A Survey Study on Water Quality of Different Household in the Industrial Area of Mymensingh and Gazipur

By

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A thesis submitted to the Department of Pharmacy in partial fulfillment of the requirements for the degree of
Bachelor of Pharmacy

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Declaration

It is hereby declared that

1. The thesis submitted is my/our own original work while completing degree at Brac University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I/We have acknowledged all main sources of help.

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Approval

The thesis titled "Assessment of the Quality of Water From household of the Industrial Area of Mymensingh and Gazipur" submitted by Md. Abid Hasan (13346003) of Summer 2013 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Pharmacy on 23 January,2020

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Ethics Statement

The study does not involve any kind of animal trial and human trial.

Abstract

Water is a vital element of life for the survival of living being. Drinking water contamination has become a hazard among the inhabitants of industrial areas. Lack of safe drinking water leads to a bad impact on the inhabitants of the industrial area. The study comprises complete assessment of water quality, water collection problem and degradation of water quality and level as because of presence of huge amount of industries in the industrial area of Mymansingh and Gazipur. From the study I found that 44.4% people are not aware about the safety of drinking water from the source and 61.5% respondent said that there is also a lack of water in the dry season as because of huge amount of ground water collection from the industries. Furthermore, 82.5% respondent said that, industries does not have any fixed location of waste disposal therefore they through or dump the waste products in open space or in drain and for this reason the environment and water quality degrades.

Keywords: Water quality; contaminations; waste disposal.

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I would like to emphasize at the end that the limitations of this thesis are entirely mine.

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List of Acronyms

GBD	Global Burden of Diseases
UNDP	United Nations Development Program
WHO	World Health Organization
UNICEF	United Nations Children's Fund
SDG	Sustainable Development Goals
JMP	Joint Monitoring Program
WSPs	Water Safety Plans
MDGs	Millennium Development Goals
EPA	Environment Protection Authority
FDA	Food and Drug Administration
GDWQ	Guidelines for Drinking-Water Quality
IPCS	International Program on Chemical Safety
IARC	International Agency for Research on Cancer
JMPR	Joint FAO/WHO Meetings on Pesticide Residues
JECFA	Joint FAO/WHO Expert Consultation on Food Additives
TDI	Tolerable Daily Intake
NOAEL	No Observed Adverse Effect Level
LOAEL	Lowest Observed Adverse Effect Level
UF	Uncertainty Factor

Chapter 1

Introduction

1.1 Background

The vital element, water cannot be substituted with any other element which is able of diversion, transportation, storage and recycling. Every sector of life requires a huge amount of water and this justifies the vital role of both surface and ground water (Singh, 2003). Water is a fundamental element for life which prevents dehydration. Without water, human cannot even think of having life for a short duration of time even. No alternative is still found or established of maintaining a healthy life and building up a sustainable country without safe and dependable source of water. Many natural and anthropogenic factors such as waste disposal site, industrial pollution, waste water discharge as well as sanitation play a vital role in assessing and maintaining physical, chemical and biological properties of water (Bodrud-Doza, 2019).

In order to live a healthy lifestyle, it is crucial to ensure a safe, clean and uncontaminated water source which can be used for drinking, cooking, bathing and washing clothes. The community is primarily dependent on the water source for the daily activities. Bangladesh, one of the developing countries yet having 827.9 million people living in slum area suffers greatly in order to provide clean and safe water for regular use though the country holds a huge network of rivers and seas (Goel, 2019). Dhaka the capital of Bangladesh contains more than 20 million people such huge population is a great burden on the water of the surface. The greatest source of fresh water to be used as drinking water along with other immerse uses like irrigation, domestic use and industrial use in Bangladesh is Groundwater (Parvin, 2019). The authority of Bangladesh like is trying to aware people periodically and suggesting

drinking water from ground water aquifers using shallow tube wells in spite of from direct surface water source for past 40 years. Since this shallow tube wells allow fresh and less microbial and chemical contaminated drinking water than the open surface water. Besides, low labor cost is needed to arrange them and it is inexpensive to install and maintain these tube wells as they are less than 140 feet deep (Goel, 2019).

The term "Water quality" is used here to denote the appropriate condition of water for various uses or processes. Any specific use of any kind of water has particular requirements for the physical, chemical and biological properties of water. Although, the different uses have some common requirements, each use also has its own demands and needs on the quality (Bain, 2012). "Water quality assessment" refers to the whole process of analyzing the chemical properties including the biological nature of water in context to the natural quality and intended uses which may affect the health of human and the aquatic system itself. Water quality testing of different particles in every sort of water sources is urgently needed as pathogens which can be stored from the agriculture and industrial sites as well as from the intensive farm units that contains slurries. Moreover, in several countries septic tanks as well as latrines in an unhealthy site can be considered as probable sources of contaminations. (Bain, 2012).

A major step in affirming the proper system of water supplies, examining disease outbreaks, marking safety of drinking water, and confirming proper actions is acted out by the Water testing process (Bain, 2012). The quality of water in today's world is affected by various natural and human causes. The most common effects are done by geologically hydrological ways and climatic disasters. Since these affect the quantity and the quality of water available in everywhere their influence is turning greater when water quantities are available in lower rate and highest use is to be made of it. Thus, although water is available in adequate quantities, the quality of it limits the uses for the regular people. On the other hand, though

our ecosystem is in harmony with the present quality of both surface and ground water any sort of changes in it will cause a significant disturb in the system.

1.2 Rationale of the Study

Water is an indispensable part of human life and people cannot go by a single day without consuming water. Although it is clear that we need clean and uncontaminated water to lead our lives, we are exposed to contaminated water due to natural and human causes. In the developing countries, people have to consume polluted ground or surface water on a daily basis. Since they do not have any alternative, they are forced to use the same poisonous water every day which leads to various kinds of diseases. This study will reveal the linkage between the water consumption level of a community in Mymensingh and Gazipur, Bangladesh and discover how it is primarily contributing to spreading of various kinds of diseases. The establishment of various industries, factories and mills is also contributing to the situation to a great extent. Industries are responsible for withdrawing high level of ground water from the surface and this is the prime reason that lacks the groundwater day by day. Although, existing studies do not delineate a direct linkage between water usage and various kinds of diseases. Hence, this study is crucial to understand how a community is affected by their water usage as they have to face financial, social, and physical losses due to the diseases that they are faced with. Furthermore, this study will also generate ways to overcome the challenges of water consumption and to find clean and germless water for drinking and household purposes.

1.3 Objective of the Study

The main objective of the research is to find out the overall quality assessment of the household and industrial water in the industrial zone of Mymensingh and Gazipur. Therefore the main purpose of our study was to know the possible reason behind degradation of the

quality of water, shortage of water, shortage of industrial facilities that is responsible for degradation of water quality. The specific objectives are as follows:

- To identify the primary sources of drinking and household water in the community
- To discover the overall quality of water in the residential and industrial area of Mymensingh and Gazipur.
- To find out the primary causes of degradation of the water quality in the residential and industrial area of Mymensingh and Gazipur.

Chapter 2

Literature Review

2.1 Water Quality around the Globe

Although 71% of the world's surface is enveloped by water, only 2.5% of this water is fresh and appropriate for consumption. But more than two-thirds of the 2.5% water is within the glaciers making it is unavailable for use and making it tough to meet the ever increasing demand of today's society (WHO, WHO-Bangladesh, 2019).

Water is a big challenge for nearly 15% of world's inhabitants which should raise concern already. According to WHO, around 2.6 billion people have least have clean drinkable water, which stands annually the main cause of death for over 2.2 million and where over the amount of children is about 1.4 million (WHO, WHO-Bangladesh, 2019). Approximately 2.5 billion people do not get proper sanitation on top of it and about 1.5 million children lost their lives from diarrheal disease. Such diseases are caused because of microbial contaminated water which is considered as the second noted factor for diarrheal disease as well as fifth prominent reason for child death less than five years old worldwide(UNICEF, 2018). As per the 2016 Global Burden of Disease (GBD), approximately 1.1 billion of cases like diarrhea are seen to occur per year among the children of South Asia including the sub-Saharan Africa. UNICEF confirms that it is only 46% of the total population of LMIC like Kenya can obtain improved source of water yet all sources of water did not meet the standards of safe drinking water according to the WHO guidelines for potable water and for this it is assumed that a higher percentage of people do not get safe drinking water (Onda, 2012). This situation leads to occurrence of diarrheal diseases and deaths. Diarrheal disease is the most ordinary

illness which occurs due to taking contaminated food and water that cause 550 million people ill and nearly death of 230,000 lives every year (UNICEF, 2018).

The increasing range of water pollution ruins the sources of drinking water, rivers, lakes as well as oceans all over the world, which ultimately affect human health and the natural environment. Furthermore, 80% of wastewater is sent into waterways without adequate treatment (UNDP, 2019). Factors like global warming, underground storage leakage, atmospheric deposition, industrial pollution, sewage and waste water, are directly responsible for water pollution. Water pollution may not exert its effect immediately but can be fatal in the long run. Industrial heavy metals those are thrown to nearby lakes and rivers are harmful to the water fauna and flora, yet humans indirectly are bound to consume those products. Serious complications like immune suppression, reproductive failure and acute poisoning may result from toxins in the industrial waste (UNDP, 2019). Moreover, infectious diseases like cholera and typhoid can arise from microbial pollutants from sewage. In the long run, since it is necessary to spend a lot of money and time to treat and control those contaminations caused by the water pollution, the overall economy of a country stand at a stake. Waste that does not disrupt quickly are being deposited to Earth's water and finally meeting the ocean. This situation can be tackled by preventing water pollution by shutting pollutants from polluting nearby waters, using effective water treatments such as biological filters, chemical filters and sand filters in polluted water bodies, etc (UNDP, 2019).

On addition to the situation, insecticides for an instance DDT that are used in crops and plants may be harmful if their concentration is higher than the permitted amount (Owa, 2014). World Health Organization expresses that every year 3.4 a huge number of individuals, particularly kids has become the casualty of this water related diseases. According to the UNICEF report, contaminated water is the cause behind the death of around 4000 children every year. WHO reports that by improving the quality of water, about 4% of

the global diseases can be reduced. For example, water that is necessary to live has been killing many people due to presence of infectious agents in Africa (Owa, 2014).

