FACTORS DETERMINING RESIDENTIAL WATER DEMAND IN NORTH WESTERN ETHIOPIA, THE CASE OF MERAWI

A Project Paper

Presented to the Faculty of the Graduate School

of Cornell University

in Partial Fulfillment of the Requirements for the Degree of

Master of Professional Studies

By

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January 2012

ABSTRACT

Growing populations and lack of available cost effective supply augmentation options make reliable estimates of residential water demand important for policy making. The interest of this thesis research was to assess factors affecting residential water demand among different households of the town of Merawi, North Western Ethiopia. Understanding variables that determine residential water demand and water source decisions helps the water supply utilities, local and regional governments and policy makers in their efforts of demand management and expanding service levels to the unserved sections of the society.

The factors that were hypothesized to affect household water demand and source choice decisions in the town were: HH expenditure, income generating activities (employment) of household members, demographic factors such as family size and age sex composition, housing ownership and characteristics of the HH head.

Data from 200 households were collected and analyzed using SPSS. Descriptive statistics was used for the descriptive results. Logistic regression and standard multiple regression analyses were also used to determine factors explaining households water source choice decisions and determinants of residential water demand (more specifically water used) of the surveyed HHs.

The analyses indicate that monthly expenditure, housing ownership and educational status of the household head were statistically significant predictors of households' decision to have private piped connection. Other factors were found not to have statistically significant contribution in predicting the water source decision of HHs.

Monthly expenditure (as a surrogate for income and HH welfare), primary source of water and employment of the head had a statistically significant positive impact on daily per capita water consumption, whereas age and sex of the household head were found to have negative effect on the quantity of water demanded.

The implications from the available data and estimated parameters shows that with the current population growth rate of 2.7% and a simple arithmetic growth rate of water demand, by 2020 the water demand of Merawi will grow by 45%. Similarly, it was also found that with the existing GDP growth rate, the current water demand for the town is expected to double by the year 2020.

BIOGRAPHICAL SKETCH

The self-made man, Dessalegn, was born, raised and attended early schooling in Merawi. He received diploma in History from Gondar College of Teachers education, worked as a teacher in Gojjam, joined Bahir Dar University and simultaneously received his B.A. degree in Economics and B.Ed degree in History.

Then, he joined the Master of Professional Studies program of Cornell University in the field of International Agriculture and Rural Development where he studied Integrated Watershed Management and Water supply.

Dessalegn wants to combine his knowledge of economics, history and watershed management with policy and practices in the water sector development of his country to improve the livelihoods of Ethiopians. He desires to pursue his education in areas of water resources management, environment and agricultural economics or hydro-politics.

Dedicated to

My brother Ayalew Chanie Dagnew: beloved, wise and strong.

ACKNOWLEDGEMENTS

God, the good shepherd, your love blessed me throughout my life. Let your name is praised and blessed forever.

Professor Tammo Steenhuis deserves my utmost thanks for his role as a program director, course instructor and my principal thesis advisor. His beloved personality, extensive research experience and kindness towards students have been an energizer in my stay at the program.

Dr. Amy Collick, Cornell coordinator of the MPS program at Bahir Dar University has been instrumental for the success of the program. The day to day advice and improvements you made on this paper is invaluable. Your dedication, hard work and deep concern for the program students is of great honor. You with Tammo did a lot to bring us in to this program, in spite of enormous challenges. Thank you so much Amy.

The continued help and advice that I received from Dr. Charles Nicholson, has been indispensable as my thesis could not be effective without his critical, insightful and constructive comments from the start of proposal preparation throughout the analysis to the report writing. His patience, commitment and punctuality makes Chuck my best favored professor I have ever had.

Professor Angella Neilan of Virginia Tech University who has taught me participatory watershed management was helpful in designing the first draft of my survey questionnaire.

Professor Dwight Bowman, Jan Liotta, Dr. Dawit Solomon, Dr. Daniel Fuka, and Dr. Zachary Easton; thank you all for your efforts to come, teach and share your knowledge and experiences. The help from faculty members of

BDU Siefu Admassu and Essayas Kaba (current Cornell PHD students) was also essential for the program.

Families especially Mum, Tesfu, Alex, Fasil, Zemu, Selamawit, and Tsedi; I am fond of all you. Mum is the queen of my heart. You have been the secret behind every stride I made. Your life has been and continues to be quintessential example to me. I do understand that you are one of the strongest and best mums in the planet.

Mr. Bazezew Gelaw, my former high school teacher and later boss, has been formative in my life. I usually sit and wonder how his ‘scrap of paper’- agreement letter- at the right place and right time changed my whole life. Your good work always shines in my life. Thank you very much indeed.

Friends whom I can’t manage mentioning all your names, I am indebted for what you did to me. Your moral encouragement, financial and material support has been a source of inspiration in my stay at the program. God bless you all; a friend in need is a friend indeed.

Respondents of heads and members of the surveyed households deserve sincere thanks for your willingness and cooperation for providing pertinent and reliable answers to the surveyors.

The fund for this research and the scholarship for me were granted from Cornell University and I wholeheartedly acknowledge the university.

TABLE OF CONTENTS

LIST OF FIGURES

Figure **Page**

LIST OF TABLES

ABBREVIATIONS

AICD	Africa Infrastructure Country Diagnostic
CSA	Central Statistical Agency
CVM	Contingent Valuation Method
DV	Dependent variable
ETB	Ethiopian Birr (currently $1=17.02)
FDRE	Federal Democratic Republic of Ethiopia
GDP	Gross Domestic Product
GNP	Gross National Product
HH	Household
HHH	Household Head
LPCD	Liters per capita per day
MDGs	Millennium Development Goals
MoFED	Ministry of Finance and Economic Development
OECD	Organization for Economic Cooperation and Development
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PCCE	Population and Census Commission of Ethiopia
RWU	Residential Water Use
SPSS	Statistical Package for Social Science
UAP	Universal Access Program (2005)
UN	United Nations
VIF	Variance Inflation Factor
WB	World Bank
WHO	World Health Organization of the United Nations
WSP	Water and Sanitation Program

CHAPTER ONE

1 INTRODUCTION

1.1 Background and Justification

According to the U.N.'s Millennium Development Report of 2005, the urban population was projected to exceed the rural population in developing regions of the world. Urban populations were growing at more than 3 percent per annum in 2007, three times faster than the populations of rural areas. More than one-third of city dwellers—almost 1 billion people—lived in slums, in conditions characterized by overcrowding, high levels of unemployment and underemployment, poor water, sanitation and health services, and widespread insecurity including violence against women. For the urban poor residing in such slums, lack of water supply and sanitation services represents a frightening challenge and multiple strategically targeted initiatives will be required to meet one of the targets of the MDGs of reducing by half the proportion of people without sustainable access to safe drinking water and basic sanitation (U.N., 2005).

Many countries in both the developed and developing world face significant problems in maintaining reliable water supplies, and this is expected to continue in future years due in part to the impacts of global climate change. Growing populations will further increase the demand for water, and there are limited cost-effective water supply augmentation options (Dharmaratna and Harris, 2010).

As a result, reliable estimates of residential water demand, water source choice decisions and the factors affecting it have become more important for policy making in the water supply sector.

On the one hand, there is a debate around whether policies aimed at reducing water consumption should use price or non-price methods. On the other hand, supply augmentation requires several years of planning and large amount of capital investments before the water is available. In light of these challenges, governments are opting for strategies that promote water conservation, particularly with residential consumers (ibid, 2010).

During 2000 to 2006, the proportion of the population with access to an improved drinking water source in developing regions rose from 74 percent to 84 percent. However, nearly 1 billion people were still using water from unimproved sources such as shallow wells, rivers, streams, ponds and drainage ditches-with their attendant health and safety risks. Large numbers of those who lack access to improved water supply infrastructure live in urban areas (World Bank, 2009).

