

**SOCIAL IMPACT ASSESSMENT OF WATER POLLUTION:  
A CASE STUDY ON BANGSHI RIVER, SAVAR**

**A DISSERTATION  
BY  
MUHAMMAD REZAUL KABIR**



**INSTITUTE OF GOVERNANCE STUDIES (IGS)  
BRAC UNIVERSITY, DHAKA, BANGLADESH  
NOVEMBER 2014**

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BY  
MUHAMMAD REZAUL KABIR  
ID NO. 13372016  
MAGD 5<sup>TH</sup> BATCH**

**In Partial Fulfillment of the requirement for the Degree of MA in Governance  
and Development**



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BRAC UNIVERSITY, DHAKA, BANGLADESH  
NOVEMBER 2014**

## **DECLARATION**

I do hereby declare that this dissertation entitled “Social Impact Assessment of Water Pollution: A Case Study on Bangshi River, Savar” is my own work, and that all the sources I have used or quoted have been indicated or acknowledged by means of completed references.

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## **Certificate of Approval**

I have the pleasure to approve the dissertation titled, “Social Impact Assessment of Water Pollution: A case study on Bangshi River, Savar” by Muhammad Rezaul Kabir to be presented to the BRAC University in Partial fulfillment of the requirement for the Degree of MA in Governance and Development.

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Dated: 15 November 2014

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**DEDICATED TO**

**My parents who brought me up with  
their endless love, support and encouragement**

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## **Abstract**

A river is an important component of environment which carries freshwater, keeps a boundless significance for harmonizing a suitable environment in this earth. But most of the river of Bangladesh especially near the cities is being polluted through discharging various wastes such as industrial wastes and household wastes without any measures and treatment into it. Bangshi River is one of them, which is being extremely polluted in the recent time.

This study has been undertaken to investigate water pollution scenario and to assess the social impact of water pollution of the Bangshi River on human health, aquatic life, the society and environment.

This water pollution of Bangshi River through discharging of different types of wastes such as industrial wastes, household and growth centre related wastes, chemical fertilizers, and landfill leakages has affected all fishes and most of the aquatic animals to death, disruption of food-chains, and critical diseases to human, destruction of ecosystems and environment, and socio-cultural habits of the people in the area. Lack of proper management of industrial wastages release and lack of proper implementation of the policies are the main reasons of it. It can be improved the scenario of water pollution of the river by taking care about recommendations of the study which can have the positive changes to the human and aquatic life, environment and ecosystem of the river area.



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### **LIST OF CASE STUDY**

Case study-1	Buriganga turns into a toxic dump
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## LIST OF ACRONYMS

BBS	Bangladesh Bureau of Statistics
BOD	Biochemical Oxygen Demand
EC	Electrical Conductivity
EC	Environmental Canada
CBC	Canadian Broadcasting Corporation
COD	Chemical Oxygen Demand
DG	Director General
DO	Dissolved Oxygen
DOE	Department of Environment
EIA	Environmental Impact Assessment
EPHA	European Public Health Alliance
EMP	Environmental Management Plan
ETP	Effluent Treatment Plant
FAO	Food and Agriculture Organization
IEE	Initial Environmental Examination
MT	Metric Ton
NGO	Non Government Organization
NOC	Non-Objection Certificate
OECD	Organization for Economic Co-operation and Development
PPCP	Pharmaceuticals and Personal Care Products
SPSS	Statistical Package for the Social Sciences
SS	Suspended Solid
TDS	Total Dissolved Solid
TS	Total Solid
USEPA	United States of Environmental Protection Agency
UFRGS	Federal do Rio Grande do Sul, Brazil
WHO	World Health Organization



## CHAPTER ONE: INTRODUCTION

### 1.1 Background

Safe environment is the prerequisite of safe life. But serious environmental degradation has taken place in the recent years in Bangladesh. There are many dimensions of this degradation. There are so many components of the environment. River and its water are the most important components of environment. Water is the most essential requisite that nature provides to sustain life for plants and animals, and also has tremendous role in every mode of human life. No life can exist without water since water is as essential for life as air is. Water is absolutely essential not only for survival of human beings, but also for animals, plants and all other living things (Raj, 1997).

Water is one of the essential elements of life. Because of its need and use, water availability is a planer and determiner of civilization and cultures. Water is a renewable natural resource. It is delivered from the atmosphere in the form of rain, snow, hail, fog, and condensation and returns to the atmosphere by evaporation and transpiration. While on the earth, it runs over the ground to lakes, rivers, streams, and oceans and seeps into the ground to be taken up by growing plants to become a part of the ground-water reservoir, eventually discharging also to streams, rivers, lakes, or the ocean (Hennigan, 1969).

Knowledge of water, chemical composition and its properties is necessary for the solution of scientific and applied problems concerned with water use for human domestic and other activity such as water supply (drinking, hygiene, public, industrial, agricultural), fish-breeding, recreation, hydropower and hydraulic engineering, reclamation, exploration and exploitation of mineral deposits, etc.(Wikipedia, 2013)

Despite its importance, water is the most poorly managed resource in the world. The existing tendency of industrialization and urbanization may contribute greatly to the poor quality of water through indiscriminate disposal of solid waste, industrial effluents and other toxic wastes which are the major environmental issues posing threats to the existence of human being (Rahman et al., 2008). Water pollution is any change chemically or biologically in water quality that has a negative impact on living organisms in this water and those who use this water. The effects of water pollution not only impact people, but they also can kill animals, fish, and other organisms. It also disturbs the food chain (Wikipedia, 2014).

Bangladesh is a country of rivers. There are about 230 small and large rivers in Bangladesh (Wikipedia, 2013). Most of the people of Bangladesh depend on them for daily living and for transportation. But most of the rivers have been polluted due to industrialization, urbanization or any other steps taken by man for his own achievement or for the societal purpose over the last few years.

Bangshi River is one of the most important rivers in the central part of Bangladesh in respect to irrigation, fisheries, transportation, recreational uses and so on. The water of Bangshi River is undergoing continuous changes in terms of quality. The degradation of water quality of Bangshi has aggravated at an alarming rate as a result of increasing industrialization, urbanization and development activities. Bangshi River receives millions of litter of sewages, domestic wastes, industrial and agricultural effluents.

This is a common trend all over the world that most of the cities and towns are situated near or on the bank of the rivers. Here, Dhamrai Upazila, Islampur and Nayarhat are situated near the bank of Bangshi River. It is the most important river of Savar, Dhamrai, Nabinagar, and some surrounding areas for various reasons. This river was full of different kinds of fishes and exotic animals like Ganges dolphins. The prosperity of local agriculture, fish mostly depends on this river. The local people of this area get many kinds of fishes from this river. The river is also important locally for communication and transport. There are some old people in this area had seen fishermen catching Hilsa (not in a huge quantity though) from this river even in mid 1980s. Boats, launches and steamers move on the river in all the year round. Men, material and goods are going and carried from one place to another and one port to another port through this river.

But the above scenario has been changed due to industrialization near the Bangshi River. Pollution has taken away everything. The Dhaka Export Processing Zone, Monno Group of industries, Kohinoor Spinning Mill, Beximco Park, Biswas Group, and some other different garments factories and industries are the major industries existing and growing on the bank of the Bangshi River discharging wastes and causing pollution to the river. The mentioned industries producing tons of waste without any measures and treatment throwing to the river causes pollution of it. Like many rivers of Bangladesh, Bangshi also has become a victim of industrial pollution, siltation and many other man made factors. The industrialization, unplanned

urbanization has affected all fishes and most of the aquatic animals to death, disruption of food-chains, critical diseases to human, and destruction of ecosystems of the river area (Nahar, 2009).

## **1.2 Statement of the Problem**

Polluted water is the world's biggest health risk, and continues to threaten both quality of life and public health in most of the country of the world. Clean and plentiful water provides the foundation for prosperous communities. We always rely on clean water to survive, but still we are heading towards a water crisis all over the world.

Most of the rivers near the big cities in Bangladesh have been polluted in the last 20-25 years due to various reasons. There is a lot of significance of a river in terms of communication, irrigation water, fishes, source of ground water reservoir, maintaining ecological diversity, balancing the environment and temperature, providing water-purpose of birds and animals etc. Bangshi River is one of the rivers which keep a set of importance for Savar, Dhamrai, Nabinagar, and its adjacent area for aforesaid reasons. But the river water is severely polluted which is now no longer suitable to use.

This water pollution hampered on ground water contamination, skin rashes and other health problems like cancer, reproductive problems, typhoid fever and stomach sickness in humans. Ecosystems destroyed by the rising temperature in the water, aquatic animals caught and killed from suffocation. The accumulation of solid waste and soil erosion in streams and rivers sometimes causes flooding. Fishermen and boatmen shifted to other profession. It causes some changes in per capita income, health condition, agricultural change, socio- cultural change, and change in financial condition of fishermen and boatmen. In this way, it has a great negative impact of water pollution of this river on the society.

## **1.3 Scope of the Research**

Through this study, my main task is to find out the social impact of the water pollution of the river. This expected social impact depends on different causes of water pollution of the area. So it is important to know the causes of the water pollution of the river. Socio-economic status of the people of the area is changing due to the effects of water pollution of the river. Most of the fishermen and boatmen of the area are being affected because of water pollution. For this reason the livelihood changes of fishermen and boatmen has been mostly covered in this study. It has

been provided some recommendations about the problem for implications through identification of the causes of water pollution and its social impacts on the society.

#### **1.4 Rationale of the Research**

Any river, especially in Bangladesh, has its vital role for having a sustainable bio-diversity, ecological balance, surface water condition, ground water level, agricultural development, fish and fishermen development, communication, business, and cultural practices and cultural ecology etc. Before 20-25 years back, the river had its fish which was the wealth of local people. The fishermen were engaged in fishing with their livelihood in the river. The different type of cultural practices going on for various purposes was there. This type of livelihood manner, cultural practices are not now happening in this area due to water pollution as a result of unplanned industrialization, lack of water for not proper dredging, and lack of implementation of rules and regulations. A few boats are seen in the river now a day. The river side was like a health resort about 25 years back.

The river lost its characteristics, though some development activities have been established over there. The people those who coming to the river side especially in winter season smell bad as the intensity of pollution in the water enhanced during this season due to reducing the volume of water. So, the people are not interested to come and visit the river and different spot beside the river. Some workers and laborers those who bound to work in and around the area come to the river water and the adjacent area.

Now the water crisis takes places in Dhaka city and its adjacent areas. The fresh underground water in different area is also getting contamination due to the surface water pollution of the river and other water bodies. So, it is important to examine the causes and effect of the water pollution of the river. The government and local government may take initiatives by making policy and its implementation for solving water pollution on the basis of the recommendation of the study. It can ensure a better sustainable environment which causes positive socio-economic effects all over the country. It needs to give more attention on stakeholder, specially fishermen and boatmen those who have been severely affected with the water pollution of the river. This study may assist some extent to improve their socio-economic status and their culture.

## **1.5 Research Questions**

The research will be carried out with a view to answering the following questions:

- (a) What are the causes of the water pollution of Bangshi River?
- (b) What is the social impact of the water pollution of Bangshi River?

## **1.6 Objectives of the Research**

The objectives of the study are as follows:

- (a) To assess the social impact of the water pollution of Bangshi River on the society,  
and
- (b) To provide some recommendations about the problem for implications through identification of the causes of water pollution, and its social impacts on the society.

## **CHAPTER TWO: STANDARD WATER AND BANGSHI RIVER WATER QUALITY**

### **2.1 Introduction:**

The main focus of this chapter is to review brief history of Bangshi River, importance of river, the key concepts of physical and chemical characteristics of water, standard water quality, and Bangshi River Water Quality relevant to the study.

### **2.2 Brief History of Bangshi River**

The Bangshi was a distributary river of the old Brahmaputra flowed in the southwardly direction through Tangail and discharged in the river Dhaleswari near Savar at Dhaka. But, after the change of the Brahmaputra in 1787 to its present Jamuna channel, the head of the Bangshi had been gradually cut off. It flows more or less 90<sup>0</sup> E meridians. There are the Banar Rivers in the east, Fuljani and Jhenai River in the west and old Brahmaputra and Dhaleswari in the north and south of the river respectively. The river has a length of about 148 miles of which only 25 miles is in the district of Dhaka (Belayet, 1974).

### **2.3 River and its importance**

A river cuts a lot of importance for any country. It has special significance in the country like Bangladesh. Bangladesh is called a land of rivers as it has about 700 rivers including tributaries. The rivers are not, however, evenly distributed in the country. For instance, it increases in numbers and size from the northwest of the northern region to the southeast of the southern region. The total length of all rivers, streams, creeks and channels is about 24,140 km usually the rivers flow south and serve as the main source of water for irrigation and as the principal arteries of commercial transportation. The rivers also provide sweet water fish, an important source of protein (Chowdhury, 2001).

Environment is the most important thing for our life. Environment constitutes of many components. River is one of the major components of it. The whole environment of a place mostly depends on the wetland and water body of that place. From a strictly human perspective, healthy rivers perform numerous ecosystem services the processes carried out by natural ecosystems that benefit human societies and economies. Rivers, wetlands, and either freshwater

ecosystem constitute part of the natural infrastructure that keeps our economies running. Like workers in a factory, wetland plants and animals are organized and productive team—absorbing pollutants, decomposing waste, and churning out fresh, clean water. With great efficiency, periodic floods shape river channels and redistribute sediment, creating habitat essential to fish and other riverine lives (Sandra Postel et al., 2004).

## **2.4 Indicators of river water quality**

Some indicators have been considered to assess the water quality of the physical characteristics of water in the following way:

### **2.4.1 Physical characteristics**

Physical characteristics of the water are described below:

#### **2.4.1.1 Temperature**

Temperature is one of the most important parameter for aquatic environment because of all physical, chemical, biological activity is governed by temperature. The life cycle and natural process of aquatic organisms are closely related to water temperature may result in the decrease of dissolved oxygen and increase in chemical reaction in water. Normal life patterns of aquatic organisms may be completely disrupted by artificial changes in water temperature (Stoker, 1976).

#### **2.4.1.2. Color**

Color of the water depends on the humus content of the decaying vegetative matter and industrial waste and by any other elements (Wikipedia, 2013).

#### **2.4.1.3 Electrical Conductivity (EC)**

It is the measurement of concentration of mineral constituents present in water. In water body higher electrical conductivity means higher pollution. The proposed standard of fishing water has an electrical conductivity in the range of mg/l in the rivers (BBS, 1998).

#### **2.4.1.4 Odor:**

The volatile compounds produce odor (Khopkar, 1995). The odor can be relatively described as-

- Medicinal (phenolic)
- Fishy(due to algae)
- Earthy (decaying matter), and
- Chemical(chlorine)

#### **2.4.1.5 Turbidity**

The turbidity of water is caused by insoluble and colloidal compounds of inorganic origin (clay minerals, silica 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 (Wikipedia, 2013).

### **2.4.2 Chemical characteristics**

Chemical characteristics is very important in assessing the equality of water, the total solid and the  $p^H$  value etc following elements are calculated for measuring the water quality (Hopker, 1995).

#### **2.4.2.1 Hydrogen Ion Concentration ( $p^H$ )**

A  $p^H$  scale indicates alkalinity or acidity level in the water. In other word it indicates the strength of acids and alkalis. All acids have a  $p^H$  level less than 7. Lower  $p^H$  in water is harmful for the aquatic life. A bivalve mollusk cannot survive if the  $p^H$  of the water decreases below 6 but a wood frog can survive in water with a  $p^H$  as low as 4 (Wikipedia, 2013).

#### **2.4.2.2 Dissolved Oxygen (DO)**

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 presence of oxygen in water is a positive sign of a healthy body of water but the absence of oxygen is a signal of severe pollution.



