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TOPIC OF THE PROJECT WORK
Socio-Economic Problems of Water Pollution: The Case of Akaki River

Project Work Submitted to Indira Gandhi National Open University in partial fulfillment of the requirements for the Degree - Masters of Arts in Economics. I hereby declare that this work has been done by me and has not been submitted elsewhere.

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CERTIFCATE

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It is recommended that this Project be placed before examiner for evaluation.

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Abbreviation/ Acronyms

AAEPA- Addis Ababa Environmental Protection Authority

BOD - Biological Oxygen Demand

CO2 – Carbon dioxide

COD - Chemical Oxygen Demand

CSAE - Central Statistical Authority of Ethiopia

DO - Dissolved oxygen

EPA – Environmental Protection Authority

FDRE - Federal Democratic Republic of Ethiopia

FEPA - Federal Environmental Protection Authority

GC – Gregorian calendar

OECD - Organization for Economic Co-operation and Development

OEPA - Oromia Environmental Protection Authority

OEPO - Oromia Environmental Protection Office

OSZSF - Oromia Special Zone Surrounding Finfine

TDS - Total Dissolved Solids

TSS- Total Suspended Solids

UNDP – United Nation Development Program

WHO – World Health Organization

EXCUTIVE SUMMARY

The main purpose of this research thesis is to explore the socio-economic problems of Akaki River on the rural community in the catchment areas. To that end, through descriptive research methodology, multiple data sources such as official documents and previous research results were consulted so as to validate the findings regarding the issue through descriptive approach. Due to anthropogenic sources of pollution, the river is becoming hosts of excessive quantity of heavy metals and high concentration of chemical hazards. Consequently, these pollutants are turned into becoming the sources of social and economic problems to the local community more than being undesirable sources. This phenomenon is gradually harming agricultural productivity, cattle production and human health while destroying aquatic life and affecting considerable environmental hazards in the rural areas. With the existing urbanization speed and industrial expansion in the upstream (in Addis Ababa City) and surrounding, the problem will be aggravated and to be uncontrollable.

The researcher concluded that unless the community of the study area is provided pure and potable water, the human and animals' health problems are very harsh. Because of this, the river's pollution needs immediate response. Hence, it is the assertion of this research paper that the identified problems can be competently addressed by the promotion of treatment plants by waste generating bodies, being accompanied by awareness creation and continues monitoring and controlling of the discharges. By doing so, the communities' way of utilizing available sources will be improved-grossly minimizing the health hazards. It will also encourage the provision of other water sources options for the rural community in the catchment areas.

Chapter I: Introduction

1.1 Background

Next to oxygen, fresh water is the most important substance for human existence and it is essential for everything on our planet to grow and prosper (Prabu P. C. et al. 2009). It is the most essential natural resources and is vital for sustenance of life on earth. The wellbeing and the development of our society are dependent on the availability of water. This precious resource is sometimes scarce, sometimes abundant and is always very unevenly distributed (Reddy, 2001). River basins are one among a variety of the sources of water that is being used by mankind.

Fresh waters like rivers; lakes and ground water are utilized to irrigate crops, to provide drinking and to act as a sanitation system. Although we as humans recognize this fact, we are always found thoughtlessly polluting our rivers and other sources of water. As a result, most of our water resources are gradually becoming contaminated due to the addition of foreign organic and inorganic elements from the surroundings. These include organic matter of plant and animal origin, land surface washing; and industrial and sewage effluents.

The rate of population growth, the expansion and development of new industries and other diversified human activities strengthen the pollution problems. Pollution is an alteration of the quality of the water by wastes to a degree, which unreasonably affects the beneficial uses and facilities. Some of the simple water pollution indicative signs are bad taste of drinking water, offensive odors, turbidity, unusual color, unchecked growth of aquatic weeds.

Intentionally people have been using to dump wastes into water bodies that create sever pollution problems on the users. The existing poor sanitations, poor effluent treatment of factories and sewerage and waste disposal systems of the dwellers and Industries located in Addis Ababa City Government are aggravating the problems.

Improper environmental planning is also often leaded to discharge of industrial and sewage effluents into rivers. The proximity or closeness of rivers to areas of extensive population settlement makes rivers prone to the negative externalities of human interventions. This is

particularly very much true to water courses which cross metropolitan cities. In this regard, the case of Akaki River is also true.

These days the importance of environmental quality in the globe in general and around the cities in particular has recently aroused a great deal of interest. These are the reason why green economies are getting an attention. In this study area, industrial units located in and at the outskirts of the city, intensive agricultural practices-utilizing inorganic fertilizers-along the rivers sides and indiscriminate disposal of domestic and municipal wastes are becoming major sources for Akaki river water pollution. Exposure to these wastes, which are believed to contain toxic components like heavy metals, is of great concern, as it poses not only health risks to humans but also potentially unacceptable ecological risks to plants, animals and microorganisms. One worrisome aspect of these catchments is that communities in the nearby are using the polluted river water for irrigation, drinking, and livestock is watering. That being the current state of affairs, the results of previous studies failed sort of explicitly dealing with the consequences and remedial actions.

Subsequently, this study attempts to assess the cause of social and economic impacts by the pollution of Akaki River on the rural community since it is believed to be worth investigating to show the externalities that are threatening the livelihood of the rural community. To reach at the result, descriptive type of research methodology with proper sampling primary and secondary data from Addis Ababa City Government and Oromia Regional Government are employed. A survey was conducted to assess the overall status of the consequences from the community's perspectives.

1.2. Statement of the problem

The Federal Government of Ethiopia formulate Environmental Policies for the policy goal is to improve and enhance the health and quality of life of all Ethiopians and to promote sustainable social and economic development through the sound management and use of natural, human-made and cultural resources and the environment as a whole so as to meet the needs of the present generation without compromising the ability of future generations to meet their own needs.

Despite the fact that Environmental Policy is formulated, practicability of the Policy is quested. Human environment is largely dependent on the availability of water which is assumed to be unique to our planet. It is one of the necessities for human life and development activities. Its extended use for drinking, agriculture, sanitation, transport, industry, electrical power generation and recreation shows the extent to which water is an integral part of human life. It exists in different forms: surface water such as ocean, sea, lake, river, groundwater, and atmospheric water. Although water is most abundant in the biosphere, often it is a major cause of concern for human welfare.

Different researchers argue that the efficient management of water resources is becoming a crucial issue of many countries. River basins are one of the water sources with multi-dimensional contributions to the enhancement of economic development. Although they are part of renewable resources, their renewability will be put under question if their use rate exceeds their regeneration rate. With the growing urbanization and industrialization around the City of Addis Ababa areas, Akaki River is subjected to considerable use and misuse. On the other hand, as technology started to become sufficiently available, the local water sources began to fall victim of the unintended consequences of human health development. Moreover, enhancement of technology increases the capabilities to exploit, extract, pollute and manipulate the environmental resources beyond their regenerative capacity.

Due to different reasons like market location, economies of scale and other environmental suitability, the largest share of the country's industries is located in Addis Ababa and the surrounding towns. Most of the industries in Ethiopia (greater than 65%) are located in Addis Ababa and the nearby town of Akaki (CSA, 1999).

A majority of these newly established industries discharge their wastes directly into Akaki and other Rivers. According to a survey conducted by Mebratu; of the industries located in and around Addis Ababa in the years 1990 and 2000, only 6% and 20% had treatment plant respectively.

The tradeoff between urbanization and environmental management is manifested itself in the form of River pollution. In addition to industrial wastes, domestic wastes from toilets, kitchen, domestic operations, etc and by run-off from sewage of both Addis Ababa City and surrounding area Towns are polluting the Rivers. Despite the pollution abatement policy, streams are serving as natural sewerage lines for domestic and industrial wastes, hence making them popular for their offensive odor and black color. On top of that, effluents discharged from these urban areas and containing substances like oils, greases, detergents, nutrients, heavy metals etc. are seriously aggravating the extent of environmental pollution.

Since a very large number of people have no other source of water for domestic use, agricultural irrigations and livestock watering, 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, more than 63,000 people of the downstream residents living in the catchment areas of the rivers-uses these rivers for different purposes (OEPO, 2004).

Different organizations and individuals conducted a research regarding the pollution level of Akaki River. However, these studies have mainly focused on the assessing the contamination level of the river while ignoring the socio-economic problems that arise due to the pollution on the catchment areas. Some studies only show the availability of heavy metals in per liter of the water due to uncontrolled discharge of the wastes and horticultures produced around the Akaki River. Though the socio-economic consequence of the pollution of this river is diverse, until to date, no serious study about their socio-economic problems has been conducted. In this regard, this study will tries to assess the major socio-economic problems of the pollution of the river on the rural community and suggest mitigating measures so as to ensure environmental sustainability in the study area.

1.3. Research Question

The research focuses on the following basic questions and is going to answer them. These questions are**:**

1**.** Is pollution of the natural water in the City of Addis Ababa is properly valued and measured in the manner that serve the existing and the coming generation in a sustainable manner? Is there any proper care for the natural water or river resource that is available to the area?

2. What are the magnitudes of problems due to the pollution of Akaki River?
3. What are the major causes for the pollution of the rivers?
4. To what extent do the surrounding people rely on this river for their livelihoods?
5. What major social and economic problems are faced on the surrounding people due to the increasing pollution of this river?

1.4. Research Objectives

1.4.1. General objective:

The main objective of this research is to assess the socio-economic problems due to water pollution especially the Akaki River. It is to identify that the causes and consequences of water pollution problems within the City of Addis Ababa and downstream of the River in the rural areas and then propose conceivable mitigating measures to meaningfully minimize the negative impacts.

1.4.2. Specific Objectives:

The specific objectives of the thesis are:

- To identify the problems and causes of water pollution of Akaki River;
- To measure up the extent to which the surrounding people rely on the river for their livelihood;
- To examine the River pollution effects on human and livestock health.
- To examine the socio-economic problems of Akaki River pollution on beneficial uses of the communities along the river course.

1.5 Significance of the Study

1. Regardless of several & persistent efforts to protect the environment in general and natural resources in particular are underway by the International Agencies, the Government, NGOs

and other concerned bodies. Protecting water resources is not only local it is global as well. In such a context this study is anticipated to shed light on the required environmental regulations, specifically water body regulations to the areas in the implementation strategies and supervisions demanding urgent attention to the Rivers.

2. In spite of the gravelly of the problem the domestic scientific literature on the social and economic problems of the pollution of Akaki River on the surrounding people is insufficient. In this regard, this study is believed to contribute its own share by-way of demonstrating the severity of the challenges highlighting the various pertinent issues around the phenomenon and its problems on the community.
3. Additionally, by carrying an in depth analysis on the issue, the present study is expected to serve as a stepping stone towards rigorous research on the subject area.

1.6. Limitations of the study

In addition to physical limits such as time and financial constraints, absence of adequate data and cross-sectoral and time series information on the subjects area have been the main bottlenecks that this study has been obliged to face. The absence of sufficient laboratory test report of the water compositions on the hands of the researcher is another problem. On the other hand, confounding variables that might affect the water quality and the capacity of utilizing irrigable lands in the study areas but which are out of the scope and expertise of this study might have had some impacts on the result of this study.

Nevertheless, the effectiveness of those to overcome stumbling factors, emphasis has been given for the selection and utilization of critical variables; and exhaustive triangulation has been also done by the researcher.

1.7. Scope of the Study

Content and Geographical Coverage: This thesis has covered the issues only related to the major social and economic problems faced by the surrounding people who are directly and indirectly affected by the pollution of Akaki rivers. Geographically, it spans about ten Kebeles of Akaki District out of a total forty one kebeles in the rural areas and one sub city in the City of Addis Ababa that fall under the territorial jurisdiction of the District.

1.8. Organization of the Thesis

The paper has constitutes with five chapters, which explain the issues under each chapter of main topics. The first chapter presents introduction part of the study which consists of background of the study, statement of the problem, objectives, significances, limitation and delimitation of the study.

The second chapter presents reviews of the related literature that are contributing significant role in aggravating water pollution problems in the cities and rural of developing countries and specifically in Ethiopia. Chapter three presents the methodology of the study and describes the study areas. The forth chapter deals with the discussion and the analysis of the data. The final part is chapter five, and it summarizes the major findings of the study, draws conclusions made from the findings and the recommendations that are important for policy implications suggested by the researcher.

Chapter II: Review of the Related Literature

In the second chapter, different related and relevant points from different books, journals, official reports and internet have been reviewed to establish convincing arguments about the issue being under study. Moreover, previous study reports about the water resource, environmental protections and water pollution are referred and examined. The literature review enters in to the study by defining about water pollution and winds up with the description of ways of managing water quality and National Water Policy.

2.1. 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.

2.2. 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 S.,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 (AAEPA, 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 (OEPA, 2004).

2.3. Water and Human Beings

Our earth, the blue planet that is fragile and precious home has vast water resources. Water held in the Oceans and other water bodies, as well as in the land masses and their vegetation, continuously evaporates into the atmosphere, hence it returns to the earth through rainfall. On land it gathers as surface water and infiltrates as groundwater. Of the entire world's water, 97.4% is in the oceans and only 2.6% is land based, in addition to the atmosphere. Of all the land's

water, 76.4% is in ice caps and glaciers, 22.8% occurs as groundwater, and 0.6% is surface water, half of which is saline seas (Ward & Robinson, 1990 cited in Stephen Merrett, 1997). It is that small volume of fresh water that must meet the needs of billions of people, the variety of animals and the plethora of plants that make this planet remarkable (Sylvain and et. al 2006). Water is vital for food production not only because of its direct effects on yields and cultivated area, but also because sustainable water supply induces more often than not farmers to invest in other essential crop inputs, such as improved fertilizers and capacity building for better resource management.

The importance of water for socio-economic development is well recognized globally; but with increasing population size and the rapid process of industrialization unfolding, water scarcity is looming high in many countries of the world. Lack of water hampers development through constraining food production, health and industrial development (Economic Commission for Africa, 2006). Due to its multiple properties, humankind very extensively uses water. However, the different uses affect both the quality and quantity of the available water. Rivers are one of the natural resources, which are highly exposed to intense human activity. The proximity or closeness of rivers to areas of extensive population settlement makes them much more prone to the effect of human activities. This is particularly true of watercourses, which cross metropolitan cities. For further vast development, it is unlikely that significant increase in abstraction of water from nature at reasonable costs is plausible without severe environmental or social disturbance in most countries (Sylvain and et. al, 2006).

The effects of human activity on such watercourses are not only limited to excess use, but also due to various improper utilization of it. Such prudent and ruthless exploitation of river waters can usually lead to excessive pollution, which in the end pollutes the river to the extent that it can no more be fit to provide any beneficial use. The pollution of such rivers extends to the extent of posing various forms of risks to the surrounding inhabitants.

2.3.1. Values of water

Water is needed in all forms of life. For sustainable development, it is necessary to take into account water's social, economic and environmental aspects. A clear definition of value of water should recognize the concept of valuing water both as an economic and social good while taking

at the same time environmental considerations (National Water Development Report for Ethiopia, December 2004). People generally attach religious and cultural values to water. The values of drinking water, domestic uses, irrigation and industrial uses have very often been socially established. The vital role of water for the satisfaction of basic human needs, food security, poverty alleviation, national economy and functioning of ecosystem is well realized.

The value of water depends largely on where it is available. Its value is site-specific and it is time–bound. The physical features of the country-matter the value that are given by the residents for available water sources-are composed of highlands, plateaus and lowlands. In this regard, the highlands are mostly associated with high rainfall, several springs, lakes, streams and rivers.
Because there is plenty of water in the highlands, people did not value water very much. However, in the lowland areas, water is scarce; people give more value to water. On the other hand, water is given more value in the arid, semi-arid and drought-prone areas than in the high land and rain-abundant areas. In a place where options are very limited-such like in Akaki catchment areas-people give more value for the existing water resource; the River, since their life is very dependent on such resources. People, particularly rural people, value a reliable water supply much more than the intermittent and unpredictable supply commonly experienced. In addition to considering the Rivers as worship area, the Oromo people of Ethiopia value greatly rivers and ponds.

Regarding the value of water, the government of Ethiopia has formulated and issued a comprehensive Water Resources Management Policy in the year 1999. This water policy is believed to enhance the development of the country's water resources to make optimum contribution to an accelerated socio-economic growth. To translate the water policy in to practice, Water Sector strategy has also been developed (National Water Development Report for Ethiopia, December 2004).

The policy has given due attention and recognition to the value of water. In the general objective of the policy, it has been stated that the development of the water resources of the country is to be for economic and social benefits of the people on equitable and sustainable basis. Regarding the value of water, the fundamental principles of the policy have also highlighted the following:

Water is a natural endowment commonly owned by all the peoples of Ethiopia. As far as conditions permit, every Ethiopian citizen shall have access to sufficient water of acceptable quality, to satisfy basic human needs. In order to significantly contribute to development, water shall be recognized as both an economic and a social good.

Moreover, the policy has clearly recognized the disadvantaged groups of the population by citing that, "Although all water resources development ought to be based on the economic value of water, the provision of water supply services to the underprivileged sectors of the population, shall be ensured based on a special social strategy" (National Water Development Report for Ethiopia, December 2004). While having the awareness about values of water, each of us are expected to know quality issues of rivers to observe the actual activities with practicable water resource management.

2.4. Major Sources of River 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 (National Water Development Report for Ethiopia; December 2004), the extent and severity of the problem is glaringly manifested in major cities of the country. Addis Ababa is a metropolitan city. The surrounding areas are one among those the places where the problem of river pollution is at its highest peak. To overcome the problems of river water pollution governing the sources in wise ways is necessary.

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 Federal Environmental Protection Authority in 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 metropolitan City of Addis Ababa and the surrounding 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.

Table 2.1 -- Major categories of water pollutants

Category	Examples	Sources
A. Causes health problems		
1. Infectious agents	Bacteria, viruses, parasites	Human and animal excreta
2. Organic chemicals	Pesticides, plastics, detergents, oil, and gasoline	Industrial, household, and farm use
3. Inorganic chemicals	Acids, caustics, salts, metals	Industrial effluents, household cleansers, surface runoff.
4. Radioactive materials	Uranium, thorium, cesium, iodine, radon	Mining and processing of ores, power plants, weapons production, natural sources
B. Causes ecosystem disruption		
1. Sediment	Soil, silt	Land erosion
2. Plant nutrients	Nitrates, phosphates, ammonium	Agricultural and urban fertilizers, sewage, manure
3. Oxygen-demanding wastes	Animal manure and plant residues	Sewage, agricultural runoff, paper mills, food processing
4. Thermal	Heat	Power plants, industrial cooling

Source: http//www.Ag-Runoff-fact sheet, chapter 20 pollution4

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 located in Addis Ababa, about 90% 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).

In accordance with the views of the National Water Development Report for Ethiopia (December 2004) and my own observation, most of the high water consuming industries in the Awash basin, in the City of Addis Ababa and in the Akaki area draw water for production purposes from river

water supply sources. Moreover, they discharge their by-product wastes in to streams and rivers without putting in place any kind of treatment. Besides there is no restriction on industrial plants that discharge their wastewater into the rivers and watercourses. However, few industries in the city of Addis Ababa have treatment facilities. Nevertheless, they are seen diverting their raw wastewaters into the storm water drainage system or else the watercourses. The reason could either be for technical reasons related to the wastewater treatment plant operation or else for reasons that there are no enforcement and effective control regarding industrial effluent discharges.

Some studies indicate that the industries equipped with some form of effluent treatment facilities have undersized installations and frequently inoperable. It seems that the main reason for installation of these facilities appears to have been for obtaining a building permit required to construct the factories. Very few industries in the city of Addis Ababa use septic tanks for the disposal of industrial waste effluent. According to the 1996 report by the Ministry of Health- a study on liquid waste management-out of 118 industrial establishments assessed in the city of Addis Ababa, 40 have solid waste discharges, 61 generate air pollutant discharges while 62 generate liquid wastes that are discharged to the surrounding. Only six out of the investigated factories are found to have some form of wastewater treatment plants while the rest discharge their wastes without any form of treatment.

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. The hazards resulting in from municipal and domestic pollution of the Akaki River and-in particular-its tributaries in the upper reaches were identified by studies conducted in the past (National Water Development Report for Ethiopia, December 2004).

The drainage systems, which were meant to collect run-off water (storm-water), are also being used for disposal of almost all categories of wastes, which include domestic, industrial, commercial, private, public etc. consisting of solid wastes and grit that are major causes for the frequent blockage and overflow of waters on to streets and surroundings.

The major municipal sources 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.

2.5. Effects of River Water Pollution

Water pollution occurs when the use by one segment of society 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. AAEPA in 2002 GC and FEPA in 2005 GC identified the following major social and economic problems of the pollution of rivers. For the purpose of this study, let us emphasize on social and economic problems created because of river water pollution.

2.5.1. Social Problems

Usually**,** the social problems of river water pollution are manifested in the form of human and animal health problems and its subsequent influences are on educational time and financial loss.

Problems Associated with Human Health: Most polluted water contain 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 and AAEPA, 2006).

Problems Associated with animal health: these toxic substances can be health hazards to livestock when ingested with water. It is learned that animals become affected after consuming the water. Most of the time, sick animals, which were using polluted river water, show the symptoms like gastrointestinal disorders, bloat body diarrhea, nerves signs like tremors and paralysis, edematous swelling, dermatitis and loss of hair (FEPA 2005). The problem is further worsened by the fact that the river water has bad odors and unpleasant taste so that animals do not drink it on regular basis until they get very thirsty. Thirsty animals consume high volume of water together with substantial amount of pollutants that could result in health problem.

Pollutants may have their main effect on aquatic organisms by reducing the dissolved oxygen (DO) content of water. The amount of oxygen that is dissolved in water varies greatly, and the

impact of pollutants on this DO can be measured either in terms of biological oxygen demand (BOD) or in terms of chemical oxygen demand (COD) (Hanley N., and et.al, 2001).

2.5.2. Economic problems

Apart from causing serious health problems to the dwellers living along the polluted river course, there is also a continuous economic loss, due to problems related to water pollution. The economic losses are divided in to direct and indirect losses.

i. Direct economic losses: Whenever, the water quality is affected due to pollution the usefulness of the water for irrigation is impaired. The uses of highly polluted irrigational river water utilizes for horticulture production purposes has chronic health implications. Because of its contamination and bad odor, the desire to use the polluted river decreases. This in turn affects the production and productivity of the farmers, creating a direct economic loss on their income (FEPA, 2005). Another direct economic loss can be attributed to death of animals due to toxic or pollutant effect or loss of body condition, production such as milk and drought power of affected animals. The other direct economic loss caused due to the water pollution problems is financial loss often incurred for covering health expenses by each family. Human health problem adversely affects the labor, the working interest and initiations; lack of working interest in turn directly affects income.

ii. **Indirect economic losses:** Animals that use these rivers for drinking have poor health condition. Because of that, their body weight and physical appearance decrease resulting in decrease in price. Not only that, the other most indirect impact is the decrease in animal's reproduction performance. Such diminishing trend in size of animal population entails loss of economic benefit that the peasant could harness from the sale of animal products such as milk, butter, etc. Finally, regarding the pollution of surface water, the National Water Development Report for Ethiopia (December 2004) has the following conclusion. The pollution that has been caused by the industrial wastewater discharge has reached to level of being a major concern. Almost all of the industries upon which a sample analysis has been done are discharging, effluents that contain pollutants well beyond the permissible and internationally accepted standards. The studies conducted on the streams that are flowing through Addis Ababa have shown that most of these streams are currently dead due to the pollution problem.