According to Whittington (2009), there is a large group of households who live in the expanding slums of cities through the developing world earning incomes of less than 150 US dollars per month. Many of these households currently have neither private piped connections nor the income to obtain them. In densely crowded slums, there are often large benefits associated with improved sanitation. As improved sanitation is crucial for public health, improvements in water supply must compete with sanitation investments for the limited public subsidies. Here the challenge is to design tariffs and subsidies so that the basic needs of all households can be met.

In the meantime, the incomes of many of these households are also growing, and water planners should not design service options and tariffs that could trap these slum households with intermediate water and sanitation services. For this group of households, water planners need a

better understanding of both (a) the factors that determine households' water source choice decisions, and (b) the quantity of water used, so that piped services can be offered to the minority of households that can afford them, and other households can be served by cheaper, more basic levels of service.

Water use practices and willingness to pay for water services in urban areas depend highly on household income. To better serve the poor, it is therefore often suggested that rich households, who rely on private taps, cross-subsidize poor households because a significant number of these households is unwilling or unable to pay for water from a public tap. However, as experiences have shown, a fee on public taps is advisable because water for free leads to less sustainability, does not give any incentive for the distributor to expand networks, and might therefore be a bad policy for the poor overall (Minten et al., 2002).

For those organizations and individuals charged with service delivery in urban areas, a key challenge will be keeping up with the rapid pace of urban population growth. According to the WHO, in order to meet the recently-established MDG of 'halving the unserved population by 2015'; urban Africa will require an 80% increase in the numbers of people served. This objective would require, on average, about 6,000 to 8,000 new connections every day. Political commitment to these goals, backed by resources and action, is essential if utilities are to prevent a widening of the gap between 'served' and 'unserved' households (World Bank, 1995).

To expand water supply to urban areas, implementing proper demand management strategies is also required. Pertinent information on the residential water demand of households is necessary to properly assess

the factors that affect residential water demand. There are several factors that affect the demand for residential water of the households. Some of these factors are income of the households, price of water, household size, age and sex composition of the family members and weather variables like temperature and precipitation (Arbues et al., 2003).

Water demand analysis is aimed at providing pertinent information and knowledge for designing an effective water demand policy in general and a policy that seeks the efficient use of water in particular. In this manner, efficient use of water is defined as a pattern of use that maximizes the benefits arising from the extraction of a given water resource (Tietenberg, 1991; Pearce, 1999).

A water market would ensure efficient use by defining the optimum use and allocation among competitive users, if it is perfectly competitive. Indeed, in a market that operates under competitive conditions, the price of water would be determined by the interaction of demand and supply to reflect the actual marginal costs of water usage. This price would induce users to purchase the optimum quantity of water. In this context, no exogenous administrative intervention would be necessary, as the “invisible hand” would, by itself, ensure the efficient level of use induced by an equilibrium price that reflects water costs. Furthermore, the “invisible hand” would lead to defining the appropriate investments in order to attain the efficient use of water in the future. However, perfectly competitive market conditions for water do not and probably cannot exist in the majority of cases (Briscoe, 1997; Pearce, 1999).

In most cases, the supply of water is a monopoly whose characteristics closely resemble those of a “natural” monopoly. Specifically, the extremely

high infrastructure costs for transporting, treating and delivering water make difficult the operation of multiple water suppliers. The economic characteristics of the water sector, in combination with the fundamental social perception that water is a socially sensitive good related to human existence and health, led to a strict administrative framework for the operation of the water supply sector and hence of the water market (OECD, 1989).

In the real world, however, the fundamental decisions, like the determination of investments and prices, have been strongly influenced by administrative factors. In such a framework of direct or indirect government interventions, the estimation of demand parameters and characteristics acquires a special significance, since the decision-makers require sufficient knowledge and information. Furthermore, if the objective of water policy is to ensure socially-efficient use, demand analysis is a precondition of designing such a policy, because it defines the optimum socio-economic water use and the respective water price (Arbues et al., 2003; Martiner-Espineira et al., 2004).

In most developing countries, the quality of datasets on residential water consumption often poses a problem for demand estimation, especially as metering is not common. In contrast to developed countries, where almost all households obtain water from the utility through a piped network, the market for residential water demand in many developing countries shows much more variation. Households may have a connection to the piped network and use water exclusively from their private tap, but they may also combine piped water with water collected from wells, public taps, or purchase water from vendors; or they may have no connection and rely exclusively on non-piped water. Little is known about households' behavior

in developing countries regarding the factors driving their choices and in particular the substitution or complementary relationships between piped and non-piped water for piped households or the combination of non-piped water from different sources for non-piped households. As a result, policy decisions are often not very well informed; it is usually assumed that residential water demand in developing countries mirrors those of developed countries (Basania et al., 2008).

A more detailed knowledge of the structure of water demand of piped and non-piped households in developing countries can help to better understand consumer behavior. For planning purposes, it is essential to be able to predict the change in residential water demand for utility services that will result from any policy that would involve some change in tariffs and/or income for the household. Because under-pricing (charging a price below cost) of piped water supply occurs often and makes tariff increases necessary to ensure the long-term sustainability of the service provision, understanding how customers might react to such price increases is of importance. Secondly, many households cannot expect to be connected to the piped network in the near future. For these households one may want to make improvements in the non-piped water distribution system to improve access to safe water (Martínez-Espiñeira, 2007).

Although Ethiopia stands out among Sub-Saharan countries as having the largest average annual gain in piped-water coverage (adding almost 5 percent of its population each year) and has been most successful in curtailing reliance on surface water in urban areas, the planned target access rate of 51.5% for 2005/06 was not achieved (Performance fell short of the target by 4.2 percentage points). The overall water supply and sanitation services performance of the country show that the national

access to safe drinking water (both urban and rural) has increased from the previous 41.2% in 2003 to 47.3% in 2005/06 (MoFED, 2007; AICD, 2008).

Currently, a majority of the existing Ethiopian urban water supply and sanitation system designs (structures) are obsolete but the rate of rehabilitation and expansion has been lagging behind. Most urban water utilities do not fulfill the principle of cost recovery and self-reliance, which has undermined the interests of the external borrowers. On the other hand, contrary to its huge investment requirement of urban water supply, the flow of funds has remained very low (MoFED, 2007).

To cope with the huge capital requirements and increased demand for piped water, the FDRE is trying to move towards the commercialization of urban water supply so that urban water supply services would reflect the true cost of supplying the service. This will require the appropriate management of the demand for water services through pricing. However, the extent to which an increase in price actually results in reduced water consumption depends on the responsiveness of demand: the larger the price elasticity, the more effective environmental regulations such as water saving will be if designed to raise the costs of water for the consumer. From an ecological perspective, a drop in water consumption would be beneficial, especially in regions where water supply is scarce, but also in other regions because of the ensuing savings in energy and chemical use for processing and cleaning water, and the positive impact on a region's water balance (MoFED, 2007; Saleth and Dinar, 2000).

Towards the realizing of commercialization of urban water supply systems it is therefore necessary to have an in-depth understanding of the factors that affect residential water demand and water source choice decisions in

the country. However, it appears that limited information exists on water demand in many regions of Ethiopia; as no such study has been undertaken either for large cities of Ethiopia or for peri-urban towns, like Merawi, which is representative of characteristics shared by many peri-urban towns of the nation. Consumption patterns for residential water in the peri-urban towns of Ethiopia such as Merawi have changed over time due to the expansion of private tap connections, increases in population, expansion of house hold income generating activities that consumes water to a greater extent, improved sanitation practices and other shift variables variations. Hence, analyzing and forecasting such changes in the demand for residential water use and determinants of water source choice decisions over the short and long term is of interest to a wide variety of planning studies for the local, regional and federal water supply utilities.