The surface water receives oxygen (O<sub>2</sub>) mainly by absorption from the atmosphere at the surface of the lake and by photosynthesis of the chlorophyll bearing organisms inhabiting the pond. Moreover, the volume of O<sub>2</sub> dissolved in water is dependent upon its temperature, the partial pressure of O<sub>2</sub> in the air in contact with the water at the surface, and concentration of dissolved salts. Under the given set of conditions there is a nonlinear inverse relation between water temperature and dissolved oxygen. The solubility of oxygen in water rises above 40% as freshwater cools from 25<sup>0</sup> C to freezing point (Mukti, 2009).

#### **2.4.2.3 Biochemical Oxygen Demand (BOD)**

The waste from various sources falling into the river has biochemical oxygen demand, which also decreases the dissolved oxygen. The incensement of biochemical oxygen demand decreases the dissolved oxygen. BOD is an index of the biodegradable organics present (Clesceriet *al.*, 1998). The rate of oxygen used by organism in the aquatic systems while stabilizing decomposable organic matter is commonly referred to as BOD. It is important to understand that BOD is not a measure of some specific pollutant but it is very important phenomenon for limnological studies (Vesilindet *al.*, 1990).

#### **2.4.2.4 Chemical Oxygen Demand (COD)**

Chemical Oxygen Demand is defined as the amount of specified oxidant that reacts with the sample under controlled conditions (Clesceriet *al.* 1998). COD is one of the most important parameter for assessing the quantity of chemically oxidizing matter in water. It measures the oxygen required for the oxidation of mainly organic matter by a strong chemical oxidant (Chapman, 1992).

### **2.5 Standard water quality**

There is an international standard of water quality proposed by the World Health Organization (WHO) for different water quality. There is also a Bangladesh standard adopted by Water Pollution Control Board, which is a modified form of WHO standard.

In the year 1976, the Environmental Control Pollution Board set up preliminary and national committee for formulating water quality standard in Bangladesh with a view to the conservation and enhancement of the overall environment. The committee had rendered concerned effort

towards framing the national water quality standard. Accordingly standards for the following broad class water have been adopted.

- Drinking water
- Fishing water
- Irrigation water
- Industrial effluent
- These standards have been set keeping in view of the specific physical, chemical and bacteriological characteristic of water for each separate type of uses. In addition to this, the figures for the maximum allowable concentration of toxic substances have been provided. (Mukti, 2009).The standard (maximum allowable limits) of different types of water quality has been shown in the following (table-1):

Table 1: Different types of water quality parameter

Best Practice based classification	Parameter			
	pH	BOD mg/l	DO mg/l	Total Coliform number/100
a. Source of drinking water for supply only after disinfecting:	6.5-8.5	2 or less	6 or above	50 or less
b. Water usable for recreational activity :	6.5 – 8.5	3 or less	5 or more	200 or less
c. Source of drinking water for supply after conventional treatment :	6.5 – 8.5	6 or less	6 or more	5000 or less
e. Water usable by fisheries:	6.5 – 8.5	6 or less	5 or more	-----
a. Water usable by various process and cooling industries :	6.5 – 8.5	10 or less	5 or more	5000 or less
g. Water usable for irrigation:	6.5 – 8.5	10 or less	5 or more	1000 or less

Source: DOE-2005

## 2.6 Bangshi River water quality

Bangshi River water quality is shown in the following table (table-2).

Table 2: Different types of parameter of Bangshi River water

Parameter	Avg. Readings	Period	Remarks
Temp( <sup>0</sup> c)	24.82	January-2013	<b>Note:</b> All units in mg/L. Excepting Temperature, EC, Turbidity, Settleable Solids, and Coli colonies, BOD at 20 <sup>0</sup> c and 5 days.
p <sup>H</sup>	8.5	February-2013	
EC(Micro S/cm)	860	April-2013	
TDS	444.4	June-2013	
DO	1.5	February-2014	
BOD	7.6		
COD	87		
T.Alkalinity	134.3		
Chloride	18.94		
TS	1028		
SS	633		

Source: DOE, 2013-14

### 2.6.1 Hydrogen Ion Concentration (p<sup>H</sup>)

p<sup>H</sup> indicates alkalinity or acidity level in the water. In Bangladesh the normal range of p<sup>H</sup> for fisheries, agriculture and recreational activity is 6.5-8.5 mg/L. The average p<sup>H</sup> in Bangshi River is 8.5mg/L which is the highest range of it. It means the water of Bangshi River is highly acidic not suitable for fisheries, agriculture and recreational activities. It is the poor condition of the water (DOE, 2013-14).

### 2.6.2 Dissolved Oxygen (DO)

The value of DO in Bangshi River is 1.5mg/L whereas the standard value of DO for fisheries, agriculture and recreational purpose is 5mg/L or more. It means that the water condition of the river is extremely poor which is not suitable for fisheries, agriculture and recreational purpose (DOE, 2013-14).

### **2.6.3 Biochemical Oxygen Demand (BOD)**

Biochemical Oxygen Demand or BOD is a measure of the quantity of oxygen consumed by microorganisms during the decomposition of organic matter. The average BOD of Bangshi River is 7.6mg/L which indicates the poor condition of the water. The standard value of BOD for fisheries activities is 6 mg/L or less and recreational purpose is 3mg/L or less. So the water is not suitable for fisheries and recreational purposes (DOE, 2013-14).

### **2.6.4 Alkalinity**

The average alkalinity of Bangshi River is 134.3 mg/L whereas the standard value of alkalinity is 250-450mg/L. It means that the alkalinity value is below of the standard value which is not satisfactory for natural ecosystem and not suitable for fisheries, agriculture, and recreational activities (DOE, 2013-14).

## **CHAPTER THREE: LITERATURE RIVIEW**

### **3.1 Introduction**

The main focus of this chapter is to review water pollution, sources and causes of water pollution, and impact of water pollution on human health, aquatic animals, environment, and ecosystem of the river area relevant to the study.

### **3.2 Concept of water pollution and quality of water**

Before going in detail discussion on water pollution, it is needed to have conception on pollution and water pollution. Pollution is the state of anything which is not normal state. The state which is being changed, it is a deformed state of anything. When one thing cannot bear the quality of usage, the state of the thing can be treated as pollution. Pollution is defined as an impairment of the beneficial use(s) of a water body. Finding chemical constituents in elevated concentrations in the water column or sediments is not pollution unless these constituents are impairing the beneficial uses of the water body.

Water pollution is the state of water when water cannot be used anymore for any purpose. When water is being polluted, we treat the environment is polluted as the water is one of the major elements of environment of the nature. The water pollution is a major environmental problem. According to Hennigan- "Water pollution is one of the major environmental problems of our times. As with most other forms of environmental pollution, it has come about because of the industrial-urban growth and development over the past 60 to 70 years, particularly the past 20 years. Water pollution results when any input into the water cycle alters water quality to the extent that a legitimate use is impaired or lost. Water pollution abatement-or rather water quality management has social, economic, political, and technical aspects. Consequently, it must be approached as a complex social and technical system requiring an interdisciplinary input if problems are to be accurately defined and effective remedial action taken"(Hennigan, 1969).

Water pollution can be defined in several ways. Water pollution occurs when energy and other materials are released, degrading the quality of the water for the users. Water pollution includes all of the waste materials in the water that cannot be naturally broken down by water. In other words, anything that is added to the water, above and beyond its capacity to break it down, is pollution. Pollution, in certain circumstances, can be caused by nature itself, such as when water

flows through soils with high acidities. But more often that is not, human actions are responsible for the pollutants that enter the water (CBC, 2004).

World Health Organization (WHO, 2006) has defined water pollution as “inclusion of any foreign material either from natural or other sources into a water body, thereby changing the natural qualities of water and making it unusable for its intended purpose. Water pollution is any contamination of water with chemicals or other foreign substances that are detrimental to human, plant, or animal health. These pollutants include fertilizers and pesticides from agricultural runoff; sewage and food processing waste; lead, mercury, and other heavy metals; chemical wastes from industrial discharges; and chemical contamination from hazardous waste sites”.

The water pollution is mainly the deterioration of water quality. When water loses its quality leads to no longer use gets the state of pollution. The river water is the surface water. This surface water is being polluted by various ways of natural and manmade. According to Stark- “The quality of any body of surface or ground water is a function of either or both natural influences and human activities. Without human influences, water quality would be determined by the weathering of bedrock minerals, by the atmospheric processes of evapotranspiration and the deposition of dust and salt by wind, by the natural leaching of organic matter and nutrients from soil, any hydrological factors that lead to runoff, and by biological processes within the aquatic environment that can alter the physical and chemical composition of water. As a result, water in the natural environment contains many dissolved substances and non-dissolved particulate matter. Dissolved salts and minerals are necessary components of good quality water as they help maintain the health and vitality of the organisms that rely on this ecosystem service” (Stark *et al.* 2000).

Water quality should be assessed based on the characteristics of the water relative to the beneficial uses of the water. Water quality is not, as frequently used, a list of chemical constituent concentrations. In order to reliably assess whether the concentration of a constituent impairs the water quality – beneficial uses of a water body, it is necessary to evaluate onsite-specific basis whether the constituents present in toxic/available forms at a critical concentration for a sufficient duration to be significantly adverse to aquatic life that is important to the beneficial uses of the water body (G. Fred Lee, 1999).

Water quality is changed and affected by both natural processes and human activities. Generally natural water quality varies from place to place, depending on seasonal changes, climatic changes and with the types of soils, rocks and surfaces through which it moves. A variety of human activities e.g. agricultural activities, urban and industrial development, mining and recreation, potentially significantly alter the quality of natural waters, and changes the water use potential. The key to sustainable water resources is, therefore to ensure that the quality of water resources are suitable for their intended uses, while at the same allowing them to be used and developed to a certain extent (Terra Daily, 2006).

The waste foreign particles mixed with the water deteriorating the physical and chemical quality of water affects ecosystem. The quality of water required to maintain ecosystem health is largely function of natural background conditions. But some aquatic ecosystems are able to resist large changes in water quality without any detectable effects on ecosystem composition and function, whereas other ecosystems are sensitive to small changes in the physical and chemical makeup of a body of water and this can lead to degradation of ecosystem services and loss of biological diversity. The degradation of physical and chemical water quality due to human influences is often gradual, and subtle adaptations of aquatic ecosystems to these changes may not always be readily detected until a dramatic shift in ecosystem condition occurs. For example, in many shallow European lakes, the gradual enrichment of the surface water with plant nutrients has resulted in shifts from systems that once were dominated by rooted aquatic plants to systems that are now dominate by algae suspended in the water column (Scheffer *et al.*, 2001)

### **3.3 Causes of water pollution and degradation of water quality**

There are various causes of water pollution of river like discharge of industrial waste, household waste, chemical fertilizer and pesticides, land fill leakage, and others. Today's world is growing rapidly with industrialization and urbanization. Most of the cities of the world are situated on the bank of the river. The citizen of the cities are producing thousands tons of wastes every day. Lack of proper management and awareness the people are throwing and releasing that waste particle to the open water and making the water polluted.

According to Kinney and Schoch - "Most of the activities of human being produce some kind of environmental obstacle and disturbance that contaminate surrounding waters. Residual of eating

(body wastes), pesticides and sediment runoff through gardening and many other activities create byproducts of them that can find their way into the water cycle” (Mc Kinney and Schoch 2003).

### **3.3.1 Discharge of Industrial Wastes**

Water pollution can be caused in many ways. Wastes from industry are the main sources in terms of water pollution of industrial area. When this wastes discharge into water body, the water mixing with the wastes gets pollution. “Water pollution may be caused by different municipal waste and industrial effluent. Now a day’s water pollution has proven to be a very serious and very visible form of environmental contamination as water bodies are used indiscriminately as dumps” (Francis, 1994).

In other way, it can be described as these industrial wastes mainly contribute the toxic pollutants to the water. “Wastes from industry serve as major sources for all water pollutants. Many major industries contribute significantly to water pollution, but some of the important industries are the (i) manufacturing (ii) power-generating (iii) mining and construction, and (iv) food processing industries. Manufacturing industries like chemical, oil refining, steel etc. contribute many of the most highly toxic pollutants, including a variety of organic chemicals and heavy metals” (Mc Kinney and Schoch 2003). “Other industries have less potential impact but are still considered highly problematic when it comes to pollution. These industries include the textile, leather tanning, paint, plastics, pharmaceutical, and paper and pulp industries. In many cases both the products, such as the painter the pesticide and the byproducts from the manufacturing process are highly toxic to many organisms, including humans”. (Raja and Venkatesan, 2010)

From various industries the water can be polluted due to increase of heat. This type of pollution caused from different contributors of heat by some industries. We can have some idea about this pollution here. According to Kinney and Schoch -“Power generating industries are the major contributors of heat and radioactivity. Nearly all power plants, whatever the fuel, are major sources of thermal (heat) pollution. Radioactivity from nuclear power plants can pollute waters in a variety of ways, including discharge of mildly radioactive waste water and ground water pollution by buried radioactive waste” (Mc Kinney and Schoch 2003). In other way like heat there is another problem of radioactivity in water as pollution. According to Rao - “Radioactivity may be found in ground waters as well as surface waters. In ground waters it may be due to



radioactive material present in underground rocks, while in surface waters it may have been passed on with effluents from uranium mining and enrichment plants (Rao, 2001).

Industrial pollution can be defined in other way “Industrial pollution comes in a variety of forms. There are many federal regulations regarding types and amounts of pollutants that can be emitted from industries, though in some countries, companies who are over their limit can buy “pollution credit” from companies who are under the targeted amount. Heat pollution is commonly caused by industries, but many regions have passed legislation requiring that power plants and industries cool water before they release it. Construction, mining and logging operations can cause great amounts of sediment to pollute lakes and streams. While agricultural practices are responsible for the most sediment pollution, construction and mining” (CBC, 2004).

Heat pollution is caused by some of the industries which removing the DO important element from the water. ChandanChakraborty has carried out a study about it. “Untreated wastes of industries, solid wastes of urban and commercial area, wastes of sewerage in municipality, feces of animals, pesticides, fertilizers, radioactive wastes, erosion of lands river banks etc, are the main sources of water pollution. Even the hot water come out of die engine also pollute water. Because hot water help to removed the DO as gaseous oxygen. Oil from ships, industries also pollutes water of Buriganga (ChandanChakraborty *et al.* 2013).

The industrial, urban and municipal waste released by the management of municipality and inhabitants of the cities into the water indiscriminately. All industrial, municipal (700-1100 tones daily) and urban wastes of Dhaka city (population1989 about 6.5 million and expected to grow in year 2000 to 11.1 million) are flushed into the Buriganga River. It is estimated that total organic waste load discharged into the river will be around 250 metric tons per day (Reazuddin, 1994).

A study has been carried on the Buriganga River by A. S. M. Saifullah and two others. They have mentioned that the degradation of water quality of Buriganga has aggravated at an alarming rate as a result of increasing industrialization, urbanization and development activities. Buriganga River receives millions of litter of sewage, domestic waste, industrial and agricultural effluents. The Buriganga River is choked with industrial effluent and untreated sewage through numerous outfalls. Thousands of industrial units and sewerage lines are dumping huge volumes of toxic wastes into Buriganga River increasingly polluting the water (Islam *et al.*, 2006).

ChandanChakraborty and two others have studied on Buriganga River about its pollution causes and its impact. They have identified causes of water pollution broadly in two divisions, namely:

(a) Natural causes: The biodegraded portions of plants and animals mix with water and pollute it. Erosion of river banks caused siltation and this silt sometimes hamper aquatic lives. Many kinds of natural salts and other sub-stances mix with rain water and finally fall in the rivers and ponds.

b) Man-made causes: The major portion of water pollution of Buriganga river occurred by man-made causes. Industrious wastes, agricultural wastes, domestic wastes, excess use of fertilizer, pesticides etc. are notable man-made pollutants. Water is seriously polluted by these pollutants. Water, polluted by such types of pollutants, is very harmful for both human and aquatic lives (ChandanChakraborty *et al.* 2013).

