

**ASSESSMENT OF URBAN WATER
SUPPLY SERVICES IN AXUM TOWN,
TIGRAY REGIONAL STATE**

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BY

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ACRONYMS

AA.....	Addis Ababa
AIDS.....	Acquired Immunity Deficiency Syndrome
AWSSS.....	Axum Water Supply and Sanitation Service
CSA.....	Central Statistical Agency
CSIS.....	Center for Strategic and International Studies
ECA.....	Economic Commission for Africa
ESRDF.....	Ethiopian Social Rehabilitation and Development Fund
FGD.....	Focus Group Discussion
HH.....	House Hold
HIV.....	Human Immunity Virus
IWA.....	International water association
L/C/D.....	Liter Per Capita per Day
KM.....	Kilometer
l/S.....	Liter per second
MASL.....	Meters above Sea Level
MDGS.....	Millennium Development Goals
MOFED.....	Ministry of Finance and Economic development
MOWR.....	Ministry of Water Resources
M3.....	Meter Cubed
SAP.....	Structural Adjustment program
PASDEP.....	Plan for Accelerated and Sustainable to End Poverty
SDPRP.....	Sustainable Development and Poverty Reduction Program
TWRDB.....	Tigray Water Resource Development Bureau
UN.....	United Nation
UNCED.....	United Nation Children Development
UNCHS.....	United Nations Center for Human Development
UNDP.....	United Nation Development Program
UNEP.....	United Nations Environment Program
UNESCO.....	United Nation Education and Scientific Organization
UNICEF.....	United Nations International Children's Emergency Fund

WASH.....Water Sanitation and Health
WB.....World Bank
WHO.....World Health Organization
WSSA.....Water and Sanitation Authority
WSP.....Water and Sanitation Program

Abstract

The main objective of this study is to assess the existing urban water supply services of Axum town. Relevant data were gathered from both primary and secondary sources. Major primary data consisted of a questionnaire survey and interviews with the supply service office, prominent citizens and professionals. A sample of 300 households was drawn from all tabias using proportional to size method and respondent HHs were selected using systematic random sampling. Responses of the questionnaires were entered in to SPSS software for analysis. The survey result shows that the water produced only covers 45-59.4 percent of the demand. The distribution of water covers 70 percent of the population and includes private taps, yard taps, public standpipes and water vendors. But the poor quality of water coupled with its inadequacy had encouraged people to use unprotected sources. Hence, piped water only serves 54.9 percent of household consumption purposes. Those who depend on public standpipes need 19 fountains while only few are functional. They consume on average 15 l/c/d when compared to 19.99 l/c/d and 21.66 l/c/d yard tap and private tap consumption respectively. More than half of households get water intermittently. This in turn decreased the daily average consumption to 11 l/c/d, far below the minimum requirement of 20 l/c/d set by MoWR. The inefficiency also became a cause of price increases to 32 cents per 20 liters from 6 cents and 5 cents for public standpipe and private users at normal periods respectively.

The study also identified among others, inadequate water, poor water quality, inefficient and unfair distribution and interruption as major causes of water shortage and scarcity. This was due to lack of skill, facilities, finance and coordinated efforts of all concerned stakeholders.

The paper recommends interventions to enable the Axum water service office to overcome the problems and contributions expected from all stakeholders, including the community. The points include rehabilitation of wells, introduction of treatment plant, construction of dams to collect surface water, improving water shade management, and construction of additional standpipes, rainwater harvesting, strengthening the capacity of management and coordinating efforts among stakeholders.

Keywords: *Water access, consumption, provision, supply, distribution and coverage*

CHAPTER ONE

INTRODUCTION

1.1. Background

Water is the material that makes life possible on earth. It is a vital resource for all socio economic development activities. It is the most important of all public services. Availability of safe water supply is essential to human existence. Providing access to clean and adequate water supply system facilities and improving the performance of this sub-sector directly reduce the morbidity and mortality rates of a population. By the same token it increases the productive capacity of the economically active population. Safe water supply in addition to drinking reduces the suffering from water related diseases such as diarrhea and cholera in developing countries (MoWR, 2001).

Zewde cited in Bihon (2006) stated that water need to be managed sustainably, taking into account environmental concerns such as population pressure, drought, excessive evapotranspiration, desertification, deforestation, over application of water, water pollution etc. While water resources look adequate for the whole population as a whole, global safe water coverage rates in urban areas remained unchanged because of the increase in its distribution among residential, commercial, industrial and public, thereby creating water supply scarcity.

The demand for potable water has been increasing over time as a result of rising standards of living and population increase both from natural growth as well as rural urban migration.

Because of the increasing demand one in five people in developing world does not have access to safe drinking water and sub-Saharan Africa has the lowest water supply and sanitation coverage of any region in the world (World Bank,2004). More than 30 percent of African residing in urban areas lack access to adequate water services and facilities. In the year 2000, world health organization (WHO) estimated that Africa contains 28 percent of the world's population with out access to improved water supplies (WHO, 2000).

This shows that many urban centers in Africa including Ethiopia are facing serious problems of getting safe drinking water supply. As a result only 72 percent of the Ethiopian urban populations (38 percent if we exclude Addis Ababa) have access to clean potable water (Alleble 2004:7). Conditions are even more critical if we bear in mind that access to safe water, in our case does not mean access to adequate water supply “in which adequate was defined to mean 20 liters of water per person per day (Dessaiegn, 1999:15).

Problems are further exacerbated by the high population growth and mushrooming towns. The numbers of locations classified as township in Ethiopia are currently increasing and all are in need of water supply and sanitation services.

Additionally factors like limited capacity of water bureaus in the regions, water desks in Weredas and insufficient cost recovery for proper operation and maintenance are inhibiting the achievement of urban water supply.

More over, issues meriting attention in water supply sector in Ethiopia in general are characterized by service deficiency of physical infrastructure as well as by inadequate management capacity to handle policy and regulatory issues and to plan, operate and maintain the service (Assefa, 2006). Inadequate production with inequitable distribution system and low quality of water influences the well being of people in particular and the socio economic condition of urban areas in general.

It appears to be generally true that small towns' municipalities in Ethiopia fail to serve utilities including urban water supply properly. This is because remote areas do not have enough trained personal in management, revenue collection, budgeting and service delivery skills. They are unable to raise sufficient revenue, and many fail to meet even their operating and maintenance costs from the income generated. In this case planning for efficient, equitable and sustainable water supply systems is critical to ensure that the population receives adequate and safe water supplies.

This paper investigates the existing water supply conditions, its water supply systems and the causes to water service problems such as water scarcity, shortage, and water stress in Axum town.

Axum is one of the Zonal towns in Tigray Regional State and is about 1050km

away from Addis Ababa to the north east of the country. Axum is popular for its ancient civilization. After the fall of the Axumite Empire it was administratively an Awraja town for a long period of time. The water supply of the town was mainly from Maishum water reservoir which is believed by many historians as the ancient swimming pool of queen Sheba (Girma: 1997:12).

Recently Axum has got the status of zonal town after the current government has come to power with federalism in the country. On the other hand Axum is an important historical and tourism center in Ethiopia. These opportunities contributed to the increase of its population and expansion of the town geographically. The growth of population, the expansion of tourism industry and other socio economic activities resulted in an increased demand for water supply both in quantity and quality. Therefore, sustainable water supply is one of the critical issues in the town that needs to be frequently assessed and examined to the scarcity, shortage and management of the water supply.

1.2. Problem Statement

Water supply and sanitation should be considered as vital aspect of poverty alleviation program. In addition, programs for the provision of water supply and sanitation within the framework of an integrated approach to water resource management are other essential aspects in promoting efforts towards attaining full coverage of water supply service.

Attention has been given by the Ethiopian government to alleviate the problem of access to safe water supply and achieve rapid socio economic development. The country has integrated the Millennium Development Goal (which is planned to reduce by half the proportion of people who do not have sustainable access to safe drinking water by 2015) in its nations plan (MoFED, 2002).

In Ethiopia, 20 liters per capita per day is considered as adequate for domestic use. But, average per capita water consumption varies between 10 to 20 liters per capita per day in some urban areas and it is the lowest coverage in the world (Allebel, 2004:8). Even if there is coverage the level of service may be poor. This situation has had a direct impact on progress towards meeting the Millennium

Development Goals targets.

Axum town has been experiencing the problem of adequate safe water supply since its establishment. The people of the town were fetching water from streams, traditional wells and from Maishum reservoir. Since 1976 deep boreholes were drilled and pipelines were installed in the town.

The water supply is entirely dependent on water drawn from bore holes. The wells are characterized by low yield and poor quality of water. Consequently the town does not have adequate water supply. According to Tigray Water Resources Development Bureau (TWRDB, 2006) of 18 boreholes only 9 provide service for the water supply of the town. The remaining is not operational. Among the wells which are not operational 7 of them are completely dried. Few of the boreholes that give good yield have poor water quality in terms of higher iron and manganese content and the others have low yield.

The projected water demand of Axum town for the year 2005 was 3811.5 m³ /day (MoWR 2002) while the actual daily supply of water was 1350 m³ /day. This amount is about 35 percent of the demand (TWRDB, 2006). Concerning the population the projection was only to serve 45,000 inhabitants, the problem is more crucial when the inhabitants are estimated to be 49523 (CSA 2006).

The question here is how to solve problems of water shortage in Axum town and supply safe and adequate water for the population.

In this regard there are a number of hydrogeological studies conducted in the area. But these studies were mainly of searching potential sites to water availability. Beyond these there was no any research work that could describe the magnitude of the problem. There was not a detail investigation that describes the challenging problems that encountered the community due to water scarcity. More over the root causes of water shortage and scarcity were not clearly identified except that it states there is a problem of clean and safe water in the town.

It is here that this research work becomes vital to investigate and make comprehensive analysis of the water supply services in Axum town.

Hence, this study focuses on relevant issues of water supply services, mainly emphasizing on water availability, quality, efficiency of distribution, its sustainability, as well as the challenges that the community face. It also investigates the root causes of the problems mainly water shortage and scarcity. In addition, the research is to focus on the capacity of the service providers on how they are implementing policy statements and programs set by the government.

The output of the study will provide significant information for policy makers and, for those who are responsible to implement accordingly. It will also enable them design particular and appropriate intervention measures for sustainable development of urban water services

1.3. Significance of the study

Despite a great deal of attention has been given by the authorities' in the past decade, shortage of water supply is still an unresolved issue. The situation in the future with existing population increase with in urban areas and migration from rural is not promising.

At present, the population of Axum town is increasing because of the newly opened universities, rapid flow of tourists and the creation of special areas for the purpose of cluster industry development. These activities are creating an increasing demand for water and calls for immediate efforts to improve the existing water supply and provide alternative solutions that go along with the increasing demand for water.

To this end, assessing the existing condition is vital, as assessment is one of initial steps in any planning and evaluation. Therefore, studying the extent of coverage and dynamics of urban water supply service in Axum town helps to identify the pressing problems in the service delivery. The researcher is hoping well that the findings of the study be significant for Axum municipality, branch office of mines and energy bureau, Axum water supply service office and other stake holders for designing more effective method of water supply. On top of that the result of the study may be used as baseline data in the future, mainly for those studies that emphasize more on provision of urban services.

1.4. Objective of the study

The General objective of this study is to assess the structure, availability, quality and sustainability of water supply in Axum town.

Specific objectives

1. To describe the sources, type and coverage of water supply in the town.
2. To examine water structure distribution system and the proportion of pipe water and non-pipe water used by the population in the town.
3. To identify the population affected by insufficient water supplies and the alternative sources and type of water sources used by such households.
4. To identify major causes and challenges of water supply scarcity and shortages.
5. To assess and describe the role of government mandated agencies and stakeholders in improving water supply in the town.

1.5. Research Questions

Based on the general and specific objectives, the following questions shall guide the study.

1. What are the various available sources and type of water supply in the town?
2. What are the structure, distribution and coverage of piped water supply?
3. Is water supply increasing in quantity and quality with the increase in population?
4. What are the major problems and challenges of water supply in the town?
5. What are the roles of the local government and stakeholders in improving the problems of water supply and management

1.6. Scope of the study

The scope of the study is limited to domestic water supply of Axum town and does not include industrial and commercial water supply and consumption. In this regard it will investigate the existing water supply system and is limited to water sources, distribution, coverage; access, sustainability and major causes of water shortage and scarcity. The Sample size is limited to 4 percent of residential houses

in Axum town. Therefore, from the total 7515 residential households, 300 sample house holds are taken.

1.7. Research Methodology

1.7.1. Methods of data collection

1.7.1.1. Primary data collection

The major primary source of data for the study was questionnaire survey of households. The questionnaire was designed to be close ended and open ended. The close ended questions captured direct answers from respondents while the open ended questions allowed the respondents to express their views as they wish. The questionnaire focuses mainly on investigating the existing water supply system based on the stated objectives i.e. water sources, distribution of water , coverage, access, sustainability, causes of water shortage and scarcity, and role of government mandated agencies. For the survey, the questionnaire was translated to Amharic and responded by household heads. In the absence of household head any adult from the house hold is taken to be responsible.

Fifteen enumerators were selected from Axum preparatory school. The school administration selected them based on their merit in the class and were assigned on the Tabias they live in. The enumerators were given training on how they approach the interviewees; fill the questionnaire as well as on various issues concerning the research. They were all given questionnaire to test their activities. The findings in the pre-test helped the researcher to administer data collection as carefully as possible.

Unstructured questionnaires were distributed among selected group in order to gather as ample data as possible. The researcher supervised the enumerators and also managed the interview and gathered information from ordinary citizens, water supply service office, town administration and members of the focus group discussion. Personal observation and informal interview were carried out to support data gathering.

1.7.1.2. Secondary sources

Review of the existing theoretical and empirical literature of water supply conditions with special emphasis on developing countries, Africa and Ethiopia has been made. This yielded important background information on the water sector and its urban needs. The secondary data sources include documents from different organizations, such as Ministry of Water Resources, Economic Commission for Africa, Central Statistical Agency, and Water Aid etc. Other document such as borehole production from Axum water supply service was also used. Backgrounds of the study area are from Tigray Water Resources, Mines and Energy bureau and from Axum City administration.

1.7.2. Sampling and survey design

The underlying purpose of this study is to assess the existing water supply structure, availability, access; quality, sustainability and the major problem of water service in Axum town .Obviously the main target of the study are the households and these calls for gathering primary information from all households. However, due to constraints of finance the study concentrated on selected households. Thus sampling technique is introduced.

Axum is zonal town administratively classified in five Tabias/Kebeles. According to the information obtained from the town municipal office, in 2007 Axum town has a population of 49523 with a total residential household size of 7517. These households are grouped in to two, Households with pipe water connection and households without pipe connection. This categorization is applied in different studies since possession of private meter is taken as best standard of water supply service and the vise versa for those without. From the total residential households, 3813 households are with meter connection and 3704 are with out meter connection. The five Tabias\Kebeles are covered and each group of the sampling unit is considered in each Tabia. Proportionate stratified sampling is taken to fairly represent the total population from the study area. Sample size from each Tabia was drawn using proportional to size method from the total household in Tabias\Kebeles.

Finally, to select a respondent household a list of each Tabia in each category (with pipe and with out) was used as a sampling frame. From the sampling frame the first number from each list was selected randomly. After the selection of the starting household the remaining were selected based on systematic random sampling method. The interval was determined based on the percentage set to select the sample size. The total sample size was four percent of the total households of the town and is 300 households. The unit of analysis is the household interviewed using the structured questions.

1.7.3. Data Analysis

The data gathered has been analyzed in line with the purpose already identified. Both qualitative and quantitative data are collected and summarized. The responses of the questionnaire survey were entered into SPSS software for analysis. In the analysis of data, percentages, proportions, arithmetic means, cross tabulation and descriptive statistical methods were used, most of which are presented in frequency tables.

1.8. Limitation of the study

The sample size is limited to 300 households out of 7517 house units because of finance and time constraint. The absence of proper documentation in the archives of the municipality of the town and to some extent in the water service office has to some degree restricted data collection. Sometimes it was difficult to know the responsible person of the data bases. During data collection some respondents were not willing to tell their income. Some of the respondents lost their patience to answer all questions. For those households with out private meter connection, there was no tangible source that could be referred for the actual consumption of the household. Thus it was based on the respondent's information that their daily consumption is taken.

1.9. Organization of the Paper

The thesis consists of five chapters. The first chapter covers the introductory part which includes the background, problem statements, and significance of the study, objectives, research questions, research methodology, the scope and limitation and organization of the study. Chapter two provides literature review. The third chapter describes the background of the study area. Chapter four discusses the results and findings. Finally chapter five presents conclusion and recommendation of the study.

1.10. Definitions of terms and concepts

To meet the objective of the study a number of key concepts are explored for the analysis of urban water supply service in the study area. There are different approaches and definitions by different agencies and scholars for urban water supply that mainly depend on the variation of development status of each nation. Taking the research objectives as a frame of reference, the key concept to be used in the analysis of urban water supply service comprises of two factors. Firstly, the physical activities of the whole system, i.e. the water supply issues, concerned with water sources, access to water supply, converge of water supply, distribution of water supply and sustainability of water supply. Secondly, the institutional factors those are responsible for the follow up of the supply system to generate equitable and sustainable distribution. Therefore, to guide the analysis and also for the purpose of clarification, these concepts are defined to help understand the context in which the concepts will be used in the study.

Water supply issues: - UNDP (1997) recognizes the concept of water supply system as water provision which includes other process of water supply delivery and must be continuous in order to be successful. It is concerned with the supply of water intended for human consumption and the water is conceived as free from organisms and concentrations of chemical substances that may be hazard to health. In addition, it must be clean, free of turbidity and with the absence of colors and free from any disagreeable taste or smell (WHO,1971:9).

Water source:-is concerned with the types of opportunities from which water can be collected for water supply service. This includes surface water, ground water, rain water harvesting etc. when a choice has to be made between alternative sources the quality of raw water as well as adequacy and reliability together with potentialities for expansion in the future must be considered (WHO, 1971).

Access to Water Supply: - means that the opportunity or the right to use water. It is also concerned with the average distance of water point and the time required collecting the available water. This is influenced by factors such as the quantity,

quality and convenience (safe water enough for daily consumption and the supply being continuously through out) of the water supply system (WHO, 1971).

Water supply coverage: - implies the proportion of people served with adequate level of safe water provision (CSA, 2004).

Water Supply Distribution:- is concerned with the means (technology) by which the available water is provided to the people and it also implies the share of each system in the water provision service that include pipe water connections, yard taps, distribution taps, protected springs with pumps, protected wells etc (WHO,2000).

Sustainability of water supply: - is to mean the continuity of supply of adequate and safe water in relation to population growth and demand for fresh water. It must satisfy the minimum requirement of household consumption for different activities.

In this regard water stress and scarcity should be considered which indicate the degree at which water is supplied in comparison to international or national standards. As noted by the united nations (UN) the conversion is to treat 1700 m³ of water per person per year as the national threshold for meeting water requirement for various sectors (agriculture, industry, energy, environment etc) or as the ministry of water resource set as the minimum availability of 30-50 liters per person per day to achieve sustained health improvements. Availability of water below 1000m³ per person per year is held to represent a state of water scarcity (WHO/UNICEF, 2004).

The other major concept is related to institutional factor. Various institutions are responsible for policy making, planning, (design) Implementing (construction) and management (operation and maintenance) of water supply services. The following are important to mention.

Policy Frame Work: - which is the general description of objectives to guarantee the availability of water in sufficient quantities and qualities for different sectors,

development of water supply system for economic and social benefits of the people, on equitable and sustainable basis (MOWR, 1999).

Institutional Capacity: - institutions are responsible for planning implementing and management of water supply projects, the capacity of the management to control the over all process such as construction, operation and supervision of water supply, its reservoirs and its distribution system must be as such to exclude the inefficiency of use, and to enhance the equity of access and sustainability of the resource. The community, the water boards, the local government water service agency, the local administration, other donors and non government agencies are key stakeholders in the process of efficient management for sustainable water supply system (MOWR2, 2002).

Community Participation: - It is to promote the participation of communities in the relevant aspects of water resource management. The communities as primary stakeholders to have a continuous and active participation in the process of water supply, its main components are water board formation, which is responsible for all management issues and through the legalization of a forum created for the active participation of beneficiaries Therefore, the stakeholders in general and the water supply services agency in particular should be assessed to indicate the strength of the management and cooperation among stakeholders (MOWR, 2000).

CHAPTER TWO

LITERATURE REVIEW

2.1. GLOBAL NEED FOR CLEAN WATER

There has been considerable amount of literature documented related to water resources management, policies, regulations supply and utilization. Several international and national conferences, debates and dialogs are held on water. Government officials, public representatives, Labor unions, economists, Environmentalists, non government organizations, International financial institutions, researchers, academicians, students, all groups together talk and write about issues of water. All this is of its critical importance to humanity.

According to international water association (IWA, 2004) Access to safe and reliable drinking water is one of the most basic needs of human society and as such requires integrated approach, close cooperation and partnership between all stakeholders . Mardel Plata water conference (1977) noted that all peoples what ever their stage of development and their social and economic conditions have the right to have access to drinking water in quantities and of qualities equal to their basic needs. Water is the most important of all services. It is the most essential necessity of life. But why water, water every place and every time? Or is there a water shortage on the planet earth?

Clean and fresh water supplies were once considered inexhaustible (Eager and smith 2000). Images of our planet earth from other space show vast oceans, lakes wide rivers flowing with incredible volume. Over 70 percent of our planet earth is covered by water. In absolute terms our planet earth contains about 1.41 billion km³ of water (Enger and Smith, 2000). Then how can there be no enough water?

Not all of this water is available for humans. Of all the water on earth, more than 97 percent is salt water lethal to crop and unfit to human consumption. This water is primarily found in oceans (Miller and Tayler 1994, [http://www. Water, com.](http://www.Water.com) Water for food, Org). The Earths fresh water is much smaller, which is only 3

percent. As Miller and Tayler (1990) noted, about 2.997 percent of water is (which is fresh water) stored in the ice caps of Antarctica and Greenland and as fossil ground water. The most accessible fresh water resources are in lakes, reservoirs, rivers and streams and these resources are amounted to only 0.003 percent of global water (UNCHS, 1996).

In addition to this limited sources of water, nature itself is unequal to water distribution. Water supplies are unevenly distributed around the globe with some of areas containing abundant water and others with much more limited. A mere 12 percent of the world population uses 85 percent of its water, Enger and Smith, (2000) also noted that the total fresh water resources on earth available for human consumption on yearly basis is about 1400 km³ which equated to only 0.003 percent of all water on the planet. They further described that this number translates into 7000m³ for every human being on the earth which is more than enough water to fulfill each person's daily needs (Enger and Smith, 2000).

Unfortunately most of this water is located disproportionately to human population settlement. The imbalance between population and water supplies in some countries is pushing those countries toward conditions of water "stress" and water scarcity, meaning water supply problems are common and wide spread. One thousand m³/per year per capita is considered as "water scarce" the threshold below which serious social public health and economic problems arise (Bergen, 1999).

By these standards, for example in 1997, 270 million people lived in eleven water stress countries while 166 million people lived in 18 countries experiencing water scarcity. The number of water stressed countries will rise to 15 and be home to 2.3 billion by 2025 (WHO/ UNICEF, 2004). It is this situation that brings many researchers and international organizations to conclude that even though our planet earth may largely be made up of water only a small fraction of this is available for human use. Water availability became even more of a problem because of limited fresh water resources have to serve different sectors of the economy such as industry, agriculture and the ever increasing population and urbanization (Bergen, 1999).

In general term steadily increasing global demand for clean fresh water has already created series water shortages or will limit the availability of water to people, agriculture, industry and the environment. Nowadays about 83 percent of the global population drinks water from improved water resources leaving 1.1 billion people without access to safe drinking water (WHO / UNICEF 2004).

In the aggregate, in order to meet the millennium development goals of reducing by one-half the number of people without access to safe drinking water, 1.6 billion people will need to be served over the next decade (WHO/ UNICEF 2004). It is widely accepted that water scarcity and the lack of safe drinking water are the most serious challenges of the 21st century. These global water problems are attracting attention at the international level. To overcome the global water supply problem, various efforts were made by international organizations particularly since 1981.

The international drinking water supply and sanitation decade (1981-1990) was the period of accelerated and concerted effort to expand water supply and sanitation services to unserved poor populations. Whilst efforts under this program expanded services to 816 million people. The population growth that took place over the same decade meant that these was only 3 percent net increase in service of safe and clean supply of water (WHO/UNICEF,2000).

At world summit for children and development, the many governments made a commitment to achieving universal access to safe water and adequate sanitation by the year 2000. However these targets were not met and hundreds of millions of urban dwellers still suffer from very poor or non- existent provision of water and sanitation (http:// UNESCO. Org._water /wwwap/water/pdf/chap5/ PDF retrieved on 6/2/2008).

The concept of meeting basic water needs was strongly reinforced during the 1992 earth summit in Reode Janero stating that, in developing and using water resources, priority has to be given in the satisfaction of basic needs. UN in 1997 also explicitly addresses the question of water for basic human needs. In determining vital human needs special attention is to be paid to providing sufficient water to sustain human life.

Since 1990 WHO and UNICEF have been collaborating in the monitoring program, which has its main purpose the building of national capacity for the water and sanitation sector, monitoring and informing policy makers globally on the status of the sector. The global effort towards improving water supply was reiterated in 2000 as part of UN Millennium Development Goals (MDGs) and access to improved sanitation was added to the MDGs at Johannesburg summit in 2002. The efforts over the past three decades have focused on alleviating water scarcity and providing clean drinking water and sanitation to effected population across the planet earth. Unfortunately the world still has not universal coverage of access to improved drinking water. To day nearly one- six of the world's population does not have access to improved drinking water and are instead drinking from river streams, ponds or UN protected springs and hand dug wells WHO/UNICEF 2004).According to the world health organization (WHO) estimation, approximately 1.6 million people die from diarrhea and hygiene related illness every year. These deaths are attributed to lack of access to safe drinking water and sanitation (WHO/UNICEF, 2006).

Adequate supplies of fresh water are a cornerstone for human activities at all scales, from daily subsistence need to higher levels of economic production. Lack of access to safe clean water for drinking and sanitation is a perpetuating cycles of poverty and limiting viable development options in regions around the world. With out access to a reliable and convenient source of water family members, most often women and girls can spend hours each day collecting water. Water related diseases and requirements of water collection keep children from attending schools and keep adults from engaging in productive economic activities.

Various causes for the problems of clean drinking water or water supply in general are identified by many researchers and international organizations. Among these the major causes are population increase, urbanization economic development, industrialization and poor governance (WHO/UNICFE 2004). According to various sources the world population grew enormously in the 20th century. The UN estimation shows that 1.65 billions people lived on earth in 1900 by 1999 the world population has passed 6 billion. On the other hand during this period the annual supply of fresh water remain constant (UNCHS, 2001). The global

population projection suggest that the world population of 6.055 billion in 2000 will increase by 20 percent to 7.05 billion by 2015 and to 7.825 billion by 2025 a 30 percent increase. The projection also shows that the population numbers will reach 9 billion by 2050 (WHO/UNICEF, 2000). As the UN Commission on Sustainable Development noted, the amount of water available for each person decreases as the population growth raising the possibility of water shortage. To meet the international development target halving the proportion of people with out improved sanitation or water supply by 2025 and additional 1.6 billion people will require access to sanitation facilities (WHO/UNICFE 2000).

According to Gleick 2002) by the year 2050 one in four people will live in a country experiencing chronic or recurring shortages of water. He also noted that by 2025 more people could die of water related diseases than will perish from the HIV/AIDS pandemic. In general Global trends in population growth and urbanization among other are pushing all of humanity toward a period marked by unprecedented sweeping water scarcity, poorer water quality and greater sanitation challenges (CSIS, 2005).

2.2. Approaches to Water Management

2.2.1 Supply Driven water Management

Since the 1970s when economic growth and redistribution paradigm was underway, government and donors gave attention to alleviate poverty through providing basic needs such as drinking water. This approach was known as supply driven approach of water supply in the developing world. The argument of supply driven approach was that the poor is too poor to pay and, therefore, water a basic necessity of life should be given free to them (Khan, 2003). The basic needs (supply driven approach) was adopted to expand services of water supply with the following aims. The first one is government and donors provide minimum levels of improved water services such as hand dug pumps, to as many people as possible with the available funds. The second is to build up the capacity of government agencies to appraise, implement and manage schemes. And the third was providing subsidies to the water supply, (Kleemeier, 1995). He adds also that the assumption behind

the basic needs approach towards water supply refers to the idea that the provision of clean water would contribute to economic growth, the government should construct and maintain water schemes, public financing should subsidize water services.

The World Bank (1993) also stated that the objectives of the supply driven approach has been to improve the health of house holds through providing safe drinking water. These health benefits were used to justify heavy public investments as house holds might not be willing to make the investment. In general term, the supply oriented water supply approach focuses on technical and financial elements and monopolistic public services delivery.

The supply driven approach of water supply were challenged by the rationale of structural adjustment policies(SAPs) and Since 1980s the approach was found not to be helpful to gain the desired achievements. The problems attributed to this approach are identified by Briscoe and de. Ferranti in1989 Firstly, given the high population growth rates, the strategy of the basic needs approach to water supply would not reduce the number of people with out access to safe drinking water. Secondly, the funds needed to achieve universal coverage have proved to be very far from being in reality. Thirdly, in too many cases, schemes were not sustainable (Kleemeier, 1995). He also recognizes that, supply driven approach (interventions) have not succeeded in providing poor communities with sustainable water supplies, He adds that communities that simply “receive” a water point, playing only a minor or symbolic role in project implementation, tend to lack a sense of ownership.

2.2.2. Demand Driven water Management

The world’s developing countries experienced very poor growth and huge balance of payment deficits since, the late 1970s. This situation calls for a new paradigm shift that focuses on a macro level of SAPs to restore their growth. The basic aims of structural Adjustment Policies is to cut government function in the economic and social activities in favor of the private sector and market forces. In 1980 the strategy of donors aimed once again aimed at alleviating poverty through economic growth on the basis of macro level policy reforms (Riddle, 1987). By the early 1990s

World Bank officially adopted a new approach to water supply. This new shift is based on the assumption of addressing and correcting the shortcomings of the basic needs (supply driven) approach, insufficient coverage, high cost, and poor utilization (Kleemeier, 1995; WB 1993).

The demand responsive approach, therefore, has become the keystone of governments and water supply policies throughout the world (Kleemeier, 1995). The demand responsive approach expects the community to take the lead in water supply initiatives. Communities have to demand improved services, choose what type of facilities they want and work out how they will manage them. In addition they are required to make meaningful contribution to their projects in the form of cash, labor or materials. The central theme of the demand responsive approach is that communities should receive via the private sector safe drinking water for which they are willing and able to pay (Kleemeier, 1995; please 1984).

Proponents of demand driven approach argue that health benefits alone do not generally provide a rationale for public subsidy to water and sanitation services (WB, 1993). The immediate objective of water supply should be not to supply every one with minimum services but to provide the desired level of services to those who were willing and able to pay for it. According to this approach consumers would own schemes by lowering construction costs and providing best services. Here the issue is cost efficiency for each level of service delivery (Kleemeier, 1995). A demand responsive approach no longer believes that government agencies should be strengthened and expands their presence to implement and manage water supply scheme rather private companies or cooperatives should manage and expand schemes (Roth, 1985). In demand driven approach, private financial institutions are also considered as the most appropriate instrument for expanding loans to communities to pay for their scheme and the government should be confined itself as an educator, promoter, regulator, trainer and provider of hydrological information adjudicate conflicts and so on (kleemeier,1995).