The objective of this thesis research was to assess the factors that affect residential water demand and determinants of water source choices among the households of Merawi. Furthermore, it examined if significant differences exist among the different household socioeconomic and demographic characteristics of the town with respect to residential water use practices and source choice decisions. Understanding variables that affect households' water consumption decisions helps the water supply utilities, local and regional governments and policy makers in the water supply and development sector in their efforts of demand management and expanding service levels. This is relevant for the unserved but still water-using (demanding) households at both the national level and for peri-urban towns like Merawi where there is rising demand for piped water.

CHAPTER TWO

2 MATERIALS AND METHODS

2.1 The Study Area

Ethiopia is a unique state in the Horn of Africa having more than three thousand years of history, a center of ancient state formation and civilization. According to the national census of 2007, the total population of the country was estimated to be more than 80 million, which makes it the most populous country in Sub-Saharan Africa after Nigeria. The FDRE has a total area of 1,221,480 square kilometers. The economic mainstay of its people is agriculture, which employs 85% of the total population and accounts for half of the nation's GDP, 83.9% of exports, and 80% of total employment of the country (CIA, 2009).

Ethiopia is well endowed with fresh water resources, having twelve major lakes and twelve river basins, nine of them with perennial flows. It has an annual renewable fresh water resource amounts estimated at about 122 billion cubic meters per year, and a groundwater potential of about 2.69 BCM. The estimated per capita water resource potential for 2010 is 1,500 cubic meters per year, and the trend of this indicator is declining sharply due to population growth. As the per capita resource potential shrinks, it is close to the threshold level of World Bank for water scarcity of 1,400 m^3 / year per capita. Furthermore, the mountainous nature of the topography, the uneven spatial distribution of the surface water and increasing seasonal variability has limited the utilization of the fresh water resources and thus Ethiopia is projected to become a water-scarce country during the 21st century (UN-DESA, 2011).

Many parts of the country still suffer from water shortage. However, the available water resource provides the country the potential to develop between 3.5 and 4 million hectares of land under irrigated agriculture and it can support energy production of about 30,000 megawatts from hydropower development. Of the total water resources available to Ethiopia, only 9 percent remains in the country; the bulk flows downstream to neighboring countries, and is particularly important for Somalia, Kenya, Sudan and Egypt (UN, 2002; World Bank, 2006; UN-DESA, 2011).

The Amhara National Regional State, with its seat in Bahir Dar, is one of the constituent states of the FDRE. It has eleven administrative zones; one of which is west Gojjam where the study area is found.

Merawi, which is found 35 kilometers south of Bahir Dar, is a small district town. It recently received the status of City Administration and is the seat of “Mecha”, one of the Woredas in the West Gojjam Administrative Zone of the Amhara National Regional State. According to elderly people of the town, it was established in 1941 by Fitawrari Admassu Yimam, its first administrator and the brother of the then governor of Gojjam, Dejazmatch Abere Yimam.

Basic services such as piped water, electricity and health centers were established twenty years ago. The town received piped water services in 1983. Merawi has a total population of 18,246 out of which 7,752 are males and 10,494 are females. There are about 1,598 male headed and 960 female-headed households in the town (Tigist Endale; expert in the Office of Government Communication Affairs of the town, personal communication and unpublished document in the office).

The livelihoods of many residents of the town largely depend on the production and marketing of traditional alcoholic drinks called “Tella” and “Arekie”. It is observed that the traditional “Arekie” of Merawi is traded in different towns from Bahir Dar to the northern parts of Ethiopia like Gondar, Humera, and Metema, and is said to be smuggled in to the Sudan. The rest of its inhabitants participate in different sectors of the economy such as trade, agriculture, services and government employment.

According to sources from the city administration’s office of trade and industry, a majority of the town’s population is poor, with a monthly per-capita income of less than 100 US dollars. Access to basic services in the town such as drinking water, electricity, sanitation, as well as telecommunications, although limited, has improved over the last decade. For example, only 30 households had private connections when the town received piped water, but by 2002 this had increased to 230 connections. The residents of the town rely on private piped connections, public stand pipes, private water vendors and open sources such as from a river called ‘’Bered’’, a spring called “Burka” and hand dug wells in individual residences for the domestic (residential) water uses.

Currently there are more than 1,364 households in the town with private piped connections. There are 13 public stand pipes in the different parts of the town that supply water for those households that don’t have access to piped connections. The average monthly piped water consumption of the households with private connections from the water supply utility is estimated to be around 10,000 cubic meters (Tesfaye, an expert in the water supply office, personal communication).

According to Mr. Tesfaye, there are frequent service scrambles (a service scrambles means water is made unavailable to some households for a period of time) of piped water because the number of currently connected households is more than the expected capacity of the town's water source, due to a rapid increase in the number of its residents. During the days where there is a service scramble, the residents of the town supplement or complement water from a spring called "Burka" or from a turbid and impure water of "Bered" river. Some other households use water from shallow hand dug wells in their residences.

In order to alleviate this frequent problem of service scramble, the water supply office in collaboration with the Bureau of Water Resources Development of the Amhara Region and with funding from the World Bank's Urban Water Supply and Sanitation Project, is undertaking the expansion of the capacity of the city's water supply system and distribution lines.

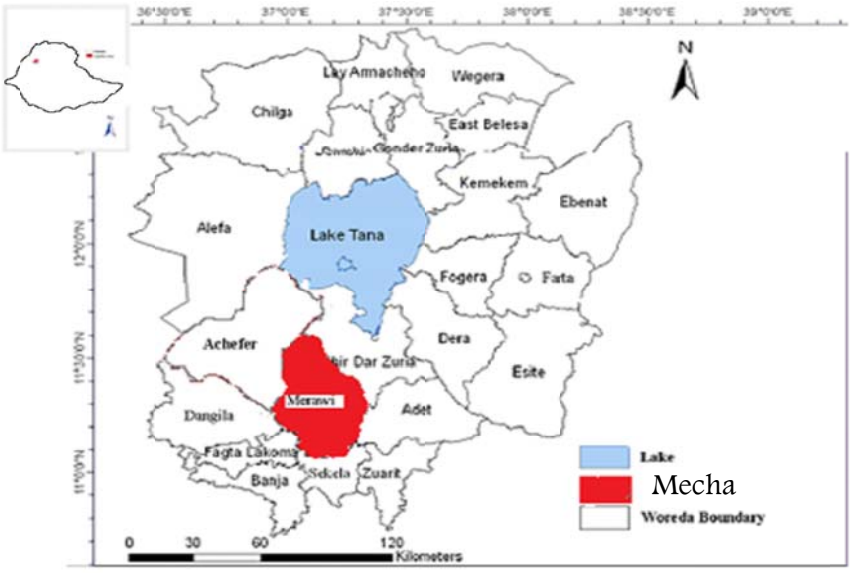

Figure 1: Map of Ethiopia, Some adjacent Woredas of Lake Tana, Mecha Woreda and Merawi (Source: adapted from Aschalew, 2009).

2.2 Methods of Data Collection

Estimation of water demand relationships requires a reliable measure of water consumption, in addition to information about factors that are hypothesized to influence it. One of the difficulties that analysts attempting to estimate household water demand functions in developing countries face is that water meter readings often are unreliable. Many piped water systems in developing countries do not provide 24-hour service due to frequent service scrambles or service breakdown. When water service in a piped distribution system is intermittent, the water pressure fluctuates. Meters typically will not provide accurate readings because air intermittently enters the pipes, such that the meter may register water as passing through when in fact it is only air. Also, because water prices are so low in many places, and because corruption is common (Davis 2003), water utilities have little incentive to keep meters in good working order; nor are they replaced on a timely basis. The end result is that in many cases no one (not the utility, not the household, and certainly not the researcher) really knows how much water a household is using.

Second, because information on the quantity of water used is often not available (even from a utility) or of poor quality if in case available, researchers have typically relied on cross-sectional surveys of households in the community under study.