There are two main sources of water pollution; point sources and non-point sources. Point sources include factories, wastewater treatment facilities, septic systems, and other sources that are clearly discharging pollutants into water sources. Non-point sources are more difficult to identify, because they cannot be traced back to a particular location. Non-point sources include runoff including sediment, fertilizer, chemicals and animal wastes from farms, fields, construction sites and mines. Landfills can also be a non-point source of pollution, if substances leach from the landfill into water supplies (USEPA, 2006).

The main industrial areas of Bangladesh are at Dhaka, Chittagong, Khulna, and Bogra districts. The mostly contributing industries for water pollution are pulp and paper, pharmaceuticals, metal processing, food industry, fertilizer, pesticides, dyeing and painting, textile, tannery etc. more than 200 rivers of Bangladesh directly receive a large quantity of untreated industrial wastes and effluent. Everyday approximately 700 tanneries of Dhaka city are discharging about 16000 cubic meters of toxic wastes. The Department of Environment (DOE) has listed 1176 factories that cause pollution throughout the country (Rahman, 2003).

These above changes in water quality by industrial effluents, agricultural pollution and human waste are creating the environment unfavorable for aquatic lives. The pollution decreases the water quality of Buriganga that may cause harm to the aquatic lives as well as agricultural and domestic uses(Saifullah *et al.* 2012).

### 3.3.2 Agricultural Wastes, Pesticide and Fertilizers

In agriculture most of the country it has been using various fertilizer and pesticides for production. These fertilizer and pesticides are mixing with the water through agricultural runoff and making the water polluted. Agricultural wastes and irrigation impacts on surface water quality. United Nations' predictions of global population increase to the year 2025 require an expansion of food production of about 40-45%. Irrigation agriculture, which currently comprises 17% of all agricultural land yet produces 36% of the world's food, will be an essential component of any strategy to increase the global food supply. Currently 75% of irrigated land is located in developing countries; by the year 2000 it is estimated that 90% will be in developing countries. In addition to problems of water logging, desertification, salinization, erosion, etc that affect irrigated areas, the problem of downstream degradation of water quality by salts, agrochemicals and toxic leachates is a serious environmental problem (Letey, 1993).

It is of relatively recent recognition that salinization of water resources is a major and widespread phenomenon of possibly even greater concern to the sustainability of irrigation than is that of the salinization of soils, per se. Indeed, only in the past few years has it become apparent that trace toxic constituents, such as Se, Mo and As in agricultural drainage waters may cause pollution problems that threaten the continuation of irrigation ( Letey *et al.*, cited in Rhoades, 1993).

A study has been carried on Water Pollution in India by Maria in 2003. An Economic Appraisal Agricultural run-off s affect groundwater and surface water sources as they contain pesticide and fertilizer residues. Fertilizers have an indirect adverse impact on water resources. Indeed, by increasing the nutritional content of water courses, fertilizers allow organisms to proliferate. These organisms may be disease vectors or algae. The proliferation of algae may slow the flow in water courses, thus increasing the proliferation of organisms and sedimentation. WHO has defined a permissible limit of concentration of nitrates of 45 mg/L of NO<sub>3</sub>, which is also accepted by the Indian Council of Medical Research (ICMR). In the agricultural sector, fertilizer use increased from 7.7 MT in 1984 to 13.4 MT in 1996 and pesticide use increased from 24 MT in 1971 to 85 MT in 1995 (Bhalla et al. 1999). It has been observed that in states, such as Haryana, the NO<sub>3</sub> concentration has exceeded the permissible limits (Maria, 2003).

Pesticides are frequently applied in agricultural, forestry and urban settings. There are tens of thousands of pesticides in use many of which are synthetically produced. Pesticides will break down in the environment forming by-products, some of which are toxic whereas others are relatively non-toxic (Baldock *et al.* 2000; Schulz, 2004). Acute (immediate) toxic effects can influence the survival or reproduction of aquatic species leading to the disruption of predator – prey relationships and a loss of biodiversity. If aquatic organisms are not harmed immediately, they may concentrate chemicals from their environment into their tissues. This bio-concentration can lead to biomagnifications, a process in which the concentrations of pesticides and other chemicals are increasingly magnified in tissues and other organs as they are transferred up the food chain. The chronic effects of these substances on aquatic organisms include health repercussions such as cancers, tumors, lesions, reproductive inhibition or failure, suppressed immune systems, disruption of the endocrine (hormone) system, cellular and DNA damage, and deformities (Ongley, 1996). Terrestrial predators that feed on aquatic species may also be affected (Baldock *et al.* 2000).

Very fine sediment is often chemically active. Phosphorus ash metals tend to be highly attracted to the ionic exchange sites associated with iron and manganese coatings that occur on small particles. Many toxic organic contaminants, such as pesticides or their breakdown products, are strongly associated with silt, clay and organic carbon transported by rivers, thus, sediments act as an agent in the process of eutrophication and toxicity in aquatic organisms (Ongley 1996; Boatman *et al.* 1999; Owens *et al.* 2005)

The greatest agricultural contributions to water pollution are through nutrient and sediment pollution. Livestock waste and fertilizers contain nitrogen and phosphorus, which, if carried to lakes and streams through runoff, can cause significant problems resulting in excess algae growth (CBC, 2004).

Sediment transport through river environments may also be reduced and/ or seasonal fluxes may be dampened by the construction of impoundments, such that water discharged downstream of dams and levees may be impoverished of sediment relative to natural states. For example-changes in suspended solids concentrations along the Rhine River, a system that is heavily managed by a series of impoundments along its length. Since sediments often carry a variety of

minerals, nutrients, and organic matter, this can lead to the degradation of an ecosystem by, in essence, starving it of the elements needed to sustain production (Owens et al., 2005)

These are generated by the cultivation of crops and animals. Globally, agriculture is the leading source of sediment pollution which includes plowing and other activities that remove plant cover and disturb the soil. Agriculture is also a major contributor of organic chemicals, especially pesticides (Kinney and Schoch2003). Pesticides are widely used in modern agriculture in most countries throughout the world and in a large range of environments. But environmental monitoring increasingly indicates that trace amounts of pesticides are present in surface and underground water bodies, far from the sites of pesticide application (Voltzet *al.*2007). The use of nitrogen fertilizers can be problem in areas where agriculture is becoming increasingly intensified. These fertilizers increase the concentration of nitrates in ground-water, leading to high nitrate levels in underground drinking water sources, which can cause methaemoglobinaemia, the life threatening “blue baby” syndrome, in very young children, which is a significant problem in parts of rural Eastern Europe. Some pesticides are applied directly on soil to kill pests in the soil or on the ground. This practice can create seepage of pesticides to groundwater or runoff to surface waters (Yassiet *al.* 2001).

High levels of sedimentation in rivers lead to physical disruption of the hydraulic characteristics of the channel. This can have serious impacts on navigation through reduction in depth of the channel, and can lead to increased flooding because of reductions in capacity of the river channel to efficiently route water through the drainage basin. For example, calculations by the (UFRGS, 1991) of erosion and sediment transport in the Sao Francisco River Basin, a large drainage system in eastern Brazil, demonstrate that the central portion of the river basin is now dominated by sediment deposition. This has resulted in serious disruption of river transportation, and clogs hydraulic facilities that have been built to provide irrigation water from the main river channel. The sediment largely originates from rapidly eroding sub-basins due to poor agricultural practices.

The huge increases in fertilizer use worldwide over the past several decades are well documented. However, fertilizer use (either mineral or organic) is not, of itself, the primary factor in downstream water quality. More important are the land management practices that are

used in crop production. There is a danger, however, in assuming that all waters have natural levels that are low in nutrients. In some areas, such as lakes located in areas of rich agricultural soils, waters have historically been highly enriched by nutrients associated with natural erosion of fertile soils. In the prairie lakes of Canada, for example, early settlers reported that the lakes were green with algae. In other parts of the world, as in Asia, ancient civilizations so profoundly impacted water quality that there are no longer "natural" levels of nutrients. In such situations the existence of eutrophication, while undeniable, must be measured against arbitrary standards that reflect water quality criteria established on the basis of societal needs for beneficial use of the water (Ongley, 1996).

### **3.3.3 Domestic wastes by household**

In modern time urbanization and municipal life produced a lot of domestic wastes by households degrade our water in various ways. These are those that are produced by households. Most domestic waste is from sewage or septic tank leakage that ends up in natural waters. In the past, some cities dumped untreated or barely treated sewage directly into rivers, lakes, or coastal waters. Plant nutrients occur in the form of nitrogen and phosphorus. These come not only from human waste, but also from fertilizers used extensively in house-hold lawns and gardens (Mc Kinney and Schoch2003). Today, many people dump their garbage into streams, lakes, rivers, and seas, thus making water bodies the final resting place of cans, bottles, plastics, and other household products (Groundwater Quality 2003). Most of today's cleaning products are synthetic detergents and come from the petrochemical industry. Most detergents and washing powders contain phosphates, which are used to soften the water among other things. These and other chemicals contained in washing powders affect the health of all forms of life in the water. (Ramandeep Singh Gambhire *et al.* 2012)

The categories of water pollution that domestic waste fits into are biodegradable waste, hazardous and toxic chemical pollutants and PPCPs. Generally, waste water treatment facilities are equipped to effectively remove harmful substances generated from biodegradable waste. The hazardous and toxic chemicals that individuals release into the environment are more dangerous (and more preventable). Chemicals, such as cleaners, dyes, paints, pesticides and solvents, which are poured down drains, are a substantial and dangerous form of pollution. Wastewater treatment

facilities are generally unequipped to remove PPCPs from wastewater; water pollution from PPCPs is a growing concern (EC, 2004).

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### **3.3.4 Thermal pollution by urbanization, agriculture and industry**

Urbanization, forestry, agriculture, impoundments and industrial effluents can cause changes in surface water temperatures. Probably the most pronounced changes in temperature regimes in aquatic ecosystems can be documented downstream of coal and nuclear electrical power generating plants, where heated water is discharged into receiving environments on a continual basis. The heated water can increase local water temperatures by tens of degrees, and in temperature systems may prevent the formation of ice on a system during the winter months. Heated effluents from power generating plants often are combined with increased discharges of water to small systems that can scour native habitats and alter the physical structure of the receiving environment (Hill, 1996).

Temperature is very important for living organisms as it affects some of the basic physical and chemical processes necessary for life. For example, temperature affects the movement of molecules, fluid dynamics, and saturation concentrations of dissolved gasses in water, and the metabolic rate of organisms. Aquatic ecosystems experience daily and annual fluctuations in temperatures. This thermal regimen is crucial for aquatic fauna, as many life history traits, such as reproduction and growth, are regulated by temperature. Therefore, unseasonable change in temperatures can eliminate species that are adapted to the natural cycle of water temperatures found in free-flowing systems. Increases in temperature will also affect the levels of dissolved oxygen in the water column, which is inversely proportional to temperature, reducing the survivorship of oxygen sensitive, species (Rajaram, 2001).

Microbial consumption of oxygen, measured as BOD, tends to increase with water temperature. Higher water temperatures affect plant life by increasing growth rates, resulting in a shorter lifespan and species overabundance (i.e., algal blooms). Increases in algae and macrophyte abundance further reduce oxygen saturation in the water column. The loss of oxygen –sensitive but highly valued trophy species like trout and the aesthetic degradation caused by ‘weedy’ receiving waters can impact the use of the system as a recreational resource (Taylor and Helwig, 1995).

Aquatic ecosystems that have received thermal effluent are able to recover from disturbance once the thermal effluent is removed. However, the degree of impact and the length of time the system were impacted. That is, systems that received thermal effluents with extreme temperature differences for decades can be expected to take longer to recover to natural conditions than systems that received thermal effluents for shorter periods with smaller temperature differences do (Lakly and McArthur, 2000).

### **3.3.5 Eutrophication by agriculture, urbanization and forestry:**

Eutrophication is another consequence caused by agriculture, urbanization and forestry causing water pollution. Cause of nutrient loading, or eutrophication, of aquatic ecosystems can be attributed to agriculture, urbanization, forestry, can also increase the abundance of cyanobacteria (blue-green algae), which produce toxins. The relationship between total phosphorus and chlorophyll a (an indicator of algal biomass) concentrations has been well documented (Vollenweider and Kerekes, 1982). Eutrophication can lead to changes in the composition of aquatic fauna, particularly the disappearance of species with high oxygen requirements; thus, biodiversity of aquatic communities is often compromised in nutrient- enriched environments (Boatman *et al.* 1999).

The consequences of eutrophication for humans are bad taste and odor events in public water supplies, production of cyanobacterial toxins that can threaten animal and human health, infilling or clogging of irrigation canals with aquatic weeds, loss of recreation use due to slime, weed infestations and noxious odors, and economic losses due to the disappearance of species targeted in commercial and sport fisheries (Ongley, 1996). In addition, nitrate in drinking water has been linked to human health problems such as methaemoglobinaemia (blue-baby syndrome), stomach



cancer and negative reproductive outcomes. High nitrate concentrations have also been linked to lower productivity in livestock (Boatman *et al.*, 1999).

### **3.3.6 Acidification by industrial effluents**

Acid mine drainage, industrial effluent and atmospheric emissions of sulphur and nitrogen oxides are largely responsible for the acidification of surface waters. Most surface waters have a pH between 6 and 8.5, and values below six can be hazardous to aquatic life. Fish, Shellfish and aquatic insects have different tolerances to acidic waters and species diversity will decrease along with increased acidification. Young organisms tend to be more sensitive to acidic waters: for example, at a pH of 5, most fish eggs cannot hatch, while only some adult fish will be affected. Tropic level effects may cause indirect survivorship challenges in instances where prey species are eliminated. Acidic waters also mobilize metals that can be toxic to aquatic species (e.g., aluminium). Metal toxicity can cause reduced survivorship in fish through chronic stress, which impairs health and decreases the affected individuals' ability to secure food, shelter, or reproductive partners (Mohan and Kumar, 1998).

Industrial effluent has the potential to alter the chemistry of receiving waters and make them more susceptible to acidification. In the case of the Periyar River, India, alkalinity downstream of a rare earth metals processing plant declined significantly in the early 1980s; this decline was accompanied by an increase in the overall variability of pH. Water quality at that monitoring station also tended to have much higher hardness, conductivity, chloride, sulphate and nitrate concentrations than a baseline, upstream monitoring station.

The largest concern about microbial pollution is the risk of illness or premature death to humans and livestock after exposure to contaminated water. Communities downstream of intensively farmed areas or municipal sewage outfalls, people working or recreating in infected waters, such as Industrial effluent has the potential to alter the chemistry of receiving waters and make them more susceptible to acidification. In the case of the Periyar River, India, alkalinity downstream of a rare earth metals processing plant decline was accompanied by an increase in the overall variability of pH. Water quality at that monitoring station also tended to have much higher hardness, conductivity, chloride, sulphate and nitrate concentrations than a baseline, upstream monitoring station (Wikipedia, 2013).

### **3.4 Social impact of water pollution:**

Severe environmental pollution especially water pollution is threatening human health and economic growth mostly all over the world. Human being consciously and unconsciously is doing a lot of harmful effects to water. A major environmental impact has been the widespread mortality of fish and marine invertebrates due to the contamination of aquatic systems by pesticides. This has resulted from the agricultural contamination of waterways through fallout, drainage, or runoff erosion, and from the discharge of industrial effluents containing pesticides into waterways. Historically, most of the fish in Europe's Rhine River were killed by the discharge of pesticides, and at one time fish populations in the Great Lakes became very low due to pesticide contamination. Fish and other aquatic biota may be harmed by pesticide-contaminated water. Pesticide surface runoff into rivers and streams can be highly lethal to aquatic life, sometimes killing all the fish in a particular stream (Toughill, 1999).