2.5.3. Ecological problems

Solid and liquid wastes can be generated from industries, commercial areas, hospitals, construction and households. These wastes are differing in their types and amount. Some of the institutions like hospitals, leather factory and industries generate hazardous wastes and heavy metals. When these wastes are disposed improperly to open areas and natural resources like rivers, these will bring nuisance, health effect, social impact, and water and soil pollution which are going to be resulted to ecological problem (EPAE, 2006). Pollutants that contain phosphate and nitrate discharged from industrial, agricultural and municipal wastes can cause excessive algae growth that can kill fish and other aquatic biota in such stagnant water of the dam. Serious cases of fish mortality can occur following the leaching of poisonous biocides from agricultural fields to rivers or streams after rainfall. These can be resulted in biotic and aquatic changes to the environment and can cause ecological disruption.

2.6. Major Water Quality Issues

Based on the National Water Development Report for Ethiopia (2004), the most significant of the water quality problems is poor microbiological and biological water quality. Most of the ten-top diseases, which affect public health, are the result of water borne and water related diseases. The possible sources of the main prevalent water quality problems result either due to natural causes that is geological or soil formation of an area or due to anthropogenic activities (domestic, industrial, commercial, agricultural. etc) and /or a combination of both.

Deborah Chapman (1999) identified the following major water quality issues in rivers:

a) Change in physical characteristics: temperature, turbidity and TSS in rivers can be greatly affected by human activities.
b) Fecal contamination: it is the primary water quality issues in rivers where human and animal wastes are not yet adequately collected and treated. The situation is more critical in fast growing cities where the population growth rate still far exceeds the rate of development of wastewater collection and treatment facilities.
c) Organic matter: the release into rivers of untreated domestic or industrial wastes high in organic matter results in a marked decline in oxygen concentration (sometimes resulting in anoxia) and a release of ammonia and nitrate downstream of the effluent input.

d) River eutrophication: it is the nutrient enrichment leading to increased primary production. The increasing level of phosphates and nitrates entering rivers has been largely responsible for eutrophication.

e) Salinisation: increased mineral salt in rivers may arise from several sources such like release of mining wastewaters, certain industrial wastewater and increased evaporation and evapo-transpiration in the river basin resulting from reservoir construction, irrigation return, etc.

f) Acidification: increased mineral salts in rivers may arise from several sources such like: direct inputs of acidic waste waters from mining or specific minerals, either as point sources (eg. leaching of mine tailings) and indirect inputs through acidic atmospheric deposition, mainly as nitric and sulphuric acids.

g) Trace elements: pollution results from various sources mainly: industrial wastewater, mining and smelter wastes, urban run-off, agricultural run-off, atmospheric deposition and leaching from solid waste dumps.

h) Nitrate pollution in rivers: urban wastewaters and some industrial wastes are major sources of nitrate and nitrite. However, in regions with intensive agriculture, the useof nitrogen fertilizers and discharge of wastewaters from the intensive indoor rearing of livestock can be the most significant sources.

i) Organic micro pollutants: enter rivers as point sources directly from sewers and effluent discharges and as diffuse from the leaching of solid and liquid waste dumps or agricultural land run-off.

j) Changes in river hydrology: many human activities, directly or indirectly, lead to modification of the rivers and its valley that produce changes in the aquatic environment.

2.6.1. Water Quality Parameters

National Drinking Water quality guideline was developed by the Ministry of Water Resources in the year of 2000 with a financial support from the UNDP. The major prevalent water quality problems in Ethiopia are those related to physical, chemical, as well as microbiological parameters. The possible causes of which are natural, anthropogenic or both. Some of the major water quality problems are shown on the following table.

Table 2.2: Water Quality Problems in Ethiopia

No.	Water Quality Problems	Parameters of concern
1	Physical parameters	Color, Turbudity, Taste
2	Chemical Qualities	Amo iron, hardness, pH, Nitrate, Fluoride, Sulfate, Nitrite, Manganese, Co2, TDS ameba
3	Microbiological	Total coli forms, E-coli, Giardia, Amoebae

Source: National Water Development Report for Ethiopia, 2004 GC

2.6.2. Managing Water Quality

The value of water is greatly reduced if its quality is so poor that it hides many of its potential beneficial uses. Considerable sums have been spent on water and wastewater treatment in both the developing and developed regions of the work. UNESCO's 1992 study indicates that in spite of considerable amount of these investments in water quality improvement and protection, they present only a fraction of the investments needed to substantially reduce water-borne diseases and meet commonly accepted environmental and ecological objectives (cited in Daniel P. Loucks and John S. Gladwell, 1999). Poor quality is most costly in the developing world. The results from the recent International Drinking Water and Sanitation Decade showed that money and technology are not the only single factors to improve water quality, sanitation and public health. Study by Daniel P. Loucks and John S. Gladwell, 1999 identified the following additional expected actions contributing to a more sustainable water quality management:

1) Population-demand control,
2) Institutional reform,
3) Implementing incentives for improved cost effectiveness,
4) More training at all levels of society on the benefits derived from better water quality and waste management practices,
5) Improved monitoring and
6) Non-point pollution control and greater recycling of waste residuals.

i. Pollution Controlling Strategies

There are different types of pollution controlling strategies. Some of which are:

- The cheapest and most effective way to reduce pollution is to avoid producing it or releasing it to the environment in the first place.
- Industry can modify manufacturing processes so fewer wastes are created.
- Recycling or reclaiming materials that otherwise might be discarded in the waste stream also reduces pollution.

Water Pollution has economic, social and political connotations. Do to the reason; it needs abatement policies and strategies. Some alternatives that useful for the policy options could be used to attain a specified target for pollution reduction. The target may be assumed to be different from the optimal level of pollution. It is assumed to have been set through the political process, using scientific inputs on likely damages, and economic inputs on both damage costs and control costs. Such targets are typically two types according to (Nick Hanley, Jason F. Shogren and Ben White, 1997).

The first is a target reduction in emissions outputs; across a specified set of dischargers while, the second type is a target improvement in ambient environmental quality. An example for the first one is targets include the US government's target reduction of 40 per cent in SO_2 emissions from power stations, relative to 1980 emission of 25.5 million tons. This target is to be achieved over two phases, phase one ending in January 1995, and phase two in January 2000 under the Clean Air Act Amendment of 1990. Another example of a load reduction target is the UK government's objective of a 50% reduction in the discharge of certain water-borne pollutions to the North Sea by 1995 (Hallett et. al., 1991).

An example for the second one is the range of target improvement in ambient water quality parameters adopted as 'environmental quality standards' by the Scottish River Purification Boards (RPB). Thus an RPB may have an objective of increasing dissolved oxygen levels in an estuary up to 7mg/l, through the policy of reducing discharges of substances exerting a biological oxygen demand (BOD) in the estuary.

For other types of target an environmental control agency has a number of policy options open to it. These are:

- Exhortation and persuasion

- Qualitative and quantitative limits on discharges (standard)
- Taxes on polluting inputs
- Taxes on emissions
- Product taxes
- Subsidy on pollution reduction
- A system of tradable emission permits
- A system of tradable input permits and
- Combinations of the preceding alternatives.

Standards may themselves be characterized into two groups: design standards, whereby the regulatory specifies the type of plant a firm or group of firms must use, and performance standards, where the regulatory specifies the maximum quality and minimum quality of a firm's emissions.

One obvious criterion which economists would suggest for the environmental quality agency is based on the efficiency of the desire to minimize the total control costs associated with achieving a given target. It is not the only criterion with which an agency should be concerned. According to Hanley et al., (1990), some researcher in the UK shows that the apparent fairness of a policy is likely to be important in terms of how the total financial burden – the sum of control costs and transfer payment incurred - the spread across dischargers, and between dischargers and the public.

The 'polluter pays' principle has been enshrined in Organization for Economic Co-operation and Development (OECD) policy statements since the early 1970s (Pezzey, 1988) and embodies a notion that dischargers should certainly bare the control costs of achieving a given level of pollution, and perhaps in addition pay any residual damage costs.

ii. Freshwater treatment

Freshwater treatment is the removal of both undesirable natural substance and man-made contaminations. This introduces the concept of water quality. A special case of treatment is the desalination of sea water to generate freshwater supplies. Desalination is energy intensive and is found largely in the countries of the Middle East and the US Sunshine Belt (Stephen Merrett,

1997). Treatment can also include the addition of soluble elements such as fluoride and the others to enhance water in the interests of public health.

2.7. The Ethiopian National Water Policy

According to Dublin-Rio statements of 1992 (cited in National Water Development Report for Ethiopia, December 2004), for the efficient management of water resources policies are very essential. The Ethiopian Water Resources Management Policy outlines some fundamental policy principles based on it. These are summarized as follows:

- Ethiopian citizens shall have access to sufficient water of acceptable quality to satisfy basic human needs. The policy gives top priority to drinking water supply over other uses;
- Water is both an economic and social good;
- Water resources development should be based on rural centered, decentralized management and participatory approaches.

This focuses on promoting decentralized management, foster the participation of user communities and support community self-initiatives in water resources management. Management of water resources shall ensure social equity, system reliability and sustainability; Integrated Water Resources Management is emphasized in the policy document and thus the policy recognizes the hydrologic boundary or basin as the fundamental planning unit and water resources management domain.

Increasingly, river basin is emerging as a unit of management of land, water and other natural resources in an integrated fashion. The Water Sector Development Program as an instrument for implementing the water resources management policy too advocates the establishment of River Basin Authorities becoming an integral part of Ministry of Water Resources. Regarding water use priority, the Proclamation states, "Domestic water use shall have priority over and above any other water uses" (FDRE, 197/2000 Article 7sub-article 1). The highest priority is accorded to domestic water or safe water for human consumption to be followed by livestock (National Water Development Report for Ethiopia, December 2004).

2.8 The Ethiopian Environmental Protection Policy

In 1997, the government adopted the Environmental Protection Policy of Ethiopia, which is based primarily on the conservation strategy of the country. The policy consists mainly of guiding principles and various sectoral and cross-sectoral policies for sustainable environmental management. The overall policy goal is to improve and enhance the health and quality of life of all Ethiopians and to promote sustainable social and economic development through the sound management and use of natural, human-made and cultural resources and the environment as a whole so as to meet sustainability in environmental resource (EPAE, 1997).

Despite the fact, the Ethiopian Environmental Authority report of 2005 indicates that the serious deficiencies in sanitation services and the inadequacy of sewerage infrastructure and random defecation in urban areas have created dangerous health and environmental problems. Rivers and streams in the surrounding area of Addis Ababa and other large urban centers have become open sewers and is one of the main sources of infections resulting in diarrhea and other diseases. Privacy is almost impossible as many latrines are shared among many people and even simple doors are often absent. Because of these reasons the formulated policy or the existence of the policy does not protected the Akaki River from pollution.

Chapter III: Methodology and Descriptions of the Study area

3.1. Methodology

The methodology of the study is descriptive analysis and mostly based on quantitative data and supported by qualitative data. The analytical results of river water samples at different points from secondary sources are utilized in the analysis.

A survey method is used to obtain the quantitative data that are collected from the targeted groups and descriptive analysis is used to describe the data obtained from the key informants. Questionnaires are used to collect quantitative data; while interviews and key informant discussions are used to collect qualitative data. To reach at the intended objectives of the study, the researcher used triangulation methods to bring the qualitative and quantitative data which is collected in the form of the following methods of data collection.

3.1.1 Data source

The study makes use of both primary and secondary sources of data. The secondary source of data is gathered from the governmental offices of the Federal, the Regional and Addis Ababa City Administration. The primary source data are from the key informants such as experts, workers, coordinators, governmental officials and the peasant associations of the rural people (peasants). Thus information is gathered through semi-structured questionnaire, interview and key informant discussion. It is analyzed by employing descriptive statistical techniques.

3.1.2 Data gathering techniques and tools

To obtain and extract sufficient secondary source of data, the researcher intended to employ document analysis. Based on the understanding from these secondary sources and the literature analysis, the researcher designed questionnaires and list of questions for interview and discussion to get in depth understanding of the issue. The data gathering tools are Pilot-tested before the final data collection. Necessary corrections were made to improve the validity and the relevance of the instruments. This improved the rates of return and maximizes the quality of the responses. Respondents have pre-informed about the objective of the study before each interview and

questionnaire is given. Based on these tools both qualitative and quantitative data are analyzed by the researcher.

3.1.3 Data analysis and presentation

The thesis gives focus on the theoretical explanation of the general principles of the problems of Akaki River pollution. The descriptive way of analysis and finally sounded arguments and conclusions are drawn. Quantitative data obtained from the questionnaires are cross tabulated around the sub-topics related to the research questions and descriptive statistics are utilized. SPSS statistical package program is used in the analysis of the quantitative data. Cross tabulation, pie chart and bar graphs are utilized in the presentation of the data. Narration and explanation of the information that gathered from those of the key informants in interview, open ended questionnaires and discussions are discussed. Percentages are also used to indicate the extent of response and its frequency per each item.

3.2. Descriptions of the Study Area

Addis Ababa is the capital City of Ethiopia as well as Regional Government of Oromia. It was established in 1886 by Emperor Menelik. The name of "Addis Ababa" to mean "new flower" was given by Empress Taytu Betul (Addisababacity. gov.et). The earlier name of the place Finfine changed to Addis Ababa and became Ethiopia's capital when Menelik II became Emperor of Ethiopia (ibid). The city is now the headquarters of the United Nations Economic Commission for Africa and the African Union starting from 1963 and numerous other continental and international organizations (Addisababacity.gov.et). Addis Ababa is often referred to as "the political capital of Africa" due to its historical, diplomatic and political significance for the continent. It is the largest City in Ethiopia, with a population of 3,384,569 according to the 2007 population census with annual growth rate of 3% (ibid).

Addis Ababa lies at an altitude of 7,546 feet (2,300 metres) and is a grassland biome, located at 9°1′48″N 38°44′24″ECoordinates: 9°1′48″N 38°44′24″E. The city lies at the foot of Mount Entoto and forms part of the watershed for the Awash. From its lowest point, around Bole International Airport, at 2,326 metres (7,631 ft) above sea level in the southern periphery, the city rises to over 3,000 metres (9,800 ft) in the **Entoto Mountains** to the north (ibid). The City is surrounded by Oromia Special Zone Surrounding Finfine of Oromia Region.

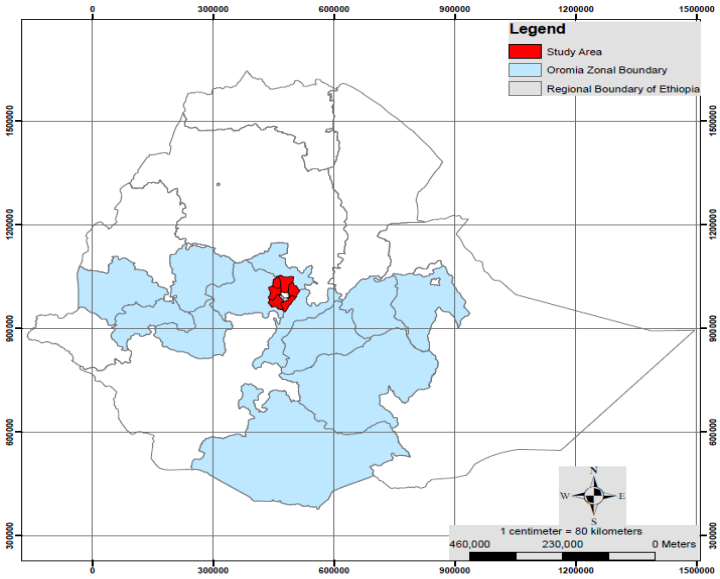


Figure 3.1. Map of Ethiopia, Oromia and Addis Ababa surrounding Oromia special zone

The long wet season is from June to mid-September; it is the major winter season of the country. This period coincides with summer, but the temperatures are much lower than at other times of year due to the frequent rain and hail and the abundance of cloud cover and fewer hours of sunshine. This time of the year is characterized by dark, chilly and wet days and nights (Addisababacity.gov.et).

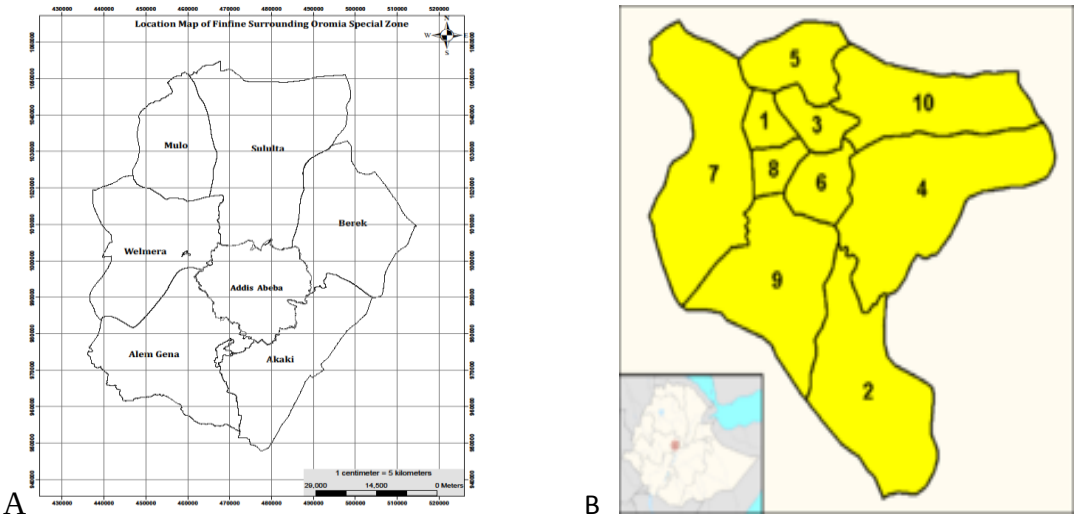


Figure 3.2. Addis Ababa surrounding Oromia Special zone (A), Addis Ababa City divided into 10 sub-cities(B)

Source: Addis Ababa surrounding Oromia Special zone, Environmental protection office & Addisababacity. gov.et.

Akaki River is a River that starts from or stream at and flow through the City of Addis Ababa. The western tributary of the river, the Little Akaki, rises northwest of Addis Ababa on the flanks of Wochecha Mountain and Burayu Town (Gefarsa) and flows for 40 Kms before it reaches Aba-Samuel reservoir (FEPA and AACA, 2006). Entoto and Wececha mountains are the major sources of springs that drain to Akaki River. This river flows down to Kolfe Karaniyo Sub-City (Area Number 1,7&8 of the above division), the most populated area and commercial center, and passes through Mekanisa Alcohol and Liquor Factory, Lafto and Kaliti the most industrial area of the city (No.9,&2). The Eastern branch of the river Great Akaki, rises North East of Addis Ababa and flows into Aba-Samuel reservoir after 35 Kms (National Consultation 2006). This Great Akaki joins with the rivers Kebena, Kostre, Bantiketu, Ginfile (No.5, 3, 10, 4&6). These streams all join at the upper side of Bole Bridge and pass through the center of the city. This is the most densely populated area; the river serves as the main dumping site of all forms of waste from the City (FEPA, 2005). Of the total ten Sub-Cities in Addis Ababa, all of them contribute their tributaries and run-off eroded for the Akaki River.

Therefore; Akaki River extends over very densely populated areas in Addis Ababa, receives discharges from industrial and domestic sources and is subject to intensive exploitation by domestic industrial and agricultural activities.

The report of Oromia Special Zone Surrounding Finfine (OSZSF, 2011), indicates that Urban and rural settlement areas are expanded from 42,740 hac. to 66,103 hac. The expansion of settlement or urbanization takes natural resources demands in larger amount. It needs water resources for drinking and industrial consumptions, and land for construction, agriculture and other purposes. The urbanization will brought water shortage, pollution of land and water resources due to population pressure, waste disposal from industries, residents (solid wastes, liquid wastes, sewages) unless there is integrated natural resources management. By the extent at which urbanization is expanded, the urban infrastructure like pure drinking water, dry waste disposal, sewages and sewerages networks are not developed. This is also another cause for urban pollution resulted in the surrounding areas of Addis Ababa.

Chapter IV: Discussions and Analysis

The chapter begins with the explanations of the characteristics and background of those respondents and followed to the presentations of the data and information that have been extracted from reports, documents of the respected offices, field observation, and survey through semi-structured interview and questionnaire are discussed in detail. 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 were also analyzed.

4.1. Background of the Respondents

The study covers a sample of 85 questionnaire respondents and 32 interviewed. The characteristics of the respondents treated here are those of the experts who are working in governmental offices, while the interviewed peoples are the rural inhabitant of the Akaki River catchment areas (Akaki District). As much as possible, the researcher tried to give chance for both gender (male and female) to fill the questionnaire and in interview selections.

4.1.1 Sex and age composition of the respondents

As one can observe from table 4.1 below, majority of the respondents are male that account 61.2% of the total respondents. On the other hand, the remaining 38.8% is female. Despite the fact that relatively fair representation of gender, number and sex composition of the worker in that professions are not equal. This is the reason why male workers have more chance to be selected and fill the questionnaire.

Table 4.1 Sex composition of the Respondents (Questionnaire respondents)

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Male	52	61.2	61.2	61.2
Female	33	38.8	38.8	100.0
Total	85	100.0	100.0	

Source: Survey Result

Table 4.2: Background of the Interviewed Respondents

No	Description		Number	%
1.	Sex	Male	20	62.5
		Female	12	37.5
2.	Age	18 - 25 years	9	28.13
		26 - 40 years	11	34.38
		Above 40 years	12	37.5
3.	Educational Status	Illiterates	5	15.63
		Read and Write	14	43.75
		Grade 1 – 6	8	25
		Grade 7 – 8	5	15.63
		Grade 9 – 12	-	-
4.	Work type	Farmer / peasant	30	93.75
		Employee	2	6.25
		Total	32	100.00

Source: Survey Result

The male respondent of an interview is about 62.5, while the female respondents are about 37.5, almost all or about 93.75 % of the interviewed are peasant. The remaining 6.25% also employed on the agricultural activity. All of them are dwellings in the catchment area of the Akaki River performing mixed agricultural activities (stock rising & animal breeding). Most of the interviewed people are living in the rural area performing agricultural activity. They are academically blow grade eight. From the total, 49% of the interviewed are either illiterate or only able to read and write.

Table 4.3. Age category of the respondents (Questionnaire respondents)

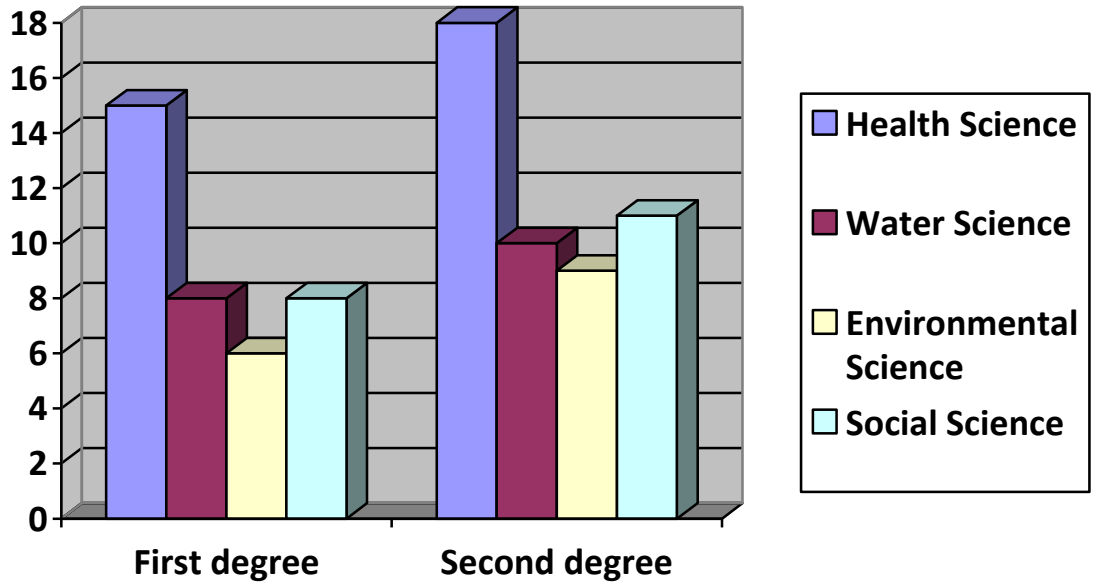
Descriptions		Gender of the respondent		Total
		Male	Female	
Age of the respondent	18-27	7	3	10
	28-37	10	10	20
	38-47	11	12	23
	48 and above	24	8	32
Total		52	33	85

Source: Survey Result

4.1.2. Educational Background of the Respondent

From the total respondent of questionnaire, 46(56.47%) respondents are second degree holder, while 37(43.53%) are the fist degeree with diferent fildes of study as it is shown by the following chart.

Table4.4. Academic level & professional background of the respondents



When we compare the professional background of the respondent, we can see that about 33(38.8%), 18(21.17%), 15(17.65%), 19(22.35%) are health, water, environment and social sciences respectively. The health science profession includes environmental health and hygiene, sanitarian health and health officer while, the professions of social science respondents are specialized in economics, management, social works and public administrations.

4.2. Causes for the pollutions of the River

One of the major causes for the pollution of Akaki River is known as anthropogenic. It is because improper disposal of industrial and home used wastes (dry and liquid wastes). Effluents from major industries are highly contributing to water quality deterioration of both surface water and ground water resources as well. In line with this, the wastewater flushing from the existing industries especially, tannery, Alcohol and Liquor, food and plastic factories are the major cause to the pollutions of the river. Improper management/treatment of the Municipal drainages and the tributaries of the Rivers are causing pollution to downstream of Akaki River.

According to Land Administration and Environmental Protection Office of Surrounding Zone (2011), Pesticides and fertilizers used for agricultural practices could be other polluting agents that pollute the river. Since for decades, people living along side Akaki River bank have been growing different vegetables and cereal crops due to proximity of the liquid home generated wastes per year respectively, it is still releasing all of it to the downstream as open waste site disposal that finally go in to river and its tributaries.

Table4. 5. Major causes of the pollution

Descriptions		What are the major sources of pollution for Akaki River					Total
		Industrial waste	Sewages & sewerage	Improper dry waste	All of them	No response	
Are the chemicals found in the Akaki River, suitable for sustenance of life	Yes			1	1	0	2
	No	21	15	12	33	0	81
	None				1	1	2
Total		21	15	13	35	1	85
Percentage		**24.7**	**17.65**	**15.29**	**41.18**		**100**

In addition to the secondary sources of data, as we can see from the table 4.5, the questionnaire respondents identified that the major sources of Akaki River pollutions are industrial wastes, sewages and sewerages and improper dry waste disposal system of the City. These factors are contributing significant level of polluting waste materials in the form of dry or liquid forms.

Table 4.6. Dry waste disposal mechanism

Descriptions		What are the dry waste disposal mechanisms most of the time that is implementing in the City				Total
		Released to the down streams	Open dumping on properly identified site	Collected to temporary Septic tanks but stay there	None	
Does the City Governmen t have a Waste disposal policy	Yes, we do have but it is not implemented properly	5	8	11	0	24
	No, we do not have waste disposal policy as the City Government	21	4	7	0	32
	I don't know	15	0	1	0	16
	Not respond	9	1	0	3	13
Total		50	13	19	3	85
Percentage		58.8	15.29	22.35		100%

Dry waste disposal system of the City is not uniformly implemented throughout the City, in some areas it is collected to dump at identified site, in other time it stay there for a longer period of time. In other area directly discharged to the river. The respondent also indicated that 58.8% are directly discharging to the river, while 22.35% and 15.29% are answered that it is collected to temporary at septic tanks & open dumping on properly identified site respectively.

On the same time, National Water Development Report for Ethiopia (December, 2004) disclosed that a number of pollution related studies have confirmed that about 90% of industries in Addis Ababa 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 reveled that, the streams are 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 flow directly or indirectly in to the River, due to limited sewerage system and treatment in the city. The major tributaries of Akaki River are also used as a receptacle of all kinds of wastes solid and liquid.

Additionally, the slaughterhouse of some areas like Burayu, leather factory around "General Winget" generating considerable polluting wastes to the downstream. There are also industries such as tannery and leather, alcohol, soap, food and plastic factories, garages and carwashes are distributed in the City, which use the streams 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). Dead animals including fish were also observed at Aba-Samuel dam. When the water samples 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 4 & 5).

4.3. Accessibility of pure water supply in the surrounding zone

The reports of Oromia Special Zone Surrounding Addis Ababa/ Finfine (OSZSF, 2011), indicated that majority of the deadly diseases reported are easily preventable and curable if there are sufficient health institutions in the areas. However; having sufficient health institutions automatically might not eradicate disease. Availability of pure water supply and provision of sanitation is the crucial aspect of public utilities. In addition, the report includes the following sources of water for different purposes.

Table: 4.7. Different Sources of Water for Different Purposes–Rural and Urban (Percentage)

Source of water	Drinking		Cooking		Cleaning		Livestock	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
River	29.1	15.1	30.9	14.9	45.2	24.5	59.4	22.3
Pond/Lake	12.4	3	12.3	3.2	14	4.1	16	4.6
Hand Dug Well	17.6	9	17.6	10.1	15.7	11.4	12.6	2.9
Developed Spring	22	2.7	22	2.6	14.2	2.4	6.2	2
Piped Water	18.8	70.2	17.4	69.2	10.9	57.6	5.5	10.5
Not Using	0	0	0	0	0	0	0.5	57.7

Source: Environmental Protection of Addis Ababa surrounding Oromia special zone (2011).

Zonal reports indicates that in rural areas, the major source of water for drinking, cooking, cleaning, and livestock watering is mostly the river. As the purpose moves from dinking to cooking, cleaning and livestock watering; the proportion increases from 29.1 percent to 30.9, 45.2 and to 59.4 percent in the rural area. This indicates that river source is the major source for the rural people surrounding Addis Ababa while, piped water sources are more available in the urban areas.

The major problem in rural areas is therefore, very low access to pure drinking water supply. Infrequent water supply; on the other hand, is also the major problem in urban areas as well. Even though they have a better access to pure water than the rural areas, there are some problems in continues provision of pure drinking water.

Using rivers as a major source is the crucial factor as revealed in the health section that health problems are entirely resulted from lack of pure drinking water. Health report of the especial zone (2011) indicated that in the catchment areas of Oromia Special zone, tuberculosis and intestinal parasites are the leading causes of mortality and morbidity. More than half of the patients who went to the health institutions have serious intestinal problems. The cause for such problem is related to sanitation, shortage of pure drinking water supply, and deficiency in nutrient food items. If health institutions are better equipped with materials, medicines, and health professionals, then the rate of morbidity and mortality can be reduced at better paces (the report conclude).

4.4. Problems associated with lack of potable water

One of the key informants of the researcher is Medical Doctor while the other one is expert in environmental science. According to the former's explanation, there are different types of problems aroused from lack of access to pure or potable water. Some of them are stated as gastro intestinal disorders, diarrhea, abdominal pain, water-washed skin diseases, respiratory problems such as asthma, cough, wounds lesions, rashes on skin and weakness. Among these problems, gastro-intestinal disorders are the major ones that affect the rural inhabitant in the catchment area. In this area a number of infected peoples' health problem is slightly acute in water-borne diseases as compared to other areas.

The questionnaire respondents are also identified that, the consequences of using contaminated river water are the suffering from water related infections like waterborne and water-washed diseases. According to their explanation, water-borne diseases occur when parasites or other disease-causing microorganisms are transmitted via contaminated water. As potential carrier of pathogenic micro-organisms, polluted water can endanger health and life. The pathogens, most frequently transmitted through water, are those, which cause infections of intestinal threat, namely typhoid, paratyphoid, bacteria dysentery etc. Regarding water related infections, water-washed and water-borne diseases are some of the common health problems in the catchment areas. Both of them (the questionnaire & key informant) stated the same idea. Table 4.8 shows the severity of the problem.

Table :4.8. Water-related infections

Descriptions	How do you evaluate the status of water-related infections in the Akaki river catchment areas?			Total
		As a Very serious problem	As a serious problem	
Would you able to identify the top five diseases that repeatedly happen down the stream of the Akaki River due to water pollution. State them.	Yes	55	20	75
	No	4	2	6
	Not respond	2	2	4
Total		61	24	85

According to the socio-economic study report of special zone surrounding Finfinne (2011) commonly prevalent diseases include: Intestinal parasites, Ameba, Gastric, Tonsillitis, Pneumonia, Respiratory problems (Acute Bronchitis), Typhoid fever, and Malarias are some of reputedly affecting the surrounding societies.

4.5. Sources of water for consumption

The rural people are left without options being forced to use such polluted rivers regardless of multiple hazards. What is alarming is that, the rural people are neglected to the backyard in using before being the river water just as it is consumed by factories. Irrespective of the long and short-term health costs that inhabitants incur, the rural people are compelled to utilize polluted water for sustaining their survival for they are left without any alternatives.

Table 4.9.Sources of water for consumption

Purposes	Collective Tap	Akak River	Pond/s	Drill hole	Spring	Others (if any, Name it)
For drinking	-	24	-	3	5	-
For bathing	-	29	-	3	-	-
Cloth washing	-	29	-	3	-	-
Animal watering	-	32	-	-	-	-
For irrigation		28	-	-	-	-
For cooking		32	-	-	-	-
For other home Consumptions		32	-	-	-	-

The researcher found that the sources of water for the interviewed peoples are from, Akaki River, springs and Drill hole. Collective taps is not available in the areas. The main sources for households' cloth washing, Animal watering, for cooking, for other home Consumptions and for irrigation they use the river at all.