It is possible to use cross-sectional data in regression models to determine associations between the source chosen (and the quantity of water used) and covariates such as household income, housing type, education levels of household members, and the collection costs of water. However, there are problems with cross-sectional data. One is that the effects of changes

in policy relevant variables such as tariffs or income on water consumption cannot be observed because of the short time interval of data collection. Nevertheless, most researchers seeking to estimate household water demand functions in developing countries have used data from cross-sectional household surveys.

Both primary and secondary sources of data were collected and used for this study. The primary sources of data were a detailed HH survey and focus group discussions. Before the survey was conducted, individual discussions were held with key informants such as experts in the water supply office of Merawi city administration and other knowledgeable experts, elderly people in the town and women who are responsible for collecting water. This discussion helped to make modifications to some of the survey questions and helped to further understand the situation of water supply in the town.

Surveying of the HHs was conducted in the months of November and December 2010 using a structured questionnaire. The survey questionnaire included an introductory section, briefly describing background and purpose of the survey. This was followed by questions on the demographic, socioeconomic profile of the household (HH), and socioeconomic profile of the respondents (often, household heads, HHH) and their spouses, questions on current water sources and supply conditions, consumption behaviors and the attitudes towards water services and quality are discussed.

The survey questions (Appendix A) were both open-ended and closed-ended types in three modules each with subsections.

Module one is about basic HH characteristics and has two sections: questions about HH demographics (section one); current HH members and their educational status and characteristics of the HH and the HHH (section two).

Module two collects information about the socio-economic status of the HH, such as sources of HH income-employments (section one), income from own business activity (section two), income apart from employment-transfers (section three) and housing ownership and quality (section four).

Module three is about water demand and uses patterns of the HH, i.e., for what purposes water is used in the household and has three sections. Section one is about sources of and access to water supply and questions related with sanitation, section two is about gender and residential water use and section three examines water conservation awareness and practices of the HHs.

The survey questionnaire was pre-tested with selected households before it was administered and some modifications and omissions of questions were made. The questionnaire was translated in to the local language, Amharic, and was administered in this format. The households in the survey differ in family size, income (socio-economic status), and range of water supply sources, religion, gender and educational status.

Data collection was undertaken by enumerators with university degrees to ensure that they properly understood the survey questions and the objectives of the study. This gave due emphasis to the quality of the survey data. Detailed theoretical training and practice followed by peer interviewing and field testing was given to the enumerators by the

researcher until they fully grasped the survey questions and inconsistencies across enumerators were minimized.

The HH survey used a two-stage sampling procedure. The first stage was to divide the city in to ten clusters so that most of the HHs in the city are represented in the sample. The ten clusters were formed by using the main roads of the city, which run from eastern to western end of the town, crossing the main asphalt road from Bahir Dar to Addis Ababa. These clusters are representative of the HHs of the city in terms of HH demography, religion, socio-economic status, access to piped water and non-piped water sources and other variability across HHs of the city. The second stage involved simple random selection of twenty households from each of the ten clusters, ten from eastern cluster of the main asphalt road and ten from west of the cluster from the asphalt road, which were previously called Keble 01 and 02 respectively (and including the recently established resident quarter commonly called “Gebriel Sefer”; surrounding the St. Gabriel church.

The mapping of the surveyed HHs was done by the researcher and the data collecting team. A total of 212 households were included in the sample. Data collection was conducted in the houses of the surveyed HHs.

At the end of the formal interviews, respondents were asked if they are willing to participate in the focus group discussions. Many respondents expressed their willingness to participate and did so.

Discussions were held by the researcher and the enumerators with different groups of HHH who responded the questionnaires. Informal interviews and talks were also held by the researcher with key informants such as elderly people, civil servants, community and religious leaders and

women of the town. These discussions that were held at the different stages of data collection helped in order to acquire pertinent information about the different qualitative factors that affect residential water demand in the city.

Secondary data were acquired from the literature of pertinent electronic and documentary sources such as the internet, unpublished materials, statistical abstracts and the regional, Zonal and Woreda offices of MoWRD.

2.3 Methods of Data Analysis

In almost all studies performed in industrialized countries, the residential water demand function is specified as a single equation linking tap water use (the dependent variable) to water price and a vector of demand shifters (HH socioeconomic characteristics, housing features, climatologic variables, etc.) to control for heterogeneity of preferences and other variables affecting water demand (Agthe and Billings, 1980).

However, some studies have estimated separate water demand models, one for piped water and the other one for non-piped water, as quality of the water from the piped network may differ from quality of water collected from a private well or from community sources such as rivers or springs (some of which are non-protected). Consistency of estimation techniques relies on the randomness of the samples considered.

For models that consider combined household demand for water from all sources, it is likely that the source influences water usage, due in part to differences in costs—either pecuniary or transactions. Thus, some studies have included water source as a variable influencing water demand. However, this implies that a control may be necessary to avoid simultaneity

bias if water demand also influences the water source used by the household. That is, a model of water demand including the source variable requires estimation of a model that explains the likelihood that HHs that have or do not have a connection to the piped network (Nauges and Van den Berg 2006).

In a developing country setting like Ethiopia, characterized by low-piped water service coverage and a high level of poverty, a key question in designing urban water policy is how the service should be designed to meet the needs of both the connected and the (usually poor) non-connected HHs.

The questionnaire was administered to heads of each of the surveyed HHs. The survey questions yielded information on a total of about 70 variables divided into a number of categories related to respondent characteristics such as educational status, age and religion of HH heads as well as general questions about the HH (e.g., number of family members, income sources and nature of household assets), primary and secondary source of water, system of payment for having private connection, cost of service, water availability and use, water quality, service breakdown or failures, satisfaction with water service and household health.

The data were entered using direct entry method in to the SPSS 16.0 software. Then screening and cleaning of the data was made using the enter and check method, differentiating between categorical and continuous variables. In order to check for errors, inspecting the frequencies of each of the variables for minimum, maximum, mean scores and valid and missing cases as well as case summaries and checking how many cases fell in to each of the legitimate categories and how many cases

have out of range values was done. When errors are found sorting cases or finding error values using find box of the SPSS data editor were used to find and correct out of range and unusual observations (Pallant, 2010).

Preliminary analysis was undertaken to identify potential outliers and unreasonable observations (e.g., HHs with a water bill higher than the expenditure/income declared). After cleaning the data and dealing with the problem of missing information, the sample size was reduced from 212 to 200 usable observations, specifically yielding 142 connected and 58 non-connected HHs.

2.3.1 Theoretical Model and Conceptual Framework of Variables

Based on review of the literature, economic theories of residential water demand and knowledge of the researcher about the study area, some selected household-specific factors are employed to assess their influence on households' water source choice and the quantity of water demanded.

Education of the heads of households (EDUC) variable is used to examine the impact of education (years of schooling) of the head on water source choice decision and water demand. The household heads' age (AGE) is defined in terms of years while family size (SIZE) is intended to examine the impact of family size on the variation of residential water use and source choice decision. Other dummy variables such as SEX (1=female heads, 0=otherwise) was introduced for a proxy of gender issues. The other dummies are OWNHOUSE (1=the house is owner occupied, 0=otherwise) for ownership of the house, the family is currently living. EMPLOYMENT is a binary variable indicating whether the household head was involved in Arekie or Tella production (1=Arekie/Tella Making, 0=otherwise). Households' monthly expenditure (EXPENDITURE) is used

as a surrogate for income, in part because data on the amounts of transfer income were not collected for this study. Thus, all the above variables are included in the econometric model.

The relationship between the dependent and independent variables can be represented by two different empirical models. The models specified are as follows:

- Probability of piped water = f (EDUC, AGE, SIZE, SEX, OWNHOUSE, EMPLOYMENT AND EXPENDITURE) and
- Quantity of residential Water consumption = f (EDUC, AGE, SIZE, SEX, OWNHOUSE, EMPLOYMENT, EXPENDITURE, SOURCE, AAGEFAM AND FEMALES).