Polluted water consists of Industrial discharged effluents, sewage water, rain water pollution (Ashraf *et al.*, 2010) and polluted by agriculture or households cause damage to human health or the environment (EPA, 2009). This water pollution affects the health and quality of soils and vegetation (Carter, 1985). Some water pollution effects are recognized immediately, whereas others don't show up for months or years (Ashraf *et al.*, 2010). Estimation indicates that more than fifty countries of the world with an area of twenty million hectares area are treated with polluted or partially treated polluted water (Hussain *et al.* 2001) and this poor quality water causes health hazard and death of human being, aquatic life and also disturbs the production of different crops (Ashraf *et al.*, 2010; Scipeeps, 2009). In fact, the effects of water pollution are said to be the leading cause of death for humans across the globe, moreover, water pollution affects our oceans, lakes, rivers, and drinking water, making it a widespread and global concern (Scipeeps, 2009).

Some of the pollutants like lead (Pb), arsenic (As), mercury (Hg), chromium (Cr) specially hexavalent chromium, nickel (Ni), barium (Ba), cadmium (Cd), cobalt (Co), selenium (Se), vanadium (V), oils and grease, pesticides, etc are very harmful, toxic and poisonous even in ppb (parts per billion) range. There are some minerals which are useful for human and animal health in small doses beyond which these are toxic. Zinc (Zn), copper (Cu), iron (Fe), etc fall into this

category. For agriculture, some elements like zinc, copper, manganese (Mn), sulphur (S), iron, boron (B), together with phosphates, nitrates, urea, potassium, etc are useful in prescribed quantities.

There are some compounds like cyanides, thiocyanides, phenolic compounds, fluorides, radioactive substances, etc which are harmful for humans as well as animals. In India, water pollution due to industrial wastes and sewage has been assuming menacing proportions. Large lakes and large stretches of most of the rivers in India have water which is unsafe for using. Survey of industrialized zones show that even ground water has become unfit for drinking due to high concentration of toxic metals and chemicals along with bacteriological contamination (Kant, 2005).

Lake ecosystems are increasingly affected by various anthropogenic impacts, such as excess of nutrients causing eutrophication, toxic contamination of industrial, agricultural and domestic origin, as well as heat pollution reaching the lakes through their attachments area and the atmosphere. Typical results of human activities proved to be elevated levels of heavy metals present in fresh water, and among these microelements lead (Pb), cadmium(Cd), mercury (Hg), chrome (Cr) are most specific(Farkaset *al.*, 2001). They are considered to be one of the most important pollutants of the aquatic eco-systems due to their environmental persistence and tendency to be concentrated in aquatic organisms (Veenaet *al.*, 1997). In addition heavy metals show harmful effects even at very low concentration on the aquatic organisms including plankton, aquatic plants, invertebrates and vertebrates (Schuurmann and Markert, 1998).

A large amount of urea is used for cultivation. Only 40% of dissolved urea is absorbed by plants. Remaining is mixed with water. If caused quick growth of unexpected plants. For biodegrading of these plants oxygen is taken from water. As a result amount of dissolved oxygen (DO) is depleted. Industrial wastes also caused depletion of DO by occurring chemical reaction. Impacts of pH on: There is no normal pH that applies to all fishes. Because fish originates in ponds, rivers, lakes, oceans, have different pH levels. But sudden change of pH can be harmful or even fatal to fishes.

The most significant impact of pH involves "Synergistic "effect. It involves the combination of two more substances that produces effects greater than their sum. For example, 4 mg/L iron would not present a toxic effect at a pH of 4.8 but as little as 0.9 mg/L of iron at a pH of 5.5 can

cause fish to die. Arsenic, lead, mercury, cadmium, chromium, nitrates, nitrites etc. may mix with water directly may be produced from the pollutants. However exceeding limit of this trace elements or ions caused various harm for human and other living beings (Dutta, 2002).

ChandanChakraborty and some others have carried a study on Buriganga; they have mentioned that the people who are living by the Buriganga which is polluted by various germs and micro-organisms are severely suffering from various diseases like cholera, diarrhoea, dysentery etc. Silt may cover the leaves of aquatic plants and increase the turbidity of water, as a result, sunlight cannot reach to the leaves of the plants and photosynthesis reaction is hampered. So, plants cannot produce oxygen and food for them. Consequently, ecosystem is hampered (Chakraborty *et al.*, 2013).

Polluted water is complex water resource with both advantageous and also disadvantageous. Generally the use of polluted water for irrigation has an advantage of crop production so benefits to farmers and the whole community but also harmful for the people and whole ecosystem of the concerned area. The main reason for the use of this polluted water is the non availability of enough funding to treat polluted water before using for irrigation purposes. As a result it degrades the environment as well as a cause of water borne diseases in the said area. All polluted water contains plant nutrients and also organic matter other than high concentration of soluble salts and heavy metals. Farmers use polluted water to save their expenses.

Harmful effects can last for several years due to extensive irrigation of polluted water so it can not only leach down the soil but also has a negative effect on ground water quality. In Pakistan more than eighty percent of the population uses ground water for drinking purpose. The effects of water pollution are numerous. Some water pollution effects are recognized immediately, whereas others don't show up for months or years. When toxins are in the water, the toxins travel from the water the animals drink to humans when the animals' meat is eaten so the pollutants enter the food chain. Infectious diseases such as typhoid and cholera can be contracted from drinking contaminated water. This is called microbial water pollution. The human heart and kidneys can be adversely affected if polluted water is consumed regularly. Other health problems associated with polluted water are poor blood circulation, diarrhoea, skin lesions, vomiting, and damage to the nervous system. In fact, the effects of water pollution are said to be the leading cause of death for humans across the globe (Mehmood *et al.*, 2010)

Application of herbicides to bodies of water can cause fish kills when the dead plants rot and use up the water's oxygen, suffocating the fish. Some herbicides, such as copper sulfite, that are applied to water to kill plants are toxic to fish and other water animals at concentrations similar to those used to kill the plants. Repeated exposure to sub lethal doses of some pesticides can cause physiological and behavioral changes in fish that reduce populations, such as abandonment of nests and broods, decreased immunity to disease, and increased failure to avoid predators, (Helfrichet *al.*, 1996).

Industrial effluents and emissions cause different waterborne disease and damage to health. It causes melanosis, kurtosis and conjunctivitis. Subsequently respiratory problem, gangrene, skin disease, diarrhoea, kidney and lung cancer would arise the Arsenic effect not only causes serious health hazards but also creates a widespread social problem (Rahman 2003).

### **3.5 Case study-1(Buriganga turns into a toxic dump)**

Buriganga is one of the important rivers in Bangladesh, especially for Dhaka city. This river is severely polluted in the recent time. In Daily Star, 2005 it has described the pollution scenario in the following way.

Severe pollution has reduced the river Buriganga into a 'dumping drain' of toxic refuse, threatening millions of people living on its banks with serious health hazards and a loss of their livelihoods. That the river is dying is clearly evident from its stench. The highly toxic waters release a 'gas' that starts irritating the nostrils and throat as soon as humans breathe it. Its foul odors can be smelled from as far away as half a kilo-meter. "Sometimes we are unable to sit in our office due to the unbearable stench from the river water," said an official at the Sadarghat river port. As the day rolls into the afternoon the heat of the sun turns the stench even fouler, making the 'pitch black' Buriganga water intolerable, he said. Soon after the floodwater receded and the river wore its lean period look, the pollution instantly increased due to a lack of dispersion. Millions of cubic metres of toxic waste from the Hazaribagh tanneries and thousands of other industries, topped with a huge volume of untreated sewage from the city, now remain almost stagnant within the river water. The situation is set to continue until a new flow of water rushes in from the upstream, beginning in perhaps another two months. In the meantime, people

living along the river are the worst victims of the pollution, which they say is worse than anything they've seen in previous years.

Thousands of water transport workers, working on the passenger and cargo vessels in Sadarghat, are forced to bring water from the river Meghna and Dhaleswari for washing. Un-able to take a bath or wash clothes for days, many of them have even begun to suffer from various diseases. "We cannot use the water of the Buriganga for bathing, washing or cooking," said Mohammad Uzzal, an employee of a launch. "For cooking, we use the water collected from faraway places in our water tank," said Mohammad Jalil, a launch cook. Farid, a ticket collector of MV Mashiron Khan-1, said that even for washing the floor of the vessels they have to bring water from relatively less polluted rivers such as the Meghna near Chandpur. "Sometimes, when we require more water while anchored at the terminal, we are forced to buy tap water at a high price," said a launch operator. "If we wash the vessel with this water passengers complain of a bad smell," he said. At least two private companies supply 'pure water' to the launches in the Sadarghat, charging about Tk. 150 for filling a 400-liter capacity water reservoir. Upstream is almost totally cut off in the lean period," he said (Khan *et al.*, 2005).

### **3.6 Legal status of water pollution in Bangladesh**

There are some laws about the water pollution prevention and control in Bangladesh. The Laws are- The Bangladesh Environment Conservation Act-1995, The Environment Conservation Rules-1997, Environment Court Law-2000, Bangladesh Water Act-2013, and National River Protection Commission Act-2013.

There are some provisions of taking any legal action about ecologically critical area, no classification change of marked water body by filling it without the permission of DG of DOE, and without the permission (NOC) of DG of DOE no one can takes initialization of any industry or factory mentioned in "The Bangladesh Environment Conservation Act-1995". For violation of a provision or for non-compliance of a direction, or for the activities specified in Act, the penalty mentioned against them may be imposed

The Environment Conservation Rules-1997 made the Act of 1995 applicable and implementable. The detail working procedures described in detail in this rule. Any industry or factory have to submit some documents and information through the procedure of Initial Environmental

Examination (IEE), Effluent Treatment Plant (ETP), Environmental Management Plan (EMP) and Environmental Impact Assessment (EIA) have been described in this rule.

There is a court established through Environment Court Law-2000 which is treated as criminal court. The DG of DOE has filed case in the court against that is responsible for any noncompliance of any order according to the Act. The court takes legal action according to the provision of the Act.

It has been described about the prohibition of filling up any water body, to collect all water and vacate any water body, and its importance of conservation in Bangladesh Water Act-2013. It has been given ample power to the DG of Water Resources Planning Organization to remove any illegal establishment in any water body mentioned in the Act.

All preventive activities about the illegal occupant of river, water and environment pollution and any illegal activities against river have been mentioned in National River Protection Commission Act-2013. The Commission can make recommendations for taking action about the river protection activities, pollution free river, illegal encroachment, illegal grabbing, and illegal establishment in river to the government (Source: DOE).

## **CHAPTER FOUR: RESEARCH METHODOLOGY**

### **4.1 Introduction**

In this chapter there is an attempt to focus on the study area, selection of the research topic, limitations of the research, tools and techniques of data collection, sample size, and data analysis. It also highlights the analytical framework to carry out the research through objectives and data analysis.

### **4.2 The study area**

The study area has been discussed in the following way:

#### **4.2.1 Location of the area**

The Bangshi is located within 23<sup>0</sup>93' North latitude to 23<sup>0</sup>81' North latitude and 90<sup>0</sup>21' East longitude to 90<sup>0</sup> 26' East longitudes. Savar area is on the bank of eastern side and Nayarhat is on the western side of the Bangshi River (Mukti, 2009).

#### **4.2.2 Industry of the area**

In Savar area close to the Bangshi River, there are about 10 industries. Moreover there are 5 dyeing, 3 brick field in Savar. There are also 3 Garments, oil mill, 2 Pharmaceutical industries, 1 soap factory, and 1 match factory along the bank of the Bangshi River. These are hampering the natural flow of the river and polluting the water massively (Mukti, 2009).

#### **4.2.3 Trade and Commerce of the area**

Many kinds of business have been flourished beside the river. Most of the business institutes are located at Savar, Nabinagar, Kalampur and Dhamrai etc. Local people sell different items of goods, daily commodities, fruits, vegetables and fishes etc in Nayarhat every day. Near about 40-50 new garments industries were established in this area. So a great portion of bank of the Bangshi River is very much engaged with business related activities (Nahar, 2009).

#### **4.2.4 Agricultural Land Use**

Most of the land of Bangladesh is being used as agricultural land. But agricultural lands are decreasing while increasing of the land in urban use. Bangshi river system area is very fertile. So



the area was used as agricultural land massively. Now the patterns are being changed even in eastern part of Bangshi River (Mukti, 2009).

#### **4.2.5 Usage of the Water**

The river is only water route of Savar, Nabinagar, Islampur, Nayarhat and Dhamrai area to communicate with southern area of Bangladesh. The sand traders are also using the river for their business purposes. Therefore a large part of the bank is being used by the people for their business and communication purposes which also a reason of water pollution of the river. The water of Bangshi River is being used mostly by the residents of the surrounding area and owners of industry for various purposes. Construction materials and industrial raw materials are being transported by the river. At present the use of water is decreasing day by day due to pollution of the water (Source: Field Survey-2014).

#### **4.3 Selection of the Research Area:**

The Bangshi river of Savar is about 238 km (Wikipedia-2013) in length. It is not possible to study all area about the river. So, about 3-4 km area surrounding Nayarhat regarding the river pollution has covered by the study because this area is severely affected with mostly industrial waste and hazards than the other areas. The intention in selecting the study area is for some valid reasons, as recently the area getting pressure of new industrialization as it is very near to Dhaka and having easy communication to the area.

Around Dhaka most of the area is occupied by different types of industries. The area, suitable for industrial activities, is not very far from Dhaka. Once, the land of the area was not very high value in rate. The communication with the area is suitable from Dhaka than other areas. So the investors, industrialists and entrepreneurs are being attracted to invest here more. Due to recent industrialization most of the rivers of the adjacent area of high way surrounding of industrial zone are being affected a lot. The Bangshi River is the river which has been severely affected by industrial waste and hazards. So, the selection of the study area deserves strong justification for the research.

#### **4.4 Tools and techniques of data collection**

Tools and techniques of data collection have been discussed below:

##### **4.4.1 Research method**

Research method is the functional action strategy to carry out the research in the light of the analytical framework and guiding research questions and or the proposed hypotheses (Aminuzzaman, 1991). There are three broad types of methodology to carry out any research; quantitative method, qualitative method and mixed method. Both qualitative and quantitative research is carried out in this study on the basis of primary and secondary data.

###### **4.4.1.1 Primary Data**

Primary data was collected with the help of a questionnaire, focused group discussion and personal interviews with the respondents. Information is collected from both male and female of the area. It has been made interview with the key informants: local UP member, UP chairman, local elites. Information was also taken from concerned UpazilaNirbahi Officer, and other related government officials like DOE officials. It has been arranged semi-structured interview for them.

###### **4.4.1.2 Secondary Data**

Secondary data were mainly used to have information about the degree of water pollution of the river, understand the studied area history, culture, livelihood, economic condition, etc by analyzing different research works done by various scholars. The basic sources of secondary data for this study were previous studies, journals, books, reports, and different websites. To have secondary data various books, journals, periodicals, magazines, newspaper and article through websites have been considered and discussed. A detail literature review is done to know the causes of water pollution and its impact to the society of different countries of the world and Bangladesh perspective. Many published documents on water pollution have been discussed for literature review.

##### **4.4.2 Data collection by Random sampling method:**

The present study is done on the basis of data collection through survey, observation, discussion, structured and semi-structured interview with limited participation of the people. Like other survey research a standardized questionnaire was used to collect information. It has been prepared a simple and appropriate worded questionnaire and try to convey the message of the

issue intelligible to them. Sample of respondents were selected from the affected community randomly both male and female, and they were interviewed through structured questionnaire. It has been assumed that the issue of water pollution of the river has started about 20 years back. The generations those who are young in age could not see the pollution free water of the river. The aged people saw both the water. So, most of the respondent has been selected with aged group of minimum 30-40 years. The key informants were also interviewed through semi-structured questionnaire. Two sets of questionnaire developed- one set for affected community and another set for key informants.