It is not the area of unreachable; being surrounding the Capital City of the country, neglecting the rural society to that extent is questionable. Proclamation Number 300/2002 Environmental Pollution Control stated as that: "*The protections of the environment, in general, and the safeguarding of human health and wellbeing, as well as the maintaining of the biota and the aesthetic value of nature, in particular, are the duty and responsibility of all*". But the researcher perceived that the implementation of the proclamation is not satisfactory.

4.5.1. How to utilize the river water

The way of using the available water sources determine the suitability of the water for the desired purposes. In this context, pre-use treatments like boiling, filtering pills and other mechanisms before using any water from the unsafe sources are recommended; but as we can understand from the table, most of the interviewed people use after traditional filtering for drinking while they use it directly for other purposes.

Table 4.10. How to utilize the river water

Services	After Traditional Filtering	After boiling	Directly	After aqua safe	Other mechanism (if any, name it)
For drinking	24	8	-	-	-
For bathing	-	5	27	-	-
For washing	-	-	32	-	-
Animal Watering	-	-	32	-	-
For irrigation	-	-	32	-	-
For cooking	-	-	32	-	-
For other home consumptions	-	-	32	-	-

Out of the total respondents, only eight family uses after boiling it, which is constitute about 25%. The remaining 75% use after traditional filtering of it. The traditional method of filtration can't able to filter out or kill the micro-organism (gram) to make the water free of pollution. For washing, animal watering, for irrigation, for food cooking and other home consumptions the water is utilized directly.

The consequences of the direct uses of such polluted local water sources have utterly failed to secure proper attention from the affected people themselves as well as the concerned health and other pertinent government authorities. The quality of surface and underground water sources are suspected to be affected by the pollution of Akaki River through run off and underground connection. Most of the rural people in the catchment areas though, vulnerable to being affected by the pollution. This is because lack of an information about the status of water qualities from ponds, hand dugs and springs.

4.6. Socioeconomic Problems of the River Pollution

According to Chemical Society of Ethiopia (2007), the water quality of Akaki River shows pattern of behavior linked to anthropogenic sources with the intensity of human pressure associated with industrial effluent, domestic sources and agricultural activities. Most of the measured variables showed a similar declining quality trend from up to downstream of the river.

A lot of research papers have been undertaken on the quality of the river, but many of the respondents do not know whether the substances in it are hazardous or not. Even though the research is undertaken, it is not publicized properly and implemented to solve the problems.

Table 4.11. Problem face due to water-related animal health

Type of problems	Level of the Problems			
	Very Serious	Serious	Faire/moderate	Not Serious
Loss of milk production	12			
Skin Disease	7	20	5	
Weight loss	17	15		
Animal death	30	2		
Others (If any, name it)	32			

The toxic substances that are found in Akaki River can be hazardous to livestock when they consume it. The respondents have faced cattle death, rapid weight loss of cattle and cattle skin diseases in the last five years due to the pollution of the River. The key informant indicated that, sick animals are being 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. Respondents also confirmed that 63 animals have died due to the consumption of this contaminated water in the last year (2014). They have been exposed to different level of skin diseases and rapid weight losses respectively since their major water sources were contaminated Akaki 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 (the key informant indicated).

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.

Table 4.12. Problems associated with family member's infection

Type of infections	**Frequency of occurrence within a year**							
	0	1	2	3	4	5	6	7&above
Water-borne eg. Diarrhea		2	7	11	10	2		
Water-washed eg. Skin & eye disease		6	11	8	7			
Other water related (if any)			1	3	8	20		

Regarding the frequency of occurrence, water-washed skin diseases (rashes on skin) are less severe. Skin and eye disease occurred at least two times in a year on about 34.37% of family members. Accordingly, unlike for water-washed skin diseases, in a matter of a year 34.37% of

the households faced water-borne diseases at least three times and 31.25% four times. Generally, almost half of the residences suffered from the health problems that emanated from river water pollution each year. This problem does have an impact on the life span, labor productivity of the people and financial loss due to incur additional medical costs that adversely affect the livelihood of the people in the catchments areas.

In generally, almost all of the residences suffered from the health problems that emanated from river water pollution each year. This problem does have an impact on the life span and the productivity of the people and force them to incur additional medical costs that adversely affect the livelihood of the people in the catchments.

In addition to the residents of rural surrounding areas of Addis Ababa, the City dwellers also participate in animal husbandry and cultivation of gardens. 677 hectares (1,670 acres) of land is irrigated annually, on which 129,880 quintals of vegetables are cultivated by the Akaki River and its tributaries (Addisababacity.gov.et). These products are produced with contaminated River water and consumed within the City. The products are also lain able to be contaminated with the chemicals found in the river. Therefore, the problem is not only affecting the rural people but also the urban inhabitant.

4.7. Bacteriological laboratory analysis

According to Oromia Environmental Protection Office (OEPO, 2004), the chemical and bacteriological laboratory analysis of the river's water samples at different critical points of test indicated that the quality of water is not appropriate for any home use. It is stated as follow:

> *"The bacteriological analysis results of the samples show that the number of total coliform bacteria is in the range of 6000 – 330,000 which is extremely beyond the WHO permissible limit of 400 counts/100ml. The result also shows a total number of e.coli in the same range (6000-330,000), which is beyond the WHO permissible standard of 5 counts/100ml for any domestic and animals drinking purposes".*

In addition to that, the pollution indicative parameters also identified as:

> *"The pollution analysis results are for the most pollution indicative parameters; DO, BOD_5, and COD range in (0-2.9) mg/l, (2.6-42) mg/l and (24-242) mg/l respectively. Comparing*

these results with ambient permissible standards for DO $\geq$ 5 mg/l, $BOD_5 \leq 5$ mg/l and COD$\leq$ 10 mg/l show that the results are beyond the standards realizing that the rivers cannot be used for any domestic purposes".

From these statements we can conclude that, Community in the catchment area is vulnerable to human & animal health problems. Abortion cases were also founded on women prevalent in the study area. The severity of the problem decreases in order; women, children, elders, and adults as it indicated. Animals' health problems were also identified with severity of oxen, young animals, cows and other small animals' death in decreasing order. With these all problems, no one take an action to improve the life of the society residing in the area.

4.8. Negative impacts of the pollution

Based on the key informant explanations and different documents, the environmental and water body pollution problem is due to untreated disposal of liquid and dry wastes on open fields and direct discharging to the river. Besides pouring chemical wastes directly into water bodies, some industrial establishments dispose their wastes on fields. Such wastes may have toxic chemicals, salts and solvents-chemical wastes from animal and plant matters and hundreds of other substances. The chemicals may poison plants and animals and kill soil microorganisms, which play part in decomposition, aeration, cultivation, aggregation and associations of soils. It affects the chemical composition of soil, thus makes the soil unfit for crop production. As a result, such soils may gradually be harden and lose fertility to absorb rainwater that enhances crop production.

Metallic elements are also fundamental component of the environment, constituting important class of toxic substances which encounter in numerous occupational and environmental circumstances. With increasing use of a variety of metals in industry and in our daily life, problems arising from toxic metals in the environment are becoming serous. Toxic metals to a large extent are generally dispersed in the environment through industrial effluents, organic wastes, and burning, transport and power generations.

Heavy metals are among the most harmful of the elemental pollutant that includes essential elements like iron as well as toxic metals like lead, cadmium, and mercury. Most of these metals

have tremendous affinity for sulphur and attack sulphur bonds in enzymes, thus immobilize them.

The effects on plants are through accumulating of agricultural fertilizers that may crowd out essential nutrients present in top soil layers where microbes enrich humus to enhance plant growth. Nevertheless, fertilizers enriched soil cannot support microbial life for long periods. Hence, there is poor humus and fewer nutrients that soil can readily become eroded by wind and rain. Lime can prevent release and uptake of several essential elements such as Zn, Mn, Ca, Ni, Fe, and Co in plants.

There is poor management regarding oil and grease usage in garages. The effects of these pollutants on getting water bodies are serous. They create health hazards in plants and animals. The heavy metals contained in them, such as lead and mercury can create health problems. For example, mercury produces nervous disorder. It brings health hazards as blindness, deafness, and even death. Lead metal poisoning causes severe retardation. Reduce the oxygen content of the aquatic environment (World book, 1990 cited in OSZSF, 2011).

Oil pollution, reduces light transmission through surface water, and hence reduces photosynthesis by marine plants. It decrease dissolved oxygen content in water and causes damages to water birds, coastal plants and animals. It also damages marine life on a massive scale and also affects the aquatic food, which enters the human food chain, (World book, 1990 cited in OSZSF, 2011).

These all problem resulted in aquatic life and environmental problem lead to ecological problems. Water bodies on top of being mainstays for many kinds of lives that render benefit to humans they also have a pivotal role for maintaining the balance of ecosystems. As described in the pollution level of the river, BOD (Biological Oxygen Demand) measurements show that Akaki River is anaerobic, for most of its parts and consequently the annihilation of aquatic life especially that of fishes is quite evident *(OSZSF, 2011)*.

Chapter V: Conclusion and Recommendations

This study is conducted with the purpose of assessing the socio-economic problems of water pollution with the especial reference to Akaki River catchment areas of Addis Ababa Surrounding Especial Zone of Oromia, the rural community in Akaki Woreda (District). To that end, a descriptive method of research has 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. In addition, two key informants in medical and environmental science of study are participated to explain the causes and consequence of water and environmental pollution. There are 85 respondents of questionnaire and 32 households are interviewed that residing in the catchment areas of the River. The respondents are selected in random sample method.

5.1 Conclusion

The socio-economic data results and discussion made reveled that Akaki River water is highly polluted by industrial wastes, domestic solid and untreated sewages that drain into the river courses from all types of pollution sources. From the survey made, it is possible to conclude that Little and Great Akaki Rivers are highly polluted as they are the principal recipients of these untreated wastes discharged from industrial establishments, domestic and municipal sources.

According to the research findings, Akaki River is highly contaminated. This phenomenon is evidently manifested in terms of nonstandard chemical composition, unpleasant odor and unusual black color of water. The physical and chemicals parameters of the river indicated that, it cannot fit for home use or consumption. Due to the concentration of heavy metals and other chemicals that exceed by far normal range, the river has health risk implications on inhabitants. Additionally the river does not meet the acceptable standard limits for both drinking and irrigation.

The excess heavy metals and high concentration of chemicals in the river are originated from anthropogenic sources of pollution. The main pollutants of the river are wastes from industrial, municipal and domestic activities located in Addis Ababa City. The river serve as natural sewerage lines for domestic and industrial wastes while used by the people at the downstream for drinking, irrigation and animal watering.

Due to little or no attention for local river water consumption, factories and urban-based activities explicitly violate the proclamation number 300/2002, which states, "The Authority or the relevant Regional environmental agency may take an administrative or legal measure against a person who, in violation of law, release any pollutant to the environment". The principles of water use priorities and basic human rights are violated. Since they are poorly managed, the industrialization and urbanization process in and around Addis Ababa City failed to consider the issues of sustainability (meeting present generation need without compromising the future generation to meet their own need). It is to mean that; environmental situation has to be considered in the activity of developmental procedure.

Consequently, both current and future generations in the catchment area suffer from social and economic problems. Since the settlers in the catchment areas have little or no other options, the rural people in the catchment areas are highly dependent on this river for their livelihood. Most people in the downstream are utilizing for drinking, irrigation, animal watering, sanitation, cloth washing, food cooking and other home consumptions. It is evident that the rural people in the catchments cannot survive without using this river. That is why, even though they know that the river is polluted and have hazardous health implications, they went on utilizing this river for various purposes.

Water-washed and water-borne diseases such as typhoid, diarrhea, 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 labor 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 local people regarding the prevention mechanisms of water related infections, the real accomplishment is insignificant.

Due to the continuation 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 centers, weak financial capacities and immature knowledge of residences many patients might not get timely health treatments. Such phenomenon forces many labor 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 physical and chemical analysis of the river at different points shows the unfitness of the water for health and irrigation purposes. Consequently, significant number of plots of irrigable lands is being converted into rain-fed farming. The alternate though safe use has lower yield, financial return and labor accommodation per hectare per production season is declining when compared with the returns from the foregone use. On the other hand, horticultures from the catchment areas are less preferable to products from other places. This has grossly impaired the

competitiveness and the self-esteem of the farmers. Put differently, shortsighted 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.

In this regard, the problem is long running due to income and life loss. In addition to the direct economic losses, weak physical appearance of farming oxen reduces the yield from rain-fed farming. It affects negatively the livelihood of the residences through hampering the farmers' and the government's efforts. The destruction of aquatic life is apparent in the river. 'Abasamuel Dam', which was serving as hosts for aquatic lives especially for fish, is now turned into host of heavy chemicals. At the meantime, though, residents in the catchment area do not significantly rely on the production of fish (fishing); the problem is acute in terms of affecting the ecological balances. The river basins are turned into 'dead' rivers. The vegetables produced in the catchment areas are transported to Addis Ababa for consumption. Everybody who consumes the vegetables without knowing form where it comes, are exposed to the health problem. Therefore, the problem is not only affecting the rural society, it is going to be multifold.

5.2 Recommendations

The study revealed that as a result of in access to clean potable water sources; the community suffered 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 primary necessity of life and is a top life saving resource, pollution protection is needed for the study area.

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

- All waste generating plants and municipalities may legally require treating their wastes before releasing 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.

- Concerned Federal and Regional Environmental Protection Offices in cooperation with stakeholders would have commonly developed 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.

- Attempting to have a single treatment plant for many sources through revisiting the industrial zoning or clustering mechanism should have to implement in the City of Addis Ababa. This is needed to minimize the industrial dispersion within the City.

- Oromia Regional State and Addis Ababa City Administration in collaboration with other stakeholders advised to invest in exploring alternative water sources based on polluter pay principle. In this regard, developing existing springs and constructing deep well sites will

have got the prior attention of those concerned bodies. Indeed, such approach fails to ensure the issue of sustainability in water management; moreover, it is employed to address the current burning issue for the demand of safe water. This alternative mechanism will be put in to practice in an integrated way in cycle with the previously mentioned approach so as to attain the goal of sustainability.

- Revisiting the drainage system (swages and sewerages) or network of the City of Addis Ababa in order to minimize the run off pollution that directly discharged to the river and arising a problem on the society. In order to ensure sustainable development, it is essential 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 advance.

- The polluted water has to be clean before leaving Addis Ababa City boundary. Oromia Water Resource Bureau and Environmental Protection Authority have to prove the quality of the river before it utilized by the catchment societies. In addition to putting prevention scheme practical, health centers that are capable to provide adequate treatment services shall be accessed in the catchment areas. Especially in the rural areas that found very far from urban areas need to have health institutions for both human beings and livestock to handle diseases before causing substantial and unmanageable damages on inhabitants.

- Municipalities have to give emphasis to have properly selected and designed waste disposal sites for their residents. Proper site selection, proper landfill site design, waste collection, transportation/or handling and safe disposal shall be the ultimate goal of a municipality in waste management.

Failing to do so is allowing the continuation of the suffering of the residences. Awareness creation works via timely, periodic, coordinated and intensified discussion with the rural people should be undertaken so as to improve the way of utilizing available sources with minimal or no harms to inhabitants. Each available pre-use treatment methods with their socio-economic benefits should be introduced and put into practices by the residences. This can be done through extension health

workers, agricultural development agents and school teachers who work in the catchment areas. In the short and medium term direct use of water from rivers for drinking must be discouraged, further chemical composition analysis of the ground water in the catchment area must be carried out by Addis Ababa City Administration and Oromia Regional Government Water Resource Bureau to handle the problem. This helps to take measures to minimize health hazard and risks to residences.

References

Hallet, S., N. Haneley, I Moffat and K. Taylor-Duncan, (1991). ' UK water pollution control: a review of legislation and practice', European Environment, 1, 7-14.

Hanley, N. and I. Moffatt and S. Hallet (1990), 'Why is more notice not taken of economists' prescriptions for the control of pollution? ; Environmental and Planning A, 22, 1421-1439.

Jayarami, P. Reddi, (2001), A Text Book of Hydrology, Laxmi Publications (pvt) Ltd, New Delhi

Nick Hanley, Jason F. Shogren and Ben White (1997), Environmental Economics, Macmillan presses Ltd.

Pezzey, J. (1988), 'Market Mechanisms of pollution control' in R.K Turner (ed), Sustainable Environmental Management: principles and practice, London: Belhaven Press.

Prabu, P. C., (2009), Impact of Heavy Metal Contamination of Akaki River of Ethiopia on

Richard L., Revesz, Philippe Sands and Richard B. Stewart (2000) Environmental Law, the Economy, and Sustainable Development, Cambridge University Press.

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

Addis Ababa Environmental Protection Authority (AAEPA, 2002), Annual Report.

Addis Ababa Environmental Protection Authority (AAEPA, 2005), Annual Report.

Central Statistical Authority of Ethiopia (CSAE, 1999), Censes Report.

Chemical Society of Ethiopia (2007), Assessment Report on the Status of the Akaki Rivers Water Pollution, Addis Ababa, Ethiopia.

Economic Commission for Africa (2006), Water in Africa, Management Options to Enhance Survival and Growth

Federal Environmental Protection Authority (FEPA, 2005). Assessment Report on the Status of the Akaki Rivers Water Pollution, in collaboration with Addis Ababa City Administration EPA, and Oromia Regional National State Environmental Protection Office.

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

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

Environmental Protection Authority, (EPA 2002). The Establishment of Environmental Organs Proclamation: Proclamation No. 295/2002, Addis Ababa, Ethiopia.

Environmental Protection Authority, (EPA, 2002). Environmental Impact Assessment Proclamation: Proclamation No. 299/2002, Addis Ababa, Ethiopia.

Environmental Protection Authority, (EPA, 2002). Pollution Control Proclamation: Proclamation No. 300/2002, Addis Ababa, Ethiopia.

Environmental Protection Authority (EPA, 1997). Environmental Policy of Ethiopia, Addis Ababa.

Federal Democratic Republic of Ethiopia (April, 1997). Environmental Policy. Addis Ababa: Environmental Protection Authority in Collaboration with the Ministry of Economic Development and Cooperation

Federal Environmental Protection Authority and Addis Ababa City Administration, 2006, Rehabilitation of the Ecosystem Functions of Akaki River Basin

Land Use and Environmental Protection Bureau of Oromia Special Zone Surrounding Finfine, 2011. The Integrated Land Use Plan.

Oromia Environmental Protection Office (OEPO, 2004), Assessment of Akaki River Pollution and It's Socio-economic Impacts, Department of Environmental Pollution Study & Control (unpublished)

Oromia Special Zone Surrounding Finfine, (OSZSF, 2011). The Integrated Land Use Development Plan.

Oromia Special Zone Surrounding Finfinne, (OSZSF, 2011). Integrated Land Use Planning Study Project Volume IV.

Oromia Water Works Design and Supervision Enterprise (OWWDSE) 2011, the socio-economic study report of special zone surrounding Finfine /Addis Ababa.

Oromia Water Works Design and Supervision Enterprise, 2009, Land Use Study Project of Urban Fringe Zone of Finfinne (unpublished)

The National Water Development Report of Ethiopia, (December, 2004)

National Water Quality Guideline, (2000), Ministry of Water Resource

Water Resources Management Policy of Ethiopia, 1999.

Ethiopian Environmental Protection Agency, (2006). Ethiopian Environmental Protection Authority**.** Retrieved July 7, 2014 from http://www.epa.gov.et/epa/ department /eia

Ethiopian Environmental Protection Authority (EPA) (2010). Environment for Development. About EPA. Retrieved July 1, 2014 from http://www.epa.gov.et/About EPA.htm

http//www.Ag-Runoff-fact sheet, chapter 20 pollution4… Date 15/4/2014

http://www. "Addis Ababa city website (site map, see the list in "Sub Cities" section)". Addisababacity.gov.et. Retrieved 2014-12-11.

http://www. "Climate: Addis Abeba (altitude: 2350m) - Climate graph, Temperature graph, Climate table". Climate-Data.org. Retrieved 6 February 2015.

http://www. Pankhurst, Richard (2001). The Ethiopians: A History (Peoples of Africa). Wiley-Blackwell; New Ed edition. ISBN 0-631-22493-9.

http://www. "Article at unhabitat.org (map of Addis Ababa, page 9)" (PDF). Retrieved2014-12-11.

Soil and Metal Toxicity on Cultivated Vegetable Crops, Ambo University College, Ambo, Ethiopia Accessed from http://ejeafche.uvigo.es/index.php?option=com_docman & task = doc_view&gid=534 on 09/02/2014

Annexes 1. Photo showing Waste disposal system.

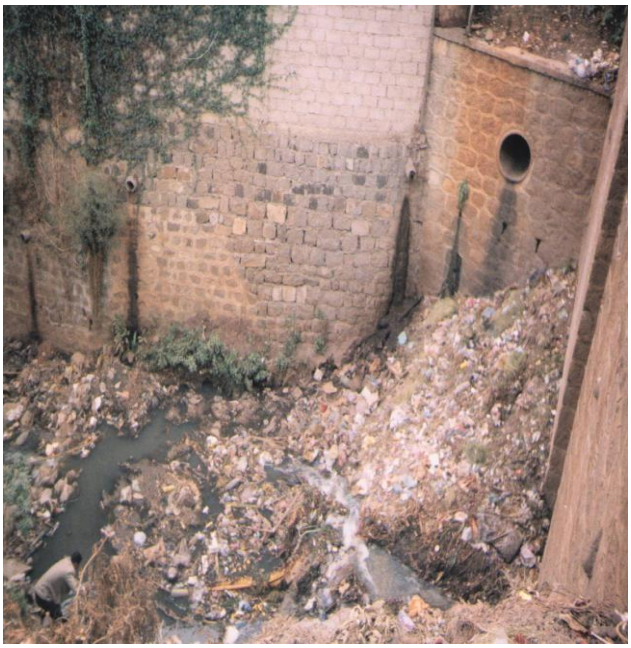


Fig. 1.9: The open waste dump lacks any operational concept and technical provision for protection of public health and the environment (Photo: UV&P, 2004)

Photo showing dry wastes and sewages are discharged to the river

Annexes 2. People using the river for different domestic purposes (for washing, for irrigation and home use).

Annexes 3. People using the river for animal watering.