This implies that the water demand equation is best understood as a "reduced-form" model that includes a relevant set of exogenous variables, and the estimated coefficients from this model will indicate elements of both water demand and the likelihood that the household will have piped water.

2.3.2 Specification of Statistical Model

Most of the models that are employed in residential water demand study both in the developed and developing countries are regression models. They typically use the form Q=f (P, Z) where P is the price variable and Z are factors or a range of shifters of demand such as income, household demographics and other characteristics such as weather variables, etc. (Arbues et al., 2000).

Different researchers have used different types of data sets in their analysis of residential water demand. For example using household survey data from 17 cities in Central America and Venezuela, Strand and Walker (2005)

derive price elasticities for piped (non-piped) households. Nauges and Strand (2006), using the same dataset, estimated water demand of non-piped households in four cities in El Salvador and Honduras, where the vast majority of the surveyed households relied on one water source only (private tap, public tap, public well, or truck). Basani et al. (2004), using cross-sectional household-level data from seven provincial Cambodian towns, estimated the price elasticity of water demand of connected households to lie in a range between *-0.4 and -0.5*. Rietveld et al. (2000), using data from Indonesia, found much higher price elasticity for connected households (Nauges and Van den Berg 2006).

The most common functional forms of the model specification are linear and logarithmic. There is no agreement about which functional form gives better results. Some researchers have selected the functional form by evaluating which model better fits their data.

In countries where complete data sets of residential water uses are unavailable from water supply offices, a cross-sectional data that are collected for a sample over individual HHs at a point in time can be used for estimating water demand of the households. In this case, there is a must to re-write the equation with an ‘i’ subscript on the variables and disturbance term to denote ‘individual’.

For this study two types of regression models are employed, namely the logistic regression for the water source choice decision and standard multiple regression models for the water demand analysis of the surveyed households.

The purpose of the Logistic regression procedure is to model the dependence of a nominal categorical response on a set of discrete and/or

continuous predictor variables. Observations with negative or missing frequency weights are discarded. Observations are aggregated by the definition of subpopulations. Subpopulations are defined by the cross-classifications of either the set of independent variables specified in the command or the set of independent variables specified in the SUBPOP subcommand.

Let ni be the marginal count of subpopulation i,

$$n_i = \sum_{j=1}^{J} n_{\mathrm{ij}} \qquad (1)$$

If there is no observation for the cell of $Y = j$ at subpopulation i, it is assumed that $\mathrm{nij} = 0$, provided that $\mathrm{ni} \neq 0$. A non-negative scalar $\delta \mathrm{c}\ \hat{\mathrm{I}}\ [0, 1)$ may be added to any zero cell (i.e., cell with n_{ij}=0) if its marginal count $\mathrm{ni}.$ is nonzero while the value of δ is zero by default.

The multinomial logistic regression analysis relies on several important assumptions. If $(n_{i1},\ldots, n_{ij})$ T is the JX1 is the vector of counts for the categories of Y at subpopulation, it is assumed that each $(n_{i1},\ldots, n_{ij})$ T is independently multinomial distributed with probability vector $(\pi_{i1},\ldots,\pi_{iJ})$ T of dimension JX1and fixed total ni. The multinomial logit regression fits a generalized logit model that can also be used to model the results of 1-1 matched case-control studies. In a Generalized Logit model, the probability π_{iJ} of response category J at subpopulation i is:

$$\Pi_{\mathrm{ij}} = \frac{\exp\left(\mathbf{x}'_{\mathrm{i}}\boldsymbol{\beta}_{\mathrm{j}}\right)\ 1+\Sigma \mathrm{J}-1\mathrm{k}=1\ \exp\left(\mathbf{x}'_{\mathrm{i}}\boldsymbol{\beta}\mathrm{k}\right)}{1+\sum_{k=1}^{J-1}\exp\left(X'_{J}\beta k\right)} \qquad (2)$$

Where, the last category J is assumed to be the reference category.

In terms of logit, the model can be expressed as

$$\mathrm{Log}\left(\frac{\pi_{\mathrm{ij}}}{\pi_{\mathrm{iJ}}}\right) = \mathrm{x}'_{\mathrm{i}}\beta_{\mathrm{j}} \qquad \mathrm{For\,j} = 1, \ldots, \mathrm{J}-1 \qquad (3)$$

When $J = 2$, this model is equivalent to the binary Logistic Regression model. Thus, the above model can be thought of as an extension of the binary Logistic regression model from binary response to polytomous nominal response.

The log-likelihood of the model is given by

$$1(\mathrm{B}) = \sum_{j=1}^{m} x \sum_{j=1}^{J} n_{ij} log(\pi_{ij}) \quad (4)$$

$$= \sum_{j=1}^{m} x \sum_{j=1}^{J} n_{ij} log\left(\frac{\exp(x'_{j\beta_j})}{1+\sum_{k=1}^{J-1}\exp(\mathrm{X'_j}\beta\,\mathrm{k})}\right) \quad (5)$$

A constant that is independent of parameters has been excluded here. The value of the constant is;

$$\mathrm{c} = \Sigma \mathrm{m_i} = 1\log\{\mathrm{n_i}!\,/\,(\mathrm{n_{i1}}!\ldots\mathrm{n_{iJ}}!)\} \quad (6)$$

The multinomial Logistic Regression model is useful for situations in which observations fall into multiple discrete categories. The objective is to determine which factors influence the observation being in a particular category (based on values of a set of predictor variables). This type of regression is a generalization of a logistic regression because the dependent variable is not restricted to two cases. The multinomial Logit model is fit for the full factorial model or user-specified model. Parameter estimation in the analysis is performed through an iterative maximum-likelihood algorithm.

The second model employed for the analysis of factors affecting daily per capita water consumption of the households is the standard multiple regression analysis. Standard multiple regression analysis estimates the coefficients of the linear equation involving multiple independent variables, that best predict the value of the dependent variable (Greene, 1990).

This linear regression model is given by the form:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \ldots + \beta_k X_{ki} + i \qquad (7)$$

Where Yi indicates the dependent or left-hand-side variable or regressant and is random; X_{ki} $(k = 1, \ldots K)$ is called independent or explanatory or right-hand-side variable or regressor, which can be fixed or random, and $\mathcal{E}_i$ is called error or disturbance term and is a random variable with mean 0. There are many reasons why $\mathcal{E}_i$ might exist. First, there are minor influences of y that are omitted from the regression model. Second, the underlying theoretical equation might have a different functional form than the one chosen for the regression. Third, some purely random variations are always there in addition to the measurement error on $Y \; or \; X$.

The β_s are called regression coefficients, they are unknown and usually assumed to have fixed values; β_0 is the intercept coefficient; β_k $(k = 1 \ldots K)$ are the slope coefficients. In the linear model, the meaning of β_1 is the impact of a one-unit increase in $X_1 \; on \; Y$, holding constant the other independent variables. The estimated regression line or sample regression function is written as:

$$\hat{Y}_i = \hat{\beta}_0 + \hat{\beta}_1 X_{1i} + \ldots + \hat{\beta}_k X_{ki} \qquad (8)$$

$\hat{Y}_i$ is called *'estimated'* or *fitted* value of Y_i; $\hat{\beta}_k$ $(k = 0 \ldots K)$ is called *estimated* regression coefficient. Define $e_i = Y_i - \hat{Y}_i$ and call e_i the residual. When $K = 1$, the regression model is simple linear regression model. When $K > 1$, the regression model is multiple linear regression model.

2.3.2.1 ***Assumptions and Issues of Multiple Regression Analysis***

Although determination of an adequate sample size can be a controversial for statisticians and researchers, Pallant (2010), suggests that a sample size of greater than 150 will address analyses problems arising from a too small sample. With small samples, it is possible to obtain a result that does not generalize to other samples, in which case they have limited scientific value.