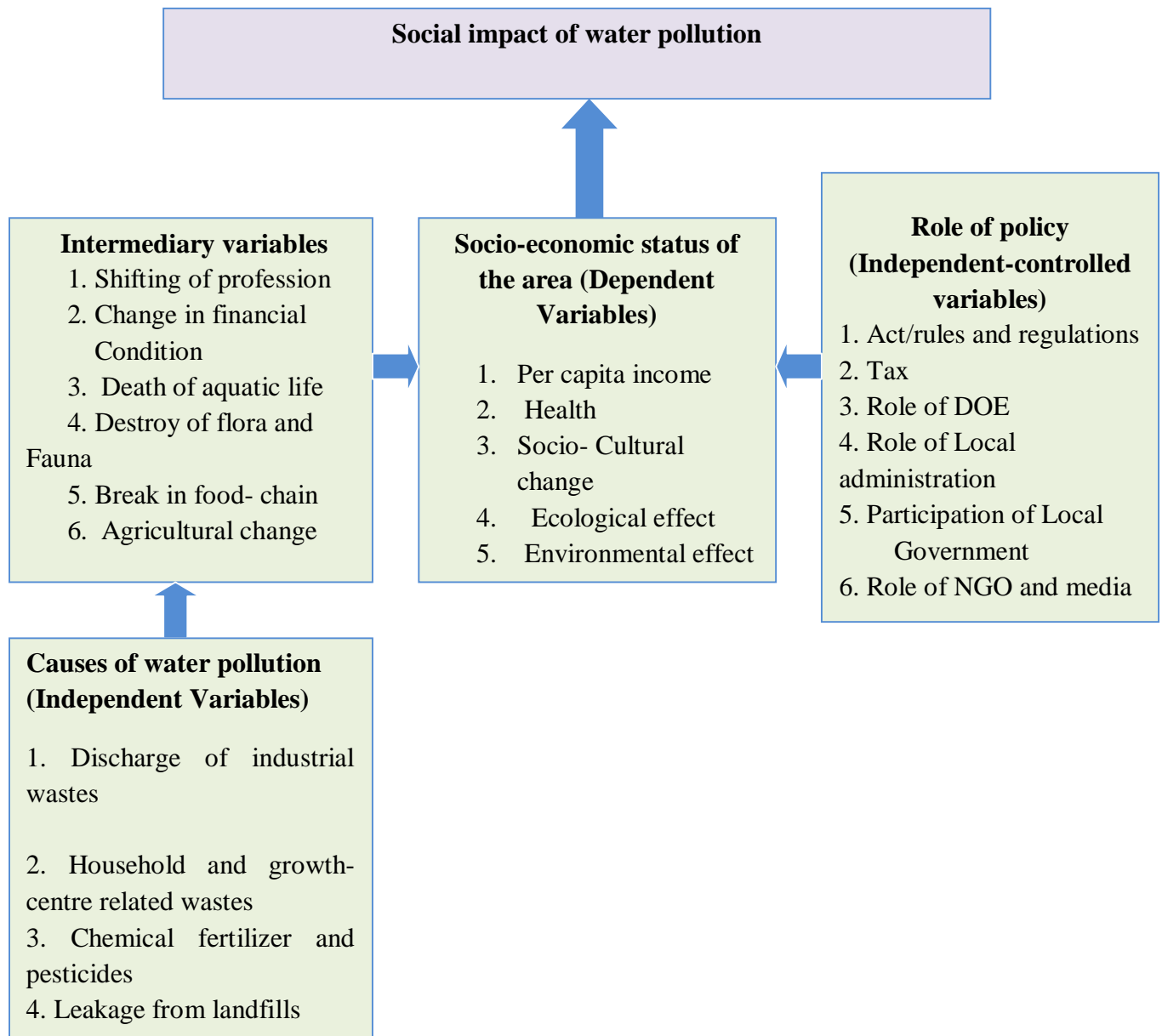
#### **4.4.3 Sample size**

The principal considerations in the selection of the sample respondents include (a) time and resource constraints of the study (duration of the field work was about 7 days, and there was a little amount of institutional fund for the empirical study), and (b) accessibility. A total number of 50 respondents both men and women were interviewed for this study, 8 key informants were interviewed from the study area which included UpazilaNirbahi Officer, Union Chairman, male and female union members, local elites, school teachers and social workers. It is mostly impossible for me to collect information from a huge number of respondents due to mentioned constraints.

#### **4.4.4 Data analysis method**

Data analysis is where the researcher continually reflects on collected data, moving deeper for understanding and representing the data, deriving an interpretation of the larger meaning of data (Creswell, 2003). The essence of this study is to convert large quantities of data into condensed forms to facilitate easy interpretation and understanding for readers. The collected data were articulated in tabular form, analyzed through SPSS software, presented by charts transcribed into texts. A relationship between data and variables was established by interpreting statements. Results are presented through narrative text, simple computations logical reasoning.

## 4.5 Analytical Framework



The present study tries to measure the social impact of water pollution to the people of the area. This social impact would be measured through some socio-economic status (Dependent Variables) such as change in per-capita income, change in health condition, agricultural change, and socio- cultural changes of the people of the area. The socio-economic status of the people is being affected with some independent variables such as industrial waste,

solid waste and sewerage, agricultural pesticides/fertilizers, atmospheric deposition leakage from landfills and role of policy such as act/rules and regulations, role of DOE, role of local administration, participation of local government, and role of NGO and media. There are some intervening variables between dependent variables and independent variables such as shifting of profession, change in financial, ecological effect, and environmental effect directly affects the socio-economic status of the people of the society. By using these variables and social impact measurement indicators the above mentioned analytical framework can be drawn to carry out this research.

#### **4.6 Limitations of the research**

For a quality research work it requires sufficient time for study, but this research has to suffer from time constraint. It was not possible to take interview of more affected people due to the unavailability of them. Due to my inexperience it was difficult for me to make the interview and compile the collected data properly. The officials, chairman, members and elites of the area were very busy during the interview. It was very difficult to make the interviewees easy before the interview as all of them were thinking unusual in it. Most of the interviewers and key informants were not interested to give interview as they thought that there might be some other reasons instead of research which may put them into difficulty later on.

## CHAPTER FIVE: RESEARCH FINDINGS AND ANALYSIS

### 5.1 Introduction

To fulfill the research objectives mentioned in chapter one, data have been collected from 50 respondents and 8 key informants of the area. In this chapter the findings of field survey have been analyzed to demonstrate the social impacts of water pollution in the area and to identify the causes of water pollution of the area on the selected indicators.

### 5.2 Profile of the Respondents

The different particulars of the respondents especially age, occupation, education and earnings have been analyzed to show the social and economic-status of the people in the society.

#### 5.2.1 Age of the Respondents

The age of the respondents are categorized into four groups (30-40, 41-50, 51-60, 61yrs +) for easily interpret the information. It is shown in the figure-1.

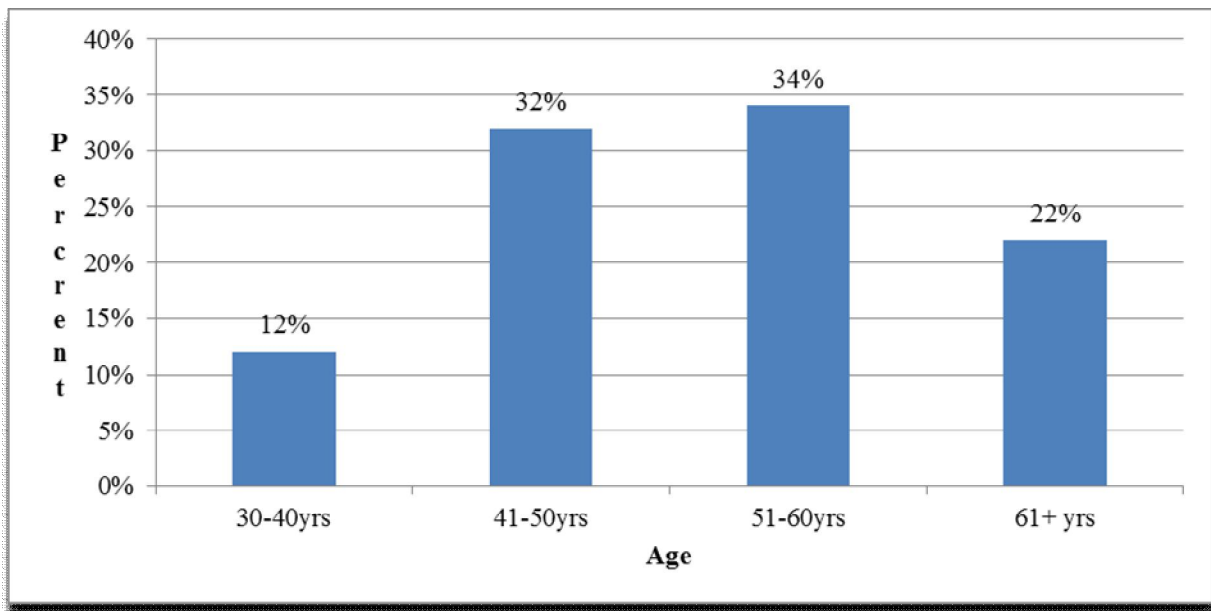


Figure 1: Age of the respondents

The field data revealed that 12% of the respondents belong to the group of 30-40 yrs, 32% belong to the group of 41-50 yrs, 34% belong to the group of 51-60 yrs, and 22% belong to the group of 61yrs+. The highest number of the respondent belongs to 51-60yrs group that is 34%.

### 5.2.2 Gender of the respondents

Both male and female respondents have been interviewed for the better result of the study. 90% of the respondents are male and 10% of the respondents are female in this study.

Table-3: Gender of the respondents

Gender	Frequency	Percent	Cumulative Percent
male	45	90.0	90.0
female	5	10.0	100.0
Total	50	100.0	

Source: Field Survey-2014

### 5.2.3 Education status of the respondents

The education status of the respondents has been categorized in four groups of no education, below S.S.C, S.S.C, and above S.S.C. It is shown in the table-4.

Table-4: Education of the respondents

Education category	Frequency	Percent	Cumulative Percent
No education	15	30.0	30.0
Below S.S.C	19	38.0	68.0
S.S.C	9	18.0	86.0
Above S.S.C	7	14.0	100.0
Total	50	100.0	

Source: Field Survey-2014

It is observed that 30% of the respondents belong to the no education group, 38% belongs to the group of below S.S.C, 18% belongs to the S.S.C group, and rest of the 14% belongs to the group of above S.S.C. The higher percentage of the respondents belongs to the group of no education

and below S.S.C which is 68%. Lowest number of respondents belongs to the group of above S.S.C (14%).

### 5.3 Socio-economic status of the respondents

Socio-economic status of the respondents has been described below:

#### 5.3.1 Occupation of the respondents

From the data in the table-5, it is seen that the higher percentage (15%) belongs to the fish monger group, 7% to farmer group, 9% to laborer group, 3% to house wife group, 2% to boat man group, and 14% belongs to other group. The businessmen, unemployed, and servicemen are included in the other group.

Table-5: Occupation of the respondents

Occupation	Frequency	Percent	Cumulative Percent
Fisherman	15	30.0	30.0
Farmer	7	14.0	44.0
Laborer	9	18.0	62.0
House wife	3	6.0	68.0
Boat man	2	4.0	72.0
Other	14	28.0	100.0
Total	50	100.0	

Source: Field Survey-2014

In table-4 and 5, it is seen in the collected data that the education level of other group occupation is S.S.C and above S.S.C. The education level of fisherman, farmer, laborer, house wife, and boat-man group is no education, below S.S.C, and S.S.C. It is noted that some of the fisherman education level is S.S.C.



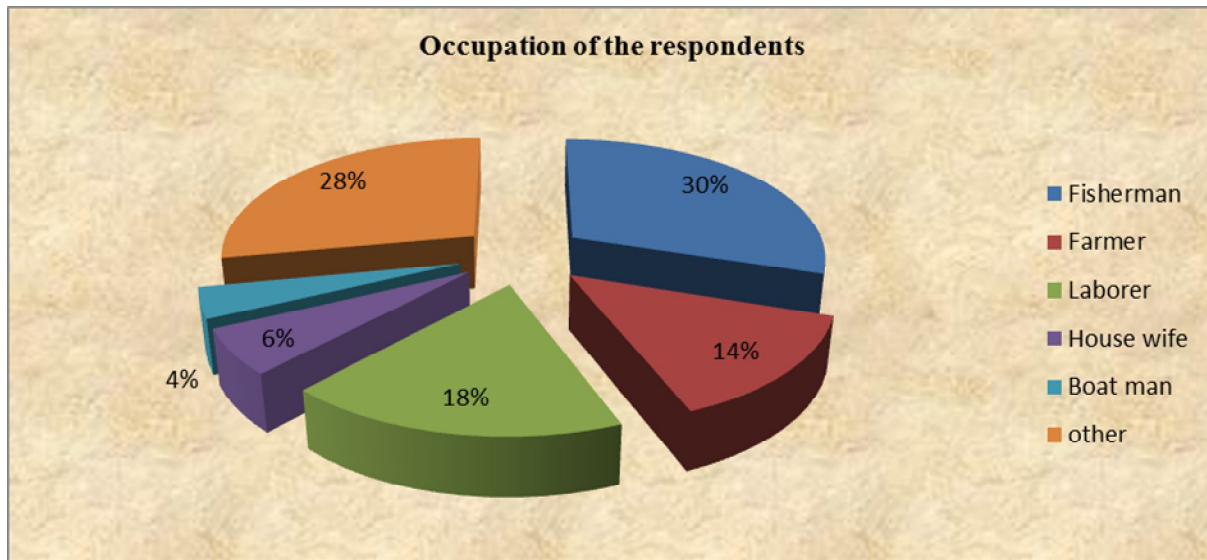


Figure-2: Occupation of the respondents

### 5.3.2 Occupation change of the respondents

The most of the respondents (52%) did not change their occupation in the last few years. On the other hand 48% respondents have changed their occupation due to various reasons, which is not negligible number. It is shown in the table-6.

Table-6: Occupation change

Criteria	Frequency	Percent	Cumulative Percent
Yes	24	48.0	48.0
No	26	52.0	100.0
Total	50	100.0	

Source: Field Survey-2014

### 5.3.3 Causes of occupation change

In table-7 it reveals the causes of occupation change of the respondents. There are so many causes of occupation change.

Table-7: Causes of occupation change

Causes	Frequency	Percent	Cumulative Percent
No fish in the river	4	8.0	8.0
Job opportunity and increases of wages	17	34.0	42.0
Other reasons	3	6.0	48.0
No change	26	52.0	100.0
Total	50	100.0	

Source: Field Survey-2014

The significant number of respondents has changed their occupation in the last few years due to various reasons. Only 8% of the respondent has answered to the causes of no fish, significant percentage of respondents (34%) answered to the cause of job opportunity and increasing of wages, and other reasons cut total 6%. Total 52% respondents answered that they did not change their job in the last few years. The reasons of occupation change are shown in the following figure of 4.

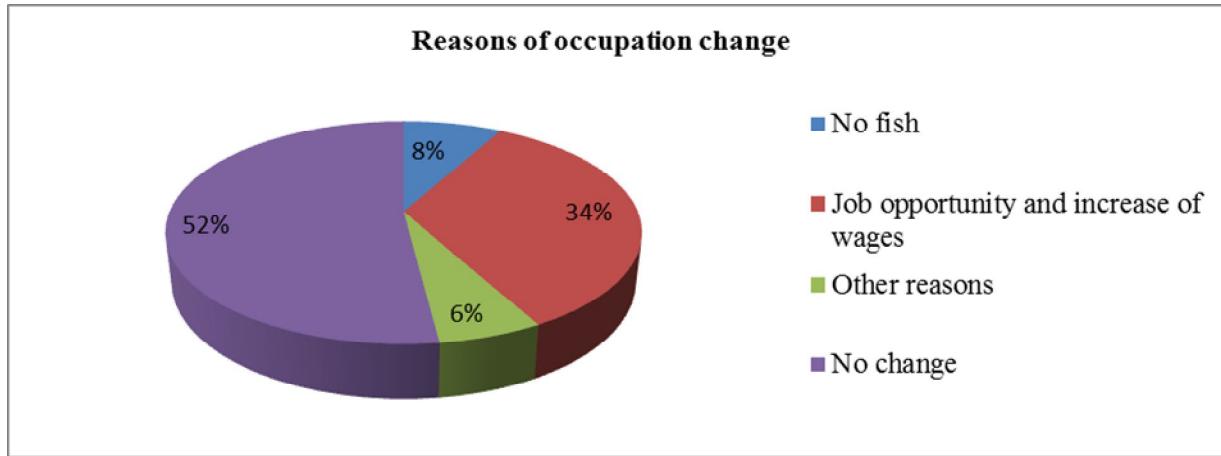


Figure- 3: Reasons of occupation change

### 5.3.4 Earning capacity of respondents

From the data in table-8, it is observed that 20% of the respondents belong to 201-250 taka group, 26% of the respondents belong to 251-300 taka group, 28% of the respondents belongs to 301-350 taka, 20% of the respondents belong to “more” taka group, and 6% belongs to no income category.

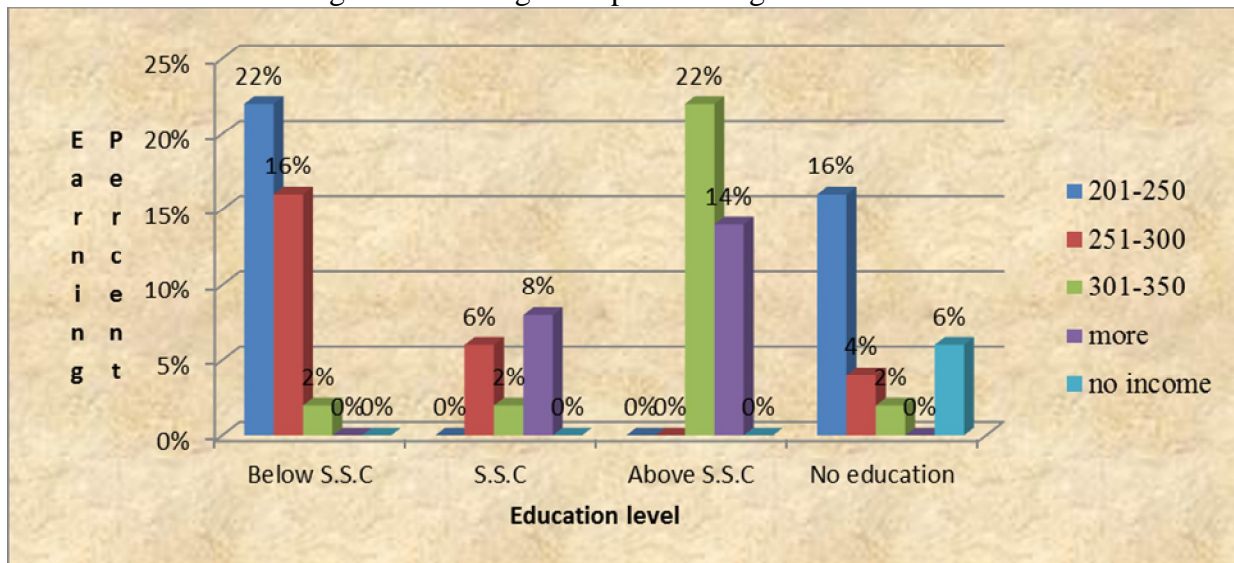
Table-8: Earning capacity of respondent

Income category	Frequency	Percent	Cumulative Percent
201-250 TK	10	20.0	20.0
251-300 TK	13	26.0	46.0
301-350 TK	14	28.0	74.0
more	10	20.0	94.0
No income	3	6.0	100.0
Total	50	100.0	

Source: Field Survey-2014

It has been revealed in the data 22% of 201-250 taka group, 15% of 251-300 taka group, and 2% of 301-350 taka group belong to below S.S.C. 16% of 201-250 taka group, 4% of 251-300 taka group, 2% of 301-350 taka group, and 6% of no income group belongs to no education group. 8% of “more” taka group, 6% of 251-300 taka group, and 2% of 301-350 taka group belong to S.S.C. 22% of 301-350 taka group, 14% of “more” taka group belong to above S.S.C education group.

Figure-4: Earning of respondents against education



### 5.3.5 Increase of wages than the past

In table-9 the data has been shown that 62% of the respondents have got their wages increased than the past and 38% of the respondents did not get their wages increased than the past. In table-4, though a little number of respondents has answered about the reasons of no fish in the river, it has some significance. If we compare the table-4 and 7 we get that those fish monger still in this occupation they did not get more wages than the past. Once the amount they earned was better.

Table-9: Increase of wages than the past

Criteria	Frequency	Percent	Cumulative Percent
yes	31	62.0	62.0
no	19	38.0	100.0
Total	50	100.0	

### 5.4 River and its pollution related information

Different types of information have been described below:

#### 5.4.1 Usage of Bangshi River water

In table-10 it reveals the number of users of the Bangshi river water. Here, most of the people do not use the water at all and that is the highest number.

Table-10: Usage of Bangshi River water

Types of usage	Frequency	Percent	Cumulative Percent
Agriculture	5	10.0	10.0
Household	6	12.0	22.0
For Bathing	3	6.0	28.0
For Recreational functions	2	4.0	32.0
Not used	34	68.0	100.0
Total	50	100.0	

Few people are using this water in agricultural sector, household sector, for bath and for recreational purpose. The number of the users also is shown in the graph figure-5.

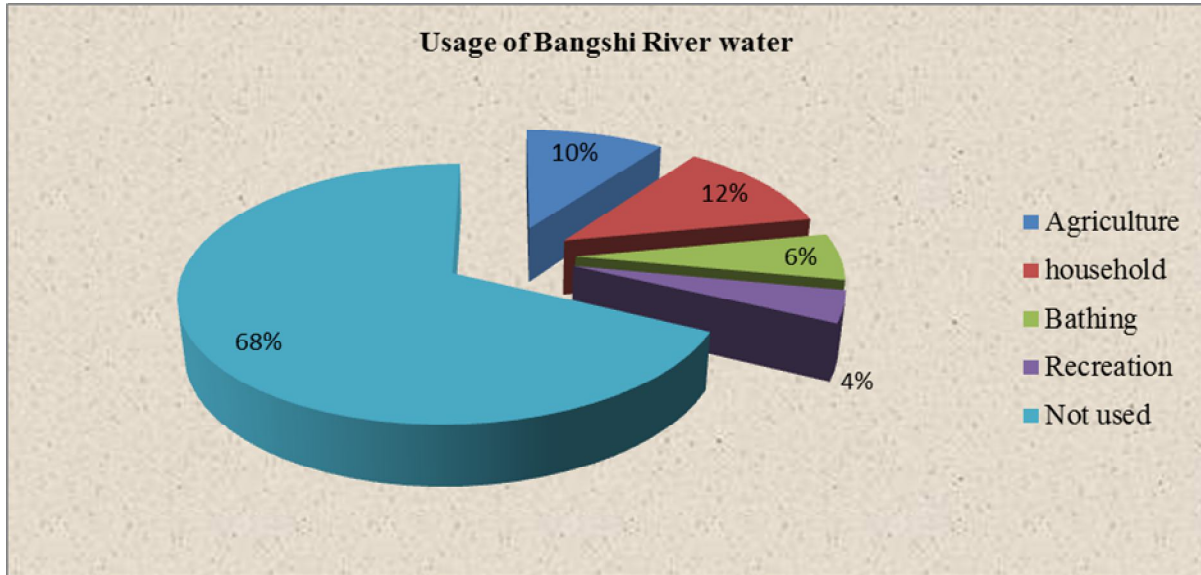


Figure-5: Usage of Bangshi river water

In figure-6, it has been observed that only 4% fishmonger, 6% farmer, 2% laborer, and 4% boatmen are using the river water for various purposes. The highest percentage of boatman is using the water of the river.

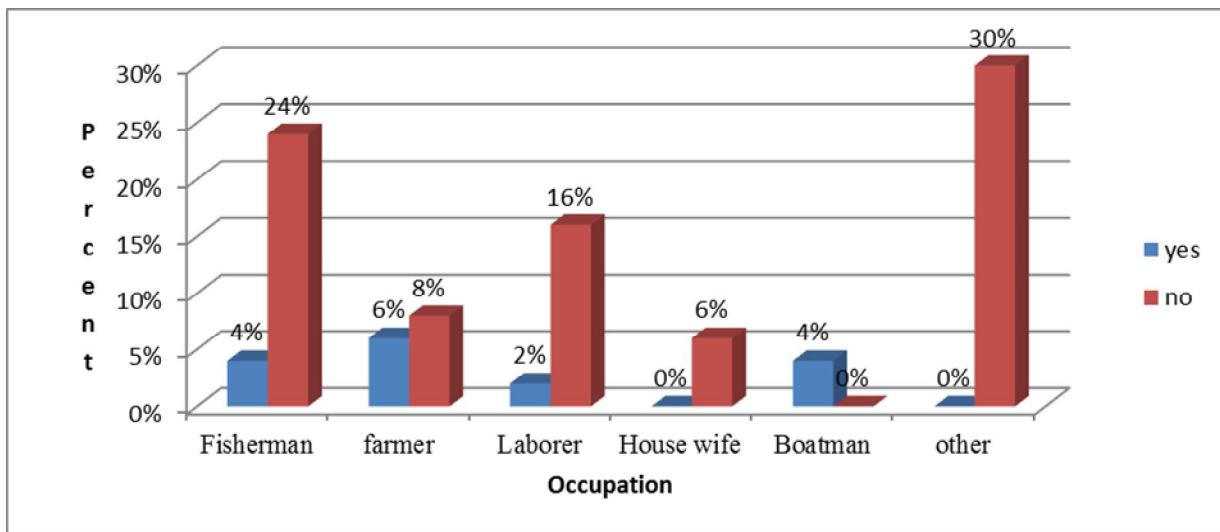


Figure-6: Using of water against occupation

### 5.4.2 Causes of water pollution

In table-11, shows the probable causes of the water pollution of the Bangshi River. Most of the respondents think about 92% for discharge of industrial waste, growth-centre related waste, chemical pesticide, and land fill leakages are the major causes for this water pollution.

Table- 11: Major causes of water pollution in the river

Causes	Frequency	Percent	Cumulative Percent
Discharge of industrial wastes	46	92.0	92.0
Household and growth centre related wastes,	1	2.0	94.0
Chemical fertilizer and pesticide	1	2.0	96.0
Land fill leakages,	1	2.0	98.0
Others	1	2.0	100.0
Total	50	100.0	

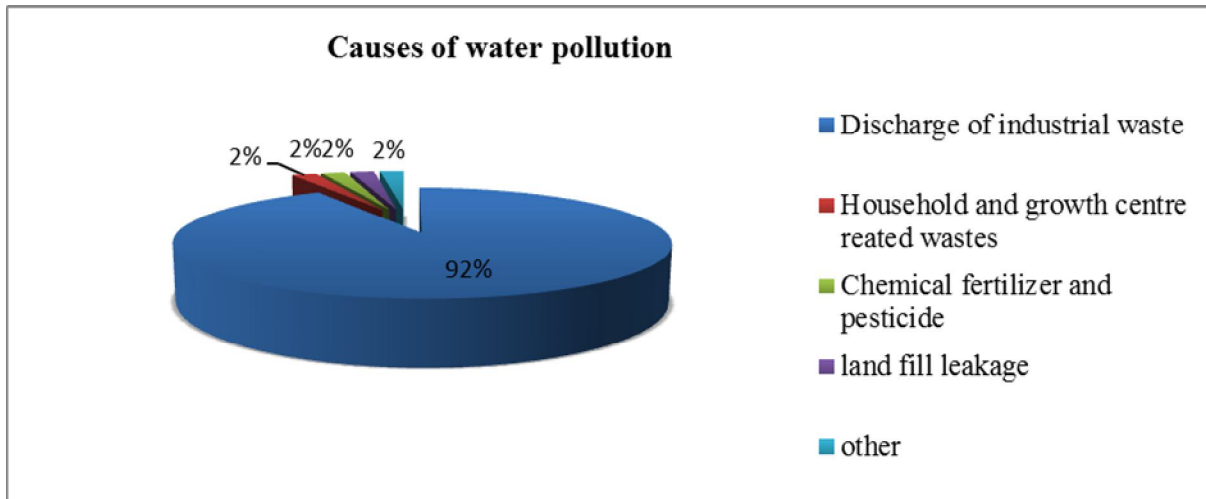


Figure-7: Major causes of water pollution

### 5.4.3 Time of the industries established in the area

From data in table-12, it is observed that about 92% respondents think that most of the industries have been established in this area more than 20 years ago. Only 2% think 15-20 years ago and 6% of the respondents think the industries established in the area about 20 years ago.

Table-12: Time of the industries established in the area

Period	Frequency	Percent	Cumulative Percent
15-20 yrs	1	2.0	2.0
20 years	3	6.0	6.0
more than 20 yrs	46	92.0	100.0
Total	50	100.0	

#### 5.4.4 Existence of pollution with the establishment of the industries

It is observed that about 100% of the respondents believe that the water pollution in this river occurred due to all these industries of the area. They believe that there was no pollution in this river and area before establishing of these industries.

Table-13: Existence of pollution with the establishment of the industries.

Criteria	Frequency	Percent	Cumulative Percent
No	50	100.0	100.0
yes	0	0.0	0.0

Source: Field Survey-2014

#### 5.4.5 Reasons of not using the water

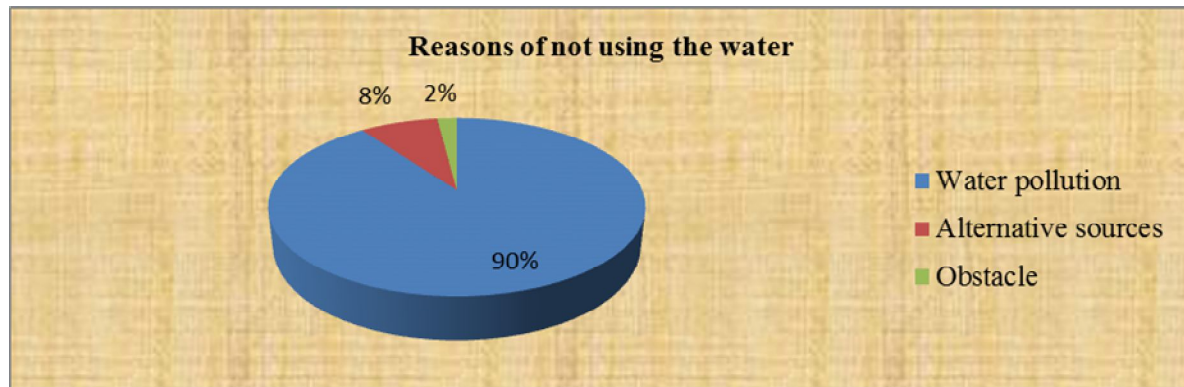


Figure-8: Reasons of not using the water

Most of the people are not using the water for various reasons. Most of the respondents told that the main reason is water pollution (90%). There are some other causes shown in the figure-8.