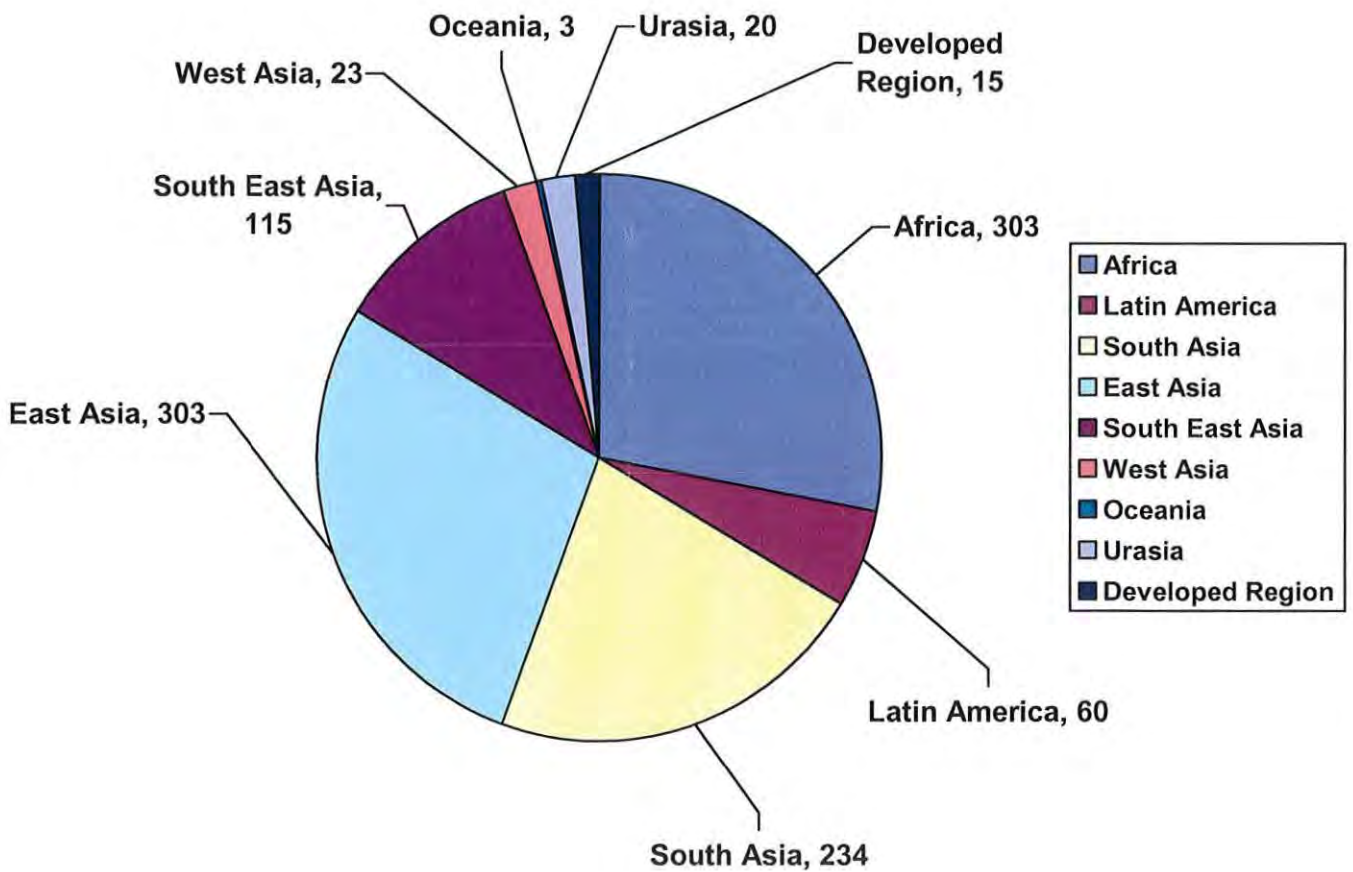
In the demand responsive approach the expected role of the community differs considerably between urban and rural areas. In urban areas private companies and cooperatives are thought to handle management whereas in rural areas

community organizations would generally have to assume all the management responsibilities, but it is still ambiguous how this would happen. In this approach government officials are still taken to assume the responsibility of motivating and organizing communities (Briscoe and Deferranti 1998). Sustainability is the touchstone by which the demand responsive must be judged. This emphasis on sustainability has proved attractive to funding agencies many of whom are now pursuing the demand driven approach.

2.3. Water Access Practices in Developing Countries

The world fact shows that Africa has the lowest total water, supply coverage of any region with only 62 percent of the population having access to improved water supply. The situations much worsen in rural area where coverage is only 47 percent compared with 85 percent coverage in urban areas. Water supply in Asia is the second lowest after Africa at 81 percent and again water supply coverage is lower in rural areas 75 percent compared with that in urban areas 93 percent. Total coverage with water supply in Latin America is approximately 85 percent of the population where large disparities are apparent between urban and rural areas; 93 percent of the urban population enjoys coverage of water supply while only 62 percent of the rural populations are covered (WHO /UNICEF, 2004).

The following figure shows the approximate number of people (**in millions**) in the world with out improved drinking water sources.



Sources: WHO/UNICEF 2004

The figure above shows that in global terms more than 1 billion of the world's people do not have adequate supply of water where most of these people are in the world's developing nations. The figure also indicates that Asia constitutes the highest number of people, 80 percent of the global population without access to improved drinking water sources. Africa is next to Asia accounting to 28 percent of the global population without improved drinking water sources; yet it is important to note proportionally this group is bigger in Africa because of the difference of population size between the two regions (http://wassifo.Org/pdf/jump-04_tables/pdf/).

Many researchers revealed that water supply access in developing countries is complex. On one hand, some section of society enjoy water supply and other services of quality comparable to those developed countries. On the other hand, many households do not have access to water piped to their home and as a result there is a variety of communal water source. These include public taps, water sold by house holds with connection and purchase from venders (Willington et al. 1991, Caricross and kiar 1992).They also include a variety of small point water supplies such as boreholes with hand pumps, protected springs and hand dug wells (Rohaman et, al. 1997;).

The situation presents also another sever problem in many developing countries where continuity of water supply is not taken for granted. Water is provided for a few hours every day or a few days a week. It is estimated that about half of the population of developing countries receive water on an intermittent basis.

The largest proportion of population in the world (76 percent) and the highest rates of increase are mainly in the developing regions where growth rates is greater than the world average (more than 3 percent) are still accounting in many countries even today (Taftise,T.and RoderGues,M,2001) The UN- projection shows that water supply and sanitation sectors will face enormous challenges over the coming decades. The urban population in Africa, Asia, and Latin America and the Caribbean are expected to be more than double over the next 25 years while that of Asia almost double. The urban population of Latin America and the Caribbean is expected to increase by 50 percent over the same period. Projected urban population growth especially in Africa and Asia suggest that urban service will face greater challenges over the coming decades to meet the fast growing needs.

To reach universal coverage by the year 2025 almost 3 billion people will need to be served with water supply and more than 4 billion with sanitation (WHO/UNICEF, 2004). Another projection show that north Africa the Middle East, south Africa and northern china will face sever water shortages due to physical scarcity and condition of over population relative to their carrying capacity with respect to water supply. For these regions the causes of scarcity will be economic constraints to developing safe drinking water as well as excessive population (WHO/ UNICEF,

2004). Prospect of a global water crisis is real. Population increase, the quest for greater food production, economic development leading to a greater consumption of water and all these put stress on precious resources. At the same time for much water security or UN equal access to water is at the core of under development and poverty (www.UNESCO.org/ science / water day 2000 World water forum org.). Due to all these factors almost all regions of the developing world are already experiencing or soon will experience water shortages and or water quality challenges.

2.4. Water Supply Situation in Ethiopia

2.4.1. Water resources in Ethiopia

The total surface water in Ethiopia is estimated at about 110 billion m³ (world bank, 1996; Dereje, 2007; water aid ,2002) and in many parts of Ethiopia where surface water resources are scarce ground water is an important source of water for domestic supply. The current estimate of available ground water resource is about 2.6 billion m³ (MOWR, 1999; MOFED, 2002). The major traditional sources of drinking water in Ethiopia are unprotected springs, traditional wells, rivers, streams, lakes and ponds that store rain water. Although Ethiopia is often referred as the water tower of East Africa, it is always affected with draught and shortage of adequate access of water resources and it only utilizes a small proportion of its aggregate annual run off. The big and main water resource problem in Ethiopia is the uneven spatial and temporal occurrence and distribution. Water resources availability interims of space indicate a marked difference when one goes from east to west. The eastern part of the country comprises seven basins with only 11 percent of the water resource and two thirds of the population while west comprises five basins with 89 percent of the water resources and one third of the population (World Bank, 1996).

Moreover its many rivers and water systems drain to neighboring countries as well as the ground water supplies are limited in many places because of the poor permeability of the crystalline rocks and variable water table depths. Borehole depths vary across the country depending on the geology of the area. Only few data

exists for general state of ground water quality of the country. The major chemicals of health concern in Ethiopia are fluorides in the rift valley and nitrates in major towns (Water Aid, 2003). At present the majority of the population use the traditional unprotected water resources while only about 36 percent of Ethiopian population use improved sources of water from capped springs, hand dug wells fitted with hand pumps, boreholes fitted with motorized pumps, ponds filtered by electro mechanical process and rain water harvested from roof catchments.

2.4.2. Access, coverage and distribution of water supply

Ethiopia has among the lowest access rates to safe water and sanitation in the world. It is characterized by low coverage in rural areas and poor service in urban communities (World Bank, 2003). Conditions are even more critical if we bear in mind that access to safe water in our case does not mean access to adequate water. Ministry of Water Resources (MoWR) defines “adequate” water supply to mean 20 liters of water per person per day and accessible with a range of 0.5 to 1.0 km from a dwelling place (Dessaiegn, 1999:15).

The average water access and coverage to clean and safe water supply is about 35.9 percent according to the report of Central Statistics Agency (2004). This can be cited as an example of very low supply and coverage level even by the Sub Saharan Africa standard which indicates 58 percent coverage according to the United Nations (2002) survey report. The report of World Health Organization (WHO) shows that Ethiopia remains the least of all sub-Saharan countries in access to clean water (WHO, 2000).

It must be noted here that the coverage figures will even reflect much worst situation considering the unreliability and UN sustainability of supply to safe water. Where there is coverage the level of service may be poor providing an average far less than the MoWR recommended minimum of 20 Liters per person per day. It is noted that in Ethiopia the average per capita water consumption varies between 10 to 20 liters per person per day in urban areas and 3 to 4 liters per capita per day in rural areas (Allebel 2004). Those unserved mainly depend on surface water sources such as unprotected springs, ponds, streams and rivers that are often very far from their villages.

According to CSA (2004) most of the households in the country (63.9 percent) use unclean drinking water. Out of which 27.76 percent of households use rivers and lakes while 36.14 percent of households use unprotected wells and springs. The problem is much more severe in rural areas of the country. About 74.5 percent of rural households do not have access to clean water when compared to 7.6 percent of urban households. In rural areas the sources of drinking water for 32.4 percent of households are rivers or lakes and 42.1 percent of households use unprotected well /spring. In urban Ethiopia 64.4 percent of households use public tap while 23.3 percent and 4.7 percent of house holds use own tap and protected spring/well respectively. On the other hand urban households that use water from unprotected well/spring constitute 4.5 percent and 3.1 percent of the urban households fetch water from rivers and or lakes. Although urban dwellers are said to have better services, the quality and quantity of water supply are not adequate in many places. Even in the capital city, Addis Ababa, the amount of water demanded is much higher than the amount supplied for example in 1998 the amount supplied by the Addis Ababa water and sewage authority was only 62 percent of the amount demanded (Tegegne,2000:16).

Rural water supply has increased considerably from year 1996 to year 2000 (MoFED 2004:24). However, due to lack of adequate operation and maintenance capacity a significant proportion of the schemes constructed are not functioning. In a study of schemes constructed by the Ethiopia Social Rehabilitation and Development Fund (ESRDF), it is reported that 8 percent of the water schemes built had been abandoned and 22 percent were malfunctioning. In Afar and Somali due to sparse population density, high live stock population, meager surface water, poor quality of ground water and shortage of skilled man power the development cost is becoming very high. In Benshangul –Gumuz and Gambela because of the low implementing capacity of the regional governments, lack of awareness and poor accessibility during the rainy season have contributed to very low service coverage. There are also pockets lacking access to water supply and sanitation in other regions of the country because of low government priority (Water Aid 2002).These can be seen by regional variations both in rural and urban as a whole. Regions and city Administrations like Addis Ababa in particular showing more population with

access to safe source of water and sanitation. Over 70 percent of the households in Amhara and Benshangul Gumuz Regions use unsafe water from lakes and unprotected wells and springs. On the other hand Regions like Harari, Addis Ababa and Diredawa have 73.3 percent, 99 percent and 90.8 percent access to clean water respectively (CSA, 2004).

Table2.1 Distribution of households by sources of drinking water in the year 2004

In percent

region	Tigray	Afar	Amhara	Oromiya	Somalia	Benshangul Gumuz	SNNP	Gambella*	Harari	Dire DAwa	Addis Ababa	National
Urban	97.3	78.1	91.8	91.0	77.2	58.4	84.0	35.0	95.3	19.95	99.6	92.4
Total	53.9	48.6	28.0	32.0	39.0	27.2	34.3	18.0	73.3	91.8	99.0	35.9
Rural	42.7	26.9	19.9	23.7	21.3	22.4	29.51	14.0	39.8	69.6	44.7	25.2

Source: CSA (2004)

* Percentage of households for Gambela is from the year 2001.

The distribution system of the protected safe water particularly individual house connection is still at its lowest stage compared to the sub Saharan African standard of 51 percent (WHO, 2000). In Ethiopia out of the 35.9 percent households that have access to safe water, 12.9 percent of households use protected well or spring, 18.8 percent of households get water from public tap and it is only 4.2 percent of households that have their own house tap connection. Lack of safe water is one of the major causes of diseases and deaths in developing countries including Ethiopia. It is believed that maximum health benefit will be achieved from adequate and safe drinking water supplies. It is also believed that it advances the quality of life. Moreover it releases the labor (particularly that of women and female children) used to carry water, which in turn could be used elsewhere in other development activities. However the poor water and sanitation coverage of Ethiopia contributes to an increased infant mortality rates. More than

80 percent of all diseases in Ethiopia are attributed to poor access to clean water and sanitation (MOFED, 2002; WASH, 2004).

Beyond the issue of health, poor access to clean water also has a determinant impact on development. In particular water scarcity affects the lives of women. Most women in rural-Urban Ethiopia spend hours a day collecting water from distant and polluted sources. Many girls never get an opportunity to go to school because of the responsibility of collecting enough water to keep their families. In addition the locations of some water points are risky and dangerous to women and children. This idea is best explained as follows.

*The community of Borena in Wollo, Amhara Region relied entirely on springs in a series of limestone caves for drinking water supplies. To collect water, several young women climbed down about 10meters and formed a human chain from the bottom up to the top of the cave. Water is then passed to each woman in a small ground and received by the older women sitting at the top. This way of collecting water was extremely dangerous and the young frequently fall and injured themselves (Davis, 1993:23).*Such conditions may cause various physical and health hazards or injuries. Carrying the heavy load water, either on the head or back, from far distant locations or sources causes various health hazards among others they suffer deformities, headaches and exhaustions due to the heavy weight of carrying water. The unprotected springs or hand dug wells also often run dry during draught periods when ground water levels are lowered. This means that through many months of the year water has to be carried long distances invariably by the women and children of the household (Alemu, 2005).

2.4.3. Sustainability of Water Supply

To make water supply sustainable the system should be capable of collecting, transmitting, treating and distributing volumes of water adequate to meet the domestic, commercial and industrial demands of population. The drinking water delivered to the population should meet recognized standards of potability. Water should be supplied to the population with out interruption and at adequate pressure ideally for 365 days a year. The operating staff should be able to overcome the problems liable to affect the supply of water and the cost of achieving the above

conditions must be kept as low as possible (IRC, 1988; WHO 1994). According to World Bank (2003) the key elements to sustainable project benefits are (i) good management water resources (ii) demand responsive approach to selecting communities (iii) community involvement in selection of technology based upon an understanding of the associated investment and ongoing operating and maintenance costs (iv) effective systems for monitoring and evaluation (v) adequately trained staff at all levels (vi) autonomy of service providers (vii) performance agreements between service providers and government bodies responsible for provision services integration.

Generally sustainability of water supply facilities mainly depends on efficient management that is capable of planning the services in advance and it also depends on timely and regular maintenance and operation of the existing system of service. However in Ethiopia it has been found that operation and maintenance of water supply facilities are in a poor state of condition. Many people still do not have access to drinking and sanitation facilities. The people who are getting water supplies are often on intermittent basis and of inadequate quantity and quality. Unacceptably, large quantities of water are unaccounted in old distribution systems. Staff moral efficiency and productivity are low. Operating costs (for chemicals, energy, manpower defective equipment and spare parts) are high and sustainability of scheme is at stake (Water Aid 2005).

Many studies indicate that in rural communities water supplies have too often been installed with out adequate training and preparation of communities to manage and maintain the system. When systems break down communities often do not have the wherewithal to obtain spare parts and maintenance support, In towns with piped water supply systems are often operating well below capacity due to maintenance problem, rationing and services interruptions are frequent. Town water supply units tend to be understaffed and under paid. They are inadequately trained and lack the required resources to do their jobs. (World Bank 2003: Water Aid, 2005). More over the demand for safe and potable water is now increasing as a result of the rising standard of living and the population increase. According to data obtained from CSA (2007), the total population has increased from 65.3

million in 2001 to 77.1 million in 2007. And it is projected increase by 23 percent to 94.5 million in 2015 and to 117.6 million by 2025.

Urban population particularly was growing at an average of 4.27 percent per annum between 2001 and 2007. In 1994 the urban centers were only 534, while in 2006 the towns had grown to 927 (CSA 2006). This rapid growth will call for huge investment and planning for efficient equitable and sustainable water delivery systems in both the short and long run to ensure that the population receive adequate water supply. This challenge in turn will require well trained service managers, responsive urban and rural governance. Because of these challenges and benefits of safe drinking water, the government of Ethiopia's policy attention has been focused on this issue and also integrated the Millennium Development Goal (for environmental sustainability which aims to halve the proportion of people with out sustainable access to safe drinking water by 2015) with the countries water sustainable development program (ECA 2005).

The Ethiopia's Sustainable Development and Poverty Reduction Program (SDPRP) targets for the medium and long term are also consistent with the MDGs target. The base line for the water supply was 28 percent at 2000 and the goal is 64% at the end of 2015 (MoFED, 2004). Based on this program the target set for national water supply coverage for the year 2004 was 39.4 percent of the population but the actual remained to be 35.9 percent (MoWR, 2002). The second phase of the Ethiopian SDPRP has also been finalized and is called the Plan for Accelerated and Sustained Development to End Poverty (PASDEP) 2005-2015 (Water Aid 2005).