Multicollinearity exists when one or more of the independent variables are highly correlated (often indicated by a simple correlation, r, greater than 0.9). Singularity occurs when one independent variable is a linear combination of other independent variables. Multicollinearity inflates the estimated variance for the parameter estimates, and therefore makes it difficult to determine estimated values (and to achieve statistically significant relationships). Singularity makes it mathematically impossible to perform the analysis.

Checking for extreme values should be part of the initial data screening process done for both dependent and independent variables that will be used in the analysis. Then, outliers can either be deleted from the data set or, alternatively, given a score for that variable that is high but not too different from the remaining cluster of scores.

2.3.2.2 Independent Variables

The impacts of variables used in the empirical analysis of this study were reviewed based on previous studies to assess the expected signs. Independent variables will be classified into two groups: demographic - age, gender and family composition; and other socio-economic attributes -

monthly expenditure for water, HH income, housing ownership and primary employment of the spouse of the head or female heads.

2.3.3 Variables in the Model, Descriptions and Expected Signs

2.3.3.1 Primary Source of Water Supply

The key dependent variable is the primary sources of water for the HHs. Households in the town have access to a variety of water sources (both protected and unprotected) that are either purchased or free. One objective of this research is to determine the factors that affect HHs' decision to choose private piped connections as their primary source of water.

2.3.3.2 Water Consumption

The other dependent variable, per capita daily water consumption, was obtained by asking the total daily water consumption of the HH for different uses and dividing it by the number of people currently living in the family. For HHs with private piped water connections, it would be possible to calculate an approximate monthly expenditure on water using the information in water bills. But as there are many HHs who do not have private connections, and due to the fact that there is frequent service scrambles, which forces HHs to use other sources of water (from wells, rivers or streams), the information provided by the bills may not reliably represent the actual quantity of water used by HHs. However, both HHs who have and do not have private connections are able to estimate their average daily water uses as both of the HHs use bucket, clay jars (clay called '*Ensira*' / '*Madiga*') or plastic jars '*Jerikan*' to take water in to the house (because HHs who have private connections do not have in-house connection and thus need to take water daily in to the house for use.

2.3.3.3 Household-Level Economic Variables

The development literature supports the notion that, when dealing with HH surveys in developing countries, estimated HH expenditure is better as an indicator of HH welfare than income. The fact that HHs are likely to purchase and consume a narrow range of goods and services makes total expenditure less volatile than income. Furthermore, HHs surveyed are more likely to understate their incomes than overstate their expenditures (Deaton, 1997).

In HH-level studies, a measure of wealth often is included in addition to income or expenditure; one typical is the total value of the property that the HH owns (Arbués et al., 2000). This variable can be introduced in addition to income, acting as an indicator for wealth and HH preferences for home life-style. The total value of the property that the HH owns is normally too correlated with income and other variables to be useful in practice (Lyman, 1992; Barkatullah, 1996). As a result, several previous studies estimate different demand functions for different income levels. In this study the total monthly income of the HHs (from employment or own business and from gifts and remittances) is used.

Expenditure of the HH is expected to have positive effect on both the decision of HHs to use private pipe (and hence positive expected sign) as expenditure is a good indicator of income and livelihood. Thus, better-off HHs are likely to afford and willing to pay for the connection as well as the service charges of having piped water service. However, there might be a negative relationship between HH expenditure and daily per capita water consumption. This might be because in the town better off households do not participate in the making and selling of Tella and Arekie, which is

expected to reduce daily per capita water consumption. Hence, expenditure is expected to have a negative sign for the case of daily per capita water consumption in the case of Merawi.

2.3.3.3.1 Household Demographics and Socio Economic Characteristics

Household surveys often gather a large amount of information on HH socioeconomic and demographic characteristics such as size and composition (by sex and age) of the HH, education level and occupation of each member and earnings, as well as data on HH living conditions (structural materials, conditions of access to various services such as electricity, schooling, doctors, etc.).

Studies about the effect of HH demographics on water use per HH revealed that HH size has a positive effect on water use. However, Arbués et al. (2000) found that water use is less than proportionate to the increase in HH size or population because of economies of scale in discretionary and nondiscretionary water usage, including cooking, cleaning, car washing and gardening as there is an optimum household size beyond which these economies of scale diminishes.

Families with children could be expected to use more water as children require frequent sanitations, outdoor uses by children and teenagers might be higher, youngsters might use water less carefully, have more showers and demand more frequent laundering, while retired people might have saving and disciplined water use behaviors (Nauges and Thomas, 2000). But, Lyman (1992) found that retired people tend to spend more time at home and do more gardening, which is associated with more water use.

Sex of the HHH is expected to have a positive effect (thus an expected positive sign) on both the decision to have private piped connections and the daily per capita water consumption because it is expected that female-headed HHs are expected to make Arekie and Tella and hence need to have piped connection as their means of employment require more water and hence a higher daily per capita water consumption.

Family size and number of female members in the family are also expected to be positively related with both dependent variables because daily per capita discretionary water use for basic needs such as drinking, washing clothes and dishes, baths etc., will increase and more females would increase the likelihood of the HH to participate in making Tella and Arekie; while it is difficult to attribute the decision of households to have private piped connections or not to family size.

2.3.3.3.2 Housing and Other Related Characteristics

Factors like the size of the house and access to appliances such as showers, bathrooms, washing machines, flush toilets, availability of garden or lawn in the residence etc. also influence water demand (Renzetti, 2002). For this study, housing ownership and type of housing, type of toilet used and access to shower was collected. It is expected that housing ownership is likely to increase HHs' decision to have private piped connections as the primary source of water and is likely to increase the daily per capita water consumption. Thus, for both of the water source choice model and water demand estimation model, housing ownership is expected to have positive sign.

2.3.3.3.3 Water Price

In this study, there was a difficulty of including price in the analysis, for a variety of reasons. First, when data are obtained from one-time HH surveys conducted in a single city or village, there is usually little or no cross-sectional variation in policy-relevant variables such as the tariff, connection costs and levels of service. Second, HHs in the town obtain water from more than one source, which includes water obtained free of charge but may be far from home and its collection involves time to go to the source, to wait at the source (queuing), and time to haul the water back home. One may choose to convert collection time into collection costs using an assumed value of time. However, the value of time may differ widely across households depending on who is responsible for collecting water, and even within a specific household over time of a day or day of a week which makes another problem in including price variable. Third, the rate at which users pay for water bought from public stand pipes, water vendors or other sources is different from the rate of private connection or from free sources that have opportunity costs. This would create inconsistency if similar price is included in the analysis. Fourth, since there are frequent service scrambles and there are supplementing and complementing of water from other sources, it is difficult to rely on what HHs report their monthly water expenditure from a specific source used. Thus, the water price is excluded from the econometric analyses, which makes analysis of the effect of price impossible, despite its importance for future planning and policy decisions.

However, water demand in most cases is perceived as inelastic in its nature as water has no perfect substitutes for its basic uses. In addition, consumers do exhibit a low level of perception of the rate structure since water bills typically represent a small proportion of income (Chicoine and

Ramamurthy, 1986; Arbués et al., 2000). This is especially evident in developing countries like Ethiopia where significant portions of the HHHs, who make decisions of expenditure are in a low level of education to understand or be willing to know the rate structures. However, from review of literatures made, this paper acknowledges that prices can play a crucial role in demand management as long as the elasticities are different from zero.