Though in the western country like the USA or Europe, fresh and safe drinking water is available to people, in developing countries like Bangladesh, India, Pakistan it is not readily accessible to many people. It is imperative to test the water quality which has already got significant attention especially in terms of the Sustainable Development Goals (SDGs) set by the United Nations in 2015, in order to maintain the quality of water and safety assurance. Furthermore, the WHO and UNICEF Task Force have illustrated the importance of testing water quality as it provides information about ensuring proper ways of water supplies, verifying safety of the water, investigating possibility of disease outbreaks and taking preventive measures (UNICEF, 2018). It is very much needed at the moment as it is mandatory to uphold the physical, chemical and biological integrity of water to investigate and retain the characteristic of both household and drinking water for better sanitation and healthy lifestyle purposes. In spite of such greater need due to low resource availability, sometimes it is difficult to apply extensive and accurate testing procedures of water quality (Owa, 2014).

As a result, effective decision making cannot be possible in most of the cases because of poor information on quality and extent provided by the water test (Bain, 2012). Moreover, the developed countries like USA are also not completely out of the clutch of water-borne diseases as according to WHO, approximately half million people suffer from water-borne disease and one million suffer from mild to moderate infection which resulted in 12,000 deaths each year (Bain, 2012). There are additionally a few wellsprings of conceivable which are human-made and from which one may be a higher priority than other. It is arranged as diffuse sources and point sources (Hunter, 1997).

2.2 Sources of Drinking Water

About 71% of our planet is covered by water as result different kinds of sources of water are seen around the world. Broadly dividing the sources two kinds can be observed: The Surface water i.e. reservoirs, rivers, ponds, lakes and the Groundwater, which are the two-fundamental sources of drinking water. Water bodies of all kinds can be characterized by the three major components and complete analyzing of water quality is based on these components: (UNESCO/WHO/UNEP, 1992,1996)

- **Hydrodynamic properties:** The hydrological properties are inter-connected with all freshwater bodies from the atmosphere to the sea. This property is needed to be tested first before positioning the water for use.
- **Physical and chemical properties:** The individual patterns of physical and chemical properties are determined by the climatic or geomorphology or geochemical conditions prevailing in the drainage basin and the underlying aquifer for the water bodies.
- **Biological properties:** The growth of flora and fauna happens by environmental conditions within the surface water. Now, it is needed to be cautious about the selection of species as well as the physiological performance of individual organisms within the water body.

All the sources of water are classified as Improved and Unimproved source of water based on if they are protected from “outside contamination” or not.

Table 1: Improved and unimproved source of drinking water (Source: (Onda, 2012)

Source class	**Source types**
1. Unimproved drinking-water source	Not protected springs, Unprotected dug well, Cart with small Drum or Tank, Surface water (e.g., river, dam, stream, pond, lake etc.) and open bottled water
2. Improved Drinking water source	Water bodies inside the plot or yard, dwelling of the user, where there is a connection of piped water
3. Improved other drinking water source	Tube wells, Protected Dug wells, Public taps, Protected springs and space for rainwater collection.

According to this approach, WHO and UNICEF estimated up to 2010, that approximately 5.8 billion people were using improved source of water, on the other hand, 783 million of people were getting unimproved source of water. In most of the cases, safe drinking water could not be found in unimproved source.

About 70% of the population of Bangladesh is dependent on water from 10 million of point sources (i.e. tube well, dug well, PSF etc.). Maintaining safety of water from numerous sources is a big challenge in this country, as a result instead of a centralized and quality control based approach, Water Safety Plans (WSPs) enable water suppliers from different municipal authorities to household managed point sources to adopt a preventive approach. (WHO, 2019).

Table 2: Category of improved drinking water source (Source: (Bain, 2012)

Source Category	**Description**
1.Standpipe	Water can be gathered from standpipe or open tap from the open water point, known as an open tap or open wellspring which can have at least one taps. These are commonly made of workmanship, cement or brickwork.
2.Protected dug well	Secured burrowed well attempts to shield water from overflow water by a packaging or well covering that is raised above stage and ground level by which spilled water is occupied away from the well. It is additionally secured to shield the burrowed from feathered creature droppings and creature falling into the well which keeps the water liberated from external sullying
3.Yard connection or Household	Household connection, also known as Piped water into dwelling, can be defined as a connection of piped water service with in-house, which is plumbed to one or more taps. Another connection of water, Yard connection is also known as Piped water to yard/plot can be defined as a connection of piped water to tap outside the dwelling which is situated in the plot or yard.
4.Rainwater	The process by which rain is acquired from the surfaces and reserved in a tank, cistern or container to use.
5.Borehole	To reach groundwater supplies, borehole or tube well is a profound opening that has been drilled, bored or driven with housings or funnels, which impede the gap of little breadth from scratch in and secure the wellspring of water by overflow water from invasion.

2.3 Water Borne Diseases

The pathogens that transmit through contaminated drinking-water are varied and can change due to different natural effects on them. Drinking-water is a vehicle of transmission of these pathogens and is transmitted by the fecal–oral route. Therefore, improvement of the quality and availability of water in general hygiene is needed in reducing fecal–oral transmission of various water borne diseases. Among the many water borne diseases the most common ones in Bangladesh are stated below:

Table 3: Most common water borne diseases in Bangladesh (UNDP, 2019)

Gastroenteritis	Dysentery	Guinea-worm disease
Diarrhea	Cholera	Hepatitis
Typhoid	Meningitis	Abdominal pain & cramps

2.4 Clean Water in SDGs

It is foresighted that at least one in four people will suffer regarding water shortage within the year 2050. To fight with this dangerous case Goal 6 of the Sustainable Development Goals of UNDP states about safe and also affordable drinking water for all by the year 2030. This requires invest from every country for adequate infrastructure, for providing proper sanitation facilities and to encourage hygiene including ensuring of universal safe and affordable drinking water (UNDP, 2019). Unplanned industrialization and urban development made the world lose 70% of its natural wetlands over the last century. Although at the present day with the view of achieving the SDGs already 80% of countries around the globe have laid the foundations for integrated water resources management. (UNDP, 2019)

2.5 Safe Water in MDGs

Environmental researches have shown impurity in supplied water as a predominant problem and thus resulting in the deterioration of water quality which occurs due to the presence of infectious agents or various chemical substances (Bain, Bartram, Elliott, Matthews, McMahan, Tung, Chuang & Gundry, 2012). Thus, many communicable diseases can be managed effectively by improving the sanitation and hygiene water usage practices (Bain, Bartram, Elliott, Matthews, McMahan, Tung, Chuang & Gundry, 2012). The target 7c of the United Nation's Millennium Development Goals (MDGs) is to halve the "proportion of the population without sustainable access to safe drinking-water" between 1990 to 2015 (Onda, LoBuglio& Bartram, 2012). Moreover, the MDG indicator resembles that "the proportion using water from an improved source in households," and is marked by other countries.

2.6 Types of Contaminants

Among the various kinds of contaminants in water basically there are four kinds of contaminants, such as-

I. Inorganic contaminants
II. Organic contaminants
III. Biological contaminants
IV. Radiological contaminants

2.6.1 Inorganic Water pollutants include-

- Arsenic
- Antimony
- Ammonia from food processing waste
- Heavy metals from motor vehicles and acids.
- Chemical waste as industrial by-products

- Creosote preservative is secreted into the aquatic ecosystem.
- Fertilizers having nitrates and phosphates
- Bromide
- Copper (Zhu & Yang, 2014)

2.6.2 Organic water pollutants include:

- Wastes produced during food processing
- Detergents
- Disinfection such as chloroform
- Petroleum
- Organic compounds which are volatile
- Trichloroethylene
- Insecticides
- Polychlorinated biphenyl (PCBs)
- Chemical compounds of personal cosmetics (Zhu & Yang, 2014)

2.6.3 Biological Contaminant

Existence of living organisms such as virus or algae, bacteria or protozoan can contaminate water which is known as Biological contamination which can causes serious issues to drinking water (Daschner et al. 1996; Ashbolt 2004).

2.6.4 Radiological Contaminant

Radioactive molecules i.e. Alpha particles, Beta particles, Uranium etc. cause contamination of water.

Table 4: Radiological contaminants of drinking water (Source: Environment Protection Agency (EPA), USA)

Contaminants	MCL
Alpha particles	15 (pCi/L)
Beta particles and photon emitters	4 mrems/year
Radium 226 and Radium 228 (combined)	5 pCi/L
Uranium	30 ug/L

2.7 Chemical Contamination

Numerous contaminants can be found in drinking water which can lead to diseases in children, such as endocrine disruption, learning disorder and cancer. This is because children are more likely to be exposed to more water in comparison to their body weight than adults. Safety of drinking water is a concern for both The United States Environment Protection Authority (EPA) and Food and Drug Administration (FDA). EPA has some drinking water standards for the public water systems, which includes provisions for maximum amount of contamination level and techniques of chemical, radiological and microbial. It has fixed standards against lead, arsenic, microbial contaminants, nitrates, disinfection byproducts, pesticides and solvents (America's Children and The Environment, 2015).

Arsenic

Arsenic is a toxic compound found in the air, water and land which enters into human body when contaminated water is drank or used. However, it spreads mostly through ground water through fish, shellfish, meat, poultry, dairy products and sea food. Skin lesion and skin cancer are the major side effects of long term arsenic poisoning (WHO, 2018).The International Agency for Research on Cancer (IARC) recognized arsenic and arsenic compounds as carcinogenic to human. Initially the poisoning causes vomiting, abdominal pain and diarrhea followed by numbness, muscle cramping and finally death in extreme condition. Arsenic

contaminated drinking water effects 140 million people of 50 countries who are now exposed beyond WHO guideline value of 10 µg/L. Bangladesh has been suffering from arsenic contamination since 1990s in the drinking water and in 2012, approximately 43,000 deaths have occurred due to arsenic pollution in Bangladesh. Researchers of the US National Research Council have stated that 1 in 100 additional cancer death result from a lifetime drinking of water containing 50 µg/L of arsenic. Therefore, alternatives of high arsenic sources need to be introduced and high arsenic containing sources must be marked red as a warning. The WHO and UNICEF are working together to control the contamination of water with their Water supply, Sanitation and hygiene program and their new agenda of 2030 for Sustainable Development says, their aim is to provide safe water that is free from fecal and chemical contamination, including arsenic (WHO, 2018).