Over all the attention given to water sector in the second phase has been strengthened. However, with all these efforts, when we see the proportion of people with un sustainable safe drinking water of the world, sub- Saharan Africa and Ethiopia stand at 17 percent, 42 percent and 66 percent respectively with regard to achievement on this Goal (UN, 2005). These figures make an announcement not only identifying the gaps but also of the great challenges that the population and the government of Ethiopia are facing ahead. Ministry of water resources and water aid Ethiopia identified the most important constraints to sustainable water service.

Policy: Although government policy is now quite well developed there is a significant gap between policy and practice. Civil society has little influence in this area and political considerations still play a part in some resource allocation decisions.

Water resource scarcity: In some areas of the country where surface water is often unavailable and ground water is very deep, the cost of accessing water may be excessively high, and most organization limit the pre capita investment for water service.

Technology: the use of inappropriate designs and technologies in some cases sabotages communities' ability to sustain systems or to draw sufficient benefit from them, while in other cases the technologies that are technically feasible may have excessive investment or operational costs.

Poverty: The Ethiopian context is one of endemic and entrenched poverty in every single region of the country. Further more, especially in the rural areas, poverty engulfs whole communities. However experience show that despite their comparative poverty contribute of some kind i.e. in a labor or cash to construction and maintenance of schemes is important, to ensure owner ship, avoided dependency and ensure sustainability.

Low levels of sustainability of systems and facilities: Communities have difficulty sustaining their water and sanitations services for several reasons. These include problems related to project implementation.

Lack of operation and maintenance capacity: A central concern of the water supply and sanitation sector is the sustainability of operation and maintenance. The lack of the concerned government bodies to empower the beneficiary communities to take over project operation and maintenance is one of the challenge that confront civil society, weakness in community management systems themselves have also been identified Operation and maintenance also requires adequate supply of spare parts at close proximity to the users.

Lack of institutional incentives for urban water supply services: There is a lack of essential requirements like definition of institutional, technical and financial responsibility for operation and maintenance (Water Aid 2005:21-24).

2.5. Water policy framework in Ethiopia

The water resource management policy provides that water is to be recognized as an economic good, moving toward full cost recovery for urban schemes and recovery of operation and maintenance for rural schemes to ensure their sustainability. To effect implementation of these policies the government has established water resource development fund as a mechanism for financing for development of the water sector. The government over all policy on decentralization is reflected in the national water resource policy which states that ownership and management autonomy should be developed to the lowest possible local level. At the same time the government has developed autonomy for decisions on resource allocation to local governments by providing block grants to Weredas which can be used to improve water supply among other things at the discretion of the local governments. The policy calls for promoting involvement of all stake holders including the private sector, in the development and management of water supply and systems to improve sustainability and efficiency for service provision (MoWR, 1999: MoWR, 2001).

The water sector development program sets out the government's plans for the period 2002-2016. The sector among others included water supply and sewerage for each sub sectors. The existing situation is analyzed and through consultation with regional bureaus, targets and funding requirements have been developed. The program gives a detailed list of urban water and sewage projects and the projects requirement for meeting rural water coverage targets. The ministry has also produced an implementation manual for water supply including drinking water guidance (MoWR, 2002). Over all the water resource policy and strategy provides excellent guidance and are particularly useful in that they have an integrated water resource management approach. The program was impressive in that it brought together a diverse set of fund providers for the first phase. The fund would channel resources to water supply projects that demonstrate an ability to achieve full cost

recovery. This in turn is supposed to achieve high efficiency of use, equity of access and sustainability of the resource.

However the main problems have been that they are policy documents which are not translated into implemented programs. Further more the policy takes basin boundaries as the basic planning unit. However, political regional boundaries do not match these, resulting in problem of integration in planning design and implementation of project across basin localities.

The policy also states that water is both an economic and social good and stops there as such it provides no guidance beyond this statement. Where detail is provided that urban projects should cover capital, operation and maintenance costs, and the policy is still not exercised except the Addis Ababa Water Supply and Sanitation that tried to cover its costs. Further more, although the regions were involved in the initial drawing up the program, since then it seems that they have made their decisions on sector needs based on their own strategic planning process rather than in reference to the program. Generally there is a significant gap between policy and practice, civil society has little influence in this area and political considerations still play a part in some resource allocation decisions. Standards and implementation procedures are not sufficiently developed to harmonize approaches. Although the policy implies the emergency of autonomous service providers in large cities, urban water services in smaller towns , village water service committees in rural areas, still it remains as long term vision of the sector and efforts are needed to support the transition to these new arrangements (WSP,2004; Water Aid,2005).

2.6. Institutional Framework and organizational capacity for water supply

The Ministry of Water Resources (MoWR) is the authority with over all responsibility for water resources development and management. MoWR reorganize and strengthen the role of public sector institutions in the provision of water supply and sanitation services. The ministry is responsible to formulate and enforcement of policies, strategies Regulations and legislation as well as in

development and implementation of information management systems and capacity building programs. It is also responsible to develop and implement a comprehensive and well coordinated training plan to strengthen the technical capacities of national professionals.

The water supply and sanitation activities at regional level are the complete responsibility of the regional bureaus. The operation and maintenance of urban water supply facilities are mainly managed by the water supply services, while the rural facilities are operated and maintained by the communities with the assistance of the Wereda and Zonal offices of the water Bureaus. The local communities, being the primary stakeholders should be involved from the beginning for all water sanitation activities (MoWR, 2001) (MoWR, 2002).

Based on the institutional responsibilities many of water supply service responsibilities are now being shifted to the regional and local governments, consistent with the government's policy on decentralization. But regional and local governments have limited capacity to carry out these new responsibilities. Moreover there is wide disparity in capacity between the more developed regions (Amhara, Ormia, SNNP, Tigray, and Harari) and the emerging regions (Afar, Somali, Benshangual-Gumz and Gambella). The standard approaches to improving water supply in highlands simply do not work in the pastoralist regions. Emerging regions will likely need significant capacity building and continued support from the MoWR until they develop sufficient capacity to plan, prioritize, implement and monitor their own investment programs. Moreover, although the government advocates community involvement, there have been only limited involvements of stake holders in decision making in Ethiopia. Recently local governments in particular the Woredas are seeing it as their role to facilitate stake holder participation and to disseminate public information (World Bank 2004).

To date there has been only limited experience of the private sector on the informal sector in design and construction of water supply system, and almost none in operation and maintenance. Budget resources combined with donor and bilateral assistance have not been sufficient to significantly improve coverage and will be insufficient to meet MDG targets (World Bank, 2004). Greater focus is however

needed to ensure building and strengthening capacity of different entities. Especially critical are the legal basis and necessary powers of service providers. There is a need to strengthen capacity at regional and woreda levels where most of the responsibilities for organizing the provision of services have been devolved (WSP, 2004).

CHAPTER THREE

BACKGROUND OF THE STUDY AREA

3.1. The region: - Tigray regional state is located in northern Ethiopia and is bordered by Eritrea to the north, by the republic of Sudan in the west, the State of Afar Region in the east and the State of Amhara Region in the south. It extends from 12°15' to 14°57' N latitude and from 36°27' to 39°59' N longitude Tigray is known by the Yeha temple of the moon built around 500 BC, the Axumite Stella, the palace of Queen Sheba, the Rock hewn churches similar in design to those of Lalibela, the mosque of Ahmed Nejash, Debre Damo monastery, first written music and Ethiopian Alphabet (Geez).

The region is divided into five administrative zones, one especial zone, 35 woredas and 600 tabias\kebeles and 74 towns. The capital of the region is Mekelle located at a distance of 783kms from Addis Ababa. Its climate is hot and mild. The topography of the region ranges from 600-3000 meters above sea level. Tigray region is one of the drought prone areas. The rainfall pattern in the region is a unimodal type with rainy season from June to August. Repeated rain failure is a common feature for all the region's zones and wordeas, because of this recurrent draught was recorded in the past thirty years and this has brought food insecurity in the region. Although the region is grain deficit area the farmers own 2.7 million cattle, 73 thousand sheep, 209 thousand goats, 387 thousand asses, considerable number of horses, mules, and camels and significant number of poultry with different species.

According to the data from the central statistical agency of 2006, Tigray has an estimated total population of 4,449,000 consisting 2,193,000 men and 2,256,000 women. Out of the total population nearly 3.6 million (80.8 percent) are estimated to be rural inhabitants while 854 thousand of the population (19.2 percent) is living in 74 urban centers.

The age structure of the population is typical of developing countries and is characterized by much higher population at young age and low population at old

age, for example age group (0-15) constitute 44.8 percent while age group above 64 constitute only 4 percent. The state is predominately Tigryan accounted to 95 percent of the population, while 2.6 percent is Amhara, 0.7percent Irob (Saho) and 0.05 percent Kunama. The working language of the regional state is Tigrigna.

Concerning drinking water situation in the region, it is found at its lowest level. From the total house holds found in the region 422518 households (45.93 percent) use Rivers, lakes and unprotected wells and springs, while the rest (54.07percent) of households use water from protected well, spring, public tap and own tap. Although more than half of the population is using protected water, the access to get water is with difficulties.

In rural areas about 413,071 households (56.95 percent) walk a distance of 1 up to four kilometers, another 46252 households (6.38 percent) use to walk 4 to 9 kilometers and there are about 6788 households that are forced to walk 20 km and above to fetch water from even unprotected and unsafe water sources. Despite that the protected sources of water are better in urban centers, the situation of collecting water of towns show that about 10 percent of households walk a distance of 1to4km. There are also few households that used to walk 5 to 9 kms to bring water for their house consumption.

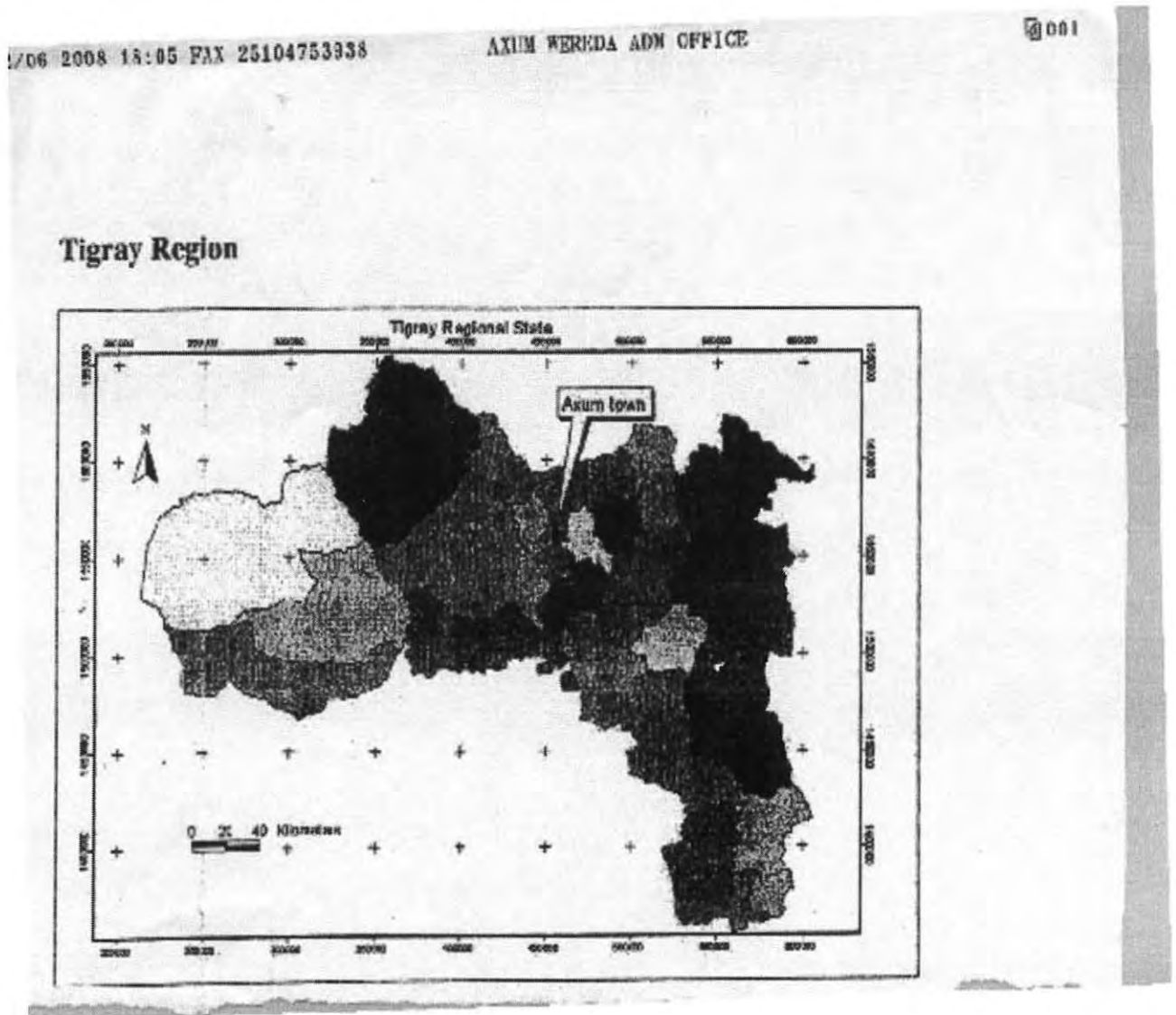
Axum town is one of the towns found in Tigray Regional State and is the seat of the Central Zone, the zone that constitutes 30.1 percent of population of the region (CSA, 2000).

3.2. Axum town

3.2.1. Background: - Axum is located 257 km north west of Mekelle town and about 1030km from Addis Ababa via the road Dessie-Mekelle-Adigrat towns. At the end of 2007 the people living in Axum town are estimated to be 49523. The town is an important historical center and tourist attraction. According to historical evidences, Axum is amongst the ancient and historical towns of Ethiopia. Since 4370 BC, Axum was the seat of Ethiopian kings. The civilization was particularly dynamic during the reign of Queen of Sheba due to foreign trade relations, administration, religion and other social institutions. From about 1000BC until the

birth of Christ about 98 kings and during Christian times that is from Abraha we Atsbaha until 922 AD, 58 kings reigned. During this long historical period Axum greatly contributed to human development. The stone stales, the rock tombs, the temples, the palaces, the stone thrones and sculptured stone monuments are some of the ancient evidences to its contribution (Girma, 1997).

(The location of Axum town in Tigray Regional State is shown below)



3.2.2. Physical characteristics

3.2.2.1. Physiography: -The town of Axum is situated on the ridge that forms the divide between two main drainage systems, the Mereb basin and Tekeze basin that drain generally to the north and south respectively. It is surrounded by mountains and hills to the north, east and west. The average elevation of the town is approximately 2100 meters above sea level (masl). The elevation varies from 1980 (masl) at the Gorges and 2640 (masl) at Bete Georges mountains to 2440 masl) at peaks of Durra. The terrain is mountainous with little or no vegetation cover.

Two valleys drain the town, Mihija creek drain the eastern part of the town and MaiAbekat creek drain the western part of the town. Since the land is de vegetated the soil has been washed away. As a consequence there are no longer springs. Retention of rainfall is practically none and limited to small areas with soil cover and the run off after rainfall creates flash floods.

3.2.2.2. Climate: - According to the Ethiopian temperature zoning Axum lies in Woynadega Zone. The town has a mean maximum daily temperature that ranges from 28^oc to 30^oc with a mean annual temperature of 19.4^oc and a mean minimum temperature from 13^oc to 15^oc and the yearly average maximum and minimum temperature is 27^oc and 11.70^oc respectively. The annual range of temperature is 3.4^oc. The warmest months are between December and February.

The mean annual rainfall of Axum town is estimated as 720 mm and the precipitation ranges from 400mm to 800 mm. Most rainfall occurs in July through September with a maximum peak in august. Practically there is no rainfall during the period of December through February. It was observed that July and august have with mean precipitation that amounts of 228 mm and 211 mm respectively which is more than 65 percent share of the mean annual precipitation.

3.2.3. Demographic trends: - according to the town administration's records and different documents the current population of the town is estimated to 49,523 and the average household size is between 5 and 6. Out of the total population male constitute 24,654 and females are 24,869. The age distribution shows that

ranges between (0-14), (15-24), (25-59), 60 and above, are 52 percent, 12 percent, 26 percent and 10 percent in order. The majority of the whole population accounting to 84 percent is Christians and 15 percent are Muslims while 1% belongs to other religions.

The average population growth rate is estimated to be 4.5 percent for the period 2005 to 2030. From 1995 up to 2000 the average growth was 5.05 percent and from 2001 to 2005 the growth rate declined and it was at 4.63 percent. This population growth (in addition to the natural growth) is primarily caused by migration from rural areas for better job opportunities and secondly it was increased with the opening of higher institutions that created opportunities to the population of the surrounding to continue their higher education program. This growth is assumed to continue at an exponential rate of 4.5 percent in the future. The growth rate indicates the pressure that will be entrusted to the town administration to deliver urban services adequately. The table below provides data of 12 years population projection of Axum town

Table 3.1 Axum Town forecasted population 2008-2020

Year	Population
2008	51752
2009	54081
2010	56615
2011	59058
2012	61716
2013	64493
2014	66874
2015	69884
2016	73028
2017	76315
2018	79749
2019	83338
2020	87088

Source: CSA (2006)

3.2.4. Socio economic trends

A detailed master plan of Axum town is prepared by urban development and planning department of the region. The town is expanding towards east where the airport is situated. The area is favorably located on a plain land which has good access to expand the town and access to road transport. According to the total

number of housing unit in the town record, it is about 8,500 from which 7,517 is used as a residential unit. The administrative kebles (tabias) are also presently restructured from five to four tabias named as Hawelti, Kindeya, Haielom and Miebale. The restructuring was coincided with the event of data collection of this research.

3.2.4.1. Education and health: - Education and health institutions in Axum town include elementary schools, secondary and preparatory schools and tertiary level institutions. These are big institutions like Axum University, Axum technical college, Axum Business College, Axum health training institute and other few private colleges like Shaba collage. There is one hospital which is also used as referral hospital for Adwa and Shire Endaselasié towns. It is well staffed with various health professionals ranging from mid-wife to surgeons and internists; however it has acute shortage of rooms, beds, medical equipments and necessary medicines and other utilities.

3.2.4.2. Economic activities: - As an administrative center of central zone ministries have branches and significant numbers of government offices are there. As an urban center the town has Restaurants, shops, bars, and other service providers. The numbers of private business establishments are estimated to be more than 1000. The major economic activities are agriculture, private business, weaving, gold and jewelry. Retailing sources of income in the town are hotel and tourism and salaries of government and private employees. There are no big industries in the town except some few flour factories and small scale manufacturing activities in the town including metal works, metal and wood works bricks and cement pipes, stone crushers, grain mills, manufacturing services and furniture production. However the town is an attraction for tourists as it has great treasures of ancient civilization. The tourist attraction includes the obelisks,

tombs of queen Shaba, tombs of king Kaleb king Bazen and St. Mary church of Axum etc. according to the information obtained from the administration, tourism is considered as an important factor for the future development of Axum town. Investment in this venture is expected to raise income through creation of employment opportunities especially for youth. On the other hand Axum has fewer prospects for agricultural development. The area has been degraded and subject to recurrent shortage of rainfall which in turn resulted in poor agricultural development. Although it is difficult to determine the income distribution of the town's population, it could be noted in general that the income gap is big as in other towns.

3.2.4.3. Power, transport and communication: - There is a 24 hour power supply to the town from the national grid system. The power supply is believed to supply the required energy for all requirements. Axum town has adequate land transport facilities to nearby towns as well as to Addis Ababa, Mekelle, Goander, Bahirdar and Humera towns. In addition regular air transport is provided by the Ethiopian airlines to and from Axum. There is a daily flight service from Axum to Addis Ababa with jet and Fokker planes and there are connections every other day to Mekelle, Gondar, Shire and Lalibela towns. The existing telecommunication system provides various services to the residents including cell phones internet networks and facilities and this can be considered as reliable service provision.

3.2.4.4. Water supply: - The current water supply of the town is mainly dependent on water drawn from boreholes. Some 15 percent of the population depends on Maishum water reservoir. The wells are characterized by low yielding and poor quality of water consequently the town does not have adequate water supply. According to information of the town water agency at present from all bore holes only 12 provide service for the water supply of the town while the rest are not operational. Seven of the bore holes are completely dried. Few of the bore holes that give water have poor water quality in terms of higher iron and manganese content and the others have low yield. The projected water demand of Axum town for the year 2007 was 3410 m³/day, while the actual daily supply is 2025m³/day. The actual average water sold per day is 1650 m³/ day. The water supply agency of the town has 3939 privately connected, out of which 3813 household clients,99

government clients, and 27 commercial clients. At present there is a growing demand of safe water and other infrastructural and economic services as households are increasing and the input for household consumption, construction small scale industries are also increasing. Besides all the number of tourists is increasing from time to time that in turn demands the hotels and restaurants to develop adequate services especially rooms with necessary sanitation facilities (TWRDB, 2006).

CHAPTER FOUR

FINDINGS AND DISCUSSION

4.1. Household Characteristics

Concerning demographic indicators, the features of sample households are considered representative of the community in the target town. The basic social characteristics that have bearing on the study issues include age, sex, family size, marital status, religion and educational level.

The sex distribution of the sample households in the study area shows that the majority are male-headed households. The data reveal that, out of the 300 sample household heads, 73.7 percent of the respondents were male while only 26.3 percent were female respondents.

The age of the respondents ranges from the minimum of 18 years to the maximum of 85 years old. The mean age of 294 respondents was almost 46 years.

With regard to marital status, the majority of the sample households are married. Out of the 300 respondents 62 percent are married while 8 percent are divorced and 19 percent are widowed. In general, 89.3 percent of the households included married couples at one time or another. The balance (10.3 percent) were found to be single

With reference to religion, 82.3 percent of sample households are Orthodox Christians, 13.3 percent are Muslim religion while just 0.3 percent identify with Catholicism.

Concerning household size, the highest frequency 18 percent occurred for responses of six members followed by households who had five members 17.3 percent. The data also indicates 4 percent have 9 to 13 family members and only 1 household was found unusual with 38 family members. The minimum household

size is 1 while the maximum household size was 38 and the mean household size was 5.12 persons (see the table below).

Table 4.1 Household family size

<i>House hold size</i>	<i>Frequency</i>	<i>Percent</i>
1-4	125	41.7
5-8	160	53.3
9-12	11	3.7
>=13	2	0.7
<i>None respondents</i>	2	0.7
Total	300	100

Source: Survey Data

The sample households have various occupations including daily laborers, private business owners and private sector employees and farmers. Out of the total 300 households, 30 percent are government employees; business owners constitute 17 percent; farmers cover 5 percent and 16.7 percent earn their income from private businesses. Daily laborers represented 11 percent while students and retired members held a share of 1.3 percent and 1 percent respectively.

With reference to their educational level, out of the 300 sample households 28.3 percent are illiterate, 16.7 percent of the household heads had completed elementary education, and 13.7 percent are high school dropouts while 11.3 percent are high school graduates. Those who have diplomas constitute 13.3 percent and 7.3 percent of the household heads graduated with first degree and above.

According to the survey results, monthly household income distribution ranges from birr 50 to birr 9000. The mean household income is 1207.32 birr per month. Taking the mean income as a point of departure, Households earning below this amount represented 53 percent of the sample while 32 percent earn above the average, showing the upward skewing resulting from a few relatively more well off individuals. The remaining, 15 percent of the households were not willing to reveal their income. As observed from the data, the household income gap is large, confirming the idea stated in the background namely economic activities.

Table 4.2 Household Income Distribution

Household income group	Frequency	Percent
50-500	82	27.3
501-1000	71	23.7
1001-1500	33	11.0
1501-2000	28	9.3
2001-2500	16	5.3
2501-3000	12	4.0
3001-3500	7	2.3
3501-9000	9	3.0
Non Responding	45	14.0

Source: Survey Data

House ownership of the sampled households' shows that majority of them have their own private house. As presented in table 4.3, out of the 300 surveyed households 64 percent are living in their own houses while only 2 percent are found to have lived-in their family houses.

Table 4.3 Home ownership status

Ownership characteristic	Frequency	Percent
Privately owned	192	64
Rented from government	5	1.7
Rented from private sector	86	28.7
Use family house	6	2.0
No response	11	3.7
Total	300	100

Source: Survey Data

Further more, other urban services such as washrooms, toilet facility, liquid waste disposal, and solid waste disposal can be considered as standard of living measures. With respect to toilet facilities, out of the 300 sampled households, 82 percent had their own toilet facilities out of these, 52.4 percent use flush type toilets while 46 percent use pit latrines, 9.3 percent use group pit latrine, and the remaining (8.7 percent) use open fields.

Concerning washrooms, 43.7 percent out of the surveyed households have their own facilities. However 54.3 percent of the house holds are without bathrooms among which 3.3 percent use springs to wash their bodies. Those who use rivers amount to 7.3 percent while 19.3 percent depend on hand dug wells.

The majority of the sampled households (53.7 percent) dispose liquid wastes in septic tanks with 18.3 percent of households possessing sewage facilities. However, a significant number of households (25 percent) use different methods including transporting liquid waste to nearby sewage cannels and disposing to waterways.

A high proportion (68.7 percent) of solid waste is disposed in containers made available by the town municipality. As shown in the above stated figure the residents in the town appear to have been provided with fairly good facilities to be

able to dispose their waste. However, 4.7 percent of the respondents still been using nearby open field to deposit their solid waste.

Among the respondents 19.3 percent have domestic animals in their compound and 27.9 percent of households contain gardens. Quite a high number of the households surveyed do not have water tankers, and it was only 26 percent of 300 HHs that possesses the tanker.

4.2. Existing Water Supply System

The concept of water supply as water provision involves the whole processes beginning from water source up to consumption. It is mainly concerned with the supply of water intended for human consumption and the water quality that must be met physically, chemically and bacteriologically. It also includes sources, distribution coverage access as well as its adequacy and sustainability.

4.2.1. Water Sources

Water sources as points of water collection include surface water, ground water and rainwater harvesting. The current predominant water source for Axum town is ground water. It is entirely dependent on water drawn from boreholes. German Water Engineering first designed the existing water supply system for Axum town in 1973. During that time, six wells were drilled on a southeastern drainage stream on the reaches of the Gebru Creek at a distance of 1-8 km from the town. Out of the six wells drilled, four were abandoned and it was only two wells that have so far been operational. Later, another additional well was drilled in 1992 in well field No 1 which is 2 to 5 km southwest of Axum town. However, the demand of the municipality was unmet by the wells drilled in 1992. Additional boreholes, funded by the Tigray Regional State, were drilled between 1998 and 2000; but these boreholes, except Ap 2 borehole, AP N-3 and APW-1 are non-functional due to poor water quality. Previously, w-8, w-9 and Hamed Gebez No. 4 were also abandoned. Another borehole by the name of Maishum was drilled near Maishum Pond. This well was designed to collect 8 liters per second for 16 hours per day, and amount that turned out to be unrealistic. When it was tasted it yields only 1.7 l/s with difficulty for less than an hour let alone pumping for 16 hours as suggested.



Water well in field No.1 near MaiAbekat (5 km south west of Axum town)

Functional boreholes, including the recently drilled boreholes of Areikto are well 1, well 2, well 4, well 5, and well 7 found at Gebru Greek; Apw2 and Apw5 found at field No 1 and My Edaga in the center of the town; Areikto 1 and Areikto 2 in Areikto near Axum University; and Debrebrhan well at Debrebrhan church locality. The researcher had also observed that a significant portion of the population use Maishum pond which is unprotected and unpurified water as their water source. Members of the focus group discussion elders' prominent and ordinary citizens of the town had all witnessed that, there are many people who entirely depend on those sources.

Table 4.4 Water supply sources

Type f source	Frequency	Percent
Piped water	208	69.3
Hand dug well	30	10.0
spring	5	1.3
River	4	1.3
Pipe and spring	17	5.7
pipe and river	13	4.3
rain water	21	7.0
Non Respondent	2	0.7
Total	300	100

Source: Survey Data

As can be observed from table No.4.5, 69.3 percent of the respondents get water from pipes drawn from ground water wells .Unfortunately 30 percent of the households still use unprotected sources including springs, rivers, traditional hand dug wells and rain water. The progress shown here is infract of a short period of time, of those households presently using piped water, nearly 40.7 percent were using hand dug wells and the remaining(24.7 percent) were victims of springs, rivers and unprotected ponds. Although the proportion of piped water stated in the above table covers the majority of the population, still most households in fact utilized a mixture of sources.



Households fetching water from Maishum water pond (unprotected source)

4.2.2. Production

Water production is the water ready for consumption and is conceived as free from organisms and concentrations of chemical substances that may be hazardous to health. Unfortunately, Axum water production from ground water has high levels of high salinity, iron and manganese.

According to the town water agency's report the average water volume produced form 2002-2006 was 1350m³ while the average daily water sales consumers amounted to 1100m³. The water loss was estimated to be 18.5 percent of the water produced. The total production of water in 2005 was as follows.

Table 4.5 water production of 2005

Boreholes	Yield L/s	Pumping hours	Yield/day In Liters
<i>Apw-2</i>	5	24	432000
<i>Apw-5</i>	0.7	24	60480
<i>w-4</i>	2.5	24	216000
<i>Ew-1</i>	3.33	24	287712
<i>Ew-5</i>	0.7	24	60480
<i>EW-2</i>	2.5	18	162000
<i>W-6</i>	1	24	864000
<i>MaiEdga</i>	1.2	7	30240

Source: Survey data (computed from AWSSS)

The actual production in 2005 was 1,356,912 L/day. This production includes the hospital well with a yield of 1.2 l/s during its five pumping hours. As water loss is expected to be 18.5 percent, the actual water sold per day was 1,105,883 liters (1106m³/day).



My Edaga water well in center of Axum town

The per capita consumption of 2005 was 24.58 liters considering the then population of 45,000 (this is calculated for domestic use only). When we consider public and industrial consumption, the per capita consumption would have been much lower. Because of the increasing demand of water, various pressures been created in the town. Additionally institutions were constructed like Axum University and seriously exacerbating the problem. In response additional wells were drilled and the capacity of production has increased. At present, 12 boreholes under the control of the water agency and one well belonging to the Axum hospital are functioning. The actual yield of the wells at present is as follows.

Table 4.6 Actual Yield of Boreholes in 2007

Boreholes	Current Yield	Pumping hours	Total Yield /Day
Apw2	5	24	432,000
Apw5	0.7	24	60,480
well 1	4	24	345,600
well 2	1.5	24	1,296,000
well 4	2.5	24	216,000
well 5	0.7	24	60,480
well 6	1	24	86,400
well 7	1	24	86,400
My Edaga	1	7	25,200
Arekeito 1	10	24	864,000
Arekeito 2	4.5	24	388,800
Debrebrahan	2	24	172,800
Total	33.9		2,867,760

Source: Survey data (computed from AWSSS)

The actual daily production capacity of Axum town, including the hospital well, is 2,887,960 liters per day (2889m³/day). Unfortunately, due to a shortage of reservoirs and overflow of water, the agency is producing only 23.9 liters/per second; that reduces the yield to 2,025,360 liters/day (2025m³/ day). The agency reported that one reservoir is being constructed and nearing completion at which time a pump will be installed. The researcher has observed the ongoing activities. Based on the facts established by the study of the Axum town's water supply and sanitation, the per capita demand for the year 2007 was 40.5 liters/day for domestic use only.

The current population of the town is estimated to be 49,523 and domestic demand amounts to 2006 m³/day. The study considers the public demand as 40 percent of the domestic demand. The same study suggested that the unaccounted

water could be taken as 20 percent of the sum of domestic and public demand. Hence, the water loss can be taken as 30 percent of the domestic demand and total demand of water (domestic plus public plus water loss) for Axum town is 3410m³/day. Therefore, the actual production covers only 59.4 percent of the demand. Taking into consideration that Axum town is a major tourist attraction and its future prospects for industrialization; it would be advisable to include 50 percent increase in domestic to industrial demand. In this case total demand increases to 4412 cubic meters while the supply is merely 45.9 percent of this amount. But with the expectation that 10 liters per second will be operational soon, the supply may be at its initial stage amount to 59.4 percent of the demand. Therefore additional supply of 1792 m³/day was needed to satisfy the water requirement of Axum town in 2007.

4.2.3. Distribution

Distribution is a process of transporting water through the supply system to the final users. The efficiency of distribution decreases water scarcity problems and narrows the gap between production and actual consumption. It is mainly concerned with the means (technology) by which the available water is provided to the people including house water connections, yard taps, distribution taps, protected springs and protected wells. In this case, Axum water supply distribution starts from the boreholes. The boreholes are equipped with electrical pumps and are connected to the national hydroelectric power grid. The water pumped from the boreholes is transported through pipes and collected in different reservoirs. Reservoirs are important when there is water production and water distribution interruption. The capacity of reservoirs depends on the total water demand of consumers. This is based on the number of population and households, the level of industrialization and relative activities of commercial establishments and public institutions. Reservoirs are vital to supply water to consumers continuously.

(Axum water resources, reservoirs, pump stations are shown in the following page)

The water supply of Axum town consists of five reservoirs situated in different areas around and at the center of the town. One additional reservoir is under construction. All of the reservoirs are constructed of concrete (mixture of gravel, sand and cement) in order to retain temperature and to avoid water loss through leakage. One of the reservoirs is located at MaiAbekat five kilometers south west of Axum town near the main road. This reservoir had a capacity of 150m³ and is equipped with a pump and chlorinates the water. This reservoir is a main station and feeds Saba Reservoir. Other reservoirs are Maikoho 1 and Maikoho2, Maiko1 reservoir is situated on the top of Maikeho Mountain that surrounds the town to the north. It has a capacity of 250m³ and presently it gets water from Hamedgebez. Maikoho 2 reservoir is found near Axum Hotel (the then Touring hotel) about 200 meters above the plain land of the hotel and half way to Maikoho Mountain. This reservoir had a capacity of 500m³ and is functional. Saba motor house reservoir is found around the Queen of Sheba historical place west of Axum town. The capacity of this reservoir is estimated to be 2000m³ and is the biggest reservoir found at Axum town. Another one is situated at Hammed Gebez, eight kilometers southeast of Axum town, and this has a capacity of 9m³. The total capacity of the reservoirs is only 2909m³, resulting in a capacity to meet 65 percent of daily demand. Currently, one reservoir is under construction around Sefeho near the referral hospital of Axum and about five kilometers south from the main road that crosses Ax um town. It is expected that this reservoir will upgrade the capacity to 3209m³.

Water from reservoirs is distributed through various distribution mechanisms including privately connected taps, yard taps and distribution taps. According to the Axum water supply agency, the numbers of house connections have reached 3939, out of which 3813 are domestic while 99 and 27 are government and commercial respectively, gauging the total domestic houses to number 7515.um town. It is expected that this reservoir will upgrade the capacity to 3209m³. In 2007, houses with private taps represented 50.7 percent of the total households. The remaining, 49.3 percent are using other alternatives like, sharing with neighbors, public standpipes, water vendors and from unprotected distribution ponds.



MaiAbekat water reservoir and main station of Axum water supply

Most of the consumers that do not have their own yard taps prefer public standpipes, as the price is relatively cheaper compared to other distribution mechanisms.

Axum town had 11 public standpipes, but only three are currently functional. When we consider the households that do not have access to house or yard tap connections, the public stand pipes are presently serving 3702 households. On average one household consists of 5.12 persons and one standpipe is serving 1723 persons. According to water supply and sanitation agency (WSSA) one public standpipe should serve on average for every 1000 public tap users. In this regard those who depend on public tap needs to have 19 standpipes. Currently since only three are functional, the office should maintain all un-functional and construct eight additional standpipes. Because of this inefficient distribution system, the population of the town is forced to use the unprotected Maishum pond and traditional hand dug wells. The survey previously indicated also that 30 percent of households entirely depend on unprotected sources. Of those (70 percent) who used piped water 51.7 percent received it through private house connections and

18.7 percent of the households use yard taps or shared from neighbors while 9.3 percent use public standpipes (See table below).

Table 4.7 Piped Water Distribution Systems

Type of Taps	Frequency	Percent
Private Tap	155	51.7
Yard Taps (Shared)	56	18.7
Public Stand Pipe	28	9.3
Water Vendor	41	13.7
No Response	20	6.7
Total	300	100

Source: Survey data

This evidence shows that the majority of the households use piped water distribution. However, it is not used for all household purposes. Therefore, only 25 percent of households were found that do not fetch water other than piped water. Nearly 75 percent of the households fetch water daily from other sources in order to satisfy their daily water requirement. Out of the total surveyed households almost 60 percent fetch water daily that ranges from one up to fifteen times for household purpose as well as for sale (see table below).

Table 4.8 Frequencies of fetching water other than pipe water

Frequency/day	No of household	Percent
1-3	156	52.0
4-6	57	19.0
7-10	9	3.0
=>11	1	0.3
Non Respondent	77	25.7
Total	300	100

Source: Survey data

The distance they cover also ranges from a minimum of 30 meters up to a maximum of 3000 meters and the mean distance being 1135 meters. The minimum time spend was also 15 minutes with a maximum time of 3 hours and 30 minutes and the average time required to fetch water is 44.82 minutes for a single round trip resulting time wastage and labor cost.

4.2.4. Coverage

Coverage implies the proportion of people served with adequate level of safe water. However, water supply in Axum town in terms of its adequacy was far beyond the required and totally inadequate. Moreover the water supplied was not safe and clean. Above all households were forced to fetch water from unprotected sources. Despite this all inefficiencies the distribution system covers the entire town, be it in the center or periphery. Looking at the figures obtained from respondents, all kebeles had the chance to get water form pipe tap systems.

Table 4.9 Coverage of Distribution Sources

Tabias	Piped	Hand dug well	Spring	River	Pipes & spring	Pipe and river	Rainwater	Total
1	25	1	1	0	1	4	4	33
2	35	6	0	0	3	4	2	50
3	48	3	4	4	7	4	14	90
4	29	8	0	0	3	0	0	37
5	65	12	0	0	3	1	0	81
Total	202	30	5	5	17	13	21	292

Source: Survey data

As revealed in the above table, piped water of all kebeles covers 68 percent of water supply: kebele one has a share of 10.8 percent and kebele two 17.6 percent kebele three 23.8 percent, kebele four 12.3 percent and kebele five has the highest share at 32.3 percent. Therefore, it was necessary to investigate the different distribution taps as to how they are concentrated or evenly distributed in each kebele. The

following survey result shows that all kebeles had the experience of using different water taps.

Table 4.10 Coverage of Different Taps

<i>Tabias</i>	<i>Private house connection</i>	<i>Yard tap with neighbors</i>	<i>Public stand pipe</i>	<i>Total</i>
1	14	5	8	27
2	26	9	8	43
3	39	22	3	64
4	26	2	4	32
5	47	17	4	68
Total	152	55	27	232

Source: Survey data

Tabia one constitutes 11.64 percent of private water tap connection, Tabia two 18.53 percent, Tabia three 27.58 percent, Tabia four 13.8 percent and Tabia five 29.3 percent. When we compare the figures with the previous proportion of piped water, Tabias one, two and three show slightly lower proportions of private tap connections than Tabias four and five. Fortunately, the total trend and rank of each kebele stood close to their original proportions. Even though the piped water coverage is not for all purposes as explained elsewhere in this study, the spatial coverage seems relatively equitable when compared to the total households of each Tabia/Kebele.

4.2.5. Access to Water Supply

Access to water supply is mainly concerned with the average distance of water point and the time expended in collecting the available water and it is influenced by factors such as quality, quantity and convenience. According to respondents accounting 72.3percent of respondents, the water in the town is not healthy and unsafe to drink. Nearly 58 percent of the respondents stated that the major problem of the water quality is salinity.

Table 4.11 specific water quality problems

Problem	Frequency	Percent
Salinity	174	58.0
Turbidity	25	8.3
Chemically unfit	16	5.3
It carries insects	1	3
Others	19	6.3
No response	65	21.7
Total	300	100

Source: Survey data

As indicated in the above table, 8.3 percent of the households witnessed turbidity, while 5.3 percent responded that the water is chemically unfit. Of the total respondents 6.3 percent confirmed that the water had all those mentioned problems. The most influential factor that affects water consumption is found to be water quality. The problem is not only with the unprotected sources but also with the piped water from boreholes. Specifically, high salinity is a commonly cited serious problem. According to the result of focus group discussions many people are suffering from water related diseases.

Table 4.12 Frequently Occurring Diseases

Type of disease	Frequency	Percent
Amoeba	29	9.7
Diarrhea	32	10.7
Cholera	5	1.7
Typhoid	6	2.0
Jardia	13	4.3
Other	23	7.7
Non respondent	192	64.0
Total	300	100

Source: Survey data

The household survey also shows the same result as focus group members, and significant number of the respondents accounting to 36 percent witnessed that their family members are victims of various diseases. Amoeba, diarrhea cholera, Typhoid and Jardia constitute 19.7 percent 1.7 percent, 2.0 percent.4.3 percent respectively. Some 7.7 Percent of the total respondents were victims of kidney problem, Arteries, Bilharzias, and vomiting. This saline water also attacks the hair and the skin of people and creates irritating disease like scabies. Many people in the town including the sample households perceived that piped water as the main source of water related disease than even the unprotected wells and springs. However, it could be difficult to conclude that the piped water is the major cause of water born diseases. Those who used piped water in Axum town also used non-piped water for different household activities. To make exact statements and remedy recommendations additional investigation is required.

Another factor that affects access to water supply is the place where the water for household consumption is found. The survey results show those who use

standpipes walk greater distances than the house connected tap or yard taps users. They also consume lower volumes of water than those using private and yard taps. The daily water consumption of the households who have private connections ranges from a minimum of three liters to a maximum of 900 liters. Therefore, the average daily consumption is 110.96 liters per day. The yard tap users also consume a minimum of three liters and maximum of 900, but the mean water consumption per day being 98.26 liters. This difference in daily consumption might be a result of the inconvenience of tap usage. The numbers of households who use taps in common ranges form 2 to 30 households. On average this accounts to 7.1 units of households.

The households using public standpipes have to travel an average distance of 896 meters. In line with this, the time expended ranges form 5 minutes to 2 hours with a mean time of 37.40 minutes. The average frequency of households fetching water is 3.2 times a day. This situation makes it clear the difficulties faced by households fetching water up to 13 times a day. The distance that households are forced to cover and the time they spend is greater than the reasonable access defined by the World Health Organization (WHO) and the Ethiopian Ministry of Water Resources. As a result of these inconveniencies the households that used to bring water from public standpoints consume lower volumes of water than those with the private or yard tap water connection.

The consumption of public tap users, according to the survey results, varies from the minimum of one liter to a maximum of 700 liters while the mean water consumption stands at 76.94 liters per day. The mean consumption of the public standpipe users is less by 21.32 and 32.02 liters per day from yard tap and private house users respectively. This is created by the inequitable distribution and very limited number of standpipes. The majority of the standpipes (72.3 percent) were not functional during the researcher's visit for the survey. This scarcity of standpipes had also created additional time wastage problems for standpipe users. For example, the average time they spend is 49.97 minutes with a spread of 2 minutes to 2 hours. This inconveniency in turn forces them to incur costs in terms of time, energy and labor. Generally, this shows how access to water supply service suppresses economic development by deploying many people to fetch water

that could have been devoted to other economic development activities. Another conclusion that can be drawn from this is that the physical distance of housing units that use the same source of water holds an inverse relationship with the water volume consumed by households.

Water access, can also be affected by socio-economic factors. As observed earlier, about 70 percent of the households witnessed use piped water. However, an attempt was made to discern if households use the same sources of water supply throughout the year. It is only a small proportion of the households surveyed (18 percent) use the same sources of water, while 74.4 percent of respondents use different sources of water. On the other hand, respondents were asked if they use the same source of water for their various household consumption purposes. Nearly 45.3 percent of the surveyed households responded that they use the same water source for different purposes. But 50 percent of the respondents use different water sources for different purposes according to their values assigned to different tasks. The overall trend is to use the combination of sources for different households' purposes. The table below shows how households use the different sources for different functions.

Table 4.13 Water Supply Sources and Purposes

Household purpose	Sources of water											
	PIPED		H and dug		Spring		River		Rain		Total	
	freq.	per	freq.	per	freq.	per	freq.	per	freq.	per	freq.	per
Drinking & cooking	156	84.8	23	12.5	3	1.6	1	0.5	1	0.5	184	100
Clothing Washing	95	35.8	105	39.6	7	2.6	26	9.8	32	12.1	265	100
Cleaning House	135	49.6	101	37.1	7	2.6	8	2.9	21	7.7	272	100
Bathing	153	59.1	71	23.7	6	2.0	8	2.7	21	7.0	259	100
Washing utensils	161	59	85	31.4	7	2.6	8	3.0	10	3.7	271	100
Watering animal	42	44.7	31	33.0	4	4.3	5	5.3	12	12.8	94	100
Irrigating garden	35	49.3	26	36.0	1	1.4	5	7.0	4	5.6	71	100
Cumulative	111	54.9	63	31.2	5	2	8.7	4.3	14.4	7.1	202.28	100

Source: Survey data

From the table above, we can observe that households are using various sources of water for different purposes. The table indicates that 84.4 percent of 184 respondents use pipe water for drinking and cooking. The proportional use of piped water for cleaning floors and clothes washing are 49.6 percent and 35.8 percent respectively. The hand dug wells cover a proportion of 12.5 percent for drinking and cooking. A small proportion of households use rivers (1.6 percent) and springs (0.5 percent) for drinking and cooking. The contribution of hand dug wells for the purpose of cleaning like clothes, floor and utensils is very significant constituting 39.6 percent 37.1 percent, and 31.4 percent respectively. The cumulative effect is

weighted according to their contribution: piped water serves for 54.9 percent of all household purposes, followed by hand dug wells covering 31.2 percent. The other sources such as rain water, rivers, springs and ponds cover nearly 14 percent of household activities. Piped water in terms of distribution and coverage was considered to be 70 percent. However the above data shows that accessibility and adequacy of water for all household purposes of the town remains only 54.9 percent. This situation also coincides with the study of World Bank that characterizes urban water supply as poor and that access or coverage does not mean access to adequate and safe water, which was indicated in the theoretical review. When we recall the capacity of boreholes of Axum town that are only capable of supplying 59.4 percent of the demand, with the above survey result of 54.9 percent contribution of piped water, it shows the accuracy of data given by the respondents during the survey work.

Why households use different sources of water for their consumption is an important question to be raised. In this regard many reasons could be identified including lack of consciousness of the differences between safe and unsafe water. The main reasons given by respondents were inadequacy of water and the frequent interruption (See table below).

Table 4.14 Reasons for using different sources

<i>Reasons</i>	<i>Frequency</i>	<i>Percent</i>
Frequent interruption	92	30.7
In adequacy of pipe water supply	72	24.0
Reduce pipe water charge	28	9.3
Reduce distance for fetching water	8	2.7
Others	49	16.3
No Response	51	17.0
Total	300	100

Source: Survey data

As indicated in the above table, the main reason for using different sources was the frequent interruption of piped water supply (30.7 percent), inadequacy of piped water supply (24 percent), reduction of charges (9.3 percent) and the need to reduce the distance of fetching water (2.7 percent). A mixture of reasons was cited by 16.3 percent of the respondents. The outcome of the survey shows that the town water supply is scarce and the individual households are relegated to use unprotected sources like hand dug wells, springs and rivers as alternatives. This calls for attention and action to improve the unprotected sources at hand to make them safer for drinking and cooking purposes.

The researcher's discussion with concerned officials and research suggests the following solutions:

- Chlorinating the Mai Shum dam that is highly used and at a reasonable distance.
- Developing the Mai Shum surrounding springs and protect them from animals and other external hazards.
- Educating the community using traditional hand dug wells and aids them in technical activities that could produce safer water.

Water access also varies because of seasons where production and consumption are affected. In dry seasons the recharging capacity of water wells decreases and in turn ground water table decrease, sometimes beyond the minimum level of water volume. On the other hand, consumption of water increases during dry season due to temperature with bathing and drinking frequencies increasing. The survey result showed that the minimum water consumed was registered in June (12.70m³) and July (13.46m³), the peak rainy season as indicated earlier. On the other hand, the maximum water was consumed from December to February as explained elsewhere in the background of the study area. The average water consumption of households in December, January and February was 20.38m³ 19.77m³ and 26.76m³ respectively. It must be noted here that the coverage and access of water supply reflects a much worse situation as a result of unreliability and unsustainability of safe water. Where there is coverage and access, the level of service may be poor provided that an average water supply is less than the MoWR recommended minimum of 20 liters per person per day.

4.2.6. Sustainability

If the water supply system is sustainable, the volume of water supplied must be adequate to meet the domestic, commercial and industrial demands of the population. The drinking water delivered to the population should meet recognized standard of potability. Water should also be supplied without interruption and at adequate pressure for 365 days a year. In this regard we have seen earlier that the water supplied for the whole town was only 54.9 percent of demand including the unsupplied 10 liters per second production at present and only 45 percent without this production. When the access result of individual households is seen the consumption of private tap, yard tap and public tap was 110.96 liters, 98.26 liters and 76.94 liters respectively. The per capita consumption for private connection, yard tap and public tap users is 21.66, 19.19 and 15.02 liters per day respectively. The average distance and time used by each household to fetch water was 896 meters and 37.40 minutes respectively. The individual household is forced to fetch water an average of 3.2 times a day. This trend shows that the inability to satisfy the projected demand of 40.5 liters per capita per day of Axum town; it is far beyond the WHO estimate of minimum water accessibility that should assure 20 liters per day from a source not more than 200 meters away except for private house connection.

Sustainability of water affected by water supply interruptions, as stated earlier, should meet the needs of the population without interruption and at adequate pressure throughout the year. However, in the study area, water supply interruption is very high. Almost 80 percent of sampled households confirmed that there is a frequent occurrence of interruption in water supply. Nearly 4.7 percent of the households have encountered no water interruption. As to seasons of interruption, almost all (95.6 percent) witnessed interruptions during the dry season. Interruptions during rainy season and during both seasons constitute 0.7 percent and 3.7 percent respectively. The dry season contributes towards the management inefficiency in addition to increased demand and reduced production. Other than mere interruption, the frequency and duration of interruption show how service of water supply is poor in the study area.

Table 4.15 Frequency of Water Interruption

Frequency of interruption	Numbers of Respondents	Percent
Daily once	29	11.9
Weekly once	77	31.6
Monthly once	20	8.2
Seasonal	117	48.0
Others	1	4.0
Total	244	100

Source: Survey data

Out of the 244 who confirmed water interruptions 48 percent claimed it to be seasonal, followed by 31.6 percent claiming weekly interruption, and 8.2 percent with monthly interruption. Apart from frequency of water interruption in the study area, the duration of water interruption at any one time also shows the severity of the problem. The maximum duration of water interruption is shown in the table below.

Table 4.16 Maximum Duration of Water Interruption

Duration	Number of Respondents	Percent
One day	51	17.0
One week	80	26.7
Two weeks	15	5.0
16-30 days	20	6.7
More than a month others	36	12.0
No Response	35	11.7
Others	63	21.0
Total	300	100.00

Source: Survey data

As shown in table 4.16, concerning the maximum duration of interruptions, 26.7 percent of households revealed there has been a week's continuous interruption, 17 percent experienced a one day interruption, and those who faced a range of two weeks to a month continuous interruption constitute 11.7 percent. 12 percent of households suffer for more than a month of continuous interruption, 11.7 percent of respondents specified different periods of interruption and the remaining, (21 percent) did not respond representing those without interruption.

At times of such interruption, households get water traveling long distances, from neighbors, public stand pipes and water vendors and face various problems such as incurring costs and wasting time as well as being exposed to unprotected sources.

Table 4.17 Sources of water at time of interruption.

Water source	Frequency	Percent
Own reservoir	17	5.7
From neighbors	43	14.3
From vendors	47	15.7
From stand pipes	11	3.7
Hand dug wells	88	29.3
River	16	5.3
spring	3	1.0
Other	19	6.3
Non respondent	56	18.7
Total	300	100

Source: Survey Data

As shown in the above table, a small proportion of households (5.7 percent) used their own reservoir at time of water interruption. Another 14.3 percent of respondents bought water from their neighbor while 47 households (15.7 percent) bought water from water vendors. A relatively high number of households (29.3 percent) used their own traditional hand dug wells during water interruption. Those use rivers and springs constitute 5.3 percent and 1 percent respectively. The average distance each household covers at time of water interruption is 1141.43 meters for one time round trip.

Water interruption is the main factor that highly affects safe water consumption. The survey result indicates, those households with interruptions consume water that varies from a minimum of 1 liter to a maximum of 500 liters. The average water use during water interruption in the sampled area is 56.70 liters. When this is compared to the average household consumption at normal periods of 110.95 liters, it only covers 51 percent of household purpose. The per capita water consumption during interruption is also reduced to 11.07 liters per capita per day. This figure is quite below what WHO recommends 20 liters per day. In addition to poor quality of water, the inability to get adequate safe water means poor health and low productivity of society. Low productivity in turn leads to low national income that results in poverty and low living standards.

The direct impact of water interruption on economic activities in the survey area was on construction works, on service providers like hotels, local laundries, cafes and other local drink providers. Water interruptions became causes to the increase water prices. At normal periods the price of a jerry can containing 20 liters of water from water vendors varies from 10 cents up to 80 cents, the average price being 24 cents. When interruption occurs, the price of the same container increased to 32 cents. The price varies from 10 cents up to birr 2 and 50 cents. There is a price increase of 8 cents for those who buy from neighbors and 27 cents for those who have own connections. The fluctuations are more aggravated during the dry season. The average price per jerry can increases to 46 cents, as the study area remains dry for more than half of the year. Consumers, except those with private taps, are also highly exposed to high prices. During such times specifically the poor tend to seek alternative unprotected sources. Public standpipe users face the brunt

of the problem. With this assumption priorities would have been given to public standpipes. However the interruption is more severe in terms of frequency and the duration of interruption.

Most of the public standpipes are also neglected by the management and have been abandoned in the last two years without maintenance and operation. When interruption occurs 59.3 percent of those public standpipe users in the study area use unprotected sources of water. This was because of the inability to resist the price increase. Those who buy water from water vendors represent 34.5 percent of the population. There are many causes for water interruption. Among others, water shortage in the source was the main cause that hinders the supply in the water service office. During the dry season the surrounding area is de-vegetated and the retaining capacity is very low. In turn, the ground water table decreases. It is important to add forest coverage to water catchments areas to help increase the recharging capacity of natural ground aquifers by regulating the flow of water. Moreover, it may be necessary to introduce education that creates awareness and participation in the conservation effort.

Management problems, especially maintenance and operation problems, contribute to water supply interruption. Those who confirmed the occurrence of interruption in the study area were asked if they are aware of the causes for interruption. Of the surveyed households 45 percent are aware of the causes. Furthermore they indicted various reasons for the interruption of water supply 14.5 percent responded power cuts, the majority (53.8%) confirmed water shortage in the sources. The other causes were lack of enough pressure and lack of proper maintenance. Generally, when unexpected interruption takes place, households encounter multi-dimensional problems like, fatigue in those who are responsible for fetching water.

The researcher observed that some of the problems identified as causes could be avoided within a short period of time: through strengthening the management capacity of the water agency, the assignment of proper responsibility, skilled manpower and necessary resources. On the other hand, serious problems, like shortage of water from the sources including its quality, may need an integrated



effort by different actors such as the government, the community and non-government organizations.

4.3. Major Problems and Challenges of Water Shortages and Scarcity

Water services of the town in general are far behind what they ought to be. The water supply activities, apart from private and yard tap coverage encountered different problems. The households under this study have numerous problems concerning their individual houses. The table below shows the possible problems of their water services and the number of households who ranked them as their major constraints, hindrances to their own water access and to raise their consumption level

Table.4.18 Major Problems of individual household services

possible problems of water service	Households who ranked as major problem	Percent
unexpected water interruption	74	24.7
Unexpected of repairing and maintenance	63	21.0
Owing for long time	34	11.3
Water quality	21	7.0
Daily water supply is very short	19	6.3
daily water supply time is inconvenient	19	6.3
Physical distance of water pint	12	4.0
High water charge	11	3.7

Source: Survey Data

The major water service problem was found to be water interruption. This problem was cited by 74 households, which constitutes 24.7 percent of total respondents. The problem of repairing and maintenance is indicated as the second major problem, which has a share of 21 percent of respondents. Queuing for a long time is mainly the problem of those public tap users. The public tap users waste on average of 50 minutes each water-fetching trip. Of the sampled households 7 percent ranked quality as their main problem. The remaining, who indicated that the daily water supply is short and daily water supply time is inconvenience are 6.3 percent each. It is believed that urban water services in developing countries including Ethiopia had numerous constraints. These include policy problem, scarcity of water resources, low-level technology, lack of appropriate tariff setting etc. In line with these, households were asked to view their ideas on the over all water supply services of the town. Almost 82.7 percent believed that the water supply in the town remains with various problems and challenges. The major problems and challenges of Axum town water supply include:

4.3.1. Inadequate Water

The water supply sources for Axum town are drawn from boreholes. The water found from these boreholes is inadequate to satisfy the minimum requirement of water, let alone to meet the demand for domestic and non-domestic requirements. The water produced from each borehole is less than what is expected and planned during drilling and installation. The ground water table is decreasing over time. Many boreholes are totally dried and abandoned from use. The surrounding land is de-vegetated. The soil had been washed away and the rainfall retention capacity is practically none. Rainwater percolation is greatly hampered due to de-vegetation and ground water recharge is very slow.

4.3.2. Water Loss

Water loss is becoming an additional problem to water shortage and scarcity. Old pipes are becoming causes of water leakage. The newly installed pipeline does not meet the standard. This is caused by selections and usage of inappropriate

technology. It was observed in the study area that water loss had further reduced the amount produced. A measure to reduce water loss and to enhance supply depends on choice of technology, capacity of skill and properly scheduled maintenance.

4.3.3. Poor Water Quality

The water quality of the boreholes with high production is poor and produces hard water types. Some boreholes are also with excess iron. The water found from all resources that is from the boreholes or the traditional wells is with high salinity hazard and low sodium hazard. In addition to water quality of boreholes about 15 percent of the population entirely depends on unprotected sources. This quality problem implies that the community is with poor health condition. There are many people in the town that are victims of different disease including typhoid, bilharzias, cholera, hook worm, arthritis, kidney infection, amoeba etc.

4.3.4. Inefficient and Inequitable Water Distribution

Even though the distribution system is more efficiently serving the house connections, the rate of private meter connection does not meet the demand of the population at present. The private meter connection covers only half of the household units. The remaining half depends on purchased water from other sources. The people with no private pipe connection are totally neglected and they have to travel long distances to get piped water. The public standpipes are very small in number in relation to the people being served. They are not evenly distributed and many people have a variety of difficulties related to water acquisitions. Moreover, out of the total 11 standpipes only three are functional. The abovementioned inefficiencies and unfair distributions of water supply, households are forced to look for unprotected water sources and reduce their consumption volume.

4.3.5. Water Interruption

Water interruption in the area is a major challenge to the management. It is one of the factors that limits smooth flow of water and causes water shortage and scarcity. Water interruption is not only creating inconvenience, but greatly affects

current duties and responsibilities are assigned according to the Tigray Regional State proclamation number 122/2007 and Rule Number 40/2007.

The office is responsible for all operation and maintenance and management of the Axum town water supply system and all supply structures. The Management Board is also established to ensure the efficiency of the water supply and to set appropriate guidelines to the water service; and to develop sustainable and effective collaboration of all stakeholders; and to legalize the forum of their participation.

One of the policy issues of water supply is to build technical, material, financial and human capacity of water supply office. In this regard all maintenance works are done within the capacity of the Axum water supply and sanitation service office. However, the office has a problem of skilled manpower in the field of water management. It also lacks technological equipments and budget.

At present, the office has 63 permanent workers, an inadequate amount and of insufficient skill levels. Moreover, there is a shortage of skilled workers. For example, the manager assigned recently is not trained in water management although he has his second degree in other fields and has improved activities of the service. Out of all permanent workers only 14 of them are professionals and semi-professionals. One of the major constraints to urban service providers is shortage of finance. The water supply policy and program of Ethiopia seeks to enhance urban water supply programs to fully cover costs through self-financing. But Axum water supply and sanitation service only tries to cover expenses of operation and maintenance.

Expenses and revenues of 2002/03 up to 2006/2007 are summarized in the following table.

Table.4.19 Axum Water Supply and Sanitation Service 2002/03-2006/07

Calendar year	Revenue	Expense
2002/03	1,010,608.20	620, 737.50
2003/04	1,024,609.46	634,868.56
2004/05	1,188,538.03	873,459.02
2005/06	1,748,087.28	1,38,9092.65
2006/07	1,395,076.00	1,822,700.20

Source: Axum Water Supply Service Office

As indicated from the table, the revenue side is inconsistent while expenses are steadily increasing. The revenue of 2006/2007 did not cover the operation and maintenance cost. Generally, the office is not self-sufficient and this hinders the quality of supervision, organization, operation and maintenance on time. The board members are from different government bureaus and from civic societies that represent the community. They include the mayor of the town, head of water resources, mines and energy bureau, head of health service, head of women's affairs, head of economic and finance, two representatives of clients from the community and head of the water supply and sanitation of the town. The mayor of the town is the chairperson of the board and the head of the water service serves as secretary. The main functions of the board among others include, proposing the water tariff to the city council, approve annual budget for water supply and sanitation office and conduct evaluations of its performances. The management board is accountable to the wereda people's representative assembly.

The management board is also responsible to meet with communities and to hold meetings to provide appropriate support to the water service office. In this regard respondents were asked if they know that the water board is established in the town and have ever been called for meeting. About 16.7 percent only know of its

establishment. Out of the 50 households who are aware of its establishment, 26 households (50.3 percent) participated in a meeting on the water issue in the previous calendar year. According to the drinking water policy, the management is responsible to equitably supply safe water to the community. Accordingly, the board is responsible to promote accountability of the management. Having this in mind the survey tried if the access to meter connection is distributed based on the request of respondents. Those who placed a request to get meter connection got responses from the office with various time gaps. The time elapsed varies from 7 days up to 4 years. The average time lapsed was 264 days. The outcome shows on one hand the weaknesses of the management to supply meter connection and on the other hand the unequal and unfair distribution.

The relationship between the water supply and sanitation service with the management board, the municipality, the wereda water resources, mining and energy bureau, regional water resources mining and energy bureau is almost none. The plans are not integrated. The office of the region never pays attention to supervision and did not make any visits to the Axum water supply and sanitation office. The office is isolated, as to its statement that says “floating ship in an ocean without direction”. Moreover the responsibility of the office is limited only to operation and maintenance. It is surprising that, the head responsible for all water services has no power to vote in management board meetings. The major problems observed in the government mandated agencies can be summarized as:

- Lack of capacity
- Limited responsibility
- Lack of institutional coordination
- Shortage of finance
- Low community participation

CHAPTER FIVE

CONCLUSIONS AND POLICY IMPLICATIONS

5.1. CONCLUSIONS

It is widely recognized that adequate supplies of fresh water are a corner stone for human activities at all scales from daily subsistence need to higher levels of economic production. However, Axum town has been experiencing the problem of getting adequate safe water since a long ago. The water supply problem is growing from time to time with its high population growth and the growth of its commercial activities.

Axum water supply is entirely dependent on water drawn from boreholes. The existing production of water from the well is inadequate to satisfy water demand for domestic and non domestic requirement of the town. The study reveals that the water produced only covers between 45 to 59.4 percent of the demand. Many boreholes including borehole APW 3 which have a capacity of 15 liters/second production are out of use because of quality problem. The production of some boreholes has declined and others are dried and abandoned. In addition to this the surrounding land is devegetated. The soil had been washed away and the retention capacity of soils is practically none. Those wells with good yield had poor water quality. The poor quality of water coupled with inadequacy had encouraged people to use unprotected sources. The out come of the survey shows that only 54.9 percent of household's activities are covered with piped water sources. This in turn has been a cause to many health hazard occurrences in the town. Many people are exposed to varieties of water born disease.

And this in turn has affected their ability to participate fully in income generating activities. The poor quality of water has encouraged people to harvest rain water, but this remains only in rainy season.

The water service reaches the residents of the town through different means. These are privately connected taps, yard taps (privately and shared), public stand pipes and water from vendors. The study shows quite significant numbers of respondents

get pipe water from public stand pipes and water vendors. But only three stand pipes are functional while the populations who depend on these pipes need 19 public standpipes which in turn affected their level of consumption. The public stand pipe users consume 15 l/c/d when compared to 19.19 liters and 21.66 l/c/d of those yard tap and private taps user's respectively. Although the coverage spatially for private tap and yard tap users looks equitable proportionally. The spatial distribution of public stand pipes is not evenly distributed. This UN equitable distribution coupled with its limited availability has created multi dimensional problems in terms of time wastage, labor and energy lost. Continuity of water supply is not taken guaranteed in the town. Water is provided for few hours every day or few days a week. More than half of the people receive water on intermittent bases. This frequent phenomenon of interruption together with water shortage itself had imposed poor and unreliable water supply service in the town. This inefficiency in turn has hampered water consumption. During this period the per capita water consumption is reduced to 11 liters per capita per day and this is far way from minimum requirement of 20 liters per capita per day let alone from the projected demand of 40.5 liters. The inefficiency of water supply has caused a price increase and those who are unable to purchase water from vendors come back to use their hand dug wells.

The study also identified cause problems to water shortage and scarcity among others, inadequate water from the source, water loss, poor water quality, inefficient and unfair water distributions, water interruption and population growth were the major ones. In addition studies indicate that an additional supply of water for future use could not be guaranteed only on development of ground water. The reason is that soils and rocks in the vicinity of Axum provide only poor conditions of surface water infiltration and storage capacity. More over the responsible office of water service in Axum town is not in a position to tackle the existing problems of water shortage and scarcity. Above all there is not a coordinated effort of all stakeholders to challenge the problems.

5.2. Policy implication

Getting safe water adequately is integrated in the process of poverty reduction and sustainable development programs. The policy of the government focuses to strengthen the issue of water supply. Water supply and sanitation policy is recognized as integral part of the water resource management policy. There is also a ministry of water resources and separate department that follows and implements water supply and sanitation services. The ministry of water resources recognizes that safe water contributes to poverty alleviation. Despite these many urban areas including Axum town lack adequate safe water. Even the available water is not distributed efficiently and equitably. Hence additional efforts should be made to alleviate the problems. Therefore, the following is suggested which is believed that can help in mitigation of problems and create enabling environment for supplying adequate safe water sustain ably.

1. To alleviate the problem of water shortage in the short run:-

1.1. Axum water supply service should try to rehabilitate the abandoned wells, especially those with relatively better production by installing treatment plants. The office had to have standard of minimum yield to be cost effective and shift expenses of low yield boreholes to high yields. Since, low yield boreholes has high operation cost per unit of production. Yields less than 1 litter / second are not recommended.

1.2. Maishum, traditional reservoir is one of the oldest water sources that supplies water to nearly 15 percent of the population. It needs protection against animal use and also introduces a treatment plant of low cost.

1.3. It is recognized that the water produced from boreholes including the traditional wells is hard water type and with excess of iron and manganese. Therefore, expenses to rehabilitate boreholes should include treatment plants to remove pathogenic organisms and toxic substances such as heavy metals, and removal or at least considerable reduction of suspended matter causing turbidity.

1.4. To improve the yield of boreholes, water shade management activities such as forestation, terracing and reserving natural conditions should be done at large scale. The Water as a basic need management board the administration and the community at large should be aware of its contribution.

2. The available water should be distributed equitably through out the town. This equitable distribution should include private, yard, and distribution points. It should consider the population density as well as relative need of water including its consumption pattern. The municipality and the water service office as a team should consider as a minimum requirement to maintain those un functional standpipes and to immediately construct 8 new once in different places, especially at places where private and yard tap is at scare.

3. Residents have shown experience of using rain water, but the contribution remains very small and limited to rainy season. This was because of tanker capacities and lack of awareness. Water harvesting schemes should also be introduced to towns like Axum with rain fall shortage areas. The town planners (Architectures) of Axum should include underground concrete tankers in planning house unites especially for those house units with relatively bigger area roofs. The town administration should take responsibility to introduce such conditions.

4. The water service office should be strengthening by training programs to the existing staff members and with additions of skilled man power. It needs also to strengthen with facilities and budgets so that it can cope with current responsibility of operation and maintenance and enable to reduce water losses. It will also enable the office to play a leading role in solving the shortage and scarcity of water. The laws and rules should be reconsidered to widen the responsibility of the water service office to accommodate its role in solving water shortage problems.

5. Adequate information of the town is necessary to be disseminated when necessary. Therefore, water service office and the town administration had to have

all information about the water services and resources and house hold characteristics of residents in general.

6. The board should create a coordinated effort among stake holders to promote the efficiency of the service. These enable the government, development agencies as well as communities to mobilize resources and to provide effective and efficient support to the water service office.

7. Additional supply of water for future use could not be guaranteed only on development of ground water. Hence, as long term solution, surface water potential should be explored .Potential sites should be identified and construction of reservoirs should follow immediately to satisfy the future demand of Axum town.

8. Water as basic human right should be accessible to all citizens safely and adequately. Thus planners should consider the trend of population growth, commercial and industrial expansion. The plans also should focus on developing potential sources to satisfy the demand instead of promoting restrictions of consumption.

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QUESTIONNAIRE 1

ADDIS ABABA UNIVERSITY

SCHOOLS OF GRADUATE STUDIES

REGIONAL AND LOCAL DEVELOPMENT STUDIES

Household Water Supply Services Survey Questionnaire

The main objective of this questionnaire is to collect information from the target area for the preparation of MA thesis in regional and local development Studies (RLDS). The data obtained from the questionnaire helps to study the current situation of water supply services for household consumption in Axum town. The study further attempts to recommend possible improvement areas for policy makers. Mean while, I would like to inform that the data obtained through this questionnaire is to be used only for academic purpose therefore I urge the respondents to be honest while discussing the issues. I thank you very much for your cooperation

Date _____

Name of Interviewer _____

Name of supervisor _____

Respondents code / Number] _____

Part I. Household characteristics

1. Address-----

Woreda _____

Kebele _____

House No _____

2. Religion

1. Christian _____

2. Muslim _____

3. Other specify _____

3. Age _____ in complete years

4. Marital status

1. Single 2. Married 3. Divorced 4. Widow

5. House hold size _____ number

6 sex, educational and employment status of household head

S1. No.	Sex		Educational status		Employment Status		
	M	f	Illiterate	Grade if literate	Unemployed	Employed	Student
1							

7. Type of occupations and monthly income of the employed family members

Sr.No.	Government	NGOS	Business		Agriculture	Daily Labor	other	Monthly Income (birr)
			Own	Employed				
1HH head								
2								

8. Does the household have any source of income other than those explained above?

1. Yes 2. No

9. If yes, Que.8, state the amount (monthly) in birr _____

10. House owner ship status

1. Private owned
 2. Rented from government
 3. Rented from private
 4. Other, specify _____
11. Do you have toilet facility?
1. Yes
 - 2.No
12. If yes, what type of toilet facility do you have?
1. Flush
 2. Pit latrine
 - 3.Others Specify _____
13. If No what system do you use?
1. Group dry pit latrine
 2. Open fields
 3. Other, specify _____
14. Where do you dispose your liquid waste?
1. Sewage system
 2. Septic tank
 - 3 other, specify _____
15. Where do you dispose your solid waste?
1. Container supplied by the municipality
 2. in the compound
 3. Near by road sides
 4. Near by open field
 5. Open field prepared for this purpose
 - 6.Other, specify _____
16. Do you have water tanker?
1. Yes
 - 2.No.
- 17 Do you have a bath room?
1. Yes
 2. No
18. If answer Que. 23 is no, where do the family members take bath?
1. From springs
 3. From hand- dug well

2. From rivers

4. Others, specify

19 Do you have domestic animals living in your compound?

1. Yes

2. No

20 Is there any garden in your compound?

1. Yes

2.No

Part II. WATER SUPPLY SOURCES

21 Which source of water supply do you use for household use?

1. Piped

5. Rain water

2. Hand-dug well

6. Piped and spring

3. Spring

7. Piped and river

4. River

22 What was your source of water before using pipe water?

1. Hand – dug well

4. Rain water

2. Spring

5. Rain water, spring and river

3. River

6. Others, Specify

23 Do you have your own water well?

1. Yes

2. No

24 What is the main reason for not using piped water?

1. High price of pipe water

2. There is no quality difference of water

3. The physical distance of stand pipes

4. High interruption of pipe water supply

5. Queuing for longtime to fresh water at public stand pipes

6. Easy access of non pipe water

7. Other's specify_____

25. If you fetch water in sources other than pipe water, what is the approximate round trip distance & time taken?

1. Distance _____ km and _____ meters

2. Time _____ Hours _____ minutes

26 How many times do you fetch water in sources other than pipe water? _____ Times/
Day

27 Is the source of water you are using at present healthy and potable?

1. Yes

2. No.

28 If Que.28 is no, what are the specific problems?

1. Salinity problem

4. It smells bad

2. Turbidity

5. It carries insects

3. Chemical unfit

6. Others, specify _____

29. Are there members of family who are victims of water related diseases?

1. Yes

2. No

30 If Que. 30 is yes, what are occurring frequently?

1. Amoeba 2. Diarrhea 3. Cholera 4. Typhoid 5. Jhardia 6. others _____

31 Do you use the same sources of water supply thorough out the year?

1. Yes

2. No

32 If Que.32 no, what type of water supply do you use during dry season?

1. Piped water, river

4. Hand dug well, river

2. Piped water, spring

5. Piped, spring, River, hand-dug-well

3. Piped water, hand dug-well

6. Other s, specify _____

33. If Que.32 no, what type of water supply do you use during rainy season

1. Pipe water, rain

4. Hand dug well, rain

2. Rain, river

5. Rain, river, pipe

3. Rain, spring

6. Others, specify _____

34 Do you use the same source of water supply for different purpose??

- 1. Yes
- 2. No

35. If Que. 35 is no, indicate your sources for cooking and drinking.

- 1. Piped water
- 2. Hand- dug well
- 3. Spring
- 4. River
- 5. Rain
- 6. Others, specify

36. What is your source of water other than drinking and cooking?

- 1. Cloth washing _____
- 2. Floor washing _____
- 3. Dish washing _____
- 4. Body Washing _____
- 5. Domestic animal watering _____
- 6. Garden watering _____
- 7. Others, specify _____

37 What is the main reason/s for using different sources of water for different purpose?

- 1. To reduce pipe water charge
- 2. Inadequacy of pipe water supply
- 3. Frequent interruptions of pipe water supply
- 4. To reduce distance for fetching water
- 5. Others, specify _____

Part III. WATER DISTRIBUTION, COVERAGE, SUSTAINABILITY

38 If you are using piped water what type of water tap do you use?

- 1. Private House connection
- 2. Yard tap (with neighbors)
- 3. Public stand pipes
- 4. Others, specify _____

39. If it is private House connection where is the location of your water tap?

- 1. Inside the house
- 2. In the compound
- 3. In both

40 If yard tap what are the number of households using one tap? _____ numbers of house holds/ tap.

41. If yard tap how much water does the household use on the average per day _____ liters per day

42. If yard tap what is the price of water for a Jerican? _____ Birr and _____ cents/Jerican

43 If public stand pipes mention the round trip distance and time taken from your home?

1. Distance _____ km _____ meter

2. Time _____ hour _____ minutes

44. What type of container do you use for fetching water at public stand pipes?

1. Bucket

3. Jerican

5. Others, specify _____

2. Pot

4. Barrel

45. How many times do you fetch water form the public stand pipes? _____ times/day

46. How much water does the household consume from the public stand pipes per day? _____ liters/day.

47. How much time do you spend in queuing at public stand pipes to get water? _____ Hours and _____ minutes

48 Had there been any water supply interruption from your private or yard tap connection during the last twelve months March 2007-Feb 2008)?

1. Yes

2.No

49 If yes in which season of the year

1. Dry season

2. Rainy seasons

50. On average basis indicate the frequency of this interruption

1. Daily Once

3. Monthly once

2. Weekly once

4. Seasonally

51 On average basis indicate the durations of interruption

1. For one day

4. For 16-30 days

2. For one week

5. For more than month

3. For -15 days

6. Others- specify

52 Where do you get water at the time of water supply interruption?

- 1. Own reservoir
- 2. Buying from neighbors
- 3. Buying from vendors
- 4. Buying from stand pipes
- 5. Hand dug – well
- 6. Rivers
- 7. Spring
- 8. Other specify_____

53 What is the approximate round trip distance & time taken to fetch water during tap water interruption? Time ___ hour and ___ minute

Distance_____ Km. and _____ meters

54. How much water does the house hold use per day on the average when private and yard tap water service interruption? _____ Liters

55. How much water the house holds use on the average when it's private or yard tap services is doing smoothly? _____ Liters

56. What is the price for a Jerican during water interruption sold by water vendors? _____ Birr and ___cent.

57 Would you please show your water consumption bill which you have covered form February, 2007 and January 2008

Months of the year	amount m3/liters	cost in Birr	Months of the year	Amount m3/literes	Cost in birr
February			August		
March			September		
April			October		
May			November		
June			December		
July			January		

Average month consumption

58. Had there been any interruption of water supply from the public stand pipes

- 1. Yes
- 2. No

59. If yes, on the average, how frequent was this interruption

- 1. Daily once
- 2. Weekly once
- 3. Monthly once
- 4. Seasonally

60 On the average, indicate the duration of interruption

- 1. For 1 to 5 days
- 2. For 8 to 15 days
- 3. for 16 to 30 days
- 4. For 1 to 2 months
- 5. For more than to 2 months

61. When there is an interruption in the stand pipes from where do you get water?

- 1. Buying from vendors
- 2. Buying from other public stand pipe
- 3. Rivers
- 4. Spring
- 5. Others specify _____

62. Do you know the causes for water service interruption?

- 1. Yes
- 2. No

63. If Que.63 is yes, what is the cause?

- 1. Power cut
- 2. Shortage of water at the source
- 3. Lack of enough pressure in distribution systems
- 4. Lack of maintenance
- 5. Others Specify _____

64. Is there any seasonal variation in price of water?

- 1. Yes
- 2. No

65 If Que.65 is yes what is the price per Jerican in rainy season and dry season?

- 1. Rainy ___ Birr and _____ cent / Jerican
- 2. Dry _____ birr and _____ cent / Jerican

66. What are the main problems faced by the household during pipe water interruption

- 1. Walking for long distance
- 4. Tiredness of Carrying Water

2. Taking long hours

5. Others Specify _____

3. High water cost

**IV. PROBLEMS OF EXISTING WATER SUPPLY AND CAPACITY OF
WATER SERVICE OFFICE**

67 Are there problems to your household water supply system?

1. Yes

2. No

68 If Question 66 is yes rank the problems in order of their importance

(Please give no.1 to the highest ranked problem and continue)

1. The daily water supply time is very short _____

2. The daily water supply time is in convenient _____

3. Physical distance of the water point _____

4. Queuing for long time to fetch water at public stand pipes _____

5. High water charge _____

6. UN expected water interruption _____

7. Problem of repairing and maintenance of water pipes _____

8. Water quality _____

9. Other specify _____

69. Have you ever placed a request for private meter?

1. Yes

2. No

70. If Que.70 is no, indicate the major reasons

1. High installation costs

3. Cheaper from stand pipes

2. Near by stand pipes

4. Others, specify _____

71. If Que.70 is yes, indicate the time elapsed since you place the request. ____ Year and ____ months.

72. State the reasons why you did not get private connection so far.

1. Shortage of meters

2. Shortage of pipes

- 3. Inefficient bureaucracy
- 4. Shortage of finance
- 5. I do not know
- 6. Others specify _____

73 Is water board established in the town?

- 1. Yes
- 2. No

74. If que.74 is yes, have they ever called you for discussion on water supply issue?

- 1. Yes
- 2. No

75. Have you ever seen pipe water interruption through out the whole town in the previous year? (March, 2007 to Feb.2008).

- 1. Yes
- 2. No

76. If Que. 76 is yes, for how many days?

- 1. For one day
- 2. For two days
- 3. For 3 days
- 4. For a week
- 5. More than a week
- 6. Other specify _____

77 If Que.76 is yes, how did the organization alleviate the problem?

- 1. Distributing water from the reservoir with water tanker
- 2. Distributing water with water tanker from neighboring towns
- 3. Using shift distribution
- 4. Others Specify _____

78. Which of the following do you think is better water supply provider?

- 1. Municipality
- 2. Water supply and sewage agency
- 3. The community
- 4. Private institution
- 5. Community and municipality

79. Give your own reasons for what you choose in Que. No. 79_____

80. Do you believe that there are major problems to your water supply Service?

1. Yes

2. NO.

81. If question 81 is yes, what are these major problems (list them in order of their importance)

82. What measures do you think should be taken to solve these major problems?_____

83. State your general feeling about the water supply service of the town to ensure safe, adequate and improved water for all house holds.

Questionnaire 2

Questions Forwarded to Axum Town Water Supply Service Agency.

1. When was the agency established?
2. What are the responsibilities and duties of the water supply agency?
 - a) _____
 - b) _____
3. Is the agency equipped with adequate?
 - 3.1 Man power _____
 - 3.2 Technological equipment _____
 - 3.3 Budget _____
4. Is the town or woreda water Board established? _____
5. Who are the members of the board (List the name of member persons or organizations?) _____
6. What are the main functions of the water board?

7. To whom is the water board responsible? _____
8. Does the board held meetings? _____
9. When the board does hold meetings? _____
 - 9.1 weekly
 - 9.2 every tow weeks
 - 9.3 monthly
 - 9.4 others specify
10. What are the main supports that the board provides to improve water supply in the town? _____

11. What are the types of water sources in the town?

12. What are the estimated volumes of each water supply source in liters per day?

13. Is there a serious problem of water shortage in the town? _____

14. What are other alternatives to solve water supply deficiency of the town? _____

15. Do you think the provision of the existing water supply system is Reliable?

If yes How? _____

If no why? _____

16. What is the volume (Liters) of water demanded per day in the town?

17. How many residents demand House water connection per year?

18. How many new lines of pipe water supply are connected to individual households per year? _____

19. How do you maintain when there happened a failure of operation?

a) With regard to capable technicians _____

b) With regard to spare parts _____

c) With regard to support from other agencies _____

20. Do you meet your strategic plan every year? _____

If no, Why _____

21. Do you think all expenses are covered by revenue generated from the water supply service?

If no what proportion of the expense is covered?

22. Who studies a water supply project?

23. What is the relationship of the water supply service agency with water boards, municipality and regional authorities?

24. Who is responsible to implement new water supply project in the town? _____

25. State your views, opinions, suggestions about the water supply service in the town _____

Questionnaire 3

Questions for discussion with Focus group and Water Board Members

1. How did you briefly explain the Axum town water supply?
2. Are you one of the members benefiting from the water supply? If no what sources do you use?
3. Do you get water from your supply tap through out the year with out any break or is it intermittent?
4. How frequent is the interruption you faced?
5. Are there other sources to solve your problem of water shortage during Interruption?
6. Have you ever heard about water born or water related diseases? Is it common in this town? What do you think are the major diseases occurring?
7. Do you know the differences between safe and unsafe water
How do you explain them? How do you relate water with economic development?
8. Do you believe the treated piped water is safer than the water collected from river and springs?
9. Who do you think are responsible for the water supply and who are the main actors/ stakeholders equally responsible? How do you see your relationship with these stakeholders?
10. Is there any difference in price between the piped and non piped water if so, how much do you pay for piped water per Jerican and for that of none piped water?
11. What do you think are the major problems of the existing water supply and the challenges that the community are facing
12. What measures should be taken to alleviate the existing water supply service of the town

13. Would you please state the general feeling you have including your vision about the service to fulfill safe, adequate, reliable and sustainable water supply for civilizes of the town.