of agricultural groundwater leads to increasing level of nutrients in ground and surface waters, especially from non-point sources difficult to prevent compared to point sources. Agricultural activity is major non-point sources pollution including use of nitrogen fertilizers, application of livestock manure, legume fixation and mineralization of soil nitrogen[1]. The objectives of this study are; (1) to establish the number of point and non-point sources and extent of pollution in the Bansi River; (2) to identify which area source pollutions have potential to increase the pollution rate in Bansi River area; and (3) find out pollution effects on human habitat. This research will benefit all to know about basic information on how and what substances enter in the waterways. The number of point and non-point source pollution can be reduced and controlled if people and community leaders have the information they need.



Map 1: Administrative Map of Savar

Source: Compiled by the author



Map 2: Study River, Pathalia and Savar Upazilla

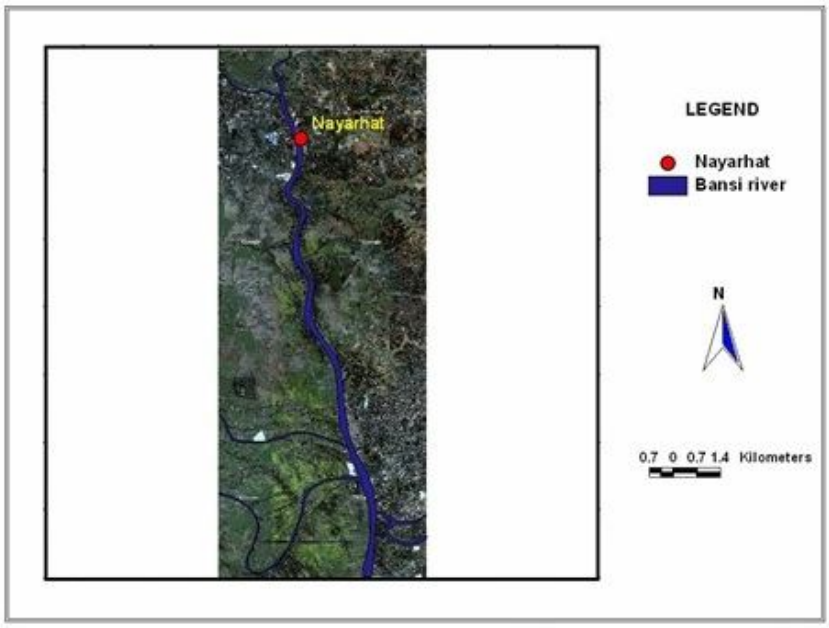
Source: Compiled by the author

METHODOLOGY

This study involved both field and laboratory data study. The field study is conducted to establish the number of point and non-point sources pollution and in-situ measurement of selected variables. The main river catchment area is 14.8 km². The catchment of Bansi River upstream comprises 34.9%, industrial area 31% residential area, 20% vegetation covered area and 18% agricultural area [1]. In order to further strengthen the report, activities and land use of upstream catchment areas have been observed to determine the point source and non-point source pollution. Most of Bansi River's catchment area had been observed surrounded by agriculture land, farm and livestock, which are identified as non-point source pollution. Meanwhile, domestic and industrial zones were categorized as point source pollution to the Bansi River.

While the secondary laboratory data is collected for the study from the Department of Environment (DOE) and Bangladesh Water Development Board (BWDB), the parameters involved are divided into three categories which are physical, chemical and biological parameters. These parameters are selected based on National Water Quality Standard (NWQS) for Bangladesh and DOE

Water Quality Index Classification by Department of Environmental (DOE, 2007). The physical parameter involved temperature, color, electrical conductivity, odor, clarity and turbidity. While chemical parameter analysis involved Hydrogen Ion Concentration **(**pH), Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), alkalinity, chloride (as chlorine) and Total Dissolved Solid (TDS), the total of sampling points in this study is one single point (Nayarhat).



Map 3: Sampling point selected at Bansi River area

Source:Compiled by the author

Result And Discussion

Number of Source Pollution in Bansi River

Bansi River is a major river that gives sources pollution to surrounding lake, cannels. It is passing through western and northern part of Dhaka city. The River originated from the Jamuna River System. And the Turag has met with the Bansi at Dhaka District area. However, the main flow of the Bansi River comes from the Jamuna river system and it meets with the Dhaleshwari River at Munikganj, Pungli and Lowhojong River at Tangail. The Bansi River has a great economic importance but this river is being polluted at alarming rate. By observation and

measurement, it has been found that the river is going to be highly polluted. There are many point sources pollution found in these district areas such as industries and factories, residential and domestic areas. Point source pollution is from a specific source, and is released at a known discharge point or outfall, usually a pipe or ditch.

Based on observation at Bansi River, there are industrial and domestic areas identified as point sources. Agricultural activities, workshops, livestock, market area and erosion from construction site are regarded as non-point source. The River Bansi is running by the side of the Dhaka City situated in Dhamrai and Savar area. It is one of the polluted rivers in Bangladesh. The Greater Dhaka City is also one of the most densely populated cities in the world, and this study area is populated as well. While it is a densely populated area, less than 15% are served by sewage treatment facility among them. Many industries have set up around the area during the last decade. The numbers of new industries are continually increasing. As a direct consequence, the amount of untreated wastewater being discharged into the Bansi has risen steadily. That is why in the lean flow period of dry season (six months), quality of water within the 17 kilometers reach of the river is much lower than required for the sustainability of aquatic life, posing a severe threat to the dwellers of the study area. The Bansi is being polluted through various ways. Hundred tons of untreated and highly toxic liquid and solid wastes are polluting its water every day. Now the river Bansi has turned into a stagnant sewage.

There are a lot of industries on the bank of the Bansi River, which are polluting the water mostly. The largest concentrations of industries within Savar and Nayarhat at present are the export oriented garment industries, numbering nearly 7. There are also several hundred other industries of different sizes and categories of industries, including nearly 3 tanneries. Every day thousand tons of industrial effluents are falling into the water and polluting the river. At present, color of water of the river and around the capital has become almost black with bad smells, making it impossible for fish to survive as the organic wastes have been absorbing the dissolved oxygen from water. The garment factory wastes are generally cloth pieces, and are recyclable, but the factories with dying functions cause liquid chemical waste of hazardous nature. The tanneries produce liquid wastes and seriously pollute the adjoining rivers. These also have solid waste which is partly recycled. The main sources of industrial pollution are Nayarhat industrial area and Savar industrial area. At Nayarhat area there are about 5 processing industries and at Savar industrial area there are about 8 various industries.

Table 1: Distributions of point sources

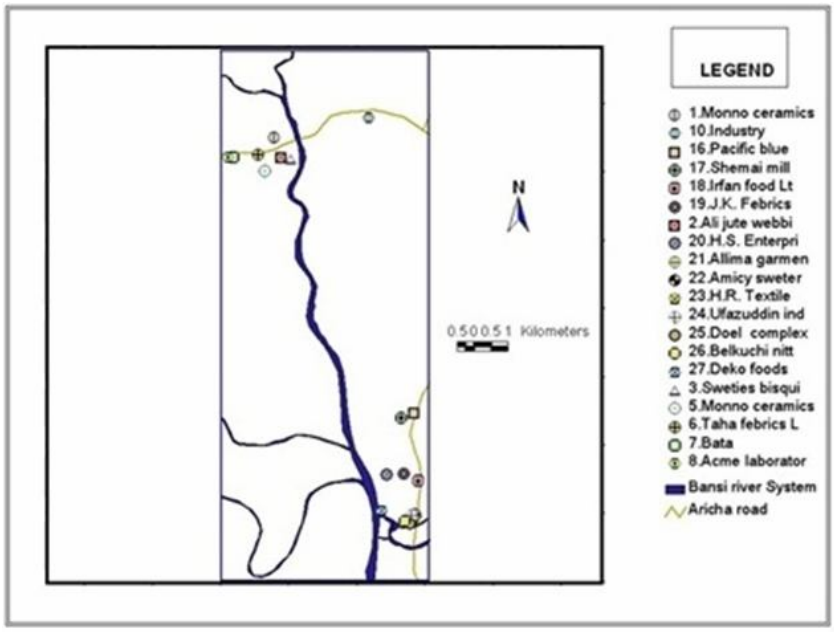
	Savar area	**Nayarhat area**
1. Textile	14	03
2.Brick field	04	00
3.Tannery	01	01
5.Food processing Industries	03	02
6.Housing	01	00
Total	23	07
Grand total		30

Table 2: Distributions of non-point sources

	Savar area	**Nayarhat area**
6.Agriculture	12	25
7.Market/Bazar	02	01
8.Others	02	00
Total	16	26
Grand total		42

Source: Upazilla Ansar and VDP Office, Savar, Dhaka, 2009

The industries found in the study area are textile and tannery. The domestic areas were housing and market. During the observation, children of the area were bathing and playing in the river. Some residents use river water to wash clothes with soap. Contaminants and faecal pollutant come from human body and soap will contribute pollution into stream nearby areas. The major sources of pollutant are generated from domestic wastes (solid waste and sewage) which were disposed into the river [4]. Non-point sources are organic or inorganic pollutants coming from rainfall and runoff into the river. Agricultural activities are distributed in huge area of Bansi Rriver catchment. Agricultural activities center upon mix crops like sugarcane, paddy and jute. Fertilizer and pesticides give high inputs of ammonia nitrogen into the river brought by runoff and rainfall. The waste from livestock produces unwanted faecal contamination and toxic into river and could harm the aquatic life. Improper control of animal wastes and animal healthy could give significant bad impact and contamination to the river and fish in the living tank.



Map 4: Point sources of pollution in Bansi river area

Source: Compiled by Author

Waste Generation

The estimates for solid waste production for Savar has varied from 350 metric tons to 450 tons per day on a very rough per capita basis, which has been taken to be between 0.25 and 0.20 kg. Taking the mid-figure of 400 tons per day at present, and with a 5 percent growth rate of population, the area is apprehended a proportionate increase in solid waste generation [5]. By 2015 more than 600 tons of Solid Waste will be generated in the Savar and Nayarhat area. Various studies and survey reports have concluded that the formal waste management system of this area cannot collect and dispose of more than half of the waste produced, the other half remain either uncollected or partly picked up by informal sector people, or gathered in drains. The magnitude of the problem has alarmed the people concerned.

Solid wastes are basically of two types- (a) Soft wastes or organic wastes, which include vegetables, fruits, leftover food stuffs from households, hotels and restaurants, and(b) Hard wastes, such as pieces of wood, metals, glass, plastics and polythene materials, paper, rubber, clothes and textile factory waste and construction materials.

Chemical wastes comprise 60 percent of all wastes in Dhaka city, while about 18 percent comprise of plastic, rubber, wood and leathers, 11 percent is paper products, about 9 percent comprise food and vegetables, while rocks, dirt, debris, etc., make 2.3% and metals constitute only 0.15 [6].

Composition of Solid Waste (SW) in study area are combined with Chemicals 59.91; plastic, rubber, wood and lather17.67; Paper products 11.21; food and vegetables 8.76; Rock, dirt, debris & Misc 2.3; Metals 0.15 [6].

In terms of sources of solid waste, households account for nearly half of the wastes generated in the city while markets or commercial centers contribute one-fifth, industrial waste account for about 24 percent and hospitals and clinics contribute about 7 per2`cent respectively.

Total solid waste generation per day (2006) was for Residential purposes 718 tons, which was 49.08 %, for Commercial purposes 122 tons, which was 20.86%, for Industrial purposes 335 tons, which was 23.86%, Hospital and Clinics 55 tons, and which was 7.29%. So, yearly total 1215 tons solid waste are generated in that area [7].

Population Growth and Unplanned Development

Savar and Dhamrai Upazilla of Dhaka districts, being the administrative, commercial and cultural area of Bangladesh, have now turned out to be most populous areas of the country. It is the nerve centre of this total area. A principal reason of such a rapid growth is over concentration of maximum activities and development works in the area and little improvements like other cities, towns and villages in terms of infrastructure development and economic activities. Improved road communication in the country further made it easy to converge on the capital in search of employment and better quality of life. High-density population as well as shortage of land cause intense densification in the existing built up areas.

Industrial waste and household waste of this area are falling into the Bansi River through some different routes like Karnapara Khal and other drains. Pollution characteristic varies from industry to industry. There are various industries like Textile industry, Food processing industry and Chemical Industry. In the textile industries, there are high alkalinity, high BOD, and high amount of floating material in Tannery Industry there are high salinity, high BOD, high dissolved solid materials, presence of sulphide, chromium, etc., in Pharmaceutical Industry there are high COD, high BOD, high alkalinity and in rubber and plastic Industry there is medium salinity, medium BOD, phenol, etc. [7].

According to Department of Environment, about 5800 m^3 wastes are falling into the Bansi River from Savar area, about 500 m^3 wastes from Nayarhat area and 700 m^3 wastes from other area are falling into the Bansi River and these are increasing gradually [8]. According to the estimation of 2006, about 10 thousand

kg (3000 m^3/day) pollutants from Savar area and about 5 thousand kg (500 m^3/day) pollutant from Nayarhat area are falling into the Bansi River daily. The numbers of pollution source from Savar area are 27 and from Nayarhat area are 8.

Result Analysis

Temperature is one of the most important parameters for aquatic environment because of all physical, and chemical activities. Biological activity is also governed by temperature. The standard temperature in the river varies between 20º-30.2º Celsius. In 2007 the highest temperature was 30.4ºC and the lowest temperature was 21.5ºC. From this data, it can be said that the water of the Bansi River is suited for recreation and fish cultivation [10]. In April and May the temperature is normally high because of low discharge and industrial waste. Overall, the temperature of the Bansi River is tolerable and effective for fish cultivation, recreation and also for agriculture.

Color of the water depends on the humus content of the decaying vegetative matter and industrial waste. Collected water samples from the lakes had different shades of green color, ranging from light green to dark green.

In any water body higher Electrical Conductivity (EC) means higher pollution. According to BBS (1998), the proposed standard of fishing water has an electrical conductivity in the range of mg/l in the rivers. Electrical conductance or conductivity is the ability of a substance to conduct an electric current[8]. In 2007 the highest EC was 850µs /Cm (in the month of January) and the lowest EC was 189µs /Cm (in the month of December) where the standard is 500/µs/Cm-700 µs/Cm. From this data it can be said that the water of the Bansi River is suited for recreation and fish cultivation [9].

The volatile compounds produce odor [10]. The odor can be relatively described as medicinal (phenolic), fishy (due to algae), earthy (decaying matter) or chemical (Chlorine). The odor of the river water is very unpleasant due to excessive pollution. The color of the water is blackish, clarity unclear, algae lot, and odor unpleasant of Bansi River

The turbidity of water is caused by insoluble and colloidal compounds of inorganic origin (clay minerals, silicic oxide, hydrated oxide of iron and magnesium, etc.), or of organic origin (organic colloids, bacteria, plankton etc.). In the groundwater turbidity is caused mainly by the presence of inorganic substances. Turbidity causes an undesirable appearance of drinking and surface water. The turbidity of the Bansi River is very high which also may not be suitable for various activities.

Chemical characterization is very important in assessing the quality of water [10]; the total solid and the pH value have been calculated from the collected water sample of Bansi River. pHindicates alkalinity or acidity in the water. A pH scale indicates the strength of acids and alkalis. It runs from 1-14. All acids have a pH

less than 7. Lower pH in water is harmful for the aquatic life. A clam cannot survive if the pH of the water decreases below 6 but a wood frog can survive in water with a pH as low as 4. pH is a master variable controlling chemical system. It is defined as the negative logarithm of the hydrogen ion activity and describes whether a solution is acidic (pH, l-7), neutral (pH-7), or basic (pH-7-15), pH may be raised by adding a base or by removing CO2 from a solution, e.g., by photosynthetic assimilation. The pH value of Bansi River water is being different with the temperature or seasons such as, in dry season (May) pH value is 6.9 and in winter season (January) pH value is 9.5 [10]. (Field Survey, 2007)

Many types of fish and bottom-dwelling animals cannot survive where levels of dissolved oxygen drop below two to five parts per million (ppm). When this occurs, it kills aquatic organisms in large numbers which leads to disruptions in the food chain [11]. Like terrestrial animals, fish and other aquatic organisms need oxygen to live. As water moves gills (or other breathing apparatus), microscopic bubbles of oxygen gas in water, called Dissolved Oxygen (DO) are transferred from the water to their blood. The solubility of oxygen in water rises above 40% as freshwater cools from 25˚C to freezing point. The value of DO ranges from 1.5-7.0 in surface water samples whereas the standard DO ranges from 4.5 to 8 mg/L [10]. (Field observation, 2007)

The waste from various sources falling into the river has Biochemical Oxygen Demand, which also decreases the dissolved oxygen. BOD 5 is the most commonly used parameter for determining the oxygen demand on the receiving water of any water sources for assessing the productivity. The average BOD of the Bansi River is 8-30 mg/L, and in the month of March 2007 this amount was 48 mg/L which indicates the poor condition of the water. (Field observation, 2007)

Therefore, simply measuring pH may not be sufficient. For a more complete assessment of water quality, most scientists also measure alkalinity. Alkalinity is measured to determine the ability of a stream to resist changes in pH. Alkalinity values of 20-200 ppm are common in freshwater ecosystems. Alkalinity levels below 10 ppm indicate poorly buffered water bodies. The average Alkalinity of the Bansi River is 25-170 mg/L, and in the month of October 2007 this amount was 25 mg/L which indicates the normal condition of the water on the basis of alkalinity. (Field observation, 2007)

The Total Dissolved Solid (TDS) denote mainly the various kinds of minerals present in water. TDS do not contain any gas and colloids. Total dissolved solids in surface water samples ranges from 224-554 ppm. The highest value is nearest at Nayarhat which is 620 ppm and the lowest value is 370 which indicate the poor condition of the water. (Field observation, 2007)

There is shown average BOD 5.25 mg/L whereas standard BOD is for drinking 50 mg/L, for fishing 250 mg/L, for irrigation 500 mg/L. The average dissolved oxygen is 4.2 which is a lower limit of standard value according to the Department of Environment [10].