Fluoride

An increased concentration of fluoride (>10mg/l) in drinking water can cause serious problems, especially in the Indian Sub-continent and Africa. Dental fluorosis results from higher exposure of fluoride in water which causes brown mottling of teeth. Moreover, higher intake can cause skeletal fluorosis, where bone density is increased and can ultimately cause fractures. According to WHO, person who intakes 14mg of fluoride every day are vulnerable to skeletal fluorosis and increased risk of bone fracture and loses working capability in the long run; thus, financially and physically disabled for life. (Fawell, 2003)

Iron and Manganese

Even though they are necessary to health but sometimes, they are not microbiologically safe, as at higher doses they may be injurious to health. (Fawell, 2003)Manganese is a natural mineral that can contaminate water in higher concentration from natural sources. Generally, it is needed by humans as it is an essential trace element but can causes problems in the nervous

system, including hyperactivity and also other behavioral activity at chronic higher doses (Fawell, 2003).

Selenium and uranium

Selenium containing drinking water may result in high hair fall, weak nails and skin lesions and can also cause changes in the peripheral nerves and lower the prothrombin time. On the other hand, Uranium causes serious issue on kidney in the long term exposure which increases calcium excretion and protein leakage from the kidney such as microglobulinuria (Fawell, 2003).

Industrial Chemicals

Urbanization has led to many chemicals penetrating to drinking water sources from industrial production and waste. For example, trichloroethylene and tetrachloroethylene are widely used in industries as solvents, adhesives and lubricants and trichloroethylene causes birth defects in the heart and high level of tetrachloroethylene exposure causes miscarriage in pregnancy and reduced body weight of new born babies. (USEPA, 2013)

Agricultural chemicals

Chemical contaminations such as nitrates and nitrites can be introduced in significant amount in the groundwater sources of drinking water due to fertilizers, livestock manure and human sewage. Long term exposure can cause blood disorders and also sometimes thyroid dysfunction in children and pregnant women. Moreover, lower childhood IQ scores and other developmental effects, along with complicated pregnancy may occur due to deficiency of maternal thyroid hormone levels during pregnancy. (USEPA, 2013)According to WHO, the guideline value is 50mg/l nitrate however the concentration was higher 50-100 mg/l. Pesticides like atrazine and glyphosate cause water contamination and glyphosate cause serious reproductive issues. (USEPA, 2013)

Table 5: Agricultural contaminants of drinking water (Source: Environmental Protection Agency, USA)

Pesticides	Nature	Maximum contamination level (MCL), lg/L
Carbofuran	Nematicide	40
Dalapon	Herbicide	200
Dibromochloropropane	Nematocide	0.2
Dinoseb	Insecticide	7
Dioxin	Herbicide	0.0003
Diquat	Herbicide	20
Endothall	Algicide	100
Ethylene dibromide	Insecticide	0.05
Glyphosate	herbicide	700
Methoxychlor	Insecticide	40
Oxamyl	Insecticide	200
Pentachlorophenol	Fungicide	1
Picloram	Herbicide	500
Simazine	Herbicide	4
Toxaphene	Insecticide	3

2.8 Microbial contamination

Pathogens are causing fatal waterborne diseases and micro fungal contamination of water is weakening our basic immune system and paralyzing antibodies to fight against the microbes. The diarrhea caused by pathogens is the most significant health issue and it occurs due feces containing pathogenic organisms, especially human feces. In nineteenth century, there was a prevalence of cholera and typhoid that had massive impact on the cities in Europe and North

America. Moreover, hand washing and other hygiene practices can help to minimize the spreading of infections. (Fawell, 2003)

Ways for protecting water from getting contaminated:

- E .coli bacteria are an effective pathogenic indicator of groundwater contamination which helps identify the contaminated water and take the steps needed.
- It is crucial put emphasis on the water that is being supplied and stored, to avoid further decline of water before consumption. We should be careful not to throw any kind of waste material into the water and have a separate sanitary sewer system.
- In the wake of expending any sort of strong or fluid meds, wrapping it up with dry squanders is significant to avoid mixing it with the water flow and also avoid exposing any kind of heavy metals or carcinogenic substances. And before drinking water we should boil it properly and also gather proper knowledge about the usage of water in our daily activities. (Lautenberg, 2016).

2.9 Heavy Metals in Water

Heavy metals have different chemical properties. Moreover, they are used extensively in electronics items, machines, etc. this results in them entering into the aquatic and food chains from various anthropogenic sources. At present, most of the aquatic environments go through this metal concentration that destroys the water quality criteria. The heavy metals are one of the most common pollutants found in wastewater and have toxic effect on both human beings and animals.

Table 6: The standard metal concentration in drinking water

Metals	Effects	Drinking Water Standards
Lead	• High dose of lead can cause metabolic	• Maximum

	poisoning and it is toxic for humans and also aquatic environment • Among children it can cause tiredness, irritability anemia and behavioral changes	concentration: 0.1 mg/L (Environmental Protection Agency) • Maximum Concentration: 0.5mg/L(European Community)
Nickel	• Higher dose can cause DNA damages • High phytotoxicity • Can damage fauna • Phytotoxic	• Maximum concentration: 0.1mg/ L (Environmental Protection Agency) • 0.1mg/L (European Community)
Copper	• Copper can cause damage to aquatic fauna • Phytotoxic • Mucosal irritation and corrosion • Can cause irritation in the Central Nervous System followed by also depression	• Maximum concentration: 1mg/ L (Environmental Protection Agency) • 3mg/L (European Community)
Zinc	• Anemia can occur • Lack of muscular coordination • Abdominal pain • Phytotoxic	• Maximum concentration: 5mg/L (Environmental Protection Agency)

		• 5mg/L (European Community)
Chromium	• Can cause Necrosis nephritis and eventually death in man • Irritation of gastrointestinal mucosa	• Maximum concentration: 0.1mg/L (Environmental Protection Agency) • 0.5mg/L(European Community)
Cadmium	• Causes serious damage to kidneys and also the bones in humans • Diseases like : bronchitis, emphysema, anemia • Acute diseases in children	• Maximum concentration: • 0.005mg/L (Environmental Protection Agency) • 0.02mg/LEuropeanCommunity
Mercury	• Mutagenic effects are seen • The cholesterol level is effected	• Maximum concentration: 0.002mg/L (Environmental Protection Agency) • 0.001mg/L (European)

Water monitoring

Water quality monitoring systems are used in modern technologies as contamination in supplied water is a major problem and it occurs due to the viral and bacterial attack. In addition, water should be stored safely and regular authorization is necessary. Thus, by

following good sanitation and hygiene, it is possible to prevent a plethora of water borne (Brain, 2012).

Detection of Microbes

A device called the Biosynthetic Nose is used to detect microorganisms in water as it resembles human nose and can detect the Earthy and musty odor produced by bacteria. The bad odor is due to two different odorous molecules geosmin (GSM) and 2-methylisoborneol (MIB) and they can be detected by Biosynthetic Nose device at very low concentrations of about 10 mg per liter water (Brain, 2012).

2.10 Standard Water Quality Guidelines

World Health Organization (WHO) makes guidelines and the key function of it is to make patients benefitted. The WHO guidelines were introduced to protect our public health and are to be used as the base for the development of national standards(WHO, Guidelines for Drinking-water Quality, 2008).

On the other hand, Chemicals and by-products or wastes, from various industrial sources also reach the drinking-water as they are not properly thrown via a proper waste control plant. Many of the times these chemicals are produced within small industrial units which are situated near the human housing areas, and thus a number of chemicals can reach water as a consequence of disposal of general household chemicals. Many of the inorganic particles may also get mixed with the surface water because of the natural contamination. (WHO, Guidelines for Drinking-water Quality, 2008)

This approach is briefly mentioned below; its available factors are:

- Drinking Water Quality
- Waste Water Reuse
- Recreational Water

Guidelines for Drinking-Water Quality (GDWQ)

In the year 1958, WHO for the first time published the "WHO Guidelines for Drinking-Water Quality (GDWQ)"? It was the first environmental health document published as International Standards for Drinking-Water. Then, In the mid-1980sthe first edition of the WHO guidelines for Drinking-Water Quality was published in 3 parts:

Volume 1: Recommendations

Volume 2: Health criteria and other supporting information

Volume 3: Surveillance and control of community water supplies

Besides, the chemical, physical and microbiological aspects of water quality, microbiological contaminations are also being importantly studied and guidelines are being formed. Critical reviews are done based on the chemical or physical or radiological contaminants on the water before using it. For many of the chemicals, the risk assessment results in the derivation of a dose below which adverse effects do not occur and is the basis for a Tolerable Daily Intake (TDI).

2.11 Water condition of Industrial Areas in Mymensingh, Bangladesh

The irregular disposal of industrial wastes has created pollution problems for a long time since this waste is disseminated in the environment or is accumulated in sediments, aquatic organisms and water. (Singh R, 2012) Moreover, as majority of manufacturing processes are water based and a considerable volume of effluent is ejected to the environment in either treated or inadequately treated form, leading to surface and groundwater pollution.

Industries of Bangladesh have also contributed to serious and widespread deterioration in the quality of water. Among the heavy metals found in the industrial wastewaters of Mymensingh area of Bangladesh the most dominant metal was Zn followed by Cu, Cd, Pb,

Cr and Ni. The amount of Cu in there varied from 0 to 0.356, with an average value of 0.0405 ppm, concentration of Zn varied from 0.2 to 1 ppm where the mean was 0.512 ppm. Moreover, objectionable appearance of canal water could be attributed in this region due to the discharge of untreated industrial wastewaters. (Sarker, 2015)

Chapter 3

Methodology

3.1 Research Design

Research was planned in 3 stages. Initially, broad writing survey was done to comprehend the general state of drinkable water Bangladesh particularly in Mymensingh and Gazipur district. We pick Mymensingh and Gazipur on the grounds that there is a nearness of parcel of ventures, for example, tannery industry, concrete industry, block industry, and nourishment industry, etc. The entirety of the waste is setting off to the stream, lake, open field, cannel, channels and cremation straightforwardly. Along these lines, we pick the territory close Mymensingh and Gazipur for directing the exploration. Besides, reimbursement of the water source and GPS attaching of the territory of our examination region was done to approve our

exploration. In this progression we restricted down our examination zone for directing the point by point overview. In conclusion, a nitty gritty survey was made to get the general thought which obviously shows the state of drinking water of this zone and furthermore portrays the ailments that they have in view of this hazardous and contaminated water. An aggregate of 300 members filled the study and 257 were found as totally approved. The information that we gather from the examination region was investigated by utilizing SPSS V 21.