#### 5.4.6 Using this water 20 years back

In data it has been revealed in the study, 100% people told that they used this water before the water pollution showing in the following table-14. Now most of them (68%) are not using this water for pollution shown in the table-10.

Table-14: Using this water 20 years ago

Criteria	Frequency	Percent	Cumulative Percent
yes	50	100.0	100.0
No	0	0.0	

Source: Field Survey-2014

#### 5.4.7 Odor of the water

About 100% of the respondents answered that the odor of the water is unpleasant showing in the following table-15. No respondents replied the odor is pleasant which is shown in the table-15.

Table-15: Odor of the water

Parameters	Frequency	Percent	Cumulative Percent
Unpleasant	50	100.0	100.0
Pleasant	0	0.0	

Source: Field Surve-2014

#### 5.4.8 Odor of the water 20 years ago

Table-16: The odor of the water 20 years ago

Parameters	Frequency	Percent	Cumulative Percent
Pleasant	50	100.0	100.0
Unpleasant	0	0.0	

Source: Field Survey-2014



From data it is observed that about 100% of the people answered the odor of the water was pleasant. Now it is unpleasant due to pollution answered by 100% respondents showing in the table-16.

#### 5.4.9 Fishing in the river

In table-17 it has been revealed catching tendency of fish in this river is nil. About 100% people do not catch fish in the river now due to pollution.

Table-17: Fishing in the river

Criteria	Frequency	Percent	Cumulative Percent
No	50	100.0	100.0
yes	0	0.0	

Source: Field Survey-2014

#### 5.4.10 Reasons of not fishing in the river

From data it is observed that no fish in the river is the main cause (86%) of not catching fish in the river. Change of occupation is another cause of not (10%) catching fish in the river showing in the following table-18.

Table-18: Reasons of not fishing in the river

Parameters	Frequency	Percent	Cumulative Percent
No fish in the river	43	86.0	86.0
Change occupation	5	10.0	96.0
Other	2	4.0	100.0
Total	50	100.0	

From table-5 and 6, it is found that 8% of the fish monger has changed their occupation. Here it is observed that 10% of the respondents are not catching fish for changing of occupation which is important. It is shown in the figure-9.

### 5.4.11 Causes of non-existence of fishes in the river

Most of the respondents (96%) have told that the water pollution is the main cause of no fish in the river and another cause is shallow water (4%). It is shown in the figure-9.

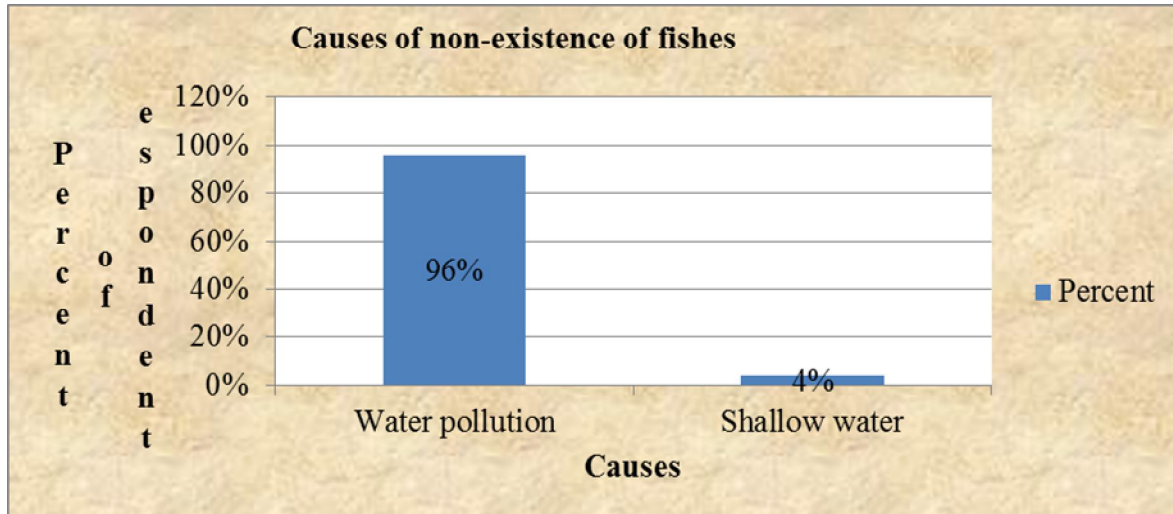


Figure-9: Causes of non-existence of fish

### 5.4.12 Existence of fish in the river 20 years ago

About 100% respondents have answered that existence of fish was available in the river 20 years back showing in the following table-19. From the table-18 it is observed that no fish is available in the river now.

Table-19: Existence of fish in the river 20 years back

Criteria	Frequency	Percent	Cumulative Percent
yes	50	100.0	100.0
No	0	0.0	

Source: Field Survey-2014

**5.4.13 Existence of flora and fauna in the river**

From figure-10, it was found that only 12% of the respondents have answered for existence of flora and fauna in the river and 88% of the respondents pointed out of no existence of flora and fauna in the river.

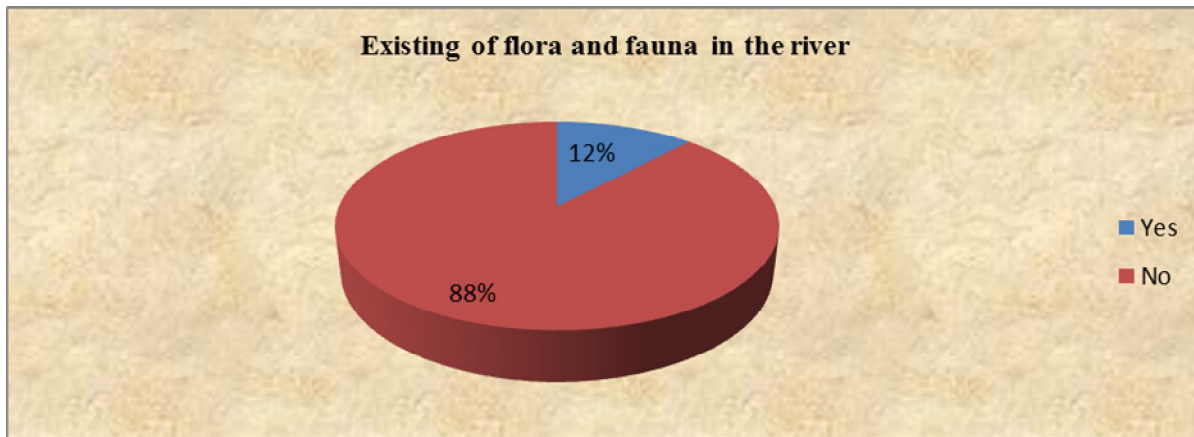


Figure-10: Percentage of flora and fauna in the river

**5.4.14 Existence of flora and fauna in the river 20 year back**

About 100% of the respondents have pointed out about the existence of flora and fauna in the river 20 years back. If we compare table-19 and 20, we find that most of the flora and fauna have disappeared due to the pollution of water in the river

Table 20: Existence of flora and fauna in the river 20 year ago

Criteria	Frequency	Percent	Cumulative Percent
yes	50	100.0	100.0
No	0	0.0	

Source: Field Survey-2014

**5.4.15 Present color-state of the water**

From table-21, it is observed that the color of the water is blackish green which is pointed out by 64% of the respondents. Another 30% respondents guess that the color of the water is black and

rest of the 6% respondents think that the color of the water is dark black. Blackish green, black and dark black are not the normal color of the water. It may be clear and light green in color. The change of the water has been occurred here due to pollution.

Table-21: The color-state of the water

Parameters	Frequency	Percent	Cumulative Percent
Black	15	30	30.0
Dark black	3	6.0	54.0
Blackish green	32	64.0	64.0
Total	50	100.0	100.0

Source: Field Survey-2014

#### 5.4.16 the color-state of the water 20 years back

From table-22, it is observed that the color state of the water was clean which is pointed out by about 100% respondents. On the basis of color it can be guessed that the water was not polluted at that time.

Table-22: The color-state of the water 20 years back

Parameters	Frequency	Percent	Cumulative Percent
clean	50	100.0	100.0
Other color	0	0.0	

Source: Field Survey-2014

#### 5.4.17 Impact of water pollution on Human Health

Table-23 shows the disease pattern of the area. Most of the people (54%) are affected by skin disease, 6% are affected by diarrhoea, 8% are affected by dysentery, 30 of people are suffering from respiratory diseases and 4% are suffering from asthma which is shown in the figure-11.

Table-23: Number of people suffering from diseases

Types of diseases	Frequency	Percent	Cumulative Percent
Skin disease	26	54.0	52.0
Diarrhoea	3	6.0	58.0
Dysentery	4	8.0	66.0
Respiratory disease	15	30.0	96.0
Asthma	2	4.0	100.0
Total	50	100.0	

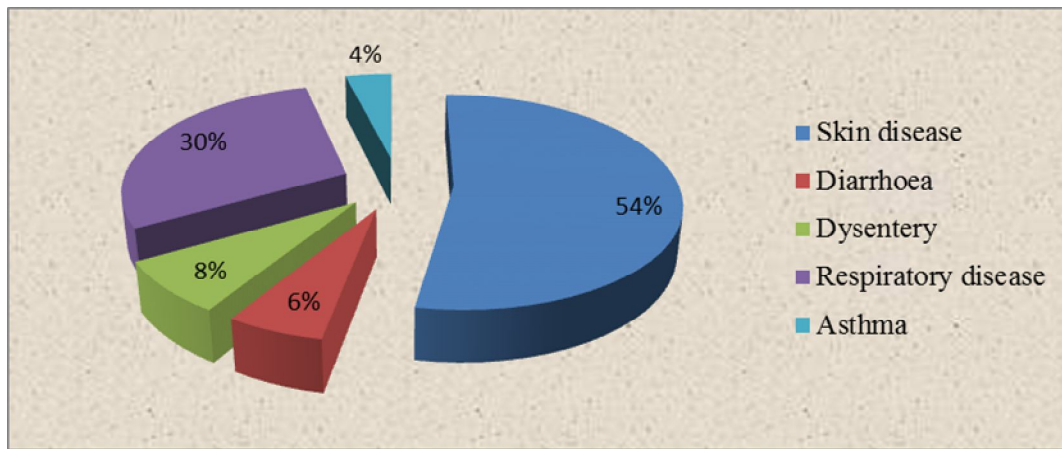


Figure: 11: Number of people suffering from diseases

#### 5.4.18 Intensity of diseases 20 years back

From data in table-24, the intensity of diseases in the area was not high 20 years ago which is observed by 62% respondents and intensity was high answered by 38% respondents.

Table-24: Intensity of the disease 20 years ago

Criteria	Frequency	Percent	Cumulative Percent
Low intensity	31	62.0	62.0
Intensity high	19	38.0	100.0
Total	50	100.0	

Source: Field Survey-2014

#### 5.4.19 Impact of polluted water on soil

In table-25, this exhibits the polluted water pollutes soil by using the water in agriculture purpose answered by 10% respondents which is 100% of farmer respondents. If someone does not use this water can not affect soil answered by 90% respondents.

Table-25: Pollution of soil by using this water in agriculture purpose

Criteria	Frequency	Percent	Cumulative Percent
yes	5	10.0	10.0
No effect of no use	45	90.0	100.0
Total	50	100.0	

Source: Field Survey-2014

#### 5.4.20 Impact of polluted water on soil 20 years ago

In table-26, there was no impact of pollution on soil 20 years ago answered by 100% respondents. Before 20 years the effects was not occurred due to use of the water on agriculture.

Table-26: water pollution affects on soil 20 yrs ago

Criteria	Frequency	Percent	Cumulative Percent
No	50	100.0	100.0
Yes	0	0.0	

Source: Field Survey-2014

#### 5.4.21 Impact on Human Health 20 years ago

From table-27, there was no impact on human health 20 years ago pointed out by 100% respondents. The human health is severely affected using this water as all respondents uttered in favor of it.

Table-27: Existence of diseases by using this water 20 yrs ago

Criteria	Frequency	Percent	Cumulative Percent
No	50	100.0	100.0
Yes	0	0.0	

Source: Field Survey-2014

#### 5.4.22 Action taken by the government

From table-28, most of the respondents (98%) answered that no action taken by the government against this water pollution and these industries. Only 2% respondents answered that action taken by the government.

Table-28: Action taken by the government against this water pollution

Criteria	Frequency	Percent	Cumulative Percent
yes	1	2.0	2.0
No	49	98.0	100.0
Total	50	100.0	

Source: Field Survey-2014

#### 5.4.23 NGO and media raise voice

From table-29, most of the respondents (96%) answered that no voice raised by the NGO or media against this water pollution and these industries and 4% respondents thinks voice raised by the NGO or the media.

Table-29: NGO and media raise voice against this water pollution

Criteria	Frequency	Percent	Cumulative Percent
yes	2	4.0	4.0
No	48	96.0	100.0
Total	50	100.0	

Source: Field Survey-2014

### 5.5 Legal action taken against this water pollution in Bangshi River noticed by the key informants

No. of key informant	Type of key informants	Different types of observation by the key informants
KI-01	Assistant Director, DOE	He knows about the water pollution of Bangshi River. He finds out industrial waste as the main cause of this water pollution. There are some other causes of this water pollution. They are working according to existing rules and regulation of the government on this issue. The activities of the department would be strengthened in future against this water pollution in this area.
KI-02	UpazilaNirbahi Officer	He is also known to this issue. He also says industrial waste is the main cause of this water pollution in this area. It is rarely done the activities against this water pollution from the government. The action of the government about this issue should be strengthened and developed.
KI-03	Union chairman	As the UP chairman of the concern union he has the information about the water pollution of Bangshi River. He also finds the industrial waste as the main cause of this water pollution. They do not know about the legal action against this water



		pollution. Some NGOs are raising voice against this issue. The action is taken by the government should be improved.
KI-04	Male UP Member	As the UP member he is well known about the water pollution of Bangshi River. He also says that the industrial waste is the main cause of this water pollution. He does not have the information about the legal action against this water pollution. The necessary action is taken by the government should be strengthened with in time.
KI-05	Female UP Member	He has also the proper information about the water pollution of Bangshi River. As like the other informants she puts her eyes to the industrial waste as the main cause of this water pollution. She is rarely known about the legal action against this water pollution. Local leaders are not aware about it. The action taken by the government should be strengthened properly.
KI-06	Local elite and social worker	He is also well known to the water pollution of Bangshi River. He informs that out of many reasons the industrial waste is the main cause of this water pollution. They do not know about the legal action

		operation taken against this water pollution by the government. He also says the local leaders are not aware about it.
KI-07	Teacher	The water pollution of Bangshi River is awfully known to him. He also finds out industrial waste as the main cause of this water pollution in this area. There are some other causes. The Government does not take any action against the water pollution in this area, he added. Local leaders are not aware about it. The action is taken by the government should be strengthened.
KI-08	Local elite	They also know about the water pollution of Bangshi River. He things that the industrial waste is the main cause of this water pollution. There are some other causes of this water pollution in this area. They do not know about the legal action taken by the government against this water pollution. Local leaders are indifferent about this issue.

## **5.6 Assessment of data:**

From the above findings of the collected data from field survey, it can be mentioned that the water pollution of the river has been occurred by different causes including discharge of industrial wastes, growth-centre related wastes, chemical pesticides; land fill leakages and home keep wastes which has some impact on the human health, economic and financial status, socio-culture, aquatic life, food-chain, environment, and ecosystem of the area. In case of shifting of profession in table- 5 and 6, it is seen that 4 respondents of fish mongers (8%) out of 15 fishermen have changed their occupation. In farmer group, 10% respondents have changed their occupation. In laborer group, significant number of percentage (16%) has changed their occupation, and other group 14% changed their occupation to other occupation. In house wife group has no change in occupation. In boat-man group and house wife group have not changed their occupation.