Table 1: Variables, their description, measurement, expected sign and Descriptive statistics of the results

Variable	Description and measurement	Exp. Sign	Obs
DEPENDENT VARIABLES			
WATER SOURCE	Primary water source (1=private pipe and 0 otherwise)		200
DPCWATCON	Quantity of Water consumed (Liters per capita per day)		200
INDEPENDENT VARIABLES			
SEX	Sex of household head, binary (1= females, 0 otherwise)	+	200
EDUC	Education of the head, years	+	200
AGE	Age of the HHH , years	-	200
SIZE	Family size, Numbers	+	200
OWNHOUSE	House ownership, Dummy (1=own house, otherwise =0)	+	200
EXPENDITURE	Monthly expenditure of HHs in thousands (ETB/month)	+	200
EMPLOYMENT	Primary Employment of the head ,dummy(1=Tella/Arekie selling, 0=otherwise)	+	200
AAGEFAM	Average age of family members, years	-	200
FEMALES	Female members in the family, numbers	+	200

CHAPTER THREE

3 RESULTS AND DISCUSSION

3.1 Descriptive Statistics

3.1.1 Household Socio-economic Characteristics

3.1.1.1 Characteristics of Household Heads

Seventy-three percent of the interviewed HHs are male-headed, whereas the rest (27%) are female-headed HHs. Households with piped water had a much higher proportion of male HHHs than HHs with other principal water sources (Table 2).

Of all HHHs, 62% are married to single spouse while the rest are single, divorced, widowed or not together for any reason. The proportion of single, divorced or widowed HHHs is much higher among HHs with other principal water sources (Table 2).

Eighty-seven percent of the heads are Orthodox Christians while the remaining (9% and 3.5%) are Muslims and Protestants; respectively. Households with piped water had a higher proportion of HHHs with religions other than Orthodox Christian. More than ninety-four percent of the heads reported Amharic while the rest reported Tigrigna and Oromiffa as their mother tongue, and there were no apparent differences in the principal language spoken by the household by principal source of water (Table 2).

Table 2: Characteristics of Heads of the surveyed HHs

Variable and responses	Private piped water users (N=142)		Other water source users (N=58)		Total (N=200)	
	N	%	N	%	N	%
Sex of HHH	142	100.0	58	100.0	200	100.0
Male	120	84.5	26	44.8	146	73
Female	22	15.5	32	55.2	54	27
Marital Status of the family head	142	100.0	58	100.0	200	100.0
Married, single spouse	107	75.4	18	31.0	125	62.5
Single	9	6.3	13	22.4	22	11.0
Divorced	6	4.2	9	15.5	15	7.5
Widowed	14	9.9	12	20.7	26	13.0
Not together for any reason	6	4.2	6	10.3	12	6.0
Religion of the HHH	142	100.0	58	100.0	200	100.0
Orthodox Christian	119	83.8	56	96.6	175	87.5
Muslim	17	12.0	1	1.7	18	9.0
Protestant	6	4.2	1	1.7	7	3.5
Mother Tongue of the HHH	142	100.0	58	100.0	200	100.0
Amharic	133	93.7	56	96.6	189	94.5
Oromiffa	1	0.7	0	0.0	1	0.5
Tigrigna	8	5.6	2	3.4	10	5.0
Place of Birth of the HHH	142	100.0	58	100.0	200	100.0
In the town	35	24.6	27	46.6	62	31.0
Out of the town	107	75.4	31	53.4	138	69.0
Reasons of the Head for coming to town	142	100.0	58	100.0	200	100.0
Came to live with the spouse	7	4.9	14	24.1	21	10.5
To look for employment	96	67.6	14	24.1	110	55.5
Returned from army	2	1.4	1	1.7	3	1.5
Others	2	1.4	2	3.4	4	2.0
not applicable	35	24.6	27	46.6	62	31.0

Sixty-nine percent of the interviewed heads were born out of the town, and this proportion was higher for HHs with private piped water. More than two-thirds of respondents came to Merawi to look for employment or live with their spouse. This is an indicator of the increase in the rate of urbanization and population of the town due to rural-urban migration from its surrounding areas (Table 2).

3.1.1.2 Age-Sex Composition and Current Family Members

The mean age of the HHHs was 48 years. HHHs of piped water users have a mean age of 50 years while it is 44 for other water source users. The average age of the family members was found to be 28.5 years and there is no significant differences between different water source users.

The mean years of schooling of HHHs with private pipe users was found to be 6.8 years, it was 4.2 for HHHs using other water sources while 6.1 years is the mean years of schooling for the surveyed HHHs (Table 3).

Table 3: Age-sex composition and current family members

Variable, characteristic	Private piped water users (N=142)	Other water source users (N=58)	Total (N=200)
Age of the HHH, years			
Mean	49.9	43.7	48.1
S.d.	12.8	10.6	12.0
Min.	24.0	26.0	24.0
Max.	75.0	69.0	75.0
Years of Schooling			
Mean	6.8	4.2	6.1
S.d.	5.9	4.7	5.7
Min.	0.0	0.0	0.0
Max.	16.0	14.0	16.0
Family size			
Mean	5.1	3.5	4.7
S.d.	1.6	1.4	1.7
Min.	1.0	1.0	1.0
Max.	10.0	6.0	10.0
Male members of the HH			
Mean	2.5	1.5	2.2
S.d.	1.1	1.1	1.2
Min.	0.0	0.0	0.0
Max.	5.0	4.0	5.0
Female members of the HH			
Mean	2.6	2.0	2.5
S.d.	1.1	1.0	1.1
Min.	0.0	0.0	0.0
Max.	6.0	4.0	6.0
Average age of family members, years			
Mean	28.7	27.9	28.5
S.d.	6.1	7.6	6.6
Min.	18.0	16.0	16.0
Max.	43.0	62.0	62.0

The mean family size of the surveyed HHs was found to be 4.7 persons and there was significant difference between HHs with different water sources because it is 5.1 persons and 3.5 persons for private pipe users and other source users, respectively. Male and female members of the surveyed HHs were found to be 2.2 persons and 2.5 persons respectively.

3.1.1.3 Income and Expenditures of the Households

The mean monthly income of HHHs from employment/own business was 2,297 ETB for users of private pipe while it is significantly lower (596 ETB) for other water source users. There was also a significant difference in monthly income between the HHs with piped and other water sources. The HHH of piped water users earned 1,804 ETB more on average than the head for HHs without piped water and for spouses, the difference between HHs with and without piped water was 364 ETB for the heads and their spouses of surveyed HHs, respectively (Table 4).

Table 4: Income and expenditures of the households

Variable, characteristic	Private piped water users (N=142)	Other water source users (N=58)	Total (N=200)
Monthly income of the head of HH from employment/own business, ETB/mo			
Mean	2,296.7	596.4	1,803.6
S.d.	2,987.9	297.2	2,636.1
Min.	0.0	0.0	0.0
Max.	30,000.0	1,700.0	30,000.0
Monthly income of the spouse from employment/own business, ETB/mo			
Mean	453.7	143.9	363.8
S.d.	973.8	256.3	842.9
Min.	0.0	0.0	0.0
Max.	10,000.0	850.0	10,000.0
Monthly expenditure of the HH, ETB/mo			
Mean	1,733.8	723.9	1,440.9
S.d.	632.3	237.6	714.5
Min.	400.0	300	300.0
Max.	5,000.0	1200	5,000.0
Monthly expenditure on water (either as bill or buying water), ETB/mo			
Mean	20.9	16.3	19.6
S.d.	9.0	6.2	8.5
Min.	7.0	7.0	7.0
Max.	50.0	35.0	50.0

A significant difference was also observed in the mean monthly expenditure of the surveyed HHs; expenditures were 1,734 ETB for piped water uses and 724 ETB for other water source users, respectively. The mean monthly expenditure of the surveyed HHs was found to be 1,441 ETB with maximum and minimum of 5000 ETB and 300 ETB (Table 4).

Respondents were also asked about the expenditure of the HH for water as monthly bill or payment for buying and water carrying (without considering the opportunity cost of collecting water). The overall mean expenditure on water of the surveyed HHs was found to be 20 ETB/month. Given the difference in overall expenditures between the two groups of HHs, the difference in water expenditures is small. Households with private piped water spent an average of 21 ETB/month on water, whereas HHs relying on other sourced expended 16 ETB/month. The maximum and the minimum expenditure on water of the surveyed HHs were 50 ETB and 7 ETB, respectively. The average cash expenditure (that is also not including time costs) on water was less than 1.5% of the total expenditure of households.