Table 4: Pollution level of surface water in comparison to DoE standard

Chemical Parameters	Average Sample Reading	DoE Standard of		
		Drinking	Fishing	Irrigation
BOD	5.25 mg/L	50 mg/L	250 mg/L	500 mg/L
Chloride (c1)	20 mg/L	600 mg/L	600 mg/L	600 mg/L
D.O	4.2 mg/L	4.5-8 mg/L	4.5-8 mg/L	4.5-8 mg/L
pH	7.32	6-9	6-9	6-9

Source: [9]

From results discussed, it can be concluded that water quality parameters of Bansi River will be more polluting day by day. It will be increase with the development of industries and population growth of the country. So better is that all sources maintain the rules of effluent extraction and all environmental rules.

On the other hand, source pollution along the Bansi River is definitely having a potential to increase the pollution rate. The agricultural soils surrounding river catchment could contribute pollutant in river water due to intensive use of fertilizers that exceeds the nutrients of the crop [3]. Human activities such as deforestation or construction activities transport toxin materials into the river and contaminat aquatic habitats [3].

Effects on Surrounding Savar & Nayarhat Area

Sources of the Pollutions

Most of the respondents about 90% respondents think industry and Bazar related waste are the major causes of the pollution. Among those industry and Domestic waste are 90%, Bazar related waste are 6% and other wastes are 4%. (Field Survey, 2009)

Uses of the Bansi River Water

15% people are using this water in agricultural purposes, 5% of them are using household purposes, 12% use for bath, 8% use for recreational purpose and the remaining 60% use other sources of water are because of pollution.(Field observation, 2009)

Impact on Human Health

Most of the people are suffering from skin disease and respiratory disease and it is about 36% and 32% of the total population.

Table-5: Disease Pattern of the local populations

Age Limit (Year)	***Disease Type***						
	Diarrhea	Skin disease	Heart Disease	Respirator Disease	Asthma	Number	Percentage
1-10	6	11	1	5	2	25	25
11-20	2	5	-	4	1	12	12
21-30	2	8	-	15	5	30	30
31-40	-	6	4	3	2	15	15
41-50	-	4	1	3	2	10	10
51-60	-	2	3	2	1	8	8
Total	10	36	9	32	13	100	100

Source: Field Survey, 2009

Table-6: Various diseases and percentage of sufferers

Disease Types	**Number**
Diarrhea	10
Skin disease	36
Heart Disease	9
Respirator Disease	32
Asthma	13

Source: Field Survey, 2009

In Savar area rapid urbanization and industrialization are increasing the wastages day by day [10]. Most of the rivers in our country are being polluted by industrial waste. Various kinds of germs coming from urine, household waste and hospital wastes are polluting surface water. As a result, water is considered a media of some diseases such as Typhoid, Para-typhoid, Dysentery, Cholera, infections Hepatitis, etc.

With over 500 tons of untreated and highly toxic liquid and solid wastes contemning its water every day, the river Bansi has turned into a stagnant sewerage. The repeated toxic onslaught on the life line of this area has

contaminated the ground water and the agricultural land around it. Due to lack of flow in the water during the lean period, the wastages are accumulating at an alarming rate. The water is tick and resembles discarded engine oil, emitting an unbearable stench. During eight months of the year, Bansi is out off from its sources, the Jamuna River in the upstream near Manikganj [12].

Conclusion

This study not only presents the water quality of Bansi River, but also identify the important sources of pollution that threaten water quality in this river. Based on the analysis of water quality, Bansi River was identified as source of pollution to from the surrounding area to the river. This study also revealed both the point sources and non- point sources pollution threatening the water quality. By establishing number of point source and non- point source in the catchment area of Bansi River, totally 72 point and non- point sources pollution were identified, which are 30 point sources and 42 non- point sources pollution were in Bansi River. Based on water quality analysis, the level of TDS, BOD, EC, DO and Turbidity are identified as polluted water quality as per water standard, DoE, Bangladesh and Water Quality Index classification. Due to water quality only suitable for sensitive aquatic species, conventional and extensive treatments were required. The level of pH is unacceptable concentration. For overall, we can conclude that point source and non- point sources pollution of Bansi River have potential to increase the pollution rate in the river water. The effect of water pollution was studied carefully and found out that a lot of people are suffering from various diseases; especially skin and respiratory diseases. Make changes in the pattern of waste removal from household and industries in the area is the way to recover all of these problems.

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