3.2 Research questions

A total of 15 questionnaires were selected for analysis and these are as follows:

RQ 1: What is the name of your District?

RQ 2: What is the name of your Union?

RQ 3: Do you think water from your main source is safe for drinking?

RQ 4: How can pond/river/cannel water be made safe?

RQ 5: What are the benefits of hygienic latrine?

RQ 6: What are the types of solid waste?

RQ 7: What are locations of waste disposal?

RQ 8: What are the main sources of drinking water?

RQ 9: What is the most serious problem you face in collecting water?

RQ 10: Water availability in dry season?

RQ 11: What is the condition of water logging in your area?

RQ 12: Is the industry having ETP in your area?

RQ 13: What are types of industrial solid waste in your area?

RQ 14: What are the locations of industrial waste disposal?

RQ 15: Is there any fixed location of industrial waste disposal?

3.3 Method of Data Analysis

The analysis of the collected data has been conducted using the quantitative and qualitative analysis method. Since this research is conducted in a mixed method, the analysis for both qualitative and quantitative data will be ensured. In order to analyze the quantitative data, I have used various data analysis tools such as SPSS, MS Excel etc. The combination of usage of various data analysis tools have ensured the accurate scrutiny of data and helped to present the findings in convenient and understandable graphs and charts. I also used bar charts, pie charts and other graphs to present the findings of the data effectively. The qualitative part of the data was also analyzed with the qualitative data analysis method. Using the interview questionnaire and open-ended questions, the internal perception of the respondents has been discovered. Using the mixed method of research, I have discovered new areas of interest which can be explored further on the way. For this research, the data analysis process is quite robust and it will pave the way for a desirable finding and conclusion along the way.

Chapter 4

Results and Discussion

The survey was done in the industrial area of Gazipur and Mymensingh. A total number of 257 household survey was done and among them 95 sample was in Gazipur 162 sample was in Mymensingh that is respectively 37% and 63%.

Table 7: Name of the District (project location)

	Frequency	Percent	Cumulative Percent
Gazipur	95	37.0	37.0
Mymensingh	162	63.0	100.0
Total	257	100.0	

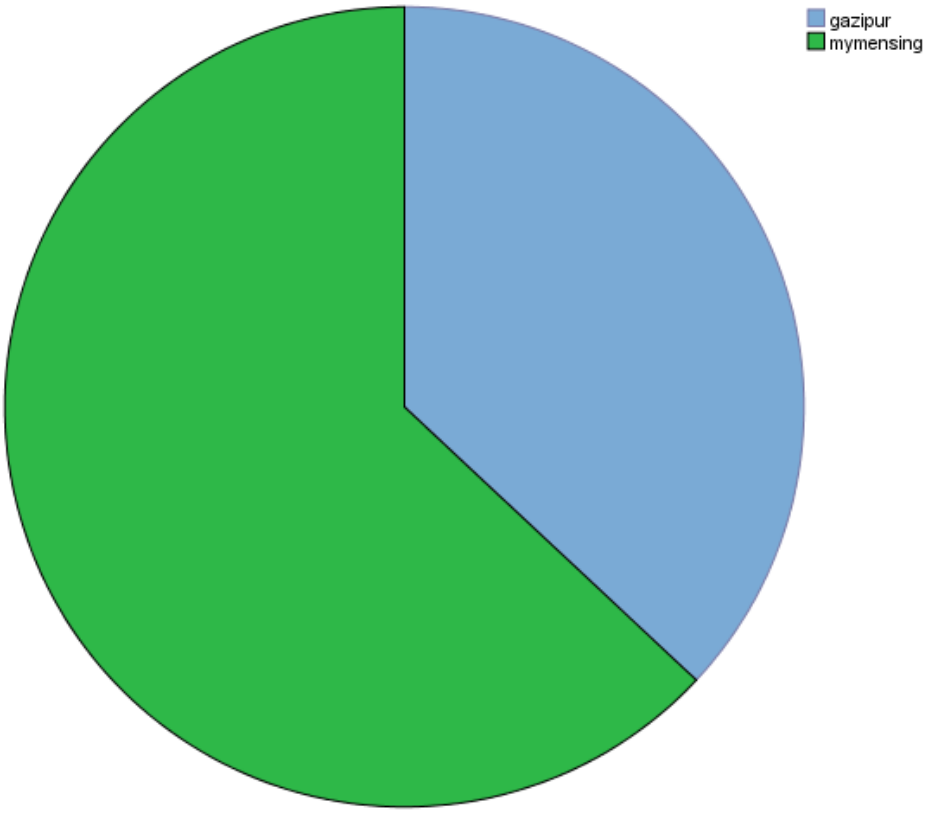

Figure 1: Name of the District (project location)

The survey comprises 7 unions of 2 Districts. The union that we covered in the survey is Bhaluka, Habirbari, Kaoraid, Mallikbari, from Mymensing district Maona, Rajai and Telihati from Gazipur district.

Table 8: Union Name

	Frequency	Percent	Cumulative Percent
Bhaluka	46	17.9	17.9
Habirbari	41	16.0	33.9
Kaoraid	28	10.9	44.7
Mallikbari	38	14.8	59.5
Maona	28	10.9	70.4
Rajai	36	14.0	84.4
Telihati	40	15.6	100.0
Total	257	100.0	

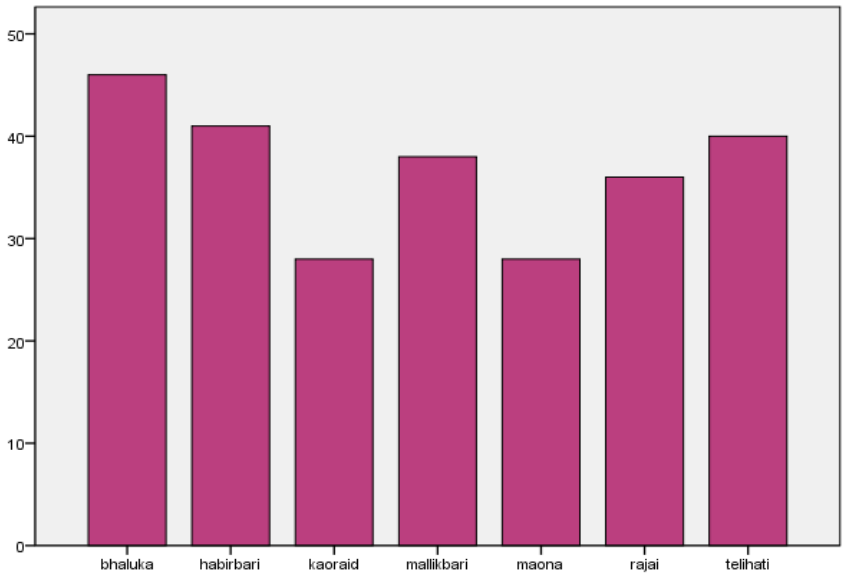

Figure 2: Union Name

The Mymensingh and Gazipur area has a lot of industries, beverage, food industry and these industries are responsible for water pollution. About 55.6% people said that the water is safe as they are talking it from ground water and the rest 44.4% people said that the water gets polluted because of the huge number of industries.

Table 9: People's awareness regarding safety of drinking water from the source

	Frequency	Percent	Cumulative Percent
Yes	143	55.6	55.6
No	114	44.4	100.0
Total	257	100.0	

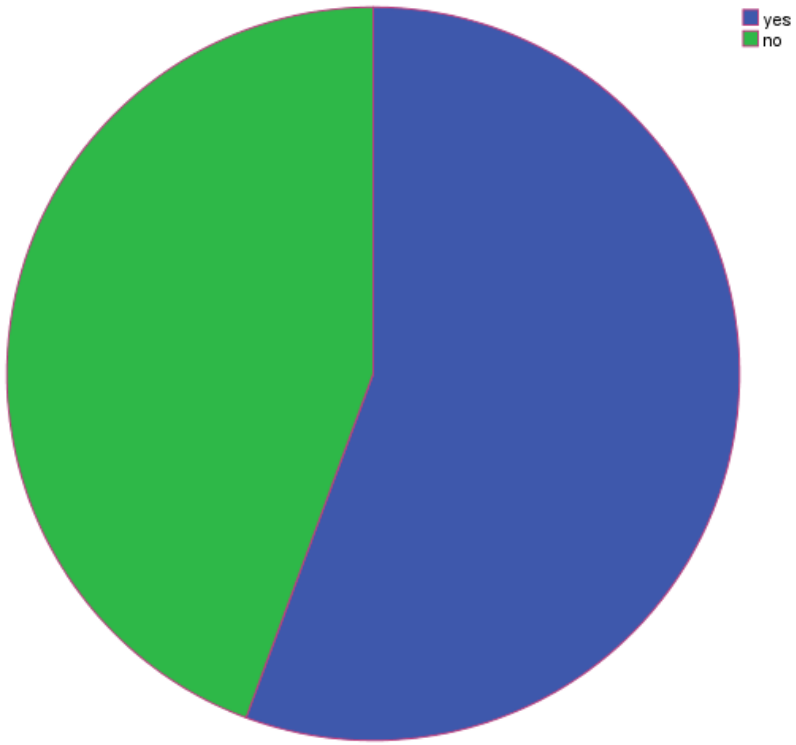

Figure 3: People's awareness regarding safety of drinking water from the source

The safety measure ensuring is very crucial to remain adequately. The people said that about 45.9% know that by boiling water can be purified. About 25.7% people know about chlorination and 23.3% people know about boiling and water purification tablet.