3.1.1.4 Primary Employment of the Head and Spouse of the HHs

Around 61% of heads of HHs with private pipes are either professionals or traders (own their business) whereas only a very tiny fraction of other water source users engage in employment in these. More than 80% of HHs who obtain water from sources such as public stand pipes, water vendors, springs and rivers are all employed either in Tella and Arekie selling or some type of skilled or unskilled labor such as daily labor, tailor, masonry and other handcrafts. This is an indicator that water source choices are influenced by the primary employment of the HHHs in Merawi (Table 5).

Table 5: Primary employment of the head and spouse of the head

Variable and responses	Private piped water users (N=142)		Other water source users (N=58)		Total (N=200)	
	N	%	N	%	N	%
Primary employment of the HHH	142	100.0	58	100.0	200	100.0
Professional	41	28.9	2	3.4	43	21.5
Skilled / unskilled labor	15	10.6	21	36.2	36	18.0
Trader/own business	50	35.2	1	1.7	51	25.5
Unemployed / not working / pensioned	16	11.3	5	8.6	21	10.5
"Tella" and "Arekie" making	13	9.2	26	44.8	39	19.5
Others	7	4.9	3	5.2	10	5.0
Place of employment of the HHH	142	100.0	58	100.0	200	100.0
In the town	94	66.2	37	63.8	131	65.5
Nearby(surrounding villages)	19	13.4	9	15.5	28	14.0
Nearby towns	9	6.3	3	5.2	12	6.0
Not applicable	20	14.1	9	15.5	29	14.5
Additional employment (if any)of the HH	142	100.0	58	100.0	200	100.0
Non available	132	93.0	57	98.3	189	94.5
"Tella" and "Arekie" selling	7	4.9	1	1.7	8	4.0
Trader/owns business	3	2.1	0	0.0	3	1.5
Primary employment of the spouse	142	100.0	58	100.0	200	100.0
Unemployed	46	32.4	3	5.2	49	24.5
"Tella" or "Arekie" selling	35	24.6	14	24.1	49	24.5
Trader/owns business	10	7.0	2	3.4	12	6.0
Professional	15	10.6	0	0.0	15	7.5
Not known	2	1.4	1	1.7	3	1.5
Not applicable	34	23.9	39	67.2	73	36.5

From among spouses of HHHs who use piped water, 32% are unemployed, 25% practice Tella and Arekie making, 11% are professionals and 7% are traders (own business) while from among the spouses of HHs who use water from other sources, 5% are unemployed, 25% practice Tella and Arekie making. This shows that a proportional percent of the spouses of both piped water and other source users participate in HH income generating activity (making and selling Tella and Arekie) that use water to a greater extent.

Twenty-five percent of the surveyed HHHs reported trade/own business, 21% were government employed (such as teachers, clerical, administrative, police, judge, etc.), nearly 21% percent reported Tella and Arekie selling as their primary employment, and the remaining 10.5% responded that they are unemployed/not working /pensioned. Meanwhile, around 95% responded that they have no additional employment. The remaining 4% responded that Tella and Arekie selling is their additional employment (Table 5).

3.1.1.5 Income Apart from Employment and Own Business

The proportion of HHs receiving transfer income during the previous month or year was nearly equal for the two types of HHs (Table 6). Remittance income contributed the greatest share of the transfers received by the surveyed HHs followed by gifts. Of those who had transfer income (N=33 piped water households and N=16 other water source households), more than 90 (N=30) of piped water households indicated that the transfer was received from a non-resident family member; more than two-thirds of households with other water sources (N=11) reported that the transfer was provided from this source (Table 6).

Households were also asked about the existence of family members who covers/shares for the expenditures of the family. About 22% of private pipe user and 7% of other water source users responded yes while the remaining responded no to the question. Nearly 18% of the surveyed HHs reported that there are family members who share/cover expenditures of the HH, whereas the remaining (78%) responded there are no family members who shares expenditures (Table 6).

Table 6: Income of the HH apart from employment/own business

Variable and responses	Private piped water users (N=142)		Other water source users (N=58)		Total (N=200)	
	N	%	N	%	N	%
Transfer to the HH within the last month	142	100.0	58	100.0	200	100.0
Yes	33	23.2	16	27.6	49	24.5
No	109	76.8	42	72.4	151	75.5
Transfer to the HH within the last one year	142	100.0	58	100.0	200	100.0
Yes	33	23.2	16	27.6	49	24.5
No	109	76.8	42	72.4	151	75.5
Type of Gift/Transfer received	142	100.0	58	100.0	200	100.0
Remittance	29	20.4	8	13.8	37	18.5
Gift	4	2.8	8	13.8	12	6.0
Not applicable	109	76.8	42	72.4	151	75.5
The Source of Gift/Transfer	142	100.0	58	100.0	200	100.0
Nonresident HH member	30	21.1	11	19.0	41	20.5
Relative/friend/neighbor	3	2.1	5	8.6	8	4.0
Not applicable	109	76.8	42	72.4	151	75.5
Location of the source (main) of Transfer	142	100.0	58	100.0	200	100.0
In the town	6	4.2	5	8.6	11	5.5
Nearby towns	4	2.8	4	6.9	8	4.0
Regional center	12	8.5	3	5.2	15	7.5
Addis Ababa	2	1.4	2	3.4	4	2.0
Abroad / diasporas	9	6.3	2	3.4	11	5.5
Not applicable	109	76.8	42	72.4	151	75.5
Existence of family Member who covers/ shares for the expenditures of the HH	142	100.0	58	100.0	200	100.0
Yes	31	21.8	4	6.9	35	17.5
No	108	76.1	48	82.8	156	78.0
Not applicable	3	2.1	6	10.3	9	4.5

3.1.1.6 Housing and Other Related Characteristics

Ninety-two percent of HHs who are users of private piped water own the house the family is currently living, whereas only 60% of HHs with other water sources own their house while the remaining HHs live in rented houses. This clearly shows that housing ownership has a statistically significant effect on the water source choice decision of HHs that is probably related with the length of stay of the HHs in the current house is quite different for HHs who do and do not own the house in addition to tenure issues related to acquiring the service (Table 7).

Table 7: Housing and other related characteristics

Variable and responses	Private piped water users (N=142)		Other water source users (N=58)		Total (N=200)	
	N	%	N	%	N	%
The House the family currently lives	142	100.0	58	100.0	200	100.0
Owner occupied	131	92.3	35	60.3	166	83.0
Rented from individuals	10	7.0	11	19.0	21	10.5
Rented from kebelie	1	0.7	12	20.7	13	6.5
The material the roof of the main house is constructed	142	100.0	58	100.0	200	100.0
Corrugated metal roof	142	100.0	58	100.0	200	100.0
The material the floor of the main house is constructed	142	100.0	58	100.0	200	100.0
Cow dung or dung mixed with soil	73	51.4	56	96.6	129	64.5
Concrete/stone/cement	56	39.4	2	3.4	58	29.0
Tiles /bricks	13	9.2	0	0.0	13	6.5
Spending to build new/ improve house in last 2 yrs	142	100.0	58	100.0	200	100.0
Yes	9	6.3	1	1.7	10	5.0
No	133	93.7	57	98.3	190	95.0
Own extra house in the town	142	100.0	58	100.0	200	100.0
Yes	46	32.4	0	0.0	46	23.0
No	85	59.9	36	62.1	121	60.5
Not applicable	11	7.7	22	37.9	33	16.5
Own house in Bahir Dar	142	100.0	58	100.0	200	100.0
Yes	16	11.3	0	0.0	16	8.0
No	115	81.0	36	62.1	151	75.5
Not applicable	11	7.7	22	37.9	33	16.5

All of the roofs of the main houses of the surveyed HHs are covered with corrugated metal sheets. However, there are differences in the materials from which the floors of the main house are constructed between the two water source users. Around 51% of private pipe users and 97% