ADDIS ABABA UNIVERSITY
COLLEGES DEVELOPMENT STUDIES, CENTRE FOR
ENVIRONMENT AND DEVELOPMENT STUDIES

Causes and Effects of Water Pollution on Human Health and the Aquatic Ecosystems: the Case of Bahirdar Satellite Town, Blue Nile '*Abbay'* River Basin

A thesis submitted to the College of Development Studies, Centre for Environment and Development Studies, Addis Ababa University, in Partial Fulfilment for the Requirements of the Masters of Sciences Degree in Water Resource Management

By

Amare Malede Emru

Advisor
Professor Belay Simane (PhD)

September, 2020
Addis Ababa, ETHIOPIA

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By
Amare Malede Emru
(AAU ID.No.GSR/9812/09)

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ACKNOWLEDGMENTS

To begin with, I would be faithful to thank the Almighty God for being with me, realizing my goal and for this absolute love, a multitude of forgiveness and protection upon me in all aspects, through my study and writing my thesis paper at Addis Ababa University. In adding up, I am very grateful to thank the Centre for Environment and Development study and Department of Water Resource Management its staff members to support me in different ways. I would like to extend my sincere thanks to my advisor Professor. Belay Simane, for the commitment of his expensive time, helpful suggestions, comments and systematic assistance from the early design of the proposal to the final write up of the thesis. I, really, appreciate his kind and untiring effort.

I am also very grateful to the Bahir Dar Water and Sanitation office for providing me the necessary data. Study participants are highly acknowledged for their willingness to participate in the study.

LIST OF ACRONYMS AND ABBREVIATIONS

CWA	Clean Water Act
EPA	Environmental Protection Agency
EPAE	Environmental Protection Authority of Ethiopia
EPC	Entering Procurement and Construction
FAO	Food and Agriculture Organization
HHs	Households
ICRC	International Committee of Red Cross
IDPS	Internal Displaced Peoples
NSP	National Sanitation Policy
SDWF	Safe Drinking Water Foundation
SHE	Somali and Environmental Health
SIWI	Stockholm international water institute
SPSS	Statistical Package for the Social Sciences
TDS	Total Dissolved Solids
UN	United Nation
UNEP	United Nation Environmental Protection
UNICEF	United Nations International Children's Emergency
UNW	United Nation Water
UNWHO	United Nation World Health Organization
USERA	United States Endurance Racing Association
WCED	Western Cape Education Department
WDM	Water Quality Management
WHO	World Health Organization

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ABSTRACT

Water pollution occurs when unwanted materials enter in to water, changes the quality of water and become harmful to environment and human health. Despite water is an important natural resource used for drinking and other developmental purposes in Bahirdar satellite town, there are public concerns on the lack of safe drinking water, deteriorating aquatic ecosystem and water borne health problems. Thus, this thesis was imitated to investigate the causes and effects of water pollution on human health and the surrounding aquatic ecosystem in some selected areas of Bahirdar satellite towns, the *Abbay* river basins. Both qualitative and quantitative data were collected from primary and secondary data sources using a structured questionnaire, interview guides and thematization, and analyzed by using the latest SPSS software. From the study, it was found that the Bahirdar satellite town, *Abbay* river basin was highly polluted. Accordingly, discharge of domestic and industrial effluent wastes, leakage from water tanks, unlawful dumping, radioactive waste and agricultural deposition are major causes of water pollution. Agricultural pesticides and fertilizers that disposed off and industrial waste can accumulate in tan lakes and the *Abbay* river basin, proving harmful to humans and animals. Toxic effluents in industrial wastes of the '*Poly'* and '*Peda'* campuses of Bahirdar University were also the major cause of water pollution. Infectious diseases, like cholera, typhoid fever and other diseases gastroenteritis, diarrhoea, vomiting, skin problems, reproductive failure, acute poisoning and kidney problem are spreading through polluted water. Human health is affected by the direct damage of plants and animal nutrition. The pollutants were killing useful plants, molluscs, aquatic birds, fishes, crustaceans and other aquatic organisms that serve as food for human. Insecticides and other chemical waste concentration were increasing along the food chain. These insecticides were harmful for humans. Based on the findings of the research it were recommended to enhance public awareness, preventive enforcement and legislative measures and carryout mechanical and biological soil and water conservation measures so as to improve river water quality in *Abbay* River basins.

Keywords: *Abbay* River basin, Bahir Dar Satellite town, Health effect, Point Source Pollution, Non-Point Source Pollution, perception, Water pollution

CHAPTER ONE

1. INTRODUCTION

1.1 Background of the Study

Water is an important natural resource used for drinking and other developmental purposes in our lives (Bibi S, Khan RL, Nazir R, et al., 2016). Safe drinking water is necessary for human health all over the world. However, frequent water pollution occurs when unwanted materials enter in to water bodies, and changes the quality of water (Alrumman SA, El-kott AF, Kehsk MA, 2016) and harmful to environment and human health (Briggs D,2003).

Being a universal solvent, water is a major source of infection. According to world health organization (WHO) 80% diseases are water borne. Drinking water in various countries does not meet WHO standards (Khan N, Hussain ST, Saboor A, et al., 2013). 3.1% deaths occur due to the unhygienic and poor quality of water (Pawari MJ, Gawande S., 2015). Environmental difficulties are a major global alarm. In this global problem, water pollution is possibly one of the more threatening causes of environmental problems. Water is the most sensitive part of the environment, and a prerequisite for human and industrial development. The demand for fresh water continues to increase due to the population growth and access to clean water is becoming increasingly complex. Water is the most vital element among the natural resources, and is Critical for the survival of all living organisms including human, food production, and economic development (Joshua et al, 2015). The environment, economic growth, and developments are all highly influenced by water-its regional and seasonal availability, and the quality of surface and groundwater. The quality of water is affected by human activities and is declining due to the rise of urbanization, population growth, industrial Production, climate change and other factors. The resulting water pollution is a serious threat to the well-being of both the Earth and its population. Ethiopia has great potential of both surface and ground water resources and result into giving a name to the country as the water tower of east Africa, Said R (1993) as cited in Arga and Molla (2014). Unsafe industrial waste disposal causes surface water contamination in many developing countries. This is particularly true for the per-urban shanty towns and the rural hinterland villages downstream of cities that are reliant on rivers passing through an industrialized area.

Discharge of untreated industrial waste is a major problem for many communities dwelling near rivers basins through causing different health problems.

The polluted water may have undesirable colour, odour, taste, turbidity, organic matter contents, harmful chemical contents, toxic and heavy metals, pesticides, oily matters, industrial waste products, radioactivity, high Total Dissolved Solids (TDS), acids, alkalis, domestic sewage content, virus, bacteria, protozoa, rotifers, worms, etc. The organic content may be biodegradable or non-biodegradable. Pollution of surface waters (rivers, lakes, and ponds), ground waters, and sea water are all harmful for human and animal health. Pollution of the drinking water and that of food chain is by far the most worry-some aspect. Water Quality Management in India, Feb. 2008, Countries throughout the world are concerned with the effects of unclean drinking water because water-borne diseases are a major cause of morbidity and mortality (WHO, 2010). Clean

3 drinking water is important for overall health and plays a substantial role in infant and child h ealth and survival The World Health Organization (2005) estimates that worldwide about 1.8 million people die from diarrheal diseases annually. Persons with compromised immune systems, such as those with AIDS, are especially vulnerable to water-borne infections, even those which are not typically threatening to healthy individuals. The people most vulnerable to water-borne diseases are those who use an unclean drinking water source. Throughout the less developed world, the proportion of households that use an unclean drinking water source has declined, but it is extremely unlikely that all households will have a clean drinking water source in the foreseeable future. UNICEF (2010) reported that 884 million people in the world use an unimproved drinking water source, and estimates that in 2015 it will be projected to 672 million people will still use an unimproved drinking water source. Thus, it is important to understand what leads a household with an unclean water source to treat its drinking water.

Presently most industries do not treat their wastes if it contains no recyclable products which could be reprocessed or sold to generate additional revenue. As treatment would be more costly, industries are not interested to participate in safe waste disposal activities since there is no binding rule of how to dispose their wastes without affecting the nearby exposed society (Wandaig, 1977). Poor storage of industrial and other waste products also results in ground and surface water pollution. Major causes include the poor design of storage facilities, leakage from damaged stores and the seepage from treatment ponds. Large percentage of waste products

discharged directly into water sources without treatment especially in developing countries where sewage treatment is currently low. Only a few countries have primary treatment facilities to remove about 40-50% of the organic load (BOD) and very few use any secondary treatment process to remove more than 80% of the BOD (Laugril, 1990).

1.2 Statement of the Problem

Water must be sustainably free of dissolved salts, plant and animal waste and bacterial contamination to be suitable for human consumption. There are a lot of waste including Medical waste, animal and House Hold Waste, Municipal and all pollutants that can affect and reduce the quality of water, even though people know that the river is polluted and have hazardous health implications, they go on utilizing this river for various purposes (Tedla and Lemma, 1998;). Studies conducted by Yirga, et al., (2016) on Abbay River Tributaries have shown that water-washed and water-borne diseases such as typhoid, diarrheal, cholera, and rashes on skin are apparent in the catchment area. They are exposed to additional medical expenses and have negative effect on the productivity of lab or force. The continuation of such health problems undermine the development efforts and aggravate the vicious circle of poverty. The existing poor sanitations, poor effluent treatment of factories and sewerage and waste disposal systems of the dwellers and Industries is causing toxicity on the river and relatively high health problem to the society. To this regard, Nizelr (2015) stated the perception of water pollution on human health results skin indigestion, hypertension, gout, rheumatism, conjunctivitis, pneumonia, malaria, tuberculosis and cancer. Since a very large number of people have no other source of water for domestic use and agricultural irrigations, it is not surprising to come across acute and chronic health effects in evidence as a result. Being polluted, these rivers are causing different social and economic problems to the livelihood of the downstream residents. Due to the absence of alternative source of water in the areas, large number of people of the downstream residents living in the catchment areas of the rivers-uses these rivers for different purposes (Ayemere, *et al.,* 2015). Even if the pollution rate of Abbay river in Bahirdar satellite town is escalating and larger number of societies in the downstream are highly impacted by the pollution, no stakeholders either of the government or researcher tried to investigate and set solutions for health problem of the human resulted from polluted water of Abbay river. Hence, this thesis is

intended to investigate the perceived causes and effects water pollution on human health and the surrounding ecosystem in Bahirdar satellite town.

1.3. Research Questions

In line with the above statement of the problems, this paper intended to answer the following emerged research questions:

1. What are the major causes of water pollution in Abbay River in Bahir Dar Satellite town residents?
2. What is the perceived health and ecosystem related effects water pollution among Abbay River Basin, Bahir Dar Satellite town residents?
3. What strategies will be devised to reduce impact of water pollution on human health and the surrounding aquatic ecosystem in Bahir Dar Satellite town residents?

1.4. Objective of the Study

1.4.1 General Objective

The general objective was to investigate the causes and effects of water pollution on human health and recommend intervention mechanisms for the surrounding aquatic ecosystem in some selected areas of Bahirdar satellite towns, the Abbay river basins.

1.4.2 Specific objectives

1. To identify the major causes of water pollution that affect human health in *Abbay* river basin.
2. To assess the perceived human-health related and ecological effects of water pollution in Bahirdar satellite town residents and *Abbay* River Basins.
3. To recommend a mitigating strategy that curbs of water pollution and the associated health problems among the Bahirdar satellite town residents.

1.5. Scope of the Study

In Bahirdar there are 17 kebeles, considering the distance of the kebeles from the river and vulnerability the study would be limited in three districts in Bahirdar satellite town that were located nearer to the *Abbay* River in Bahirdar. Thematically, the study was intended to investigate the perception of water pollution on human health.

1.6. Significance of the Study

The study would be of beneficial to all stakeholders of the issue of Effect of Water pollution on human health. They were many but among them were the Government of Bahirdar satellite town, especially the Ministry of Water Resources, Bahirdar Water Agency, Ministry of Health to take actions on the issue; also Local Government and Non-Governmental Organizations would be beneficial from the finding of the study in order to improve their projects success. International Organizations would use the study as baseline data to their Environmental Health projects, and donors to fund and implement further studies and carry out mitigation and adaptation projects and programs of Effect of Water pollution.

Decision makers and policy implementers/formulators in central government would used the findings to evaluate the perception of water pollution on human health. The findings of this study would also help academicians and further researchers to embark on a related study.

1.7. Limitations and Challenges of the Study

The study limits itself to the perceived causes and effects of water pollution on human health and the surrounding ecosystem. Hence, it did not include physico-chemical analysis and biological data that would corroborate the finding with accurate information on the extent of water pollution on Abbay River Basin, Bahir Dar Satellite town. A medical study on water pollution on human health requires the inputs of different professionals, laboratories and facilities. However, this study did not carry out critical diagnoses on the health status of the *Abbay* basin and the nearby residents. Thus, the study might not be technically sound enough to answer all questions related to technical designs of the systems and health-related issue. It was difficult to make interviews with some officials as they made appointment repeatedly to give information and not available on the appointment dates. The other challenge was lack of sufficient, organized reports and other secondary data in some offices to capture the historical issues of the *Abbay* River basin.

1.8. Definitions of the Key Terms

Disease is a disorder of structure or function in a human, animal, or plant, especially one that produces specific symptoms or that affects a specific location and is not simply a direct result of physical injury.

Eutrophication: is an excessive richness of nutrients in a lake or other body of water, frequently due to run-off from the land, which causes a dense growth of plant life.

Perception: the ability to see, hear, or become aware of something through the senses. It is the way in which something is regarded, understood, or interpreted.

Pollutant: are agents that reduce the quality of water.

Water pollution: is any chemicals, physical or biological that changes the quality.

Water borne diseases: are conditions caused by pathogenic micro-organisms that are transmitted in water.

Water Related Disease: is to illnesses fall into four major categories including cholera, typhoid, and dysentery, are caused by drinking water containing infectious viruses or bacteria, which often come from human or animal waste.

Water washed Diseases: are infections that are caused by poor personal hygiene resulting from inadequate water availability. ... Typical water-washed diseases include Shigella, which causes dysentery, scabies, trachoma, yaws (skin disease), leprosy, conjunctivitis, skin infections and ulcers. Scabies is a highly contagious skin infection.

Water contaminated Disease: is a disease acquired by drinking water contaminated at its source or in the distribution system, or by direct contact with environmental and recreational waters. **Water-borne disease:** results from infection with pathogenic microorganisms or chemical poisoning. Waterborne diseases are conditions caused by pathogenic micro-organisms that are transmitted in water. Disease can be spread while bathing, washing or drinking water, or by eating food exposed to infected water.

Sewage materials: it is a form of waste management. A septic tank or other on-site wastewater treatment system such as bio filters or constructed wetlands can be used to treat sewage close to where it is created. Sewage treatment results in sewage sludge which requires sewage sludge treatment before safe disposal or reuse.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Concepts of Pollution

Pollution is the introduction of contaminants into a natural environment that causes instability, disorder, harm or discomfort to the ecosystem i.e. physical systems or living organisms, Webster (2010). Pollution can take the form of chemical substances or energy, such as noise, heat, or light. Pollutants, the elements of pollution, can be foreign substances or energies, or naturally occurring; when naturally occurring, they are considered contaminants when they exceed natural levels. Pollution is often classified as point source or nonpoint source pollution. The Blacksmith Institute issues annually a list of the world's worst polluted places. The non-point resource pollution is the most common and serious problem in the study area.

2.2. Type of Pollution

2.2.1 Water Pollution

Water pollution is considered polluted if some substances or condition is present to such a degree that the water cannot be used for a specific purpose. Olaniran (1995) defined water pollution to be the presence of excessive amounts of a hazard (pollutants) in water in such a way that it is no long suitable for drinking, bathing, cooking or other uses. Pollution is the introduction of a contamination into the environment (Webster, 2010). It is created by industrial and commercial waster, agricultural practices, everyday human activities and most notably, models of transportation. No matter where you go and what you do, there are remnants earths environmental and its inhabitants in many ways. The three main types of pollution are: Land Pollution, Air Pollution and Water Pollution. Both for the purpose of this research, emphasis are on water pollution and control.

2.2.2 Air Pollution

Air pollution is the introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or damages the natural environment into the atmosphere. The atmosphere is a complex dynamic natural gaseous system that is essential to support life on planet Earth. Stratospheric ozone depletion due to air pollution

has long been recognized as a threat to human health as well as to the Earth's ecosystems. Indoor air pollution and urban air quality are listed as two of the world's worst pollution problems in the 2008 Blacksmith Institute World's Worst Polluted Places report (worstpolluted.org, 2010)

2.2.3 Light Pollution

Light pollution, also known as photo pollution or luminous pollution, is excessive or obtrusive artificial light. The International Dark-Sky Association (IDA) defines light pollution as any adverse effect of artificial light including sky glow, glare, light trespass, light clutter, decreased visibility at night, and energy waste. This approach confuses the cause and its result, however. Pollution is the adding of added light itself, in analogy to added sound, carbon dioxide, etc. Adverse consequences are multiple; some of them may be not known yet. Scientific definitions thus include the following: Alteration of natural light levels in the outdoor environment owing to artificial light sources (Cinzano *et al,* 2000). Light pollution is the alteration of light levels in the outdoor environment (from those present naturally) due to man-made sources of light. Indoor light pollution is such alteration of light levels in the indoor environment due to sources of light, which compromises human health (Hollan, 2009). Light pollution is the introduction by humans, directly or indirectly, of artificial light into the environment (Marin and Orlando, 2009). The first two of the above three scientific definitions describe the state of the environment. The third (and newest) one describes the process of polluting by light. Light pollution obscures the stars in the night sky for city dwellers, interferes with astronomical observatories, and, like any other form of pollution, disrupts ecosystems and has adverse health effects. Light pollution is a side effect of industrial civilization. Its sources include building exterior and interior lighting, advertising, commercial properties, offices, factories, streetlights, and illuminated sporting venues. It is most severe in highly industrialized, densely populated areas of North America, Europe, and Japan and in major cities in the Middle East and North Africa like Tehran and Cairo, but even relatively small amounts of light can be noticed and create problems.

2.2.4 Noise Pollution

Noise pollution (or environmental noise) is displeasing human, animal or machine created sound that disrupts the activity or balance of human or animal life. The word *noise* comes from the Latin word *nauseas*, meaning seasickness. The source of most outdoor noise worldwide is mainly construction and transportation systems, including motor vehicle noise, aircraft noise and

rail noise (Michael and Gary, 1973). Poor urban planning may give rise to noise pollution, since side-by-side industrial and residential buildings can result in noise pollution in the residential area. Indoor and outdoor noise pollution sources include car alarms, emergency service sirens, mechanical equipment, fireworks, compressed air horns, grounds keeping equipment, barking dogs, appliances, lighting hum, audio entertainment systems, electric megaphones, and loud people.

2.2.5 Radioactive Contamination

Radioactive contamination, also called radiological contamination, is radioactive substances on surfaces, or within solids, liquids or gases (including the human body), where their presence is unintended or undesirable, or the process giving rise to their presence in such places IAEA, (2007). It is formally to refer to a quantity, namely the activity on a surface (or on a unit area of a surface). Contamination does not include residual radioactive material remaining at a site after the completion of decommissioning. The term radioactive contamination may have a connotation that is not intended. The term radioactive contamination refers only to the presence of radioactivity, and gives no indication of the magnitude of the hazard involved.

2.3. Soil Contamination (Soil Pollution)

Soil contamination is the presence of xenobiotic (human-made) chemicals or other alteration in the natural soil environment. This type of contamination typically arises from the rupture of underground storage tanks, application of pesticides, and percolation of contaminated surface water to subsurface strata, oil and fuel dumping, leaching of wastes from landfills or direct discharge of industrial wastes to the soil. The most common chemicals involved are petroleum hydrocarbons, solvents, pesticides, lead and other heavy metals. This occurrence of this phenomenon is correlated with the degree of industrialization and intensities of chemical usage. The concern over soil contamination stems primarily from health risks, from direct contact with the contaminated soil, vapours from the contaminants, and from secondary contamination of water supplies within and underlying the (EPAE, 1997).

2.3.1 Definition of Water Pollutions

Water pollution can be defined as any physical, biological, or chemical changes in water quality that adversely affects living organisms or makes water unsuitable for desired uses. Pollution alters the quality of a water body. It significantly disturbs the natural entity of the physical and

biological components of a water body. It also undermines the socio-economic values of the rivers or other water bodies (FEPA, 2005). Water pollution can be either man made or natural. Water is considered polluted if some substances or condition is present to such a degree that the water cannot be used for a specific purpose. Olaniran (1995) defined water pollution to be the presence of excessive amounts of a hazard (pollutants) in water in such a way that it is no long suitable for drinking, bathing, cooking or other uses. Pollution is the introduction of a contamination into the environment (Webster.com, 2010). It is created by industrial and commercial waster, agricultural practices, everyday human activities and most notably, models of transportation.

2.3.2 Types of Water Pollution

The most serious water pollutants in terms of human health worldwide are pathogenic organisms. The main source of these pathogens is from untreated or improperly treated human wastes. Both bacterial and viral, nitrates from fertilizer use, heavy metals from soil and urban runoff, mineral oil discharges from illegal dumping, chlorinated solvent discharges from poorly managed waste disposal sites, acid rain, and a cocktail of poisons from working industrial and mineral sites (Merrett, 1997).

The interaction of human being with the natural environment around him has been the basis for continuity and survival of life on the planet Earth. In this process, man has been utilizing natural resources that are necessary to support daily life. The intensity of resource utilization has progressed in parallel with the ever increasing population and to satisfy the growing development needs of humankind. It is beyond any reasonable doubt that urbanization is part of such development of natural resource that has the effect of shrinking the possible but unnecessary impact exerted on the resource (EPAE, 2002).

According to William and et.al (1995) .water pollution sources are distinguished into two. These are point and nonpoint pollution sources:

i. **Point sources:** are emissions, which enter water bodies from an easy to-identifying single source, such as pipe from a factory or the outfall from a sewage works. Factories, power plants, sewage treatment plants, underground coalmines, and oil wells are classified as point sources. Because these categories are discharge pollution from specific locations, these sources are discrete and identifiable; and relatively easy to monitor and regulate. It is

generally possible to divert effluent from the waste streams of these sources, treat it before it enters to the environment, and pollute the water. Point sources are fairly uniform and predictable throughout the year.

ii. **Nonpoint sources:** these types of water pollutions are scattered or diffuse, having no specific location where they discharge into a particular body of water. Nonpoint sources include runoff from farm fields, lawns and gardens, construction sites, logging areas, roads, streets and parking lots. Nonpoint sources are often highly episodic.

In developed countries, sewage treatment plants and other pollution control techniques have reduced or eliminated most of the worst sources of pathogens in inland surface waters. The situation is quite different in less-developed countries. The United Nations estimates that at least 2.5 billion people in these countries lack adequate sanitation, and that about half these people also lack access to clean drinking water. Water quality control personnel usually analyze water for the presence of coli form bacteria, any of the types that live in the colon or the intestines of humans and other animals (EPAE, 2005).

2.4. Causes of Water Pollution

Today river pollution problems are heard all over the globe because of the ever-increasing population, industrialization, urbanization and other human activities. Though Ethiopia is facing the problems that emanates from water quality deterioration in general (UNESCO, 2004). The extent and severity of the problem is glaringly manifested in major cities of the country. The pollution of water is attributed to many sources and types of pollutants. When pollutants are discharged in to a river, a succession of changes in water quality takes place, in the downstream side from a point of pollution. The study conducted by the EPAE (2006) identified the following major pollutants.

2.4.1 Industrial Sources

In our country, industrial pollutions are observed around urban areas because urban areas have better infrastructure and they are suitable for the establishment of industries. In Ethiopia, most of the industries are found in most urban areas. The major pollutant industries, which are found in this area, are food and beverage, leather factories, textile, tanneries, rubber and plastic, metallic and non-metallic mineral products and wood industries. Most of the industries that are found discharge their wastewater and liquid effluents into open ditches (municipal drainage), which finally ends up in the river. Among these industries most of them discharge their wastes without

any treatment in to the nearby water bodies and open spaces (National Water Development Report for Ethiopia; December 2004).

2.4.2 Municipal Sources

Cities in developing countries are experiencing unprecedented population growth, because they are expected to provide better economic and social opportunities than do rural areas. Because of this, rural to urban migration is very high. Ethiopia is one of those developing countries, where by urban population growth rate is higher. When population increases, the municipal solid and liquid waste generation also increases accordingly. Miss-proportionality of the population growth and urban facilities can result to urban pollution. Hence, it is apparent that one of the sources of river water pollution is the municipal waste of urban areas. Regarding to population growth and urbanization Bahirdar is becoming one of highly populated and urbanized city in Ethiopia.

2.4.3 Major Types of Municipal Wastes that Contribute Water Pollution

The major sources of municipal wastes that contribute for water pollution are:

i. **Municipal solid waste:** "municipal solid waste" includes street sweeping waste, commercial, industrial and other institutions' solid wastes. When there is no adequate municipal solid waste management facility, the domestic solid waste is not collected properly. Often it is piled on available open grounds, stream banks, and bridge areas and is transported by storm and run off into the rivers. Municipal solid waste management problem is considered to be among the most serious environmental challenges that the world is currently encountering.

ii. **Municipal liquids wastes:** Domestic liquid waste from overflowing and seeping pit latrines, septic tanks. This municipal liquid waste is mainly caused by liquid waste from toilets, liquid waste from kitchens and bathrooms, open urination and defecation places. Public and communal toilets, open ground excreta defecation, flow to the rivers through drainage lines are the source of municipal liquid wastes.

iii. **Other Chemicals:** Deferent types of used chemicals and stored obsolete chemicals are also observed in different organizations. Much of these chemicals can easily be washed away to the rivers, and chemicals used for different purposes in industries discharged to the river after finishing their process. Fuel stations, laundries and oils from garages are

discharged their waste products to open space storage, drainages and rivers which can contaminate river and ground water. Generally, chemical pollution is one of the sources of rivers water pollution. To this regard, there are institutions such as "*Sema'etat hawilt* office" and "abattoir" in Bahirdar city that discharge liquid and solid waste and chemicals to *Abbay* River.

2.4.4. Perception of Water Pollution on Health

Water pollution occurs when the use by one segment of human interferes with the health and well-being of other members. Due to the pollution problem of the rivers, negative impact on the social, economic and environmental conditions have been observed. Strong toxic wastes effluents could kill all plants and animals in the stream in to which they are discharged. Less toxic pollution may also engender quite complex hazards whose ill effects are due to nutrients and suspended matter.

Most polluted water contains substances such as nutrient elements, heavy metals and other toxic compound which can affect human health when present in excessive amounts, are regarded as potential contaminants. These contaminants may endanger the health of both human and aquatic organisms. The major potential negative impact of polluted water is an increase in the incidence of water-related diseases and infections. Human infectious diseases are among the most serious effects of water pollution, especially in developing countries, ware sanitation may be inadequate or non-existent. Waterborne diseases occur when parasites or other disease causing microorganisms are transmitted via contaminated water, particularly water contaminated by pathogens originating from excreta. The infections related to water supply and sanitation are numerous and the relationships are sometimes complex. Water-related diseases may be divided into those, which are caused by some chemical substances in water and water-related infections which are described because their transmission depends upon water. Human consumption in downstream of the polluted area of the river create health problem on children of school age due to river water is more pronounced problem that may have negative impact on their school attendance and educational performance (EPAE, 2006).

2.5. Impacts of Water pollution

2.5.1. Types of Disease Resulted from Water Pollution

Stanwell-Smith (2002) identified seven categories of water-related disease as waterborne microbiological disease; waterborne chemical disease; water hygiene disease; water contact disease; water vector habitat disease; excretal disposal disease and water aerosol disease.

Waterborne microbiological disease is an ailment that is related to consumption of pathogens consumed in water; most due to human or animal faecal contamination of water. Waterborne chemical diseases are disease related to ingestion of toxic substances in water. Water hygiene diseases are diseases whose incidence, prevalence or severity can be reduced by using safe (clean) water to improve personal and domestic hygiene. Water contact diseases are usually caused by skin contact with pathogen infested water or with chemical contaminated water. Water vector habitat diseases are those diseases where vector lives all or part of its life in or adjacent to a water habitat. Excretal disposal disease is a diseases related to unsanitary disposal of human waste (faeces and urine) and water aerosol diseases are related to respiratory transmission, where a water aerosol containing suspended pathogens enters airway.

2.5.2 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).

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).

2.5.3. 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).

3.5.4 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 pre y 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).

2.6. Conceptual Framework

The Conceptual framework of this thesis articulates the road map for the current study. It is about the percieved source of water, households' perception on the effects of water pollution on human health and aquatic ecosystem. It diagramatically presented (see figure 2.1) and dealt with the constructs of pollution sources and effects of water pollution. The conceptual frame work also considered how the Bahidar satellite town residents percieved the ultimate outcomes water pollution and its impact on the livelihoods of the inhabitants nearer to Abbay River basins.