Table 10: Methods of safety measure management of pond/river/cannel

	Frequency	Percent	Cumulative Percent
Boiling	118	45.9	45.9
Chlorination/line/potash	1	.4	46.3
Don't know	1	.4	46.7
Boiling and Chlorination/line/potash	66	25.7	72.4
Boiling and water purification Tablet	60	23.3	95.7
Boiling and fitkiri	11	4.3	100.0
Total	257	100.0	

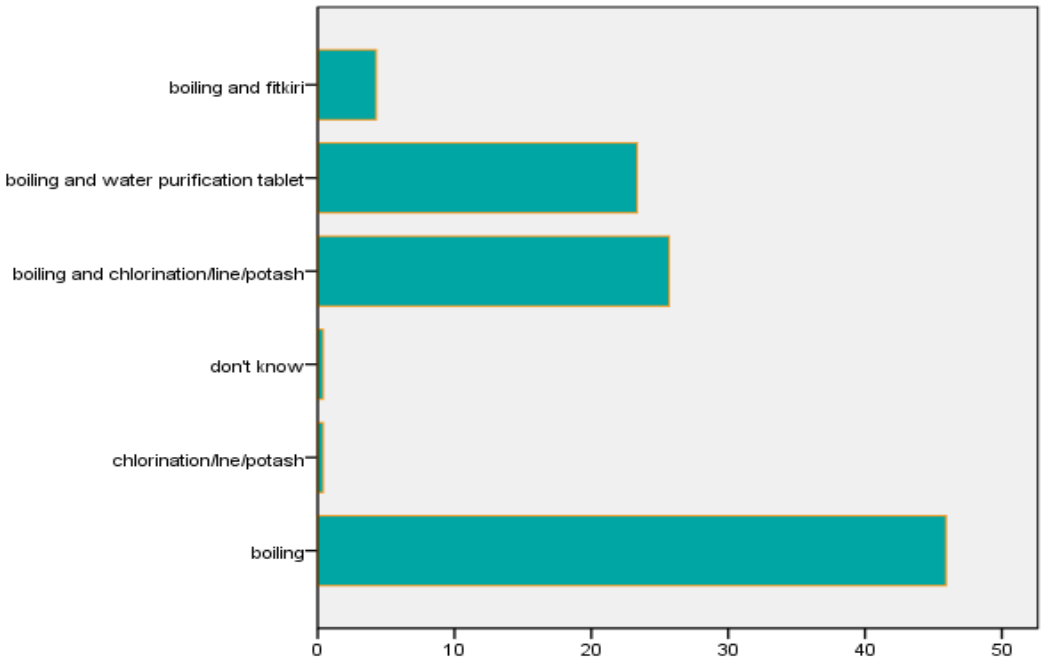

Table 11: Methods of safety measure management of pond/river/cannel

We raised a question that what are the benefits of hygiene latrine? About 46% people said that hygiene latrine is very much necessary to keep the environment clean and about 45% people said that hygiene latrine is essential to keep the environment as well as to prevent spread of diseases.

Table 12: Knowledge about hygiene latrine

	Frequency	Percent	Cumulative Percent
To keep the environment Clean	119	46.3	46.3
To prevent spread of diseases	21	8.2	54.5
Don't know	1	.4	54.9
To keep the environment Clean and to prevent spread of diseases	116	45.1	100.0
Total	257	100.0	

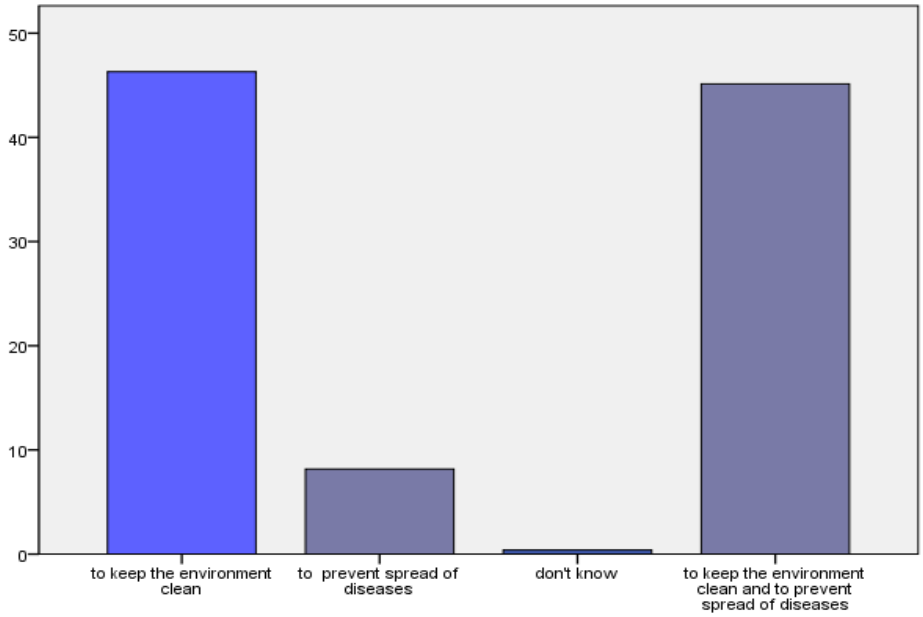

Figure 4: Knowledge about hygiene latrine

About the household solid waste generation the respondents said that the solid waste is mostly bio-degradable 50% and about 32% said that they have solid waste both bio-degradable and non-biodegradable.

Table 13: Types of household solid waste

	Frequency	Percent	Cumulative Percent
Domestic/bio-degradable	128	49.8	49.8
Chemical/ non- Biodegradable	47	18.3	68.1
Clinical	1	.4	68.5
Domestic/bio- degradable and chemical/ non- Biodegradable	81	31.5	100.0
Total	257	100.0	

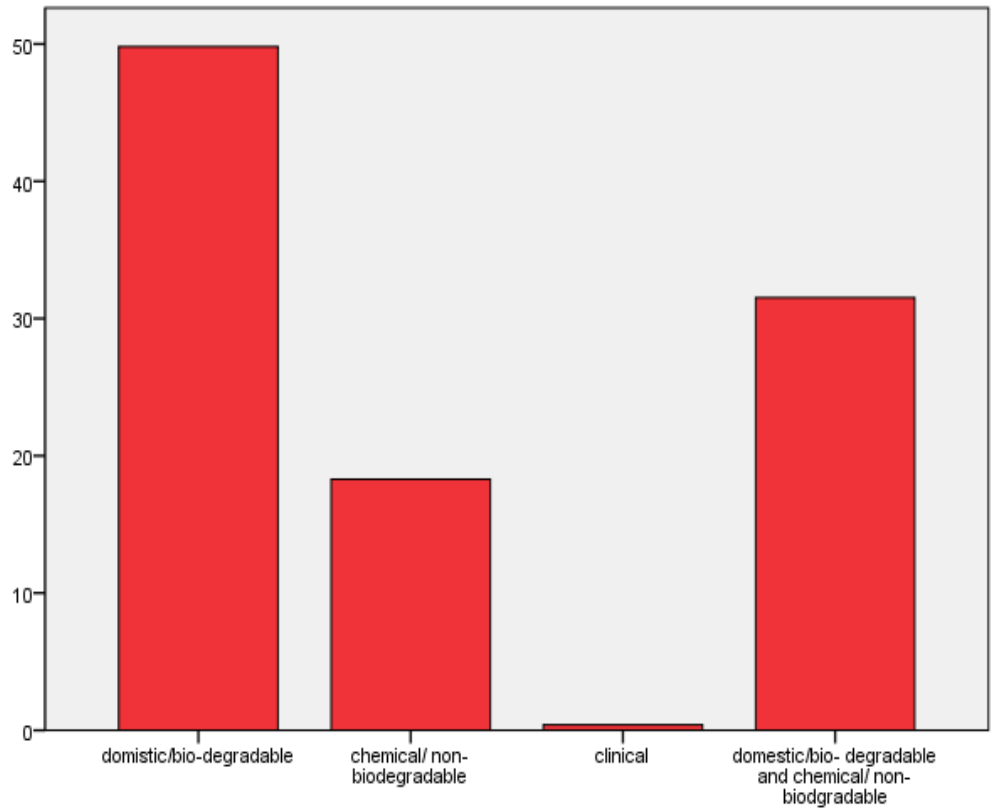

Figure 5: Types of household solid waste

About the household wastes disposal about 28%. People said about incineration, about 18% people said that they drop it in the open field, 15.6% said about land fill and 12.5% people use open field and dustbin.

Table 14: Location of household waste disposal

	Frequency	Percent	Cumulative Percent
Open field	46	17.9	17.9
Drains	4	1.6	19.5
Land fill	40	15.6	35.0
Incineration	73	28.4	63.4
Dustbin	13	5.1	68.5
Open field and pond	30	11.7	80.2
Open field and dustbin	32	12.5	92.6
Incineration and dustbin	14	5.4	98.1
Open field and land fill	5	1.9	100.0
Total	257	100.0	

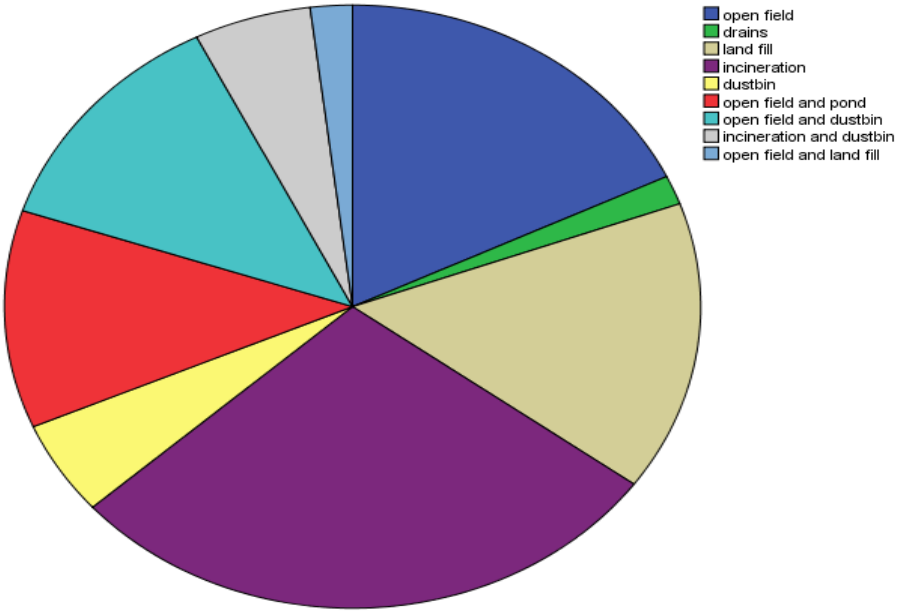

Figure 6: Location of household waste disposal

About 45% people collects water from tube well that is responsible for shortage of ground water and 46.3% people collect water from pond and about 7.8% people said that they collect water from both pond and tube well.