It reveals that in this occupation there is no increase of wages and benefits. In laborer group the highest number of respondents have answered that they have changed their occupation due to job opportunity and increase of wages. Here 34% of the respondents have changed their occupation due to increase of job opportunity and increase of wages. It means that the area has some scope of employment opportunity. Only 8% of the respondents answered that they have changed their occupation due to no fish in the river. Though it is a minimum number but it is important because the number of respondents changed their occupation mostly from fishmonger group (8%) out of 15 fishermen.

Another important thing is that the fish monger who did not change their occupation but most of them did not get increase of wages. In table-9 and 18, we get that 38% of respondents did not get change their wages than the past. Major portion of them are fish monger, because once they caught fish from the river and sold them in the market. Today they are doing the same profession but the business pattern has been changed due to no fish in the river. They are buying the fishes and selling in the market which is not profitable. Once it was profitable because it was not needed to buy fishes from the market.

It has been observed in the study that most of the respondents from S.S.C and above S.S.C group are earning about 301-350 taka and more a day. On the other hand below S.S.C and no education

group are earning to some extent little than the S.S.C and above S.S.C. It shows that those who are educated and aware they are earning more than the others. But most of the occupants like fish monger, farmers, house wife, boatman and laborer are not educated enough. So it is very difficult for them those who are directly related to the river for their earning, irrigation and household purposes to increase their earning more. These groups are directly or indirectly hampered in per capita income by the water pollution because of no fish in the river.

From figure-6, it is seen that 68% of the people do not use the river water and only 32% of them are using the river water with so many risk. Most of the people are not using the water. But in table-14, we get that once all these people (100%) used this water. According to the data in figure-9, it is observed that the people do not use the water because of pollution. Most of the respondents (90%) answered in this way. So it is found that most of the people do not use the water due to pollution. So the people do not use this water for agriculture, household, bathing and recreational purposes as before what they did. In this way the socio-cultural changes is taking place in this area due to water pollution.

Once the odor of the water was pleasant but today it is unpleasant. But the normal river water odor is not unpleasant. This is shown in table-15 and 16. In data of table-12 and 13, it is found that most of the industries those who are responsible for this pollution were established in this area about more than 20 years ago. The odor of the water was pleasant before 20 years. The industries are responsible for deteriorating the water odor of the river.

In table-11, most of the respondents think about 92% for discharge of industrial waste, Bazar related waste, chemical pesticide, and land fill leakages are the major causes for this water pollution. From this data it is found that discharge of industrial waste into the water of the river is the major cause of the water pollution.

From the data in the table-17 and 18, it is observed that no people catch fish in the river now. About 100% respondents answered like this. Most of the respondents (86%) pointed out that getting of no fish in the river is the main cause of not catching fish in the river.

From field survey data in figure-10, we get that water pollution is the main cause of no fish existence in the river now. It is found that 20 years ago the fishes were available in the river. From data in figure-11, it is found that most of the flora and fauna is existed in the river answered by 88% of the respondents. But in table-20, it is observed that flora and fauna was

available about 20 years ago. Due to water pollution the existence of fish and other aquatic animal are not available in the river now. Disappearance of fish and most of the aquatic animals cause the adverse effect on food chain, environment and ecosystem in the area.

From the data in table-21 and 22, it is observed that the water color-state is blackish green, but the color state of the water was clean 20 years ago. The water color state was being changed due to pollution in the last 20 years.

From data in table-23 and 24, pollution of soil by using this water in agricultural purpose occurred in this area which is supported by 10% respondents. But it is very significant as 5 persons from farmer sector given interview in this study. These 5 persons (10%) out of 5 farmers are using this water for agricultural purpose getting pollution on soil. It means that 100% of people when using the water for agriculture purpose which severely affects the soil. In this way this water pollution affects the soil environment which suffers the crop production and human health.

From data in table-21 shows the disease pattern of the area. Most of the people (54%) are affected by some common diseases in the country like skin disease, 6% are affected by diarrhoea, 8% are affected by dysentery, 30 of people are suffering from respiratory diseases and 4% are suffering from asthma which is shown in the figure-12. On the other hand in table-24 shows that the intensity of diseases was not high. It reveals that in present the intensity of diseases to the human is high due to water pollution.

It is observed that action from government sector has not been taken against this water pollution and the industries liable for it because the total 98% interviewee responded this way. It means that the existing policy implementation is very weak and no monitoring as well in this regard. On the other hand about the voice raise by NGO or media is also very weak because the total 96% interviewee answered in favor of it. From these two sides it is found that the policy implementation from the government side about water pollution in this area is very weak.

## 5.7 Findings of the study

Extreme pollution in the river adjacent Dhaka and Savar is not only causing severe sufferings to thousands of people living on the banks of the river but also creating a lot of threats to the existence of the river. The major rivers surrounding Dhaka Bangshi, Buriganga, Turag, Balu and Sitalakkha remain stagnant for about eight months (September- April) in a year when tons of toxic liquid and solid wastes from different industries, Growth-centre related wastes and homes keep wastes discharging and accumulating in the river water every day. There is virtually no movements in the river water during these eight months. The only movement of the river water occurs in four months(May, June, July and August) caused by the high tide and low tide, which pushes the polluted water further upstream during high tide and downstream during low tide. The present study is conducted according to selected objectives and tried to extract the expected results which are shown as follows:

- ❖ Discharge of industrial wastes are the main cause of water pollution, however there are other causes which are accused of pollution such as Household and growth-centre related wastes, chemical pesticides, Land fill leakages and discharge of home keeps wastes.
- ❖ It is found in the study that a lot of people are suffering from different critical diseases; most of them are suffering from skin disease, respiratory disease, dysentery, diarrhoea and asthma.
- ❖ The industrialization has affected most of the aquatic animals specially fish to death which disrupted food-chains,
- ❖ It is also found in the study that most of the flora and fauna has been destroyed due to the water pollution in the river which affected the whole surrounding environment and ecosystem of the area.
- ❖ It is also observed that this water pollution affects the surrounding agricultural land and soil environment which makes agricultural lands in the villages around the river into barren land. Ultimately it has the negative impact on the food production of the area

## **CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS**

### **6.1 Introduction**

This chapter intends to present an overall conclusion and recommendations of the study. In the conclusion part the results are analyzed in line with the variables incorporated in the analytical framework and then in the second part recommendations are made herewith to draw the attention of the policy makers.

### **6.2 Conclusion**

Bangshi River water turned into toxic and poisonous under the huge industrial effluents discharging into it, most of the wastes coming from the industries and factories at Nayarhat, Savar and Kaliakoir area. The river with blackish green and black water, is constantly receiving tons of industrial wastes and other toxics and poisonous solid and liquid wastes without any measures and treatment from surrounding industries, growth-centre and settlements. The industrial wastes, chemical pesticides, land fill leakages and other human garbage mixed with the river water by the forces of rain water, drain, canals, lake and flood etc. Its water is no longer clean and transparent which is almost impossible to use.

This water pollution due to industrialization, unplanned urbanization has affected all fishes and most of the aquatic animals to death, disruption of food-chains, and critical diseases to human, destruction of ecosystems and environment, and socio- cultural habits of the people in the area. Lack of proper management of industrial wastage release and lack of proper implementation of policy are the main reasons of it. If we take care about these sections we can make the river water condition and state very good which can have the positive changes to the human and aquatic life, environment and ecosystem of the river area.

### **6.3 Recommendations**

Based on the field observations some of the recommendations are put forwarded to prevent the water pollution of the Bangshi River. Tons of untreated industrial waste, household and Bazar related wastes are frequently falling into the river which polluting the water. Proper treatment of ETP should be taken by the authority so that it doesn't pollute the river. After proper treatment of industrial effluents it may release to the river. It is recommended to continue its flow capital

dredging is needed in the river. Industries and any others factories which have built up on the bank of the river illegally should be stopped and evicted immediately. Pollution free technology should be used to all industries. People should be more aware about water pollution as well as environment. Proper policy should be formulated from the government side.

It should be properly assessed the weaknesses of the existing policies in terms of implementation. Provide policy guidelines for managing a sustainable environment for

Bangladesh. It should have action plans for immediate, short term, medium term, and long terms regarding all kind of development. The industries need to have the environmental impact assessment before starting any industry. It may be imposed more taxes for the liable industries and factories producing pollution to the environment. It is also strongly recommended that heavy penalties be imposed not only on the guilty factory owners and industrialists but also on the officials who have been recalcitrant and reluctant in performing their duties.

#### **6.4 Future Research Directions**

This study has examined the causes and impact of water pollution of Bangshi River. The findings have identified the areas where further improvements are required for having the way of preventing the water pollution of the Bangshi River. Therefore, it is recommended for in-depth research on the area can be conducted. Future research may also be carried out to explore some of the important issues like impact of water pollution on human habits and cultural changes. By analyzing the issues it can be recommended to the proper policy guidelines which can improve the human and aquatic life.



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## Appendix-1

### Questionnaire for Respondent

**(Topic: Social Impact Assessment of Water Pollution: A Case Study on Bangshi River, Savar)**

(N.B: Your valuable information would be used only for research purpose)

#### Demographic Part (PART-A)

Name	Address	Age	Sex	
			Male	Female
1.				
2. What is your education status?	<input type="checkbox"/> Below S.S.C	<input type="checkbox"/> S.S.C	<input type="checkbox"/> Above S.S.C	

#### Socio-economic part (PART-B)

3.	What is your occupation now?  <input type="checkbox"/> Fisherman <input type="checkbox"/> Farmer <input type="checkbox"/> Laborer <input type="checkbox"/> Housewife <input type="checkbox"/> Boatman  <input type="checkbox"/> Unemployed <input type="checkbox"/> other
4.	Did you change your occupation in the last 20 years? <div style="float: right; margin-top: 10px;"> <input type="checkbox"/> Yes    <input type="checkbox"/> No           </div>
5.	If yes, why you have changed your occupation?  <div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; padding: 5px; width: 25%;">No fish in the river</div> <div style="border: 1px solid black; padding: 5px; width: 25%;">Job opportunity and increase of wages</div> <div style="border: 1px solid black; padding: 5px; width: 25%;">Other reasons</div> </div>

6.	How much do you earn a day now (BDT)? <input type="checkbox"/> 201-250 <input type="checkbox"/> 251-300 <input type="checkbox"/> 301-350 <input type="checkbox"/> more <input type="checkbox"/> No income
7.	Is your wages increased than the past? <input type="checkbox"/> Yes <input type="checkbox"/> No

### River and its pollutionrelated information (PART-C)

Sl. no	Information																		
8.	Do you use Bangshi river water for any purpose as follows: <table border="1"> <thead> <tr> <th>Types of uses</th> <th>Yes</th> <th>No</th> </tr> </thead> <tbody> <tr> <td>Agriculture</td> <td></td> <td></td> </tr> <tr> <td>Household</td> <td></td> <td></td> </tr> <tr> <td>For Bathing</td> <td></td> <td></td> </tr> <tr> <td>For Recreational functions</td> <td></td> <td></td> </tr> <tr> <td>Not used</td> <td></td> <td></td> </tr> </tbody> </table>	Types of uses	Yes	No	Agriculture			Household			For Bathing			For Recreational functions			Not used		
Types of uses	Yes	No																	
Agriculture																			
Household																			
For Bathing																			
For Recreational functions																			
Not used																			
9.	If not, why? <input type="checkbox"/> Water pollution <input type="checkbox"/> Alternative source <input type="checkbox"/> Obstacles <input type="checkbox"/> Other																		
10.	What are the causes of pollution of the river water? <input type="checkbox"/> Discharge of Industrial Waste <input type="checkbox"/> Household and growth-centre related <input type="checkbox"/> Chemical fertilizer and pesticides <input type="checkbox"/> Landfills leakage <input type="checkbox"/> Other																		
11.	when was the industries establish in this area? <input type="checkbox"/> Less than15yrs <input type="checkbox"/> 15- <input type="checkbox"/> More than20yrs																		
12.	Did this pollution exist before establishing all these industries? <input type="checkbox"/> Yes <input type="checkbox"/> No																		
13.	Did you use this water 20 yrs ago ? <input type="checkbox"/> Yes <input type="checkbox"/> No																		
14.	How do you feel about the present odour of river water ? <input type="checkbox"/> Pleasant <input type="checkbox"/> Unpleasant																		
15.	How was the odor of the river water 20 yrs ago? <input type="checkbox"/> Pleasant <input type="checkbox"/> Unpleasant																		



16.	Do you catch any fish in the river now?	<input type="checkbox"/> Yes	<input type="checkbox"/> No				
17.	If not, why?	<input type="checkbox"/> No fish	<input type="checkbox"/> Occupation change	<input type="checkbox"/> Other			
18.	If no fish, why?	<input type="checkbox"/> Water pollution	<input type="checkbox"/> Shallow water	<input type="checkbox"/> Other			
19.	was there any fish in the river 20 yrs ago?	<input type="checkbox"/> Yes	<input type="checkbox"/> No				
20.	Is there any aquatic flora and fauna exist in the river now?	<input type="checkbox"/> Yes	<input type="checkbox"/> No				
21.	Was there any flora and fauna in the river 20 yrs back?	<input type="checkbox"/> Yes	<input type="checkbox"/> No				
22.	What is the color-state of the water?	<input type="checkbox"/> Black	<input type="checkbox"/> Dark black	<input type="checkbox"/> Blackish green	<input type="checkbox"/> Clean		
23.	What was the color-state of the water in the past 20 yrs back?	<input type="checkbox"/> Black	<input type="checkbox"/> Dark black	<input type="checkbox"/> Blackish green	<input type="checkbox"/> Clean		
24.	What sort of diseases you are suffering now ?	<input type="checkbox"/> Diarrhoea	<input type="checkbox"/> Cholera	<input type="checkbox"/> Dysentery	<input type="checkbox"/> Skin disease	<input type="checkbox"/> Other	<input type="checkbox"/> No disease
25.	How was the intensity of these diseases 20 years back?	<input type="checkbox"/> Intensity was not high	<input type="checkbox"/> Intensity high				
26.	Is this water affecting the soil as using it for agricultural purpose?	<input type="checkbox"/> Yes	<input type="checkbox"/> No				
27.	Was there any soil pollution due to this river 20 yrs back?	<input type="checkbox"/> Yes	<input type="checkbox"/> No				
28.	Is there any action taken by Government/local government against the activities of these industries?	<input type="checkbox"/> Yes	<input type="checkbox"/> No				
29.	Does any NGO/media raise any voice against this water pollution by the industries?	<input type="checkbox"/> Yes	<input type="checkbox"/> No				

## Appendix-2

### Questionnaire for key respondent

(Topic: Social Impact Assessment of Water Pollution: A Case Study on Bangshi River, Savar)

(N.B: Your valuable information would be used only for research purpose)

I. Name .....

II. Sex :  Male  Female

III. Profession: .....

IV. District:..... Upazila:  
.....

Union:.....

Ward:.....Village:.....

1. Do you know about the water pollution of Bangshi River?  Yes  No

2. What are the causes of the pollution?

Industrial Waste	Solid waste and sewerage	Agricultural pesticides	Leakage From land fill	Others
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3. What sort of measures have the government taken to control this pollution?

Legal action	Awareness /Motivation	Provide assistance	Other
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4. Is it good enough to control the water pollution?  Yes  No

5. How can we improve the water pollution situation of this river?

Legal action	Awareness/motivation	Provide assistance	Other
--------------	----------------------	--------------------	-------

6. Do you know any legal action taken against any industries or any persons for polluting water?

Yes

No

7. Is any NGO/or other organization working on this issue?

Yes

No

8. Please make over all comments on this issue( water pollution):