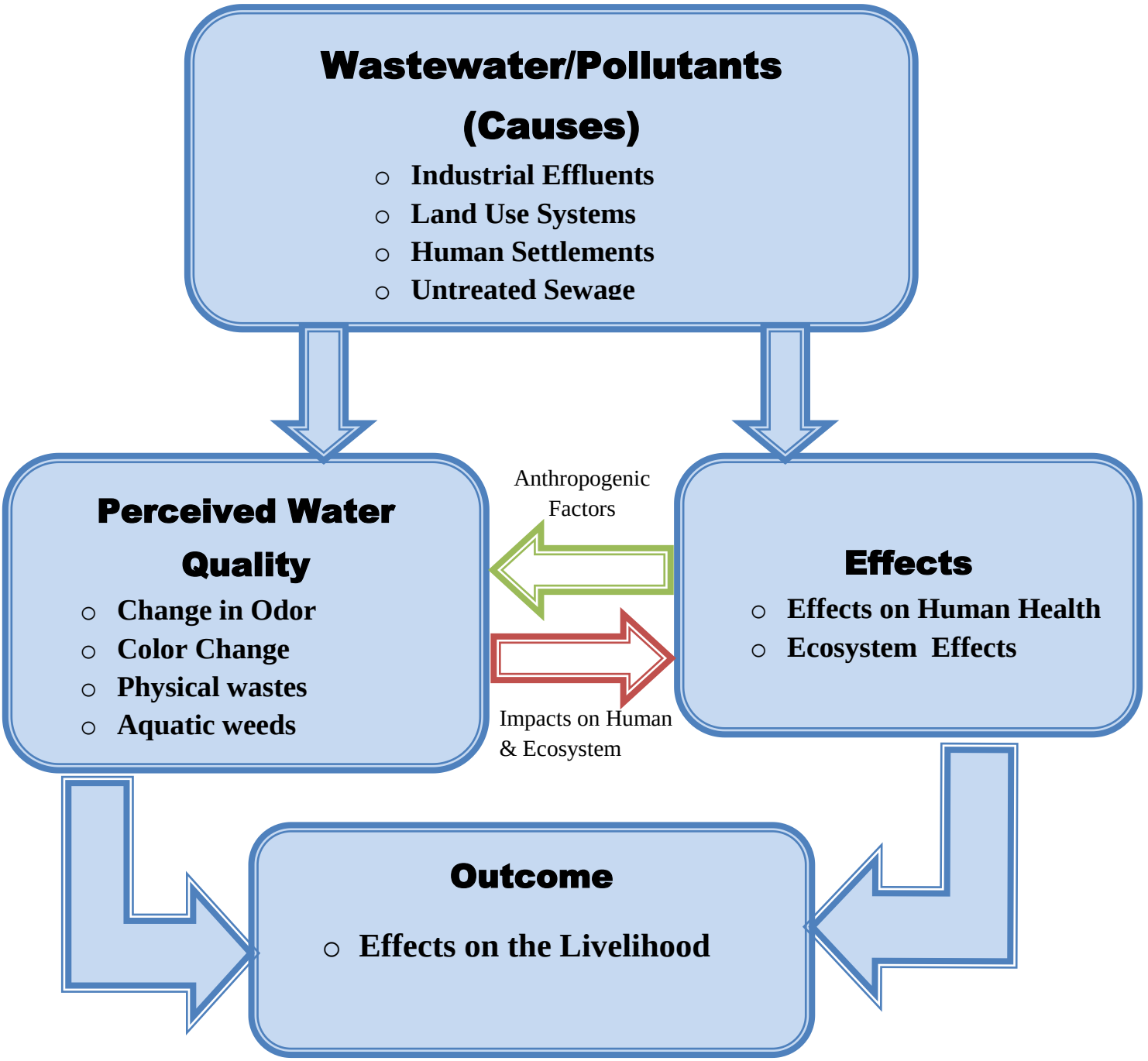


Figure 1. Conceptual framework of the causes and effects of water pollution on human health

CHAPTER THREE

3. MATERIAL AND METHODS

3.0. Overview

This chapter presents the research methodology used in the study. In particular, the research was employ descriptive statistics in order to describe the perception of Water Pollution on human health in the three satellite town. It also presents the description of the study area, research design, source of data, data type, sampling technique and sample size, data collection method, data analysis, and presentation.

3.1. Description of the Study Area

Bahir Dar city is located in the north western part of Ethiopia and is faster growing city in the country (UNEP,2010a). It has a total population of 96,140 in 1994 and 230,344 in 2007 (CSA,2007), and estimated 297,749 in 2014. Currently, the city serving as a regional capital of Amhara National Regional State (ANRS), Federal Democratic Republic of Ethiopia. It has become one of the major tourist destinations of the country with a variety of attractions in the nearby Lake Tana (Ethiopia's largest lake and famous for churches and monasteries on the lake's 37 Islands) and Blue Nile river. A global position of the city is between 15.620 N latitude and 37.420 E longitude, and enjoys tropical type of climate with an average annual temperature of 19.60C and the average elevation of the city is estimated 1801 m above sea level. The city has expanded rapidly throughout the 20th century. Today, waste discharges into Lake Tana have become a serious and highly visible problem (FFE, 2010). In Bahir Dar city, urbanization is increasing at an alarming rate (287,756) in 2014 and it is 301,425in 2015) (CSA, 2007). It is putting immense pressure on municipal services. One of the problems of the urbanization and increasing population is the increased generation of waste. Solid waste generation per day continuously increase and estimated to be 212.2 tones solid waste will be generated in 2022, and which is greater than when it compared with Mekele and Awassa cities. Bahir Dar town divided in to 17 administrative Kebelles land after 2007 reforms these Kebelles arranged with a total of 52 zones (smallest legal administrative units). And there are four satellite towns around Bahir

Dar town. The study focused on the three satellite towns. These are *Andasa*, *Sebatamit* and *Tis Abbay.*

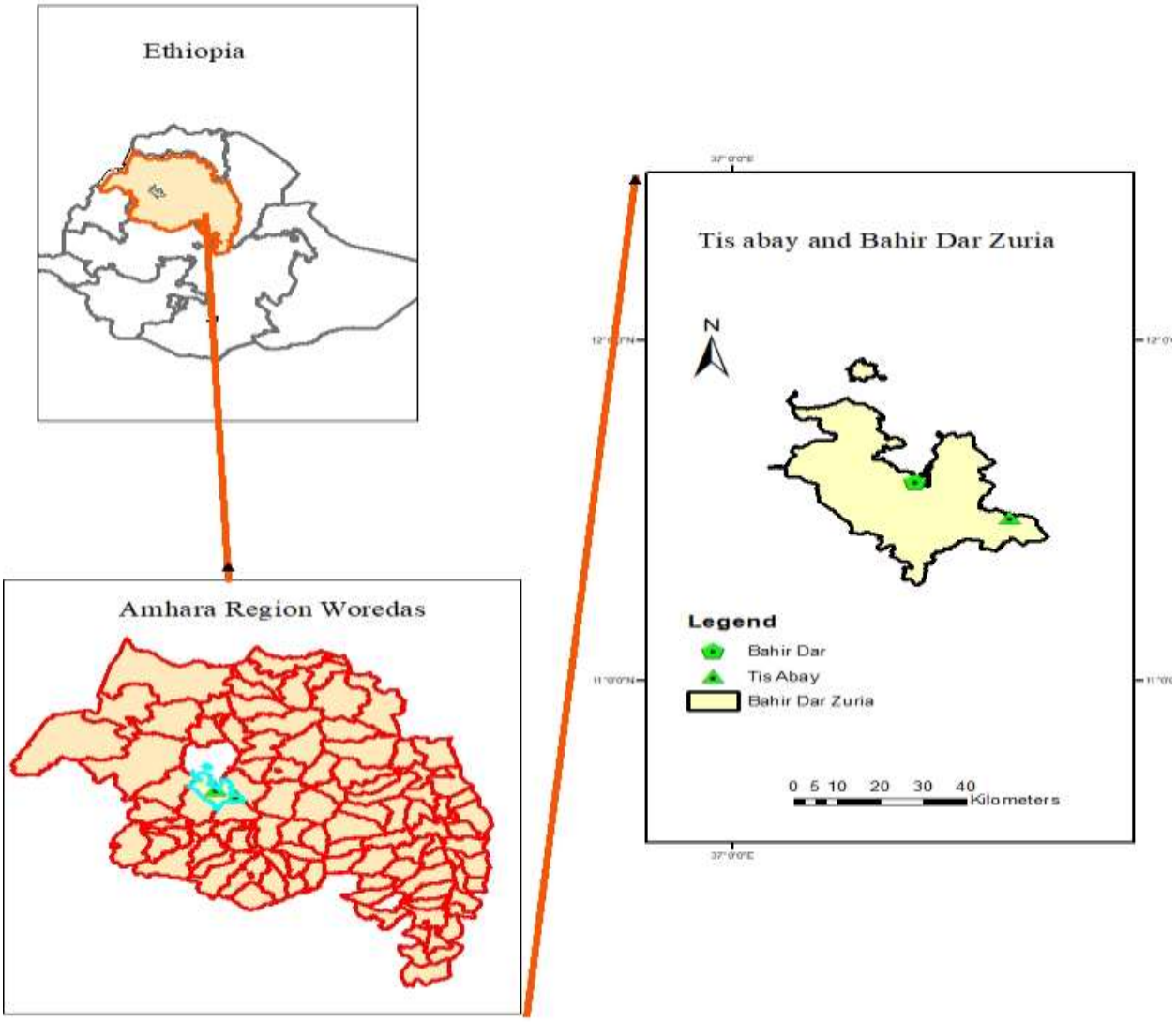


Figure 2 Map of Study Area

3.2. Source of Data

Both primary and secondary sources of data would be used on this study.

3.2.1. Primary data

Household survey: this survey mainly focuses on flow of the perception of water pollution on human health the case of Abbay River in the study area. In order to obtain quantitative primary data for this research work, questioners were performing with households who live in the study areas of the satellite towns. In addition, health professionals in the health centres would be

interviewed about their perception with the water consumption and its perception on health in the catchment area.

Key informants interview: since the study centres on the perception of water pollution on human health the case of Abbay River in the study area, it is basically involving key informants from Bahirdar water agency, health professionals in the health centres and Sewerage Service.

3.2.2. Secondary data

Secondary data of the study would be collect concerning its relevant from review of documents, from the health centres on major health problems Books, earlier research, government publication and Websites. The study used probability sampling techniques was employ to draw sampling satellite towns with random techniques lottery method and used systematic random sampling techniques to draw the sample households and key informants from the total households in the three selected satellite towns.

3.3 Data Collection Techniques and Tools

Data collected from various primary and secondary sources found in Bahirdar Satellite Towns, *Abbay* River basins was analysed with afore set procedures and precautions. To audit the data and a formal checklist was developed. Interview sessions were audio-taped, organized and cleared. The collected data was transcribed in the respondents' local language (Amharic) and was translated to English language by the principal investigator. Qualitative data was collected from both household survey and key informants.

3.4 Data Analysis and Presentation:

3.5 Population of the Study

The study was conducted within the districts of Bahirdar satellite towns, *Abbay* River Basins. Targeted places including, three main districts of the Bahirdar satellite town with the total population 12700 where each Bahirdar satellite town dwellers and those surrounding the *Abbay* River use polluted water from *Abbay* River. Accordingly, from the dwellers in the three satellite town a sample respondents were drawn as the population of the study.

3.6 Sampling Size

The sample size was estimate using sample size determination formula for single population proportion using the following assumptions. a prevalence level that estimate maximum sample size (50%) was considered, marginal error (0.05), non-response rate of 10% or possible absenteeism and refusal to participate in the study, design effect of two with 95% confidence certainty and alpha (0.05). Based on these assumptions the total samples size calculated using the formula indicates below gives 422 respondents.

$$n = \frac{(Z\ \alpha/2)2\ P\ (1-P)}{d2} = 384$$

Where,

n= sample size

$(Z_{a/2})$ = confidence level; taking 95% level of confidence interval,

P=50%, q = 1-p=50%

d=margin of error tolerated (0.05)

Based on the above assumption.

$$n = \frac{(1.96)^2 x 0.5\ (1-0.5)}{(0.05)^2}$$

n= 384

Therefore, n=384+10% (384) =422

The entire field data collection covers 422 households selected from sampled study areas. These households certainly represent the total household due to homogeneous and the increment of household does not bring different results. The list of selected satellite towns and number of households are show in the table 3.1 below.

Table 3.1: The list of selected satellite towns and number of households are show in the

s.n.	Satellite town	Total Population	Total Households	Selected Households	Percent (%)	Sampling Technique
1	*Tis Abbay*	4,500	2682	142	34%	Random
2	*Andasa*	3,200	3218	171	40%	Random
3	*Sbatamit*	5,000	2048	109	26%	Random
4	Total population	1,2700	7948	422	100%	

(Source: selected the three satellite town administrative office (2017)

3.7 Sampling Procedure

There are 17 kebeles in Bahirdar city where the three satellite towns are located in different margins of the town. From these, three downstream satellite town from *Abbay* River Basins were selected purposively on the basis of proximity and vulnerability. Accordingly, *Chis Abbay, Andasa* and *Sebatamit* with population of 4500, 3200 and 5,000, respectively, were taken into consideration. The target participants of the study were randomly selected after proportional allocation of the sample for the three satellite towns. Considering the total number of households, which is 12900, systemic random sampling was used by taking "K" value of 16. The first household was selected randomly by proportional lottery method to the satellite towns. With regard to the qualitative data, participants of interview were taken from government office and non-government office.

3.8 Variables

The dependent variable for this research was the outcome variables such as the perceived causes and the effects of water pollution on the *Abbay* River basin residents and the Bahirdar zuria areas. The independent variable used in the research included characteristics of households such as socio-demographic variable (Age, Sex, Education of the households, Average family size of the households, the house of ownership), and the physical manifestation of water pollution water color change, faulty smell and other pollution indicators (Eutrophication, Sewage materials, Liquids wastes, Solid waste, Industrial Waste dumped in to water) were considered.

3.8 Data Analysis and Presentation

The collected data were analyzed by simple statistical tools like frequency, mean, median, mode and percentage and they were operated with the statistical package for social science (SPSS Version 24). Logistic regression model was used to examine the associated factors for perception of water pollution. P value 0.05 was used to determine level of statistical significance. Some descriptive data were presented using bar graph.

3.9. Ethical Consideration

Ethical clearance was secured from Addis Ababa University College of Development Study and letter of support secured from different offices in Bahir Dar Satellite town. Information was gathered after informed consent and the participants were free to leave the study at any time. Privacy and confidentiality were maintained during surveying.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0. Overview

The chapter begins with the explanations of the socio-economic characteristics and background of the respondents and followed to presenting data and information that had been extracted from reports, documents of the respected offices, field observation and survey through semi-structured questionnaires and interviews. In spite of employing alternative research methodologies, the research has been obliged mainly to rely on the data obtained from primary sources. In addition, in order to assess the level and consequences of river water pollution some secondary source of data was also analysed and discussed in detail.

4.1. Socio-Demographic Characteristics of Respondents

The study administered sample of 422 respondents for a questionnaire and 11 experts in the surrounding area. Twelve residents of the area were also interviewed. The characteristics of the respondents treated here were those of the experts who are working in governmental offices, while the interviewed peoples are the rural inhabitant of the Abbay River areas (satellite town). As much as possible, due emphasis was given for representing both gender (male and female) to fill the questionnaire and in interview selections.

The analyses of the demographic characteristics of the respondents showed that more than half of the respondents were male (238 or 56.4% are male) and the rest 184 or 43.6% are female) (see Table 1). Table 2 below shows the age variation of respondents in the study area. The age of respondents ranged between 14 and over 65 years. Most of the respondents were stripling. The greatest number of respondents (65.9%) was aged between 30 and 65 years. The second largest group of respondents (25.8%) aged above 65 years. Only 8.3% aged between14 and 30. Table 3 below shows the marital status of the respondents from the total sampled 422 respondents 205 were married, 149 were unmarried, 54 were and 14 were widowed. The finding shows the family size of the respondents' out of the 422 respondents 20 had 1, 52 respondents had 2, 89 respondents had 3, the majority 104 respondents had 4, 95 respondents had 5, 34 respondents had 6, 25 respondents had 7 and the rest 3 respondents had 8 families. The finding shows the educational background of respondents as well. It is reported 7.1% of the respondents were

illiterate, while 15%, 5%, 15.2%, 22.7%, 29.1% and 5.5% had grade 1-4, grade 5-8, secondary, diploma, postgraduate respectively. The study shows the respondents occupation 14% were employed NGO, 35.1% were employed Government, 14.2% were house wife, 20.1% were merchant and the rest 16.6% were laborer.

Table 4.1: Demographic Information of the Respondents (N =422)

Basic information	Group	No Respondents	Percentage
Sex	Male	238	56.4
	Female	184	43.6
Age	21-30	35	8.3
	31-65	278	65.9
	Above 65	109	25.8
Marital status	Married	205	48.6
	Unmarried	149	35.3
	Divorced	54	12.8
	Widowed	14	3.3
Family size	1	20	4.7
	2	52	12.3
	3	89	21.1
	4	104	24.6
	5	95	22.5
	6	34	8.1
	7	25	5.9
Education	Illiterate	30	7.1
	Informal	65	15.4
	1-4	21	5
	5-8	64	15.2
	9-12	96	22.7
	Diploma	123	22.7
	Degree	23	5.5
Occupation	NGO	59	14
	Government	148	35.1
	Housewife	60	14.2
	Merchant	85	20.1
	Labourer	70	16.6
Monthly Income (in ETB)	500-1000	24	5.7
	1001-2000	186	44.1
	2001-4000	212	50.2

(Source: Own survey, 2018)

4.2. Household Perception on the Existence of Water Pollution in the study Area

Assessments were undertaken to determine the perception of the respondents on the existence of water pollution in the study area. Exploring the general perception of households regarding water pollution, as shown in Table 3, the level of awareness of the households on the level of pollution had been surveyed. The results revealed that 66.6% of the respondents were aware about causes of water pollution and 33.4% of the respondents were not aware about water pollution.

Table 4.2. Household perception on the existence of water pollution in the area

The existence of water pollution	Frequency	Percent
Yes	281	66.6
No	141	33.4
Total	**422**	**100**

(Source: Own survey, 2018)

4.3. Possible Causes of Water Pollution in the Study Area

The respondents were requested if they were cognizant of the major causes and sources of water pollution in Abbay River basin around three selected spots of Bahirdar area. They had unleashed that mountainous farming, lack of environmental protection measures, invasive alien species, abuse and misuse of agro-chemicals and agricultural wastes, and informal settlements.

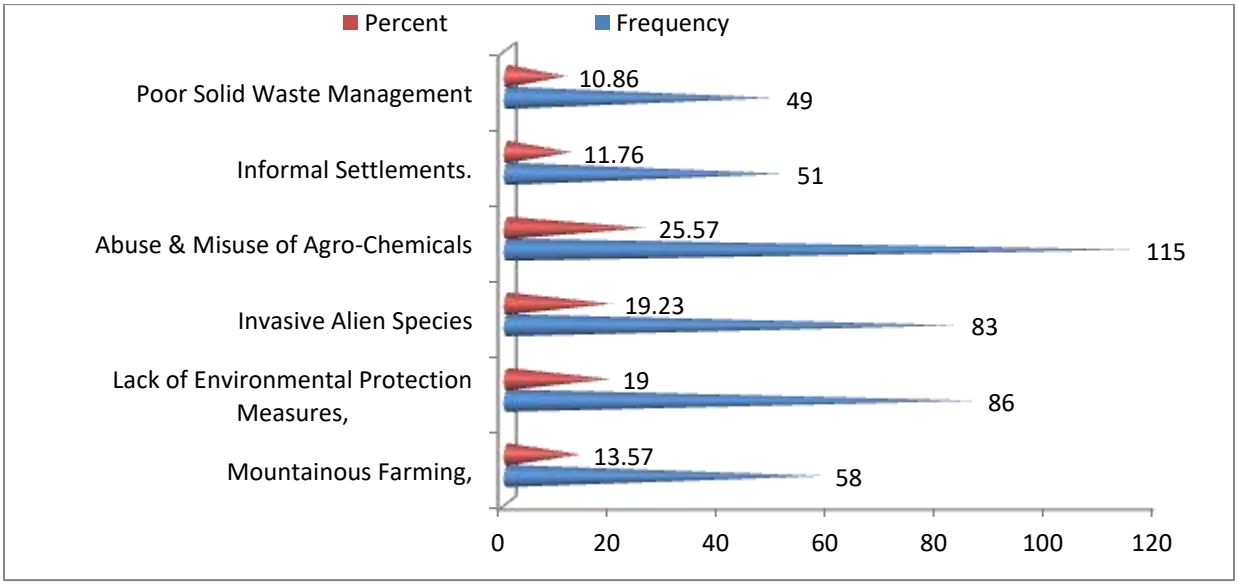


Figure 4.3. Possible Causes of Pollution (Source: Own Survey, 2018)

4.3.1. Mountainous Farming and Lack of Environmental Protection Measures

Abbay river basins, river basins found in areas where mountainous farming is widely spread from its source to the lower basin. The area is quite characterized by the mountainous and river side farming, which is called slippery slope plaguing, is highly harming the mountain and river side vegetation, which would protect the river from being filled by flood and land slide. Lack of environmental protection measures like terracing, planting trees which is comfortable for raising the river water amount causes river damage worsen from bad to the worst.

4.3.2. Invasive Alien Weeds

This weed found in Abbay River and other small ponds and tributaries were observed with reddish colour that covers the river, ponds and other water bodies of the tributaries from every corner. According to the respondents, invasive alien weeds (such as *Emboch*) were seen for the first time in 2018/19 G.C. The water weed had negative effects on the life of the residents. It causes the river water to develop bad sniff, muddy materials, cover the water surface and cause water loose. Consequently, the alien weed effects to the river pollution causes the residents who are dependent on the river water to suffer from skin etch (especially the children), dried the river water swiftly, which ultimately create water shortage for their cattle drink and agricultural purposes. This effect is mostly observed in the upper stream of Abbay.

4.3.3. Informal Settlement

In the Abbay River basins, tremendous slums and shanty settlement were observed. Houses were constructed in the riverside where the swampy areas are the sources of water for the river. This is one of the causes that decrease water volume in both the upper and lower river, and worsen shortages of water for domestic and agricultural purposes. This settlement has brought danger on water sources, and causes the human ecology to be affected by the river pollution and related danger like flood and contaminated and transmitted disease (common cold, influenza).

4.3.4. Poor Solid Waste Management System

Solid waste accumulated mainly from households, business institutions while liquid wastes, observed poisonous were dumped from industries. The solid waste deposition in the river bank is deep that different layers of deposition have been seen while local people dig the area for different purposes. *Abbay* River basins affects the community to get clean living environment. Specifically, the abattoirs waste turns the tributary of *Abbay* river basins to reddish colour. So it affects the tributary to lose its water colour and cause the local community suffered from health

problem. However, the response of government in combating these effects was minimal, almost none. The study found that the town pro-poor housings projects are built areas that is unsuitable for living, due to abattoir wastes and unstable land for resident These shortcomings together with abattoir wastes, the fermented solid waste that loam soil in the area, exacerbate the frequent occurrences of land slide and living compound to be polluted, confirmed by the community elders.

4.3.5. Misuse and Abuse of Agro-chemicals and Agricultural wastes

The agricultural activities by small holder horticulture farmers are also other non-point sources pollution besides to the large-scale flower growing companies located around the river streams. Jansen and Harmsen (2011) has reported that small scale farmers and large scale agricultural companies in the area use pesticides, chemical fertilizers, plant growth hormones and flower preservatives, which may affect the water quality of the lake and the surrounding surface waters through the release of some trace elements and residues from the agricultural fields into the surface waters (Jansen & Harmsen, 2010). Local and Commercial agricultural practices around *Abbay* River Basin use fertilizers for increasing production.

4.4. Source of High Quality Water

Participants were requested about their source of high quality water. They reported that the commonest source of quality water was from pound water, tap water and river water.

Table 4.3. Source of high quality Water

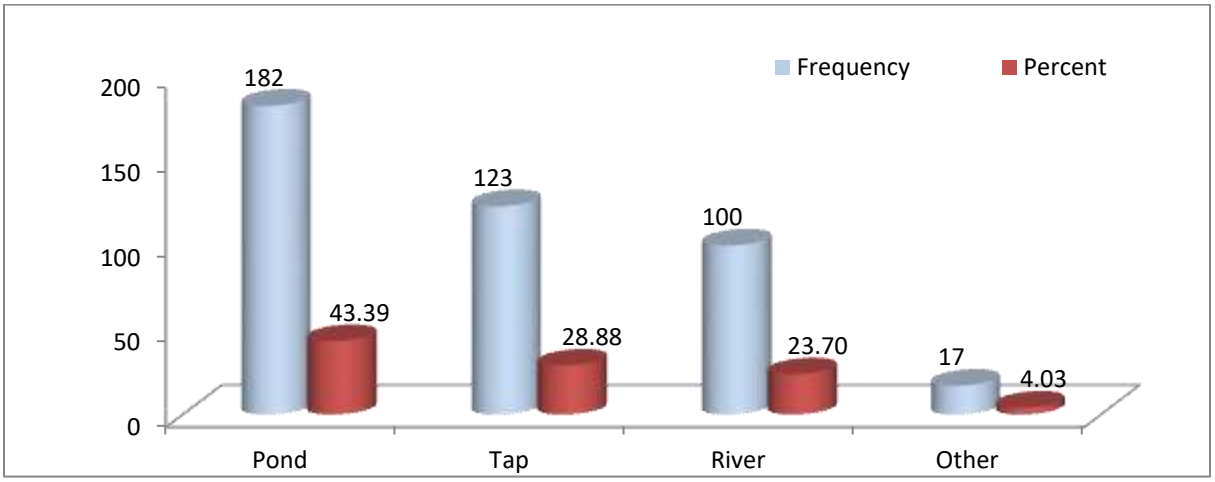
Source of Quality Water	Frequency	Percent
Pond	110	26.1
Tap water	206	48.8
River water	97	23.0
Other	9	2.1
Total	**422**	**100.0**

(Source: Own survey, 2018)

The majority of the respondent (48.8%) stated that tap water is the most common source of high quality water whereas 26.1% of them said that pond water is the top most quality water in the

study area. As to 23% of the respondents, river water was considered as the source of high quality water. Only, 2.1% of them stated that other water sources as their source of quality water. On the other hand, 43.39% of the respondents said that ponds were the most common source of water for animals and other uses while 28.88% and 23.7% of them admitted that tap and river water as important sources of quality water for animals and other uses, respectively (See Fig. 4.1).

Figure 4.1. Water quality for Animals and other uses



(Source: Own survey, 2018)

As indicated in figure 4.1, 4.03% of the respondents had unleashed that other water sources were considered as the main source of quality water for animals and other household uses.

4.5. Satisfaction on Quality of the Drinking Water

Assessments were made to determine the level of satisfaction of the residents in the Bahirdar satellite towns, Abbay River Basins. Since the river is polluted, most of them were dissatisfied.

Table 4.4. Satisfaction on Quality of the Drinking Water for Human

Satisfaction on Quality of Drinking Water for Human consumption	**Frequency**	**Percent**
Satisfied	113	26.8
Dissatisfied	309	73.2
Total	**422**	**100.0**

(Source: survey result, March, 2018)

Majority of the participants (73.2%) were dissatisfied with the quality of the drinking water provided to the respective satellite town. The current study was important to assess the perception of Bahir Dar satellite town residents' perception towards water pollution and its impact on human health. The study revealed that the majority of the people (73.2%) were dissatisfied with the quality of the water they are using. Dissatisfaction with the quality of drinking water is also common in other settings of Ethiopia including. According Environmental Protection Authority of Ethiopia (2005) and the United Nations estimates there were at least 2.5 billion people in developing countries lack adequate sanitation, and that about half these people also lack access to clean drinking water. Dissatisfaction with the quality of the drinking water could be related with the money they pay for the service and the availability of the water.

On table 4.5, the majority of the respondents were dissatisfaction the quality of drinking water in their satellite town.

Table 4.5. Satisfaction of respondents on the quality of water for Animals and other uses

Satisfaction on water quality for Animals and other uses	**Frequency**	**Percent**
Yes	57	13.5
No	365	86.5
Total	**422**	**100.0**

(Source: Own survey, 2018)

4.6. Types of Water Pollutants

As shown in figure 4.2, the majority of the respondents stated that the main water pollutants in the Bahirdar satellite town were toxic chemicals, excess sediment, home wastage and too much trash. In addition to the primary sources of data, as it was revealed in survey, the key informant interviewees identified that the major sources of *Abbay* River basins' pollutions are agricultural and industrial wastes, poor management of sewages and sewerages and improper dry waste disposal system of the Satellite towns.

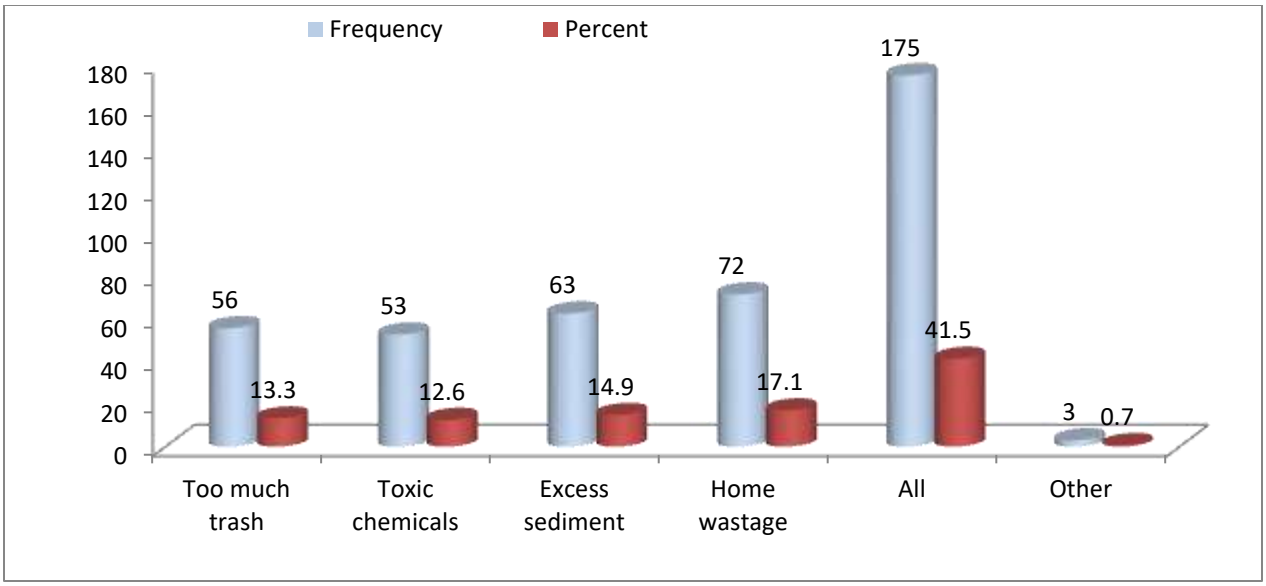


Figure 4.2. Types of Water pollutants (Source: Own survey, 2018)

The majority of the respondents were respond the main water pollutants in the satellite town were toxic chemicals, excess sediment, home wastage and too much trash. In addition to the primary sources of data, as we can see from figure 4.2, the secondary source of data identified that the major sources of Abbay River pollutions are industrial wastes, sewages and sewerages and improper dry waste disposal system of the town. These factors are contributing significant level of polluting waste materials in the form of dry or liquid forms. It is reported that 75 to 80% water pollution is caused by the domestic sewage. Waste from the industries like, sugar, textile, electroplating, pesticides, pulp and paper are polluting the water (Kamble SM, 2014). Polluted river has intolerable smell and contains less flora and fauna. 80% of the world's population is facing threats to water security (Owa FD, 2013).

Dry waste disposal system of the town is not uniformly implemented throughout the town, in some areas it is collected to dump at identified site, in other time it stays there for a longer period of time. In other area directly discharged to the river (See Annex 1).

On the same time, National Water Development Report for Ethiopia (2004) disclosed that a number of pollution related studies have confirmed that about 90% of industries are simply discharging their effluent into nearby water bodies, streams and open land without any form of

treatment. In 1997, Environmental Protection Agency conducted a survey on the kinds of waste generated by industries and the number of factories with treatment plant. The study also revealed that, the river is served as natural sewerage lines for domestic and industrial wastes, hence making them known for their offensive odor, black color and toxicity. Apart from the leach ate from solid waste, sewage water also flows directly or indirectly in to the River, due to limited sewerage system and treatment in the town. The major tributaries of Abbay River are also used as a receptacle of all kinds of wastes solid and liquid.

Additionally, dry and liquid wastages from Agricultural and Environmental Science College, from Bahirdar University Peda Campus and poly Campus, from textile Fabric, had also contributed its share for water pollution. There are also industries such as tannery and leather, alcohol, soap, food and plastic factories, garages and carwashes are distributed in the town, which use the rivers as a major waste disposal site without any form of treatment (See Annex 1).

From the personal observation of the researcher, the River have polluted with different pollutants. Such polluters can be seen and identifiable. Different solid materials such as pieces of plastics, condoms, bones, pieces of wood and others were observed along the riverside's, even covering the grazing land areas when there is an erosion. Oils from different garages, construction materials, swages and sewerages, industrial effluents and municipal drainages are directly discharged to the river without any treatment (See Annex 1, 3 & 4).

4.7. Indications for water Pollutions

Dead animals including fish were also observed at ponds, streams, the *Abbay* river basins and the Bahirdar Satellite towns. When the water margins were observed at different points, information of the site conditions such as water utilization for domestic, for livestock drinking, irrigation activities the water is not appropriate. The color of the water and the presence of algae blooms, solid wastes and others specific to the sampling site were obtained are inappropriate for home use (As shown in annex 5 & 6).

4.7.1. Change in Water Odor

The survey also indicated that the odor of water was changed. The odor of the water and the presence of algae blooms, solid wastes and others specific to the sampling site were obtained are inappropriate for home use.

Table 4.6. Change in the Odor of the Water

Change in water Odor	Frequency	Percent
Yes	208	49.3
No	214	50.7
Total	**422**	**100.0**

(Source: Own survey, 2018)

4.7.2. Change in the Color of the Water

The color of the water, according to the respondents, was changed due to the presence of algae blooms, solid wastes and others wastes. From the table 4.7, 66.6% the respondents said that the color of the water was changed were inappropriate for home use.while the rest (33.4%) of them said that there was no color change at all.

Table 4.7. Change in the Color of the Water

Change in the Color of the Water	Frequency	Percent
Yes	281	66.6
No	141	33.4
Total	**422**	**100**

(Source: Own survey, 2018)

4.8. Key Sources of Water Pollution in the Bahirdar Satellite Towns

Pollution occurs as a result of point and non-point sources. More importantly, the non-point source pollution sources were identified as the most difficult types to deal with. The participants had stated that solid wastes (trashes, plastic materials, dead animals,), toxic wastes (industrial effluents, car wash, oils, agricultural pesticides and fertilizers), and home wastes (obsolete materials, dusts, construction materials, etc) in the Satellite towns, *Abbay* River Basin. The major sources of water pollution were too much trash (13.3%), 12.6% (toxic chemicals), excess sediment (14.9%) and home wastage (17.1%) (See table 4.8).

Table 4.8. Sources of water pollution problems in the Bahirdar satellite town, *Abbay* River basins

Sources of Water Pollution	Frequency	Percent
Too much trash	56	13.3
Toxic chemicals	53	12.6
Excess sediment	63	14.9
Home wastage	72	17.1
All	175	41.5
Other	3	0.7
Total	**422**	**100.0**

(Source: Own survey, 2018)

Participants endorsed that the biggest sources of Abbay river water pollution were too much trash (13.3%), toxic chemicals (12.6%) and excessive sediments (14.9%). Other studies identified the same and other sources of water pollution. The increased the amounts of municipal waste discharged to Abbay River could increase the level of pollution of the river. Most industries established adjacent to Abbay River in Bahirdar for instance Bahirdar Textile, Bahirdar and Bahirdar Leather industry discharge their liquid waste to the river.

4.9. Impacts of Water Pollution

4.9.1. Human-health related Problem in the study Area

Another important finding of the current study could be the impact of water pollution on human physical health. About 43.4% of the total participants endorsed that water pollution caused different health problems including cholera, typhoid, and dysentery and kidney disease. About 13.5% of the participants believed the cause of kidney disease was associated with water pollution. Many participants (66.6%) were aware about water pollution. This might be due to high information dissemination about communicable diseases from different media. WHO (2000) also reported that 17.3% of deaths of children under 5 in Ethiopia were due to diarrhoeal diseases. A study conducted by Fufa (2015) on Akaki River, have shown that water-washed and water-borne diseases such as typhoid, diarrheal, cholera, and rashes on skin are apparent in the catchment area.

4.9.1.1. Common Water Borne Diseases

Participants reported that Cholera (18%), typhoid (46.4%) and dysentery (35.5%) as the main water borne diseases (see Table 4.9).

Table 4.9. Common water borne diseases

Type of water borne Disease	Frequency	Percent
Cholera	76	18.0
Typhoid	196	46.4
Dysentery	150	35.5
Other	0	0
Total	**422**	**100.0**

(Source: Own survey, 2019)

There is a greater association between pollution and health problem. Disease causing microbes are known as pathogens and these pathogens are dispersion disease openly among humans. Some pathogens are worldwide some are found in well-defined area (Kamble, 2014). Many water borne diseases are spreading man to man (Halder, 2015). Heavy rainfall and floods are related to extreme weather and creating different diseases for developed and developing countries (Ahmad, *et al*, 2014). 10% of the population depends on food and vegetables that are grown in contaminated water (Corcoran, *et al*, 2010).

As the interview made with one key informant in *Chis Abbay* said that water pollution was very difficult for our health specially children's health. In the same way, one KI in *Sabatamit* said that water pollution was the cause of skin diseases because of their clothes and body washed by polluted water.

Another KI in *Andasa* said that:

> *"the water pollution was affected our garden. Even if we fetch our garden, some of the gardens because of the water polluted by industrial wastages."*

The key informant indicated that,

"sick animals were showing symptoms like gastrointestinal disorders, bloat bloody diarrhea, nerves signs like tremors and paralysis. Some of the symptoms are similar to that of poisoning especially due to nitrate/nitrite poisoning. They had been exposed to different level of skin diseases and rapid weight losses respectively since their major water sources were contaminated Abbay River. The respondents also indicated that, the presence of, liver inflammations, coughing, hair loss, bloody urine, foot inflammations and abnormal diarrhea on animals after consuming polluted water rivers in the downstream. Animals from these catchment areas lack adequate resistance or have poor immunity that were in turn exposing them to other parasitic, bacteria and virus borne diseases than cattle found out of the catchment areas".

Since the phenomenon has had significant negative impacts on dairy product which is serving as one of the income sources, respondents regard this problem as major when compared to other cattle related problems. Furthermore, undesirable and unusual odor and taste of dairy products from the catchment areas have reduced the marketability of the product and their market price that in turn affect the income source of the households in the study areas.

4.9.1.2. Rare Waterborne Diseases (Kidney Problem)

Participants were asked if they or their children had kidney problem and 33% responded against kidney problem. The majority 67% household respondents said perceived kidney problem associated to water pollution.

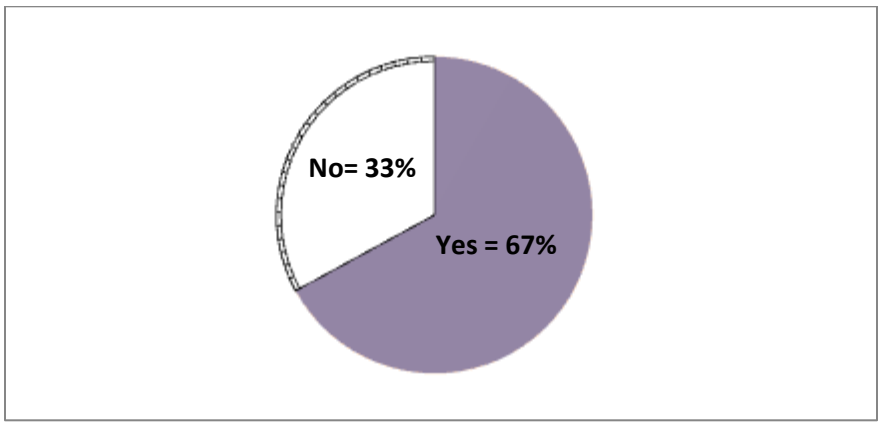


Figure 4.3. Extent of kidney problem in the water polluted Area of Abbay River Basin (Source: Own survey, 2018)

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4.9.1.3. Extent of Common Water Borne Disease Problems in the Area

The households had a varied perceived effect of water borne diseases on human and animals. As indicated in table 4.10, the majority (43.4%) respondents said that the occurrence of water borne diseases in water polluted areas as high where as 27.7% of them stated that the effect of water pollution on human health was low. In line with this, 28.9% household respondents said midium human health problem associated to Water Pollution.

4.10. Extent of Common Water Borne Disease Problems in the Area

Extent of common Diseases	Frequency	Percent
High	183	43.4
Medium	122	28.9
Low	117	27.7
Total	**422**	**100.0**

(Source: Own survey, 2018)

On the above table the majority 43.4% respondents said water pollution on human health high, 28.9% respondents said medium and 27.7% said low.

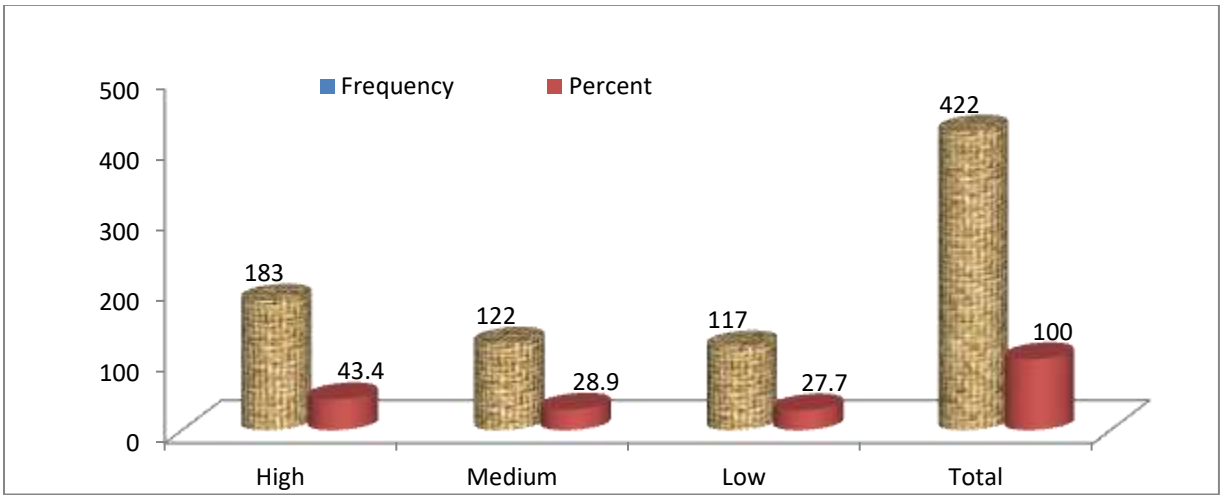

Figure 4.4. Effect of water pollution on Animal health (Source: Own survey, 2018)

Figure 4.4 shows about 43.4% of the respondents endorsed that water pollution impacts health highly and only 27.7% of the respondents perceived water pollution had low impact on health.

4.9.1.4. Ecological Effects of Water Pollution in the study Area

Vital microbial agents, Animals and plants that depend on water for life are the most affected by polluted water. The perceived ecological outcomes of water pollution is presented below, table 4.11. According to 13.12% and 19.23% of the respondents water pollution is increased loss of microbial diversity and death of aquatic lives, respectively. About 25.11% the respondents stated that the polluted river has disrupted the ecosystem function. The results showed that the concerned offices to take a useful glimpse of the impact of pollution on aquatic life.

Table 4.11. Ecological Effects of water pollution in the study area

Ecological Effects	Frequency	Percent
Loss of Microbial diversity	58	13.12
Increased Erosion	84	19.00
Death of Aquatic lives	85	19.23
Disruption of Ecosystem function	111	25.11
Reduction in water levels	52	11.76
Impacts on agriculture	52	11.76
Total	**442**	**100.00**

(Source: Own survey, 2018)

Pollution disrupts the food chain by moving the toxins from one level in the chain to higher levels. In some cases, pollution can wipe out an entire part of the food chain. Such affect the other organisms by either causing excessive growth, in case the predator dies or death (if it wipes out the prey). The introduction or elimination of certain microorganisms distorts the ecosystem. Nutrient pollution, for example, leads to an increase in algae, which depletes the water of oxygen, thereby leading to the death of fish and other aquatic life.

4.10. Outcomes of Water Pollution on the livelihoods of the residents in the study Area

The interviewees analysed that water and food security were two interrelated issue, in the age of natural resource degradation, global warming and climate change, food security for Ethiopian farmers would be increasingly affected where water scarcity arises. Ethiopian agricultural water

management permits concentration of inputs and provides stability of supply for many key agricultural products. An expert from Office of Environmental protection, Bahirdar satellite town, *Abbay* river basins said:

> *"For sustainable agriculture, there is need of appropriate water management basin-level water resource management determines the productivity of water related ecosystems including local fish capture and traditional livelihoods. Without some form of water control across the world's river basins, freshwater lakes and associated aquifers, local, regional and global food and livelihoods security would not be possible".*

Another expert from Office of Environmental protection, Bahirdar satellite town, *Abbay* river basins said:

> *"The Abbay river basin and stream resources have also been important to people for availability of cultivatable fertile land and water, for food production and to meet the domestic needs in Bahirdar satellite towns. The river also means for natural waterways for effluent discharge and traditionally the cheapest means of transportation of goods and services."*

Furthermore, deputy head Agricultural office stated:

> *"The fishing community has the link between open water body i.e. the Abbay river basin, lake Tana, streams and other open water source and land and adapted to the ecological niche. Through generation to generation with the interaction with open water body and nature, fisher folks have acquired skill and protecting, preserving and using the ecosystems sustainable along with secure livelihoods."*

From the interviews carried out among the government officials of the Abbay river basin shown that farmers were facing difficulties that hamper their livelihoods. Dislocating or displacing them by industrial development led to perennial poverty and conflicts as destroying their livelihoods, social structure and economic welfare in the Bahirdar Satellite town.

4.11. Measures Undertaken to Mitigate the Problem

4.11.1. Cleaning Drinking Water Container and the River sides

The community in which the respondents dwell was found to undertake various measures to curb the problem. Yet disparity exists on the frequency of the mitigation measures applied in the area. Most of the respondents (50.24%) stated to clean their water container once in every two weeks where as 28.44% of the respondents said they clean their container once a week. However, 21.33% were involved in cleaning their container twice a week.

Table 4.12. Frequency of cleaning the drinking water container

Frequency of cleaning the container	Frequency	Percent
Once a week	120	28.44
Twice a week	90	21.33
Once two week	212	50.24
Never	0	0
Other	0	0
Total	**422**	**100.0**

(Source: Own survey, 2018)

Regarding the different activities practiced by the participants, many usually did wash the riversides of the Abbay River basins.

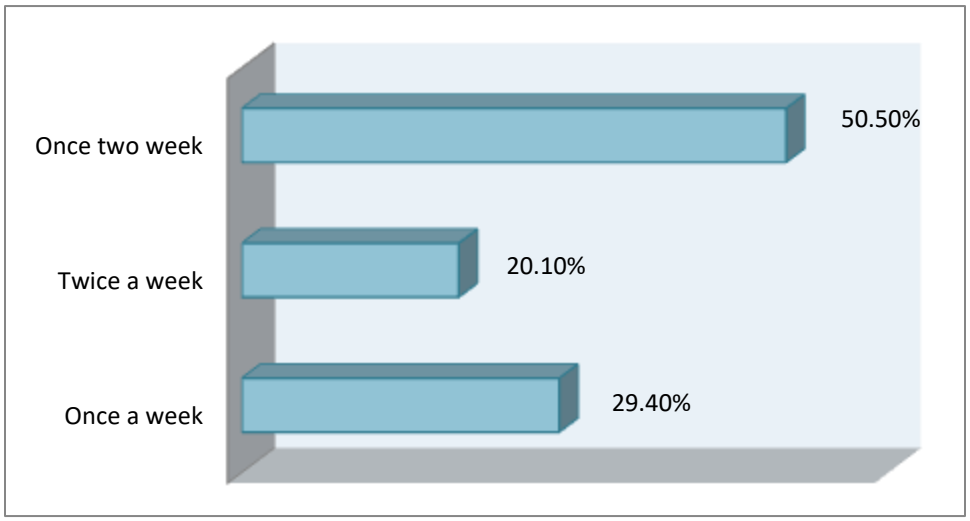

Figure 4.5. Frequency of cleaning the River (Source: Own survey, 2018)

On the other hand, half (50.5%) of the respondents said they wash the riversides about once a week and others twice a week (29.4%). In other studies, similar activities were reported to improve the river water quality (Figure 4.5).

From figure 4.5, it can be implied that the majority respondents had willingness or actively participated in once two weeks in a mitigation measure through actual cleaning of the plastic and polyethylene wastes in their proximity.

4.11.2. Organized Initiatives to mitigate the problem

The respondents had admitted that there was an attempt by the local agricultural offices, environmental protection offices and the local community to mitigate the problem. These mitigation measures include training, awareness creation campaign, farmers' day training, legal measures, area closures and protection of the riverside were the most common ones.

Table 4.13. Other Mitigation Measures Undertaken to curb the problem

Attempted Mitigation Measures	Frequency	Percent
Training, Awareness Creation, Farmers' day	124	29.4
Legal Measures	85	20.1
Area Closure, Protected area, Hygiene	213	50.5
Others	0	0
Total	**422**	**100.0**

(Source: Own survey, 2018)

According to 29.4% of the respondents, training and awareness creation are the most frequent attempts of the local government for controlling water pollution whereas half of them insisted that area closure is what the institutions attempted most. However, these measures were being undertaken intermittently. Consequently, these measures couldn't help to curb the problem (Table 4.13).

4.12. Suggested Recommendations to Mitigate the Problem

Interviewees also coined ways through which the current unwanted images of Abbay River Basins and streams can be transformed sustainably. The majority of them insisted on community mobilization. Apart from that considering the experiences of sister cities' riverside development projects and success stories, the government has to adopt and adapt its own approaches for successful transformations.

There are many approaches that could be adopted in water pollution control and management. It could be through prevention, practice efforts or join a project/program; Regulation and monitoring or engaging in control measures by reducing or minimizing waste. Experts from environmental protection agency, on the interview, clearly stated ways of preventing of water pollution. The following are suggested measures by the experts.

Table 4.14. Suggested Measures to curb the problem

Suggested Measures to curb the Problem	N	%
Washing cars far away from any storm water drains.	1	9.09
Ban throwing trash, chemicals or solvents into drains	2	18.18
Inspection of the septic system every 3 – 5 years	1	9.09
Avoid using pesticides and fertilizers that can run off into water systems	1	9.09
Sweeping driveway instead of hosing it down	1	9.09
Pumping waste-holding tanks on a safe boat	2	18.18
Use non-toxic cleaning materials	1	9.09
Cleaning up oil and other liquid spills with kitty litter and sweep them up	1	9.09
Prohibit washing paints brushes in the river streams	1	9.09
Total	**11**	**100.00**

(Source: Own Survey, 2018)

The discussants also reflected that the key way to get involved with pollution prevention was to participate in community's own initiatives or work through the existing joint projects or programs. These initiatives were available at the Environmental Protection offices (EPO) and agricultural offices' plans. On the other hand, regulation and monitoring was suggested as effective way of pollution management, expressed boldly. The KI's said that many nations worldwide have enacted legislation to regulate various types of pollution as well as to mitigate the adverse effects of pollution. Pollution control means to control the emissions and effluents into the air, water and land or soil. Without pollution control, the waster products from consumptions, heating, agriculture, mining, manufacturing, transportation and other human activities, whether they accumulate or disperse, will degrade the environment. Pollution prevention and waste minimization are more desirable than pollution control. For them, pollution could be minimized by adopting recycling (13.57%) by reusing (19%) waste minimization (19.23%) by mitigating (25.57%), by preventing (11.76%), and by composting (10.86%) practices.

Table 4.15. Mitigations Measures against water pollution

Pollution Mitigations	Frequency	Percent
Recycling	60	13.57
Reusing	84	19.00
Waste Minimization	85	19.23
Mitigating	113	25.57
Preventing	52	11.76
Composting	48	10.86
Total	**422**	**100.00**

(Source: Own Survey, 2018)

Apart from all these mentioned above, it was suggested by 29.4 % of the respondents and the unique discussants that use of pollution control devices which include dust collection system e.g. bag houses, cyclones, electrostatic precipitators, scrubbers e.g. baffle spray scrubber, ejector venture scrubber, mechanically aided scrubbers, spray tower, wet scrubber, and sewage treatments.

Table 4.16. Suggested Pollution Control Devices to curb the problem

Pollution Control Devices	Frequency	Percent
Dust collection system	124	29.4
Primary Treatment (Sedimentation& sludge bio-filters)	85	20.1
Secondary Treatment (also for industrial waste water)	107	25.5
Vapour recovery system and phyto-remediation.	106	25
Total	**422**	**100.0**

(Source: Own Survey, 2018)

For 20.1% of them, sedimentation (primary treatment), through activated sludge bio filters was the most important pollution control device. On the other hand, secondary treatments, that also be used for industrial waste water, through aerated lagoons, constructed wetlands (also used in urban runoff); industrial wastewater treatment e.g. ultra filtration, oil-water separators, bio filters, dissolved air flotation (DAF), and powdered activated carbon treatment were considered as

effective for 25.5% of the respondents. Implementing vapor recovery system and phyto-remediation were effective pollution control devices as per one fourth of the respondents (Table 4.16).

4.13. Discussion

The research revealed that Bahirdar Satellite Town and the surrounding water sources are polluted. It was also indicated in the survey that the point source pollutants are the major causes of Abbay River Basin Pollution.

Most of the respondents admitted the presence of observable large amount of domestic sewage that was drained in to river and most of the sewage is untreated. Domestic sewage contains toxicants, solid waste, plastic litters and bacterial contaminants and these toxic materials causes water pollution. Different industrial effluent that is drained in to river without treatment is the major cause of water pollution (Kamble, 2014). Hazardous material discharged from the industries is responsible for surface water and ground water contamination. Contaminant depends upon the nature of industries. Toxic metals enter in to water and reduced the quality of water (Ho YC, Show KY, Guo X., *et al*, 2012).

Solid and liquid wastes were being discharged in to *Abbay* river basins. The water is also contaminated by human excreta. In contaminated water, a large number of bacteria are also found which is harmful for human health (Desai and Vanitaben, 2014). The data from the study regarding water pollution and human health was obtained and compiled through a thorough review of various published research articles of international reputed journal and relevant books. Safe drinking water is a basic need for all humans. The WHO reports that 80% diseases are waterborne. Industrialization, discharge of domestic waste, radioactive waste, population growth, excessive use of pesticides, fertilizers and leakage from water tanks are major sources of water pollution. These wastes have negative effects on human health. Different chemicals have different affects depending on their locations and kinds. Bacterial, viral and parasitic diseases like typhoid, cholera, encephalitis, poliomyelitis, hepatitis, skin infection and gastrointestinal are spreading through polluted water. It was recommended to examine the water quality on regular basis to avoid its destructive effects on human health. Domestic and agriculture waste should not be disposed of without treating.

Another cause of water pollution was the indiscriminate use of pesticides and chemical fertilizers accompanied by poor soil and water conservation practices. That exacerbated the erosion and non-point water pollution the area. Agro-chemicals, on the other hand, were being used to kill bacteria, pest and different germs. Chemical containing pesticides were directly polluting the water and affect the quality of water. The finding strengthens the scholar that stated pesticides are excess in amount or poorly managed, then it would be hazardous for agriculture ecosystem (Yonglong, *et al,* 2015). Only 60% fertilizers are used in the soil other chemicals leached in to soils polluting the water, cyanobacteria are rich in polluted water and excess phosphate run off leads to eutrophication.

The effects of water pollution in the study area were two-fold: health related and ecological. Residues of chemicals mix with river water due to flooding, heavy rainfall, excess irrigation and enter in the food chain. These chemicals are lethal for living organisms and many vegetables and fruits are contaminated with these chemicals (Kamble, 2014). Trace amounts of pharmaceutical in water also causes water pollution and it is dangerous to human health. The residents are found to suffer from several water-borne diseases. Many waterborne infectious diseases are linked with fecal pollution of water sources and results in fecal-oral route of infection (Nel LH, Markotter W, 2009). Health risk associated with polluted water includes different diseases such as respiratory disease, cancer, diarrheal disease, neurological disorder and cardiovascular disease (Ullah S, Javed MW, Shafique M, et al, 2014).

Many health related problems had occurred in the study area in association with the polluted water. Bacterial diseases, resulting from untreated drinking water and fecal contamination of water were the major causes of diarrhea. Fever, abdominal pain, nausea, headache are major symptoms of diarrhea. Good hygienic practices and use of antibiotics can prevent this disease. By the same token, cholera is caused by the contaminated water. Salmonella bacteria are found in contaminated water and it results in inflammation of intestine and often death occurs. Antibiotics are prescribed for this disease (Haseena and Malik, 2017). Viral diseases, such as hepatitis, are very common viral diseases caused by contaminated water and infect the liver.

Encephalitis is inflammatory disease spread by bite of infected mosquitoes. *Culex mosquito* lays their eggs in contaminated water.

In an open question on predominant health problems in the community, the respondents mentioned that skin diseases, diarrhoea, gastric ulcers, and respiratory illnesses (common cold, asthma) were the most common health problems amongst the population in the area. In addition, people also suffer from indigestion, hypertension, gout, rheumatism, conjunctivitis, pneumonia, malaria, tuberculosis and cancer. At least 70 percent of the people involved in the discussions reported that they were suffering from skin diseases, diarrhoea, gastric ulcers or other gastric problems at the time that the research was taking place. The health effects of water scarcity can be seen in exposing waterborne diseases and the absence of domestic water sanitary that are leading causes of death worldwide. For under age five children, waterborne diseases are the leading of death. At any given time, the half of the world's hospital beds is occupied by patients suffering from waterborne diseases. On another study, 88% of waterborne diseases caused by unsafe drinking water, poor hygiene sanitation problems (Meseret, 2015).

According to the respondents and informants regarding the ultimate health and ecological challenges, water pollution had the posed a massive effects on the food security issues at a household levels, let alone the economic problems. The hygienic issues led to the water-borne diseases such as typhoid, ameba, and Guardia which incurred the residents for addition costs. Bahirdar satellite town people who suffered from these types of diseases considered that the current problems to the households and the occurrence of infectious disease might have emanated from the consumption of polluted water.

Thus, as it was suggested by the respondents, continuous awareness creation campaign, legal measures and river-side development must be carried out to culminate the water pollution among the residents of the Abbay River Basin. Pollution-associated health risks must be studied well to address the problem.

CHAPTER FIVE
SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0. Overview

This chapter deals with the summary, conclusion and recommendation. In summary section, the overall steps followed to carry out the research while the conclusion stipulates the implied knowledge produced from the research. Lastly, suggested mitigation measures that are needed to be carried out to culminate the situation are discussed in the recommendation part.

5.1. Summary

This study is conducted with the purpose of assessing the perceived causes and effects of water pollution on human health and aquatic ecology with especial reference to *Abbay* River in the three Bahir Dar Satellite town, namely, the satellite community in *Andasa, Sabatamit* and *Chis Abbay*. To meet the specified objectives, descriptive method of research had been utilized; and the normative survey technique was used for data gathering. The questionnaire and semi structured interview served as the main tools for collecting data. There are 422 respondents of questionnaire 11 experts and 12 households are interviewed that residing in the satellite town areas of the river basins. The respondents are selected in random sample method.

The obtained results made it known that *Abbay* River water is highly polluted by industrial wastes, domestic solid and untreated sewages that drain into the river sequences from all types of pollution sources. From the survey made, it is possible to conclude that *Abbay* River basins are highly polluted as they are the major recipients of these unprocessed wastes discharged from industrial establishments, domestic and municipal sources.

Water-borne diseases such as typhoid, diarrhoea, cholera, and rashes on skin are apparent in the catchment areas. They are exposed to additional medical expenses and have negative effect on the productivity of labour force. The continuation of such health problems undermine the development efforts and aggravate the vicious circle of poverty. Both short term and long-term crisis are apparent. From the fact that children have lower resistance to infections, school age children are highly vulnerable to water related diseases, which in turn affect their school attendance and performance.

Moreover, civil servants that are working in the areas are also suffering from lack of safe drinking water that in turn reduces their interest and commitment to work, hence adversely influence the quality of services rendered to the community. The poor practice of the residences to implement pre-use treatment mechanisms for water from unsafe sources is one of the strong evidences for the case. While there are health extension workers, in the study area, who are professionally required to increase the awareness of the satellite people regarding the prevention mechanisms of water related infections, the real accomplishment is insignificant.

Due to the prolongation of acute water related infectious in the catchments, households are forced to allocate their larger share of income for the prevention of such diseases. The problem is more pronounced on low-income group of people. On the other hand, due to long distances of medical centres, weak financial capacities and immature knowledge of residences many patients might not get timely health treatments. Such phenomenon forces many labour forces to stay away from the productive activities for a long period of time or take them to the termination. These cases are negatively affecting the productivity and increase the dependency ratio.

The study also revealed that significant proportion of Bahir Dar Satellite town dwellers were dissatisfied with the quality of the drinking water. Participants were aware about the level of water pollution in the basins of *Abbay* river and they perceive the pollution has been causing different health problems including cholera, typhoid and dysentery. Too much trashes, toxic chemicals and excessive sediments were the most significant factors of water pollution in the study. We also found based on literature reviews that the main causes of water pollution were due to low oxygen levels because oxygen levels have dropped dramatically because of sudden algae population explosions. Inadequate sewerage and drainage systems are similarly another issue for polluted water in *Abbay* River basins. Forestry, urbanisation and agricultural development have caused the impurity of the river feeders that consequently inflated the ecological dynamics and intermittent the natural food chains. Major sources of water pollution are produced by individuals, although some of them are from natural sources. Based on the intelligences, a downward trend year by year shows that the water pollution problem is becoming more serious.

5.2. Conclusion

According to the research findings, *Abbay* River basin is highly contaminated. This occurrence is obviously demonstrated in terms of nonstandard chemical composition, unpleasant odour and unusual black colour of water. The physical and chemicals parameters of the river indicated that, it cannot fit for home use or consumption.

Greed-driven competitiveness and the self-esteem of the farmers exacerbated the root causes of water pollution in the *Abbay* River Basins. Put differently, short-sighted activities that geared toward to current consumption with little care for environmental protection take the position. Moreover, the current generation loss hopes due to inappropriate returns for exerted efforts. Persistent of the problems without any improvement for a long years make residences to feel suspicious about the future and reluctant to engage in the local development activities. This circumstance adversely affects the development efforts of individuals as well as the government. Livestock, which is said to be the backbone of the rural economy, is also exposed to death, rapid weight loss, loss of appetites and different ranges of skin diseases due to drinking from contaminated river water. Consequently, the direct and indirect economic loss to the farming community is visible. The milk product in the study area has also quality and quantity problems. This has enormously decreased the marketability and revenue to be generated from the sale of the product.

On the other hand, the study provides evidence that local communities are suffering from a variety of health problems that could be a direct or indirect result of the discharge and flow of waste water. Skin problems may for example be related to the high pH of the water, which could certainly irritate the skin and result in sores. The high pH levels are likely to be the result of the large quantities of caustic soda and soda ash used in the dyeing process. It is more difficult to attribute the stomach problems to industrial pollution as people in the area do not drink surface water.

However gastric ulcers and other similar gastric problems may be related to diet and the impacts of the pollution on crops and fish consumed by people living around *Abbay* river basin. It is also possible that groundwater is being polluted by infiltration of industrial effluent but similarly there has been no empirical research into this. The problems of diarrhea and dysentery are

unlikely to be caused directly by the industrial effluent, as they are usually the result of microbial contamination. However, the high level of in-migration to the area is putting considerable pressure on poor sanitation infrastructure and may be increasing the risk of contracting communicable diseases.

By using of river water for washing clothing and bath many water born disease spread man to man. However, yellow fever, cholera, dengue, malaria and other epidemic disease also available in this area. The people lives in the aria are also suffering by the odor pollution and by the respiratory problems. For the polluted situation of the river maternal and child health of nearby riverbank slam are in a danger position.

5.3. Recommendations

The study exposed that the *Abbay* River Basin is highly polluted. As a result of lack of access to clean potable water sources; the community grieved from water pollution related problems. It is also identified that the severity of the problem is seriously increasing from time to time. Since water is a basic necessity of life and is a top lifesaving resource, pollution safeguard is needed for the study area.

In order to utilize the river for satellite town consumptions without encountering health hazards and other dependent problems, mitigating measures have to be taken urgently. To that end, therefore, the following alternative mechanisms are suggested:

- ✓ It is recommended to carryout strong awareness, sensitization and intervention programs and projects at all levels; local, regional and federal to curb the problem
- ✓ Concerned Federal and Regional Environmental Protection Offices in cooperation with stakeholders shall develop integrated and adaptive innovative strategy to address the problem.
- ✓ Meanwhile continuous follow up as well as monitoring and evaluation schemes with adequate Environmental Impact Assessment (EIA), periodic Environmental Auditing and Environmental Management Plan may be put into effect to ensure the water quality that are released from such sources. This would also help to take immediate corrective measures when there is a problem.

- ✓ All waste generating plants and municipalities may officially require treating their wastes before discharging to the rivers. Of course, such requirements are costly. It might make private investors to shy away from operating in the area where the cost has added up on their production. However, that cannot justify the contribution of existing burden on the rural community.
- ✓ Attempting to have a single treatment plant for many sources through revisiting the industrial zoning or clustering mechanism should have to implement in the *Bahirdar* town. This is needed to minimize the industrial distribution within the town.
- ✓ Revisiting the drainage system (swages and sewerages) or network of the *Bahirdar* town in order to minimize the run off pollution that directly discharged to the river and arising a problematic on the society. In order to ensure maintainable development, it is important to integrate environmental concerns into development activities, programs and policies. Strategic Environmental Assessment as one of environmental management tools facilitates the inclusion of principles of sustainable development aspiration well in improvement.
- ✓ The *Bahirdar* water and sanitation office could strongly work on securing the quality of the water delivered to the Dwellers so that health impacts will be reduced.
- ✓ The town residents should also use different techniques such as home-made (washing the container and boiling the water) and professional recommended techniques (using drugs) of water treatment before drinking the water.
- ✓ The health professions should also strength their health education on how to maintain water hygiene and early screening of the disease symptoms related to water pollution that there will be early treatment
- ✓ National Pollution code of conduct is recommended to be instilled to sustainably culminate the water pollution in the Abbay Rever Basin, Bahirdar Satellite town.

REFERENCES

Ademe Arega Shumetie, Alemayehu Molla (2014) Source and Determinants of Water Pollution in Ethiopia: Distributed Lag Modeling Approach. Intel Prop Rights 2: 110. doi:10.4172/2375-4516.1000110.

Ahmad SM, Yusafzai F, Bari T, et al. (2014). Assessment of heavy metals in surface water of River Panjkora Dir Lower, KPK Pakistan. J Bio and Env Sci. 2014; 5: 144-52.

Alrumman SA, El-kott AF, Kehsk MA. Water pollution: Source and treatment. American journal of Environmental Engineering. 2016;6(3):88-98.

Aymere Awoke, Abebe Beyene, Helmut K., Peter L.M., and Goethals, L., T. (2015). River Water Pollution Status and Water Policy Scenario in Ethiopia: Raising Awareness for Better Implementation in Developing Countries . Springer Science, Business Media, New York. DOI 10.1007/s00267-016-0734-y

Ballester, F, Sunyer, J. (2000). Challenges to public health in the new millennium. Journal Epidemiology Community Health. 2000; 54:2-5

Bibi, S., Khan, R.L., Nazir, R, *et al.* (2016). Heavy metals in drinking water of Lakki Marwat District, KPK, Pakistan. World applied sciences journal. 2016;34(1):15-19.

Blcksmith Institute September, (2007). The World's most polluted places (http://www.blacksmithinstitute.org/wwpp2007/finalReport2007.pdf).

Briggs D. Environmental pollution and the global burden of disease. British medical bulletin. 2003;68:1-24.

Michael H. and G.L. Latshaw (1973). The relationship between highway planning and urision specialty conference, Chicago, Illinois. By American Society of Civil Engineers. Urban Transportation Division (http://www.worldcatlibraries.org/wcpa/ top3mset/2930880)

Cinzano, P.; Falchi, F.; Elvidge, C. D.; Baugh, K. E. (2000). "The artificial night sky brightness mapped from DMSP Operational Linescan System measurements" (http://www.lightpollution.it/cinzano/download/mnras_paper.pdf). Monthly Notices of the Royal Astronomical.

Corcoran E, Nellemann C., Baker E., et al. (2010). Sick water The central role of wastewater management in sustainable development. A Rapid Response Assessment. United Nations Environment Programme. 2010. 20.

CSA (Central Statistics Agency). (2007). Population and Housing Census. The Federal Democratic Republic of Ethiopia. Addis Ababa, Ethiopia

Desai N, and Vanitaben, S. (2014). A study on the water pollution based on the environmental problem. Indian Journal of Research. 2014;3(12):95-96.

Ebenstein AY. Water pollution and digestive cancer in China. Institutions and governance programs. 2008:1-45.

Environmental Risk Assessment Remedies at Akaki Area (2017), Volume 1. Issue 3, 19

Environmental Protection Authority of Ethiopia, (2005). Report on the Status of Akaki River Pollution Assessment.

Environmental Protection Authority of Ethiopia, (EPAE, 1997). Environmental Policy of Ethiopia

Fufa Eticha Guta (2015). Socio-Economic Problems of Water Pollution: The Case of Akaki River. Project Work Submitted to Indira Gandhi National Open University in partial fulfilment of the requirements for the Degree - Masters of Arts in Economics.

FAO, (1996). Food and Agriculture Organization of the United Nations.

Halder JN, Islam MN. (2015). Water pollution and its impact on the human health. Journal of environment and human. 2015;2(1):36-46.

Haseena M, Malik MF. (2017). Water pollution and human health. Environ Risk Assess Remediat. 2017;1(3):16-19

Ho Y.C., Show, K.Y., Guo X., (2012). Industrial discharge and their affects to the environment. Industrial waste, InTech. 2012:1-32.

Hollan, J, (2009). What is light pollution, and how do we quantify it? (http://amper.ped.muni.cz/light/lp_what_is.pdf). Darksky conference paper, Vienna.

International Atomic Energy Agency, (2007). IAEA Safety Glossary: Terminology Used in Nuclear Safety and Radiation Protection (http:// www pub.iaea.org/MTCD/publications/PDF/Pub1290_web.pdf). Vienna: IAEA.

Jansen HC, Harmsen J (2011) Pesticide monitoring in the Central Rift Valley 2009-2010. Report 2083. Alterra, Wageningen, http://library. wur.nl/WebQuery/clc/1966024

Jansen HC, Hengsdijk H, Legesse D, Ayenew T, Hellegers P, Spliethoff P (2007) Land and water resources assessment in the Ethiopian Central Rift Valley. Report 1585. Alterra, Wageningen, http:// library.wur.nl/WebQuery/wurpubs/364475

Joshua, N., (2015). Water pollution and its impact on Health

Kamble SM. (2014). Water pollution and public health issues in Kolhapur city in Maharashtra. International journal of scientific and research publications. 2014;4(1):1-6.

Khan, N., Hussain, S..T, Saboor, A., (2013). Physiochemical investigation of the drinking water sources from Mardan, Khyber Pakhtunkhwa, Pakistan. International journal of physical sciences. 2013;8(33):1661-71.

Khurana, I. and Sen, R. (2008). Drinking water quality in rural India: Issues and Approaches-Water Aid. India water Portal.

Marín, C. and Orlando, G., (2009). Starlight Reserves and World Heritage (http://www.starlight2007.net/pdf/FinalReportFuerteventuraSL. pdf). Starlight Initiative, IAC and the UNESCO World Heritage Centre. Fuerteventura, Spain, June.

Merrett, S. (1997). Introduction to the Economics of Water Resources: an International Perspective, London: UCL Press.

Meseret Misgana (2015). Rural Households` Access to Domestic Water Use in the Sebeta *Hawas* District, Oromia Region, Ethiopia, Addis Ababa University

Michael Hogan and Gary L. Latshaw, (1973). The relationship between highway planning and urision specialty conference, Chicago, Illinois. By American Society of Civil Engineers. Urban Transportation Division.

Nel, L.H., Markotter, W. New and emerging waterborne infectious diseases. Encyclopedia of life support system. 2009;1:1-10.

Olaniran N.S. (1995). "Environment and Health: An Introduction", in Olaniran, N.S. (Ed) Environment and Health. Lagos. Micmillan Nig. Pub. Co for NCF.

Owa FD. Water pollution: sources, effects, control and management. Mediterranean journal of social sciences. 2013;4(8):65-8.

Pawari, M.J., and Gawande S. (2015). Ground water pollution & its consequence. International journal of engineering research and general science. 2015; 3(4):773-76

Tedla, S., and Lemma, K. (1998) Environmental management in Ethiopia: have the national conservation plans worked?. Organization for social science research in Eastern and Southern Africa (OSSREA), Addis Ababa

Rasmussen, (1999). Extinction Rates of North American Freshwater Fauna. Conservation Biology.

Said R. (1993) The River Nile, Geology, Hydrology and Utilisation, Pergamon Press, UK.

Stanwell-Smith, (2002). National Surveillance systems. In: Drinking Water and Infectious Disease: establishing the links (Ends P R Hunter, M Waite, and E Ronchi). CRC Press

Stephen, Merrett, (1997). Introduction to the Economics of Water Resources, an International Perspective, ULC Press, London

MoWCA (2004). National Water Development Report of Ethiopia, (December, 2004)

Ullah S, Javed MW, Shafique M, *et al.* (2014). An integrated approach for quality assessment of drinking water using GIS: A case study of Lower Dir. Journal of Himalayan Earth Sciences. 2014;47(2):163-74.

UNEP (United Nations Environment Programme) (2010). Africa Water Atlas. Division of Early Warning and Assessment (DEWA). Annual Report. The 2010 Annual Report catalogue

UNESCO (2004). World Water Assessment Programme, National Water Development Report for Ethiopia.

UNICEF WHO, (2008). UNICEF and World Health Organization Joint Monitoring Programme for Water Supply and Sanitation. Progress on Drinking Water and Sanitation: Special Focus on Sanitation. UNICEF, New York and WHO, Geneva.

UN WWAP, (2003). United Nations World Water Assessment Programme. The World Water Development Report 1: Water for People, Water for Life. UNESCO: Paris, France

UN WWAP, (2006). United Nations World Water Assessment Programme. The World Water Development Report 2: Water, A Shared Responsibility. UNESCO: Paris, France.

UN WWAP, (2009). United Nations World Water Assessment Programme. The World Water Development Report 3: Water in a Changing World. UNESCO: Paris, France

Webster.com. (2010). Definition from Webster Dictionary 08-13 Retrieved

Williams, W.B., M.E.Cuvelier, and C.Berset (1995). Use of a free radical method to evaluate antioxidant activity. LWT - Food Science and Technology. Volume 28, Issue 1, 1995, Pages 25-30. https://doi.org/10.1016/S0023-6438(95) 80008-5

WHO Regional Office for Europe (2010). European health for all database [online database]. Copenhagen, WHO Regional Office for Europe (http://www.euro.who.int/hfadb, accessed 9 August 2010).

WHO (2016a). International Health Regulations (2005), third edition. Geneva: World Health Organization (http://www.who.int/ihr/publications/9789241580496/en/, accessed 26 September 2016). WHO (2016b). Global Health Observatory Data Repository (European Region) [online database].

Yonglong, Lu, Song, S., Wang, R., *et al. (2015).* Impacts of soil and water pollution on food safety and health risks in China. Environment International. 2015; 77:5-15.

Yirga Kebede, Hassen Muhabaw, and Manalebesh Asmara (2016). Physico-Chemical Water Quality Assessment of Gilgel Abbay River in the Lake Tana Basin, Ethiopia. Department of Environment and Water Quality Monitoring, Tana Sub-basin Organization (TaSBO), Bahir Dar, Ethiopia Civil and Environmental Research www.iiste.org ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online) Vol.8, No.4, 2016

APPENDICES

Appendix 1: Survey Questionnaire (English Vesion)

Addis Ababa University

Centre for Environment and Development, College of Development Studies

Specialization in Water Resource Management

Dear Sir/ madam;

My name is **Amare Malede Emru** and I am MSc student in Water Resources Management at Addis Ababa University. The title of my thesis is "Perceived Causes and Effects of water pollution on Human health: the case of Abbay River in the three Bahirdar satellite town". I have constructed these interview questions to gather the required information for the study. Your active participation is very important and without your participation, the study will not be as complete as it should be.

Please feel free to add any additional remarks to my study, or leave blank if you have troubles answering certain questions.

Sincerely,

Amare Malede Emru

Sign: _____

Part one: Personal Background of the respondent

1. Kebele of respondent_____
2. Sex of the respondent
   1. Male 2. Female
3. Age of the respondent
   1. 15-35 2. 35-65 3. Above 65
4. Marital status of the respondent
   1. Single 2. Married
   3. Divorced 4. Widowed
5. Family size of the respondent
   1. Male 2. Female 3. Total _____
6. Educational background of the respondent

a. Illiterate b. Grade 1-4 c. Grade 5-8 d. Grade 9-12 e. Degree and above

7. Occupation of households _____
8. Sampled HH capital income per month? _____

Part Two: Current Status Perceived impact of water pollution on human health.

9. Do you have any ideas about the impact of Water Pollution on human health and aquatic ecology?

a. Yes

b. No

10. What do you feel about the present condition or perceived impact of Water Pollution on human health and aquatic ecology in your satellite town?

a. Better

b. Good

c. Fair

d. Poor

11. What are the more common disease in your point of view related to the Water Born Diseases?

a. Cholera

b. Typhoid

c. Dysentery

d. Others

12. Would you consider changing some of your daily activities if it would improve water quality?

a. Yes

b. No

13. Where, do you think, water of the highest quality is found?

a. From wells

b. Bottled water

c. From water taps

14. Are you satisfied with the quality of drinking water in your **satellite town**?

a. Yes

b. Could be better

c. No

15. Have you ever witnessed a kidney problem in your area in the last 6 months?

a. Yes

b. No

16. if your answer yes from question 13, do you identify case of kidney problem?----------

---

Part Three: Level of perceived impact of Water pollution on human health.

17. What type of water do you prefer?

a. Tap water?

b. Pond water (River Water)?

c. Water tanker ?

d. others (please identify) ----------

18. Do you think the water you drink is of good quality?

a. No, very bad

b. No, bad

c. Average/Normal

d. Yes, good

e. Yes, very good

19.What are the biggest water pollution causes for your **satellite town**?

a. Too much trash

b. Toxic chemicals

c. Excess sediment

d. Others

20. How often do you clean your drinking water container?

a. Once every day

b. 2-3 times a week

c. Once a week

d. More than a week

e. Never until it become dirty

21. Does water sometimes smell like rotten eggs?

a. Yes

b. No

c. Sometimes they smell another type

22. What are the attempts of government? A. Awareness Creation, B. Legal measures C. Protected Areas D. Others

* How about at individual levels? A/ cleaning the container B. clean the river basin C. Other

23.Recommendation

……

……

……

Thank you very much for your kind cooperation!

Amare Malede Emru

Appendix 2. Interview Guides (for Community KIs and Experts)

1. Do you know about the water pollution of Abbay River basin?
2. What are the causes of the pollution?
3. What are the effects of water pollution in the area?
4. What sort of measures have the government taken to control this pollution? (At individual level?)
5. Is it good enough to control the water pollution?
6. How can we improve the water pollution situation of this river?

Appendix 3: Survey Questionnaire (Amharic Version)

አዲስ አበባ ዩኒቨርስቲ

በውሃ ሀብት አስተዳደር ትምህርት ቤት በባህርዳር ከተማ አስተዳደር ውስጥ በተመረጡ ሦስት ሳተላይት ከተሞች ማህበረሰቡ የውሀ ብክለት በሰው ልጂ ጤና ላይ የሚያመጠውን ጉዳት ያለውን የመገንዘብ ችሎታ ለማጥናት የተዘጋጀ መጠይቅ፡ የመጠይቁ ፎርም እንደምን ሰነበቱ? የእኔስም_____ ሲባል የምማረው በአዲስአበባ ዩኒቨርሲቲ ሲሆን እርስዎ በውሃ ሀብት አስተዳደር ለምሠራው የመመረቂያ ጽሑፍ መጠይቅ በእጣ ተመርጠዋል።የጥናቱ አላማ በማህበረሰቡ መካከል ስላለው የውሃ አቅርቦት እና ፍላጐት ክፍተት እንዲሁም ክፍተቱን ለመቋቋም የሚወሰደው ዘዴ ነው። በመጠይቁ ውስጥ የእርስዎ ስምና አድራሻ አይካተትም። የሰጡትም አስተያየት የእርስዎ ስለመሆኑ በምንም ሁኔታ አይገለፅም። በዚህ ጥናት ለመሳተፍ እኛ የእርስዎን ሙሉ ፈቃደኝነት እንጠይቅ ያለምንም አስገዳጂነት ሲሆን ፈቃደኛ ካልሆኑ ከመጀመሪያውም ሆነ መጠይቁን ከጀመሩ በኋላ ከመሃ ልማቋረጥ ይችላሉ።በጥናቱ ውስጥ መሳተፍዎ ግን ለጥናቱ መደረግና ያሉትን ችግሮች አውቆ መፍትሔ ለመፈለግ ከፍተኛ አስተዋጽኦ ይኖረዋል። ስለዚህ ለመሳተፍ ፈቃደኛ ነዎት? አዎ አይደለሁም ለመሳተፍ ፈቃደኛ ከሆኑ ጥያቄውን በሚቀጥለው ገፅ ይቀጥሉ።

መረጃው የተሰጠበት ቀን ---------- መረጃውን የሰበሰበው ስም ----------ፊርማ----------

ማህበራዊ፣ቤተሰባዊ እና ኢኮኖሚያዊ መረጃዎች

1. እርስዎ የሚገኙበት ቀበሌ
2. የመላ ሹዎታ
    1. ወንድ
    2. ሴት
3. የእርስዎ የእድሜ ክልል
    1. 1-14
    2.15-65
    3. ከ65 በላይ

4. የመላሹ የጋብቻ ሁኔታ
    1. ያገባ 2. ያላገባ 3. የፈታ 4. በሞት ምክንያት የትዳር አጋር የሌለው

5. የመላሹ የቤተሰብ መጠን
    i. ወንድ ii. ሴት iii. ድምር

6. የመላሹ የትምህርት ደረጃ
    i. ያልተማረ ii. መደበኛ ያልሆነ ትምህርት የተማረ iii. 1-4 iv.5-8
    v. 9-12 vi.ዲፕሎማ vii. ዲግሪ

7. የመላሹ ስራ
    1. የግል ቅጥር
    2. የመንግስት
    3. የቤትእመቤት

4. ነጋዴ
5. ሥራ ፈላጊ
6. የቀን ሠራተኛ
7. ሌላካለ (እባክዎይግለፁልን)
8. የቤተሰብዎ የወር ገቢ ምን ያህል ነው?----------

ማህበረሰቡ የውሀ ብክለት በሰው ልጂ ጤና ስለ ሚያስከትለው ጉዳት ያለውን ግንዛቤ ለመረዳት የተዘጋጀ ጥያቄ

9.እርሰዎ በሚኖሩበት ቀበሌ የውሃ ብክለት አለ ብለው ያስባሉ?
ሀ/ አዎ
ለ/ የለም

10.የውሀ ብክለት በሰው ልጂ ጤና ላይ ያለው ጉዳት እንዴት ያዩታል?
ሀ/ የተሻለ
ለ/ ጥሩ
ሐ/ ተመጣኝ
መ/ ዝቅተኛ

11.በውሃ ብክለት ምክንያት የሚመጡ ውሃ ወለድ በሽታዎች ምን ምን ናቸው?
ሀ/ ኮሌራ
ለ/ ታይፎይድ
ሐ/ የተቅማጥ በሽታ
መ/ ሌላ ካለ እባክዎ ይጥቀሱልን----------

12.እርሰዎ የውሃ ጥራትን ለመጠበቅ ቀን ተቀን ይሰራሉ?
ሀ/ አዎ
ለ/ አልሰራም

13. ንፁህ ውሃ የት ይገኛል ብለው ያስባሉ?
ሀ/ ከጉድጓድ
ለ/ ከወንዝ
ሐ/ ከምንጭ
መ/ ከኩሬ ሠ/ ሌላ ካለ (እባክዎ ይጥቀሱ)----------

14. እርሰዎ በሚኖሩበት ቀበሌ ለመጠጥ በሚጠቀሙት የውሃ ንፅህና ይረካሉ?
ሀ/ እረካለሁ
ለ/ የተሻለ ነው
ሐ/ አረካም

15. ባለፉት 6 ወራቶች ልጆዎ በኩላሊት በሽታ ታሞበዎት ያውቃል?
ሀ/ አዎ
ለ/ አያውቅም

16. በጥያቄ 15 መልሰዎ ከሆነ የኩላሊት በሽታ በምን እንደተከሰተ ለይተዋል ?

17. እርሰዎ የሚጠቀሙት ውሃ መገኛው ከየት ነው?
ሀ/ የቧንቧ
ለ/ የሃይላንድ

ሐ/ በማጠራቀሚያ የተጠራቀመ ውሃ

መ/ ሌላ ካለ እባክዎ ይጥቀሱ----------

18. እርስዎ የሚጠቀሙት ውሃ ንፁህ ነው ብለው ያስባሉ?

ሀ/ አዎ

ለ/ አላስብም

19. እርስዎ በሚኖሩበት ቀበሌ ዋነኛ የብክለት መንስኤ ምንድናቸው?

ሀ/ ከተለያዩ ፋብሪካዎች የሚወጡ ቆሻሻዎች

ለ/ ከመኖሪያ ቤት የሚመጡ ቆሻሻቆች

ሐ/ መርዛማ የሆኑ ኬሚካሎች

መ/ ከቅሪተ አካል ዝቃጭ

ሠ/ ሌላ ካለ እባክዎ ይጥቀሱ----------

20. እርስዎ ለመጠጥ የሚያጠራቅሙበትን የውሃ ማጠራቀሚያ ምን ያህል ጊዜ ያጥቡታል?

ሀ/ በቀን አንድ ጊዜ

ለ/ በሳምንት 3 ጊዜ ሐ/ በሳምንት 1 ጊዜ

መ/ ሌላ ካል እባክዎ ይጥቀሱልን

21. እርስዎ የሚጠቀሙት ውሃ ሽታ ኖሮት ያውቃል?

ሀ/ አዎ

ለ/ የለም

22. እርስዎ ይህ ጥናት መሰራቱ ለማህበረሰቡ ምን ጠቀሜታ አለው ብለው ብለው ያስባሉ እባክዎ ሀሳበዎን ዘርዝር አድርገው ይፃፉልን_____

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Appendix 4. Photo showing Solid Waste disposal system (informal disposal of dry wastage from Agricultural and Environmental Science College)

(a)

(b)

(c)

(d)

Photo 1: Informal disposal of dry wastage from Agricultural and Environmental Science College, Bahirdar, Ethiopia

Appendix 5. Photo showing Liquid Waste disposal system in the study Area

(a)

(b)

Photo 2: Informal disposal of dry wastage from Agricultural and Environmental Science College, Bahirdar, Ethiopia

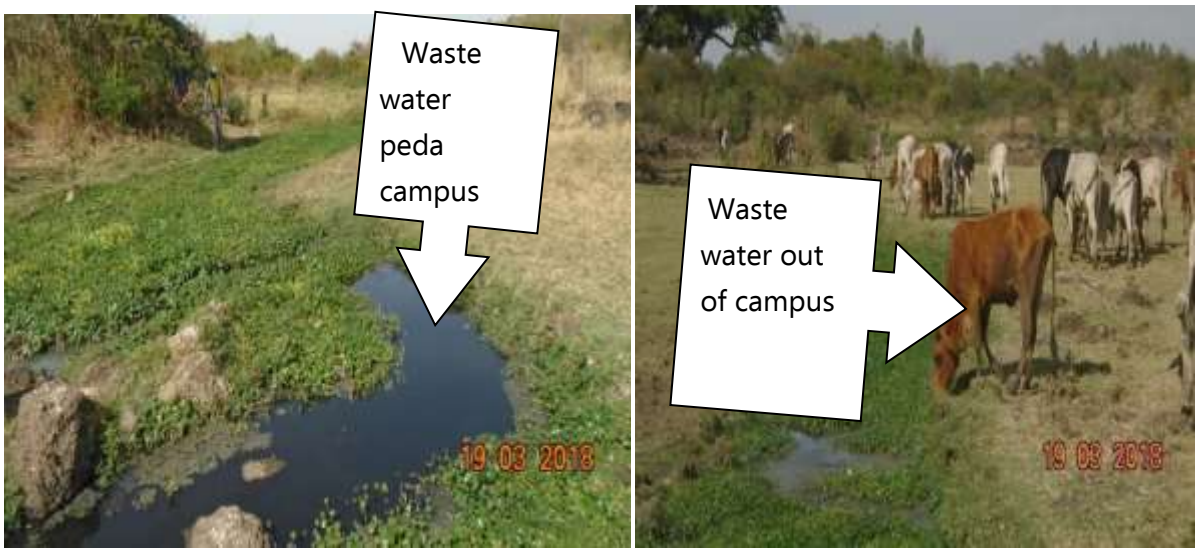
Appendix 6. Photo showing Solid Waste disposal system (informal disposal of dry wastage from *Peda* Campus)

Photograph 3: informal disposal of dry wastage from peda Campus

Appendix 7. Incinerator of dry wastage from peda Campus (Photo showing Waste disposal)

Photograph 4: Incinerator of dry wastage from peda Campus

Appendix 8. Cattle drinking on polluted water from peda Campus (Photo)



Photograph 5: Incinerator of dry wastage from peda Campus

Photograph 6: Incinerator of dry wastage from peda Campus