Table 15: Source of household drinking water

	Frequency	Percent	Cumulative Percent
Tube well	116	45.1	45.1
Pond	119	46.3	91.4
River/canal	2	.8	92.2
Tube well and Pond	20	7.8	100.0
Total	257	100.0	

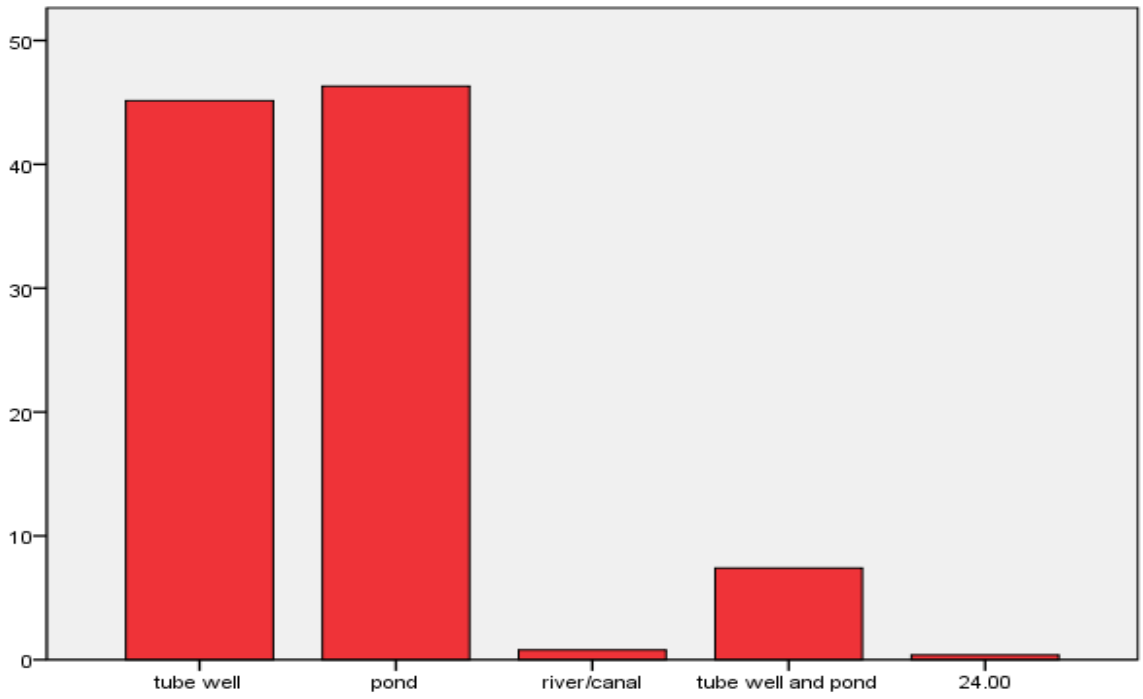

Figure 7: Source of household drinking water

44% people said that they did not face any problem of collecting water but 56% people said they face problem like distance, harassment, insufficient water, water purification problem, arsenic so on while collecting water.

Table 16: People facing problem while collecting water

	Frequency	Percent	Cumulative Percent
No problem	113	44.0	44.1
Distance	4	1.6	45.7
Harassment	4	1.6	47.3
Insufficient water	3	1.2	48.4
Water purification problem	12	4.7	53.1
Distance and harassment	74	28.8	82.0
Distance , harassment and Water purification problem	43	16.7	98.8
Distance, harassment and Arsenic	3	1.2	100.0
Total	257	100.0	

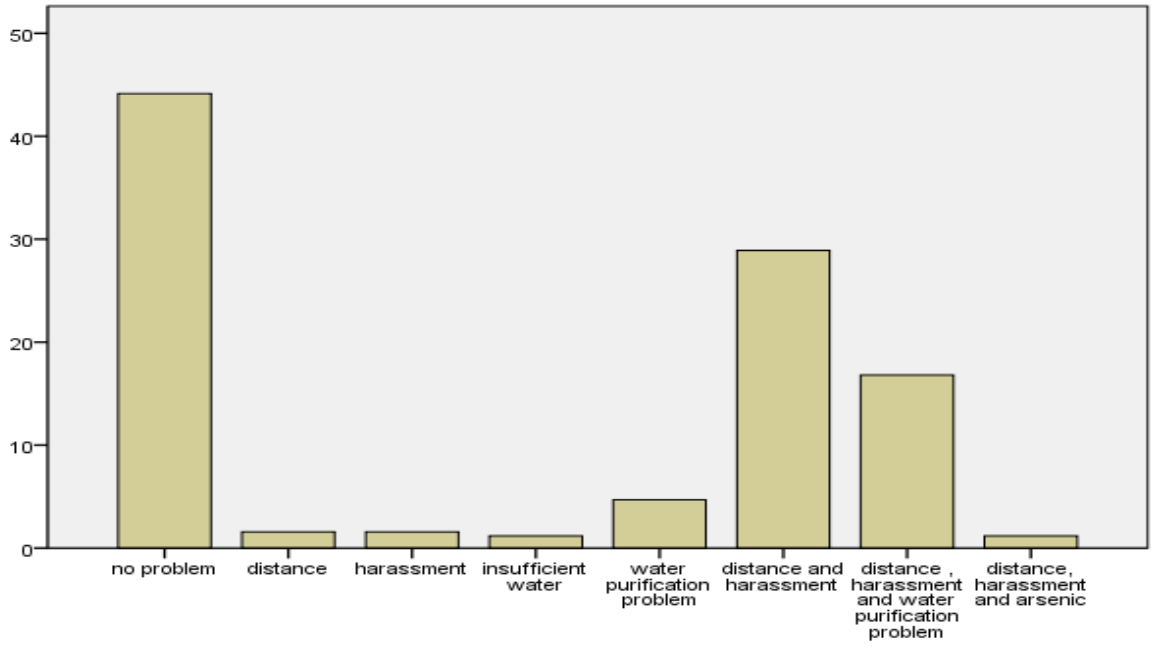

Figure 8: People facing problem while collecting water

In the dry seasons, about 38.5% respondent said that they can collect water but 61.5 % said that there is no availability of water in the dry season.

Table 17: Water availability in dry season

	Frequency	Percent	Cumulative Percent
Yes	99	38.5	38.7
No	158	61.5	100.0
Total	257	100.0	

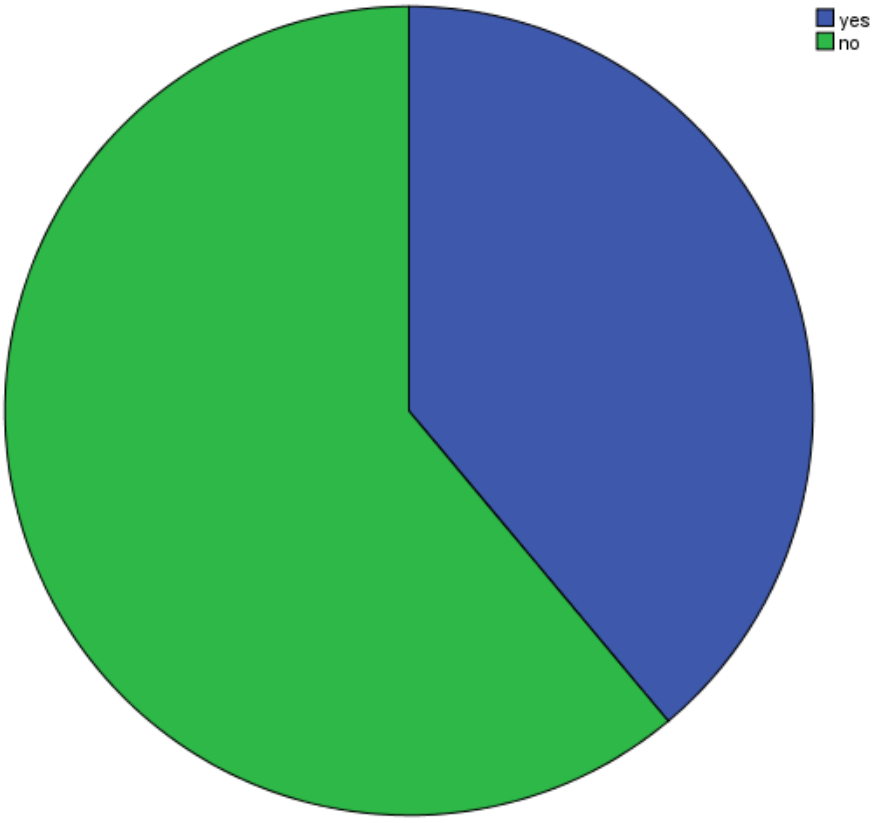

Figure 9: Water availability in dry season

About 53% respondent said that they face water logging problem in their area and the water in rainy season causes much harm to their household, livestock and their day to day lives.

Table 18: Condition of water logging in your area

	Frequency	Percent	Cumulative Percent
Yes	136	52.9	53.3
No	121	47.1	100.0
Total	257	100.0	

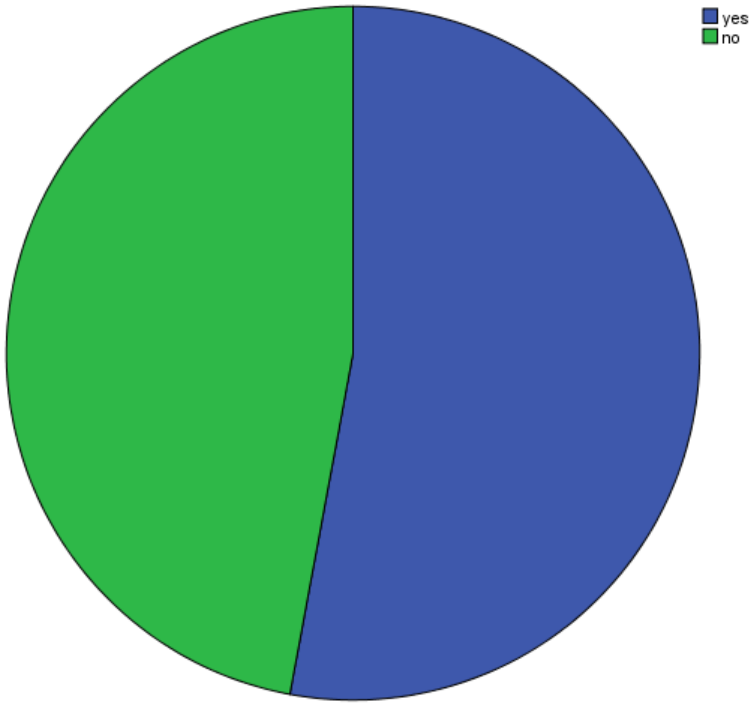

Figure 10: Condition of water logging in your area

Though 45.1% respondent said that, they do not know about the ETP of the industry in their area. But 37% people said that they have ETP in their area and 17.9 % people said that the do not have ETP that causes water related problems.

Table 19: Industry has ETP in your area

	Frequency	Percent	Cumulative Percent
Yes	95	37.0	37.0
No	46	17.9	54.9
Don't know	116	45.1	100.0
Total	257	100.0	

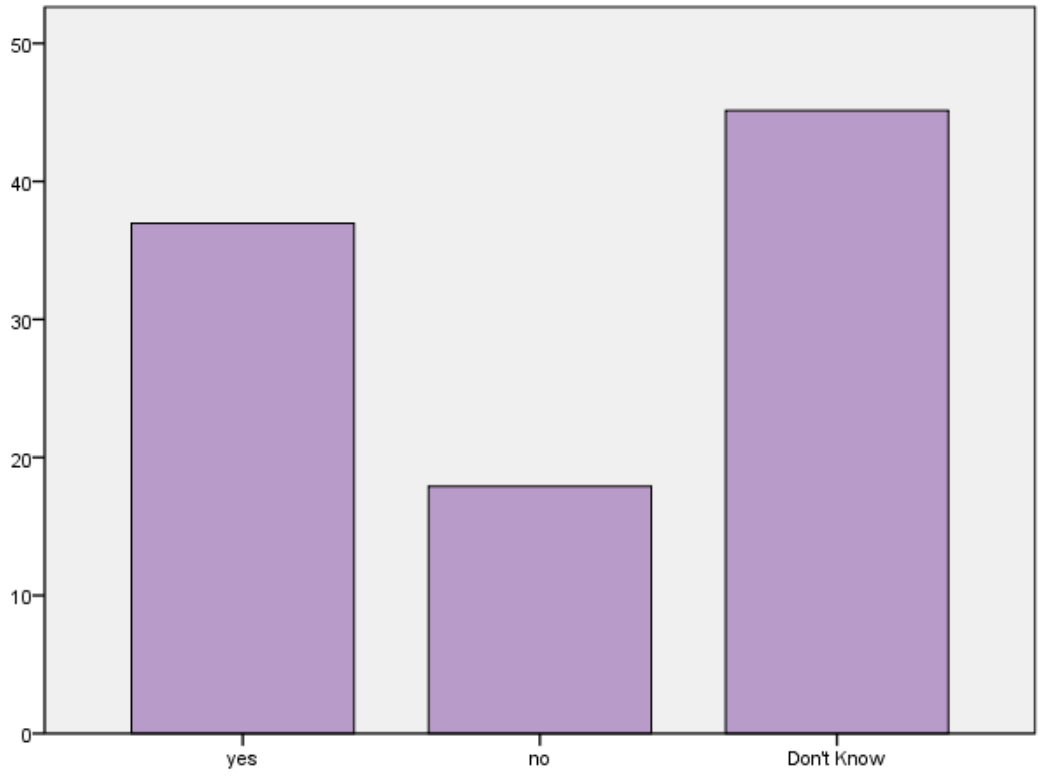

Figure 11: Industry has ETP in your area

About 60% people said that in industry of the Mymensingh and Gazipur area creates chemical and non-biodegradable waste that causes many problems in their livelihood.

Table 20: Type of industrial solid waste

	Frequency	Percent	Cumulative Percent
Domestic/bio- degradable	103	40.1	40.1
Chemical /non-bio Degradable	95	37.0	77.0
Domestic/ bio- degradable and chemical / non- bio Degradable	59	23.0	100.0
Total	257	100.0	

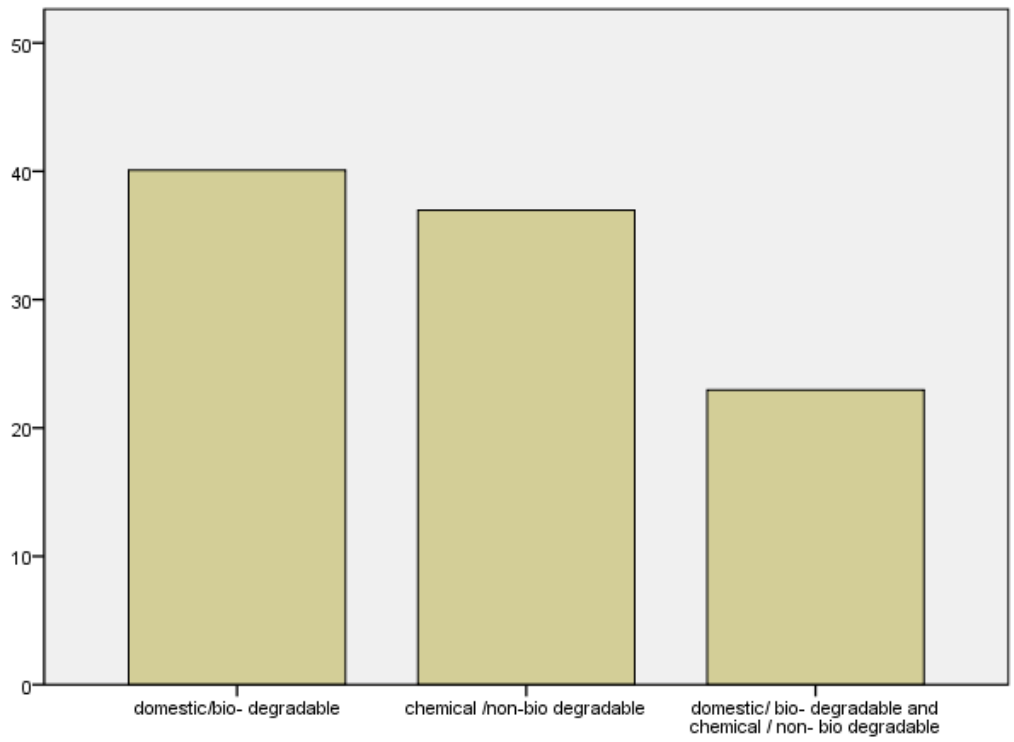

Figure 12: Type of industrial solid waste

Though 54.5% people said that the waste disposal process is incineration, other 34.6% people said that they put the solid waste in open space and 8.9% people said that they put the waste materials in the drain.

Table 21: Location of waste disposal of industry

	Frequency	Percent	Cumulative Percent
Open space	89	34.6	34.6
Drain	23	8.9	43.6
Incineration	140	54.5	98.1
Open space and incineration	3	1.2	99.2
Open space and drain	2	.8	100.0
Total	257	100.0	

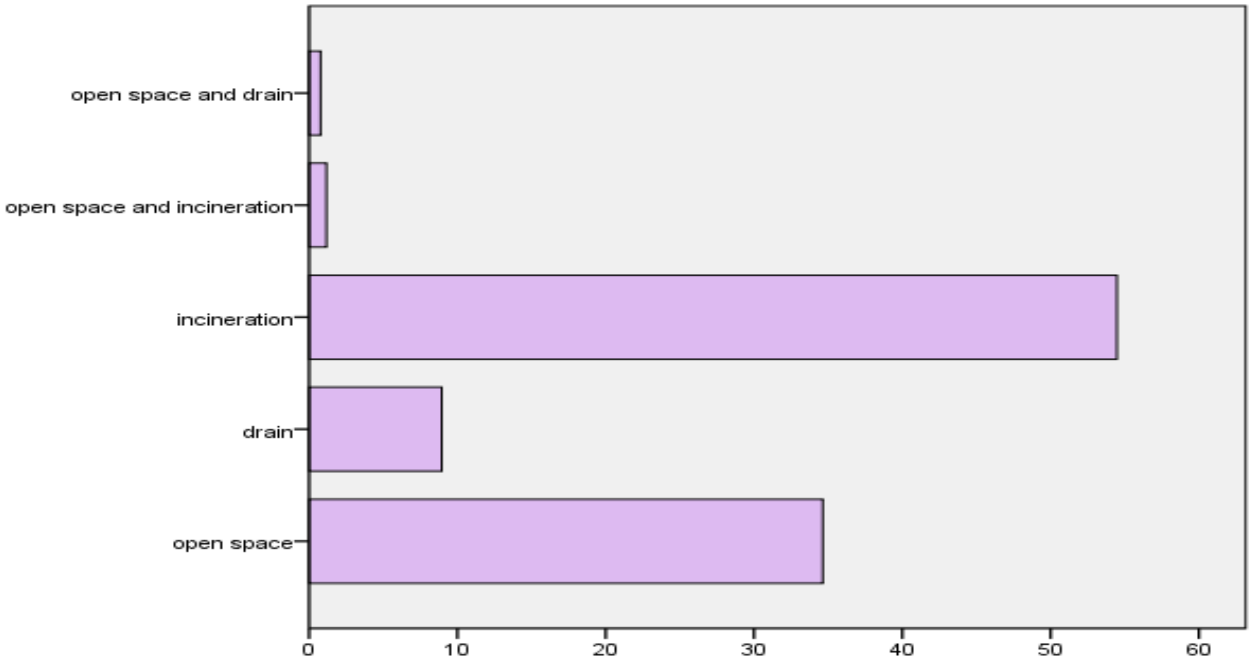

Figure 13: Location of waste disposal of industry

About 82.5% people said that they did not find any suitable location for industrial waste. The industrial wastes are mainly put in the open space, drain and other many locations that also cause's various diseases.