Annex- 4: Laboratory result of little and Great Akaki River

Ser No	Parameters	Unit	Sample Codes						
			Little Akaki River		Great Akaki River				
			No 2	No 4	No1	No3	No5	No6	No7
1	PH (on site)	-	7.65	7.59	7.73	7.73	7.74	7.70	7.90
2	Total dissolved solids	mg/1	105	659	45	290	303	361	178
3	Electrical conductivity (on site)	mg/1	69	1125	147	515	496	477	302
4	Dissolved oxygen (on site)	mg/1	8.6	Nil	8.9	Nil	Nil	1.4	Nil
5	Chemical Oxygen demand (COD)	mg/1	4.3	221	7.0	66	56	99	129
6	Biological oxygen demand (BOD_5)	mg/1	0.4	42.0	0.4	12.1	11.2	9.3	13.0
7	Total suspended solids	mg/1	Nil	167.2	Nil	118.1	172.4	2042	684
8	Total Volatile solids	mg/1	Nil	46.9	Nil	56.0	64.8	303	244
9	Ammonia as NH_3	mg/1	0.022	34.0	0.016	16.0	15.1	15.5	13.85
10	Nitrite, No_2	mg/1	0.006	0.031	0.009	0.2	0.17	0.82	Nil
11	Nitrate, NO_3	mg/1	0.07	Nil	0.1	Nil	Nil	5.5	0.7
12	Hydrogen sulfide, H_2S	mg/1	0.1	0.005	Nil	0.01	0.005	0.14	Nil
13	Phosphate, PO_4	mg/1	Nil	12.32	Nil	5.46	5.74	2.31	10.8
14	Sulfate, SO_4	mg/1	0.2	69.4	1.5	30.2	25.1	25.4	26.5
15	Total Chromium as Cr	mg/1	Nil	Nil	Nil	Nil	Nil	0.003	Nil
16	Chloride as Cl	mg/1	0.75	209	0.5	24.5	19.5	24.5	22.5
17	Acidity as $CaCO_3$	mg/1	4.0	20	3.5	8.0	6.0	5.0	7.0
18	Total Alkalinity as $CaCo_3$	mg/1	88	378	38	216	226	236	268
19	Total hardness as $CaCO_3$	mg/1	68	238	46	174	156	188	138
20	Total Coliform (MPN/100Ml)	No	-	130,000	-	330,000	130,000	9,000	-
21	Total E.coli (MPN/100Ml)	No	-	130,000	-	330,000	130,000	9,000	-
22	Temperature (on site)		13.6	23.3	12.7	20.0	20.4	19.5	25.2

Source: Oromia Environmental Protection Office Department of Environmental Pollution Study & Control

Annex – 5: Baseline Water quality Guidelines for River Water

No.	Constituent	Units	Indicative Guideline sample
1	PH		6.0 - 9.0
2	Total Dissolved Oxygen	Us/cm	450
3	Conductivity	mg/1	1500
4	Dissolved Oxygen	mg/1	5
5	Biological Oxygen Demand	mg/1	0.1
6	Chemical Oxygen Demand	mg/1	150
7	Hydrogen Sulphide	mg/1	0.0001
8	Suspended Solids	mg/1	50
9	Volatile Solids	mg/1	0
10	NH_3	mg/1	1
11	NO_3	mg/1	10
12	NO_2	mg/1	0.1
13	PO_4	mg/1	2
14	SO_4	mg/1	200
15	Chloride	mg/1	100
16	Kjedahl Nitrogen	mg/1	0
17	Acidity	mg/1	0
18	Hardness	mg/1	100
19	Alkalinity	mg/1	0
20	Cr^{6+}	mg/1	0.05
21	Cr^{3+}	mg/1	0.05
22	Total Coliform	Counts/100m1	10 WHO
23	E.coli	Counts/100m1	5

Source: Oromia Environmental Protection Office Department of Environmental Pollution Study & Control

Ques. 01

This Interview Question is presented to the society Residing Surrounding the River Basin.

Dear Respondent, My Name is **Eticha Fufa**, previously I was graduated from AAU in Masters of Arts in RLDS (Regional and Local Development Studies) and know I am studding for the program of MEC (Masters of Economics) in Indira Gandhi National Open University and conducting the final research thesis on the title of **Socio-economic Problems of Water Pollution: the Case of Akaki River**. The Thesis is used as a partial fulfillment of the requirements of Masters of Art in Economics. In this connection, I have constructed this 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 be an active to answer the following interview questions.

Date of Interview _____ starting time _____ finishing time _____

I. Personal Background of the respondent

- Age of the respondent _____
- Gender _____
- Educational level _____
- Work type _____

II. Socio-economic problems and water qualities of Akaki River

1. Do you have any piece of irrigable land along (adjacent to) the Akaki River basin? a. Yes b. No

1.1 If your answer is Yes; how much of hectare? _____

2. Are you using this piece of land for irrigation?

a. Yes b. No

2.1 If your answer is No; why? _____

_____

3. What is the extent of your dependence on this river for your livelihood?

a. Very high

b. High

c. Low

d. Very low /insignificant

4. Is there any problems that you faced and affect your livelihood activity because of using Akaki River for your irrigation?

a. Yes b. No

4.1 If your answer is yes, what practical problems that you have faced?

a) Low productivity
b) Low product quality
c) Low marketability
d) Other side effects
e) No problem

4.2. Please specify your family's main water sources (put an **X** mark where appropriate)

Purposes	Collective Tap	Akaki River	Pond (s)	Drill hole	Spring	Others (if any, Name it)
For drinking						
For bathing						
Cloth washing						
Animal watering						
For irrigation						
For cooking						
For other home Consumptions						

5. Customized way of using the water for different purposes

Services	After Traditional Filtering	After boiling	Directly	After aqua safe	Other mechanism (if any, name it)
For drinking					
For bathing					
For washing					
Animal Watering					
For irrigation					
For cooking					
For other home consumptions					

6. Your perception of water quality by source (Write an **X** where appropriate)

Water Quality	Available Water sources					
	Collective tap	Akaki River	Pond	Drill hole	Spring	Other(s) (if any, name it)
Very Poor						
Poor						
Just Ok						
Good						
Very Good						
I don't know						

7. How much serious is the problem of River water pollution to your family?

a. Very serious

b. Serious

c. Not Serious

d. Not a problem

8. Why do you use the River water for home use?

a. It is Suitable for my purpose,

b. I have no another choice,

c. It is freely accessible

d. Other reasons _____.

9. Please put a check mark before the number of years you have been living in this river's surrounding areas or kebeles?

a. 0-4 c. 10-14 e. 20 and above

b. 5-9 d. 15-19

10. Please put a check mark before the number of years you have been using this river (Akaki River)?

a. 0-4 c. 10-14 e. 20 and above

b. 5-9 d. 15-19

11. Please put a checkmark before the number of years you have been recognizing the pollution problems of the river.

a. 0-4 c. 10-14 e. 20 and above

b. 5-9 d. 15-19 f. Still I do not identify its problem.

12. Did you or your family members face any water related infection problems before?

a. Yes b. No c. I don't remember.

12.1 If your answer is yes; please specifying the number of your family members that have been affected by the water-related infection under the respective frequency and the type of infections (Write an **X** where appropriate).

Type of infections	**Frequency of occurrence within a year**							
	0	1	2	3	4	5	6	7&above
Water-borne eg. Diarrhea								
Water-washed eg. Skin & eye disease								
Other water related (if any)								

12.2 How much did you pay to get health treatment service for one of your family members at a time? (in Birr)_____.

13. Have you been faced any water-related animal health problems before?

a. Yes b. No

13.1 If your answer is Yes, Please put a checkmark in the following box (Write an **X** where appropriate)

Type of problems	Level of the Problems			
	Very Serious	Serious	Serious Fairly	Not Serious
Loss of milk production				
Skin Disease				
Weight loss				
Animal death				
Others (If any, name it)				

13.2. How do you evaluate the problems caused by water pollution on your cattle's?

a. Very high

b. High

c. Low

d. Very low

14 Your comments/suggestion regarding the pollution of Akaki River _____

_____

_____.

15 What possible solutions should be sought to tackle the problems? _____

_____

_____.

Thank you so much!

Ques. 02

Questionnaire to be presented for Water & Environmental Protection Experts and health officers in Addis Ababa City & Oromia Regional Government

Dear Respondent, My Name is **Eticha Fufa**, previously I was graduated from AAU in Masters of Arts in RLDS (Regional and Local Development Studies) and know I am studding for the program of MEC (Masters of Arts in Economics) in Indira Gandhi National Open University, conducting the final research thesis on the title of **Socio-economic Problems of Water Pollution: the Case of Akaki River**. The Thesis is used as a partial fulfillment of the requirements of Masters of Art in Economics. In this connection, I have constructed semi-structured questionnaire to gather the needed information for the research purposes. Your active participation is very important and without your participation, the study will not be as complete as it should be. Please be an active to answer the following questions and any information that you supply will be treated with the greatest confidentiality and secrecy.

I. Organizational profile

- Name of the organization _____
- Year of establishment _____
- Mission of the organization _____

_____

II. Personal Background of the respondents

- Age of the respondent _____
- Gender _____
- Academic level/ professional background _____
- Position in the organization _____

III**. Socio-economic activities and water qualities of Akaki River**

1. Has your Office (Organizations) conducted any research or study regarding the contents of Akaki River or its tributaries that found in Addis Ababa City?

   a. Yes b. No C. I don't know

1.1. If your answer is yes, what major chemicals have being found in it?

a. _____ b. _____

c. _____ d. _____

e. _____

1.2 If your answer is no (in question 1), how does your office see or evaluate the water quality of the river against to human and animals health?

a. As a very serious problem
b. As serious problem
c. Not a serious problem
d. All in all no problem

2. Are the chemicals that are found in the Akaki River, suitable for sustenance of life?

a. Yes b. No

2.1 If your answer is no, what measures are going to be taken? _____

_____

_____.

3. Would you able to identify the top five diseases that repeatedly happen down the stream of the Akaki River due to water pollution? a. Yes b. No

3.1. If your answer is 'yes' state them. _____

_____

_____

_____.

4. How do you evaluate the status of water-related infections in the Akaki river catchment areas

a. Very serious problem b. Serious problem

c. Not Serious d. Not a problem

5. What are the major sources of pollution for Akaki River?

a. Industrial waste products
b. Sewages and sewerage from the City
c. Inappropriate dry waste disposals
d. All of the above
e. Others like _____.

6. What are major problems that have been occurred due to the pollution of Akaki River?

6.1 Social problems _____

_____

_____

_____

6.2 Economic problems _____

_____

_____

6.3. Environmental / Ecological problems _____

_____

_____

7. What possible alternative solutions you recommend to mitigate the problems?

a)_____

b)_____

c)_____

d)_____.

8. Does the City Government have a Waste disposal policy?

a. Yes we do have and implementing it.
b. Yes, we do have but it is not implemented properly.
c. No we do not have waste disposal policy as the City Government.

9. What are the dry waste disposal mechanisms most of the time that is implementing in the City?

a. Recycling the waste products.
b. Released to the down streams.
c. Open dumping on properly identified site.
d. Collected to temporary Septic tanks to dispose but stay there.

10. Your comments or suggestions regarding the water quality of Akaki River, health implications of the pollution and their socio-economic problems that arising on the surrounding rural communities? _____

_____

_____

Thank You!

Ques. 03

Questions to be presented for key informants

Dear participants, the main purpose of this discussion questions are to gather information on the socio-economic problems of Akaki River pollution and the consequences of this pollution to the catchment areas. You are expected to respond to each discussion questions accordingly with genuine, accurate and balanced responses. It is highly appreciated as it determines the quality and the success of the study. So, the researcher is very much grateful for the sacrifice you pay to this end.

1. How do you perceive the water quality of Akaki Rivers in general and utilizing it for drinking, irrigation, animal watering and other purposes in particular to the catchment areas?
2. What do you think the major pollutants or sources of pollution for the river?
3. What social and economic problems are arising due to the pollution of Akaki River?
4. What actions are going to be under taken to mitigate or reduce the problems? (From polluters' point of view)
5. What possible mechanisms should be sought to deal with the problems? And Who do what? (Government, privet sectors and the societies)

Thank you so much!

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