Table 22: Fixed location of industrial waste disposal

	Frequency	Percent	Cumulative Percent
Yes	45	17.5	17.5
No	212	82.5	100.0
Total	257	100.0	

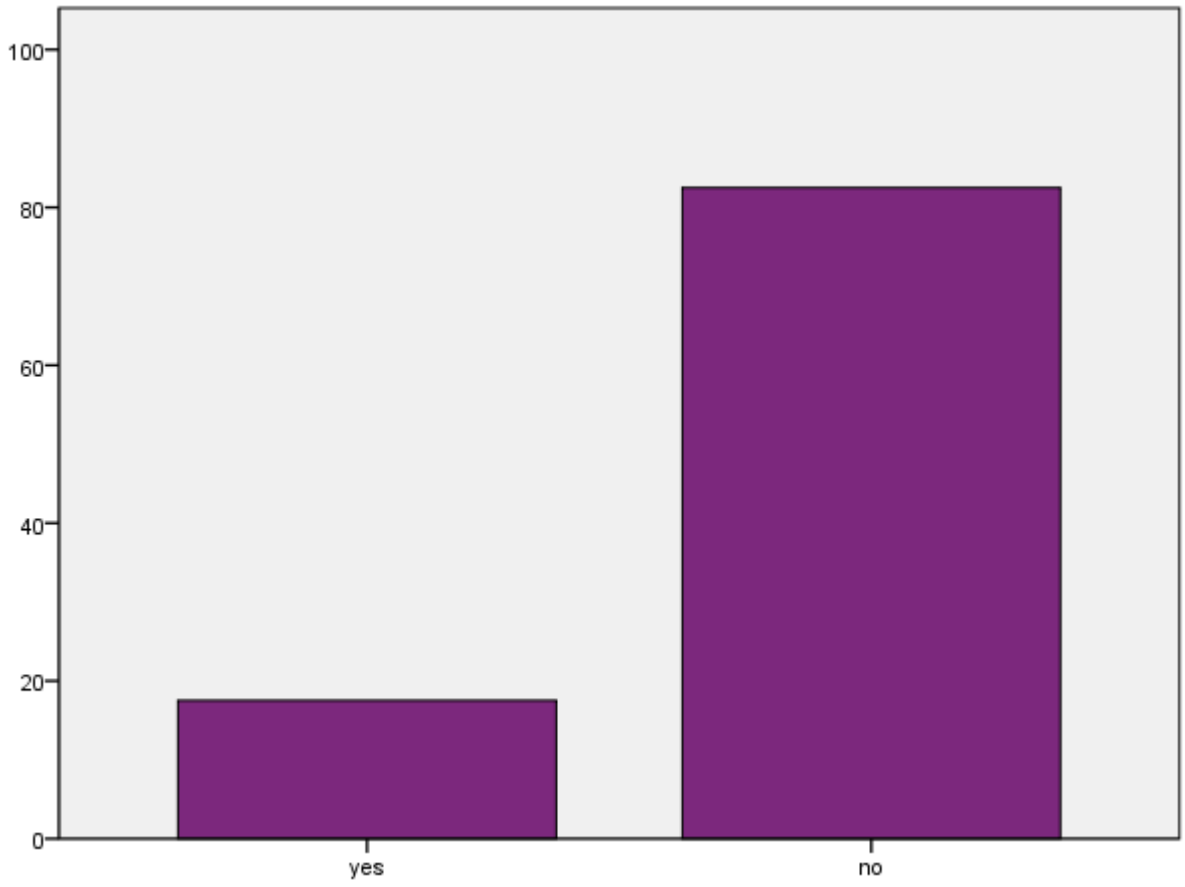

Figure 14: Fixed location of industrial waste disposal

Chapter 5

Recommendations

Solution to the pollution of water in order to provide with safe drinking water is needed at the moment which must be followed by protocols also. In order to build up a peaceful society as well as country where everyone should be aware of several guidelines such as-

- It is a pre-requisite to change and improve social and behavioral attitude of inhabitants and strict enforcement of environment and water pollution related law for betterment of the environment as well as drinking water quality.
- Supplied water and storage water should be observed carefully to avoid further deterioration of water before consumption.
- People need to gather proper knowledge compulsorily about the usage of water every time they use toilet as well as, before and after eating.
- Cleaning household items and throwing any kind of waste material is to be disposed properly in an appropriate place rather than direct throwing to water surface or rivers.
- Every citizen needs to be aware about anything that has to do with the water resources.
- Application of pesticides, herbicides and fertilizers should be controlled and disposal of these chemicals, motor oils or automotive fluids into sanitary sewer or riverside is required to be stopped.
- Solid or liquid medicines are to be wrapped with dry wastes after consumption as otherwise it can cause serious issue if mixes with water.

- Drinking water is to be purified and boiled properly before the use to ensure safety of health.
- Steps from Government and NGOs are also required to arrange awareness programs to disseminate fundamental knowledge and train mass population about the basic process of preparing drinking water.

Chapter 6

Conclusion

Water acts as crucial element for both human and plants for their evolution and nourishment. In human body, water liquefies all salts and nutrients that present in food as our body requires an aqueous medium to carry out metabolic reaction which is done by water. In addition, it also controls human body temperature and removes waste materials from the body. For many reasons like this water is a prerequisite element for blossoming of seeds and nourishment of plants as well as photosynthesis of plants. In contrast today's world is facing various types of complicity regarding recourses and water is one of the vital ones. Planning faults still exist on account of the quality of water along with possible health risks. Microbial contamination of drinking water is still significant even in most developed countries alongside the LMICs. These conditions made vigilance highly essential to protect the mankind. Comprehensive and robust epidemiological studies are right now necessary for some of the contaminants such as chlorinated by-products, arsenic, fluoride and uranium. Besides them, toxicological studies are also mandatory to determine the potential risks. Providing safe and acceptable drinking water is needed to be the key target to improve public health in many countries. Hence, now it is imperative for a country to research on drinking water system according to the context of the country following the standard guidelines.

Chapter 7

Future prospects

The outcome of the research suggests that the water quality of the targeted area has degraded over time. In future research, the researcher would like to contemplate the government interventions in the area and the improvement of the water quality. In most cases, the rural areas are urbanized as the population of the area increases at a rapid rate. Subsequently, the waste management system takes a toll and the overall water quality becomes worse over the time. There is also significant scope to conduct future research in the area of water, sanitation and hygiene so that the major problems are discovered and the government and the non-governmental organizations are encouraged to work on this issue. Moreover, the future research should also emphasize on increasing the awareness of the mass population regarding the water quality in the area and the possibility of different kind of disease in the area.

Chapter 8

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ANNEX

Questionnaire for Survey

1. RwicKvixi bvg-
2.

MÖvg	
BDwbqb	
Dc‡Rjv	
†Rjv	

3. Avcwb wK g‡b K‡ib †h Avcbvi cÖavb Drm cvwb LvIqvi Rb¨ wbivc`?

□nu¨v □bv

4. Kxfv‡e cyKzi/ b`x/ Lv‡ji cvwb wbivc` Kiv hvq ?
□ Boiling □ Filtering □ Chlorination/line/potash
□Fitkiri□ Water purification tablet □ Don't know □ Other

5. ¯^v¯'¨Ki cvqLvbvi Kx Kx myweav i‡q‡Q?
□ To keep environment clean □ To prevent spread of disease
□ Present Contamination of water source □ Drive's □ Don't know.

6. KwVb e‡R©¨I aiY
□ Domestic / Bio-degradable □ chemical /non-biodegradable
□ Clinical □ Others

7. cÖwZw`‡bi KwVb e‡R©¨ cwigvY (‡KwR‡Z) ?

8. AvcwbeR¨© †Kv_vq †d‡jb?

□ Open field □ Pond □ Drains □ Land fill
□Incineration □ N/A □ Others

9. LvIqvi cvwbi g~j Drm wKwK ?

□ Tube well □ Dug well □ Pond
□ River /Canal □ Pipeline survey

10. cvwbi Drm KZ `~‡i (wgUvi) ?

11. †K ‡ewki fvM mgq Avcbvi cwiev‡ii Rb¨ cvwb msMÖn K‡ib ?
□ Woman □ man □ Boy or Girl

12. cvwbmsMÖni †ÿ‡ÎAvcbvime‡P‡q ¸iæZimgm¨vKxKx ?

□ No Problem □ Distance □ Harassment
□ Insufficient Water □ Arsenic □ Water purification problem

wkí Ges cÖvwZôvwbK Rwic

13. wkí/cÖwZôv‡bi bvg - .....|

14. cvwbi Drm mg~n-
□ Ground water □ Surface water
□ Treated recycled water. □ Others.

15. cÖwZw`b wK cwigv‡Y cvwb cÖ‡qvRb nq (wjUvi) ?

16. cÖwZeQi †h cwigvYcvwbcÖ‡qvRb nq (wjUvi) ?

17. Avcbv‡`iwKBwUwc (ETP) Av‡Q?

□nu¨v □bv

18. Type of solid waste.
□Domestic/Bio-degradable □Chemical/non-bio degradable
□Clinical □Others

19. Location of waste disposal.
□Open space □Drain □Loral ditch/ponds
□Incineration □Others

Water Quality and Use

20. ‰ewk‡ó¨iaiY-

□Tube well □Dug well □Pond
□Deep Tube well □submergible pump
□ Others

21. cvwbie¨envi-

□ Drinking □ Bathing □ Washing □ Irrigation
□ Cuffing □ Fishing □ Others

22. wbf©ikxjgvby‡limsL¨v-

23. ïK‡bv †gŠmy‡gcvwbimnRjf¨Zv-

□nu¨v □bv

EIA (Environmental Impact Assessment)

24. AvcbviGjvKvqcvwbiRjve×Zvicwiw¯’wZ †Kgb?

25. Avcbv‡`i ^`wbKe¨envh© eR©¨ †djviwbw`©ó RvqMvAv‡QwKbv?

□nu¨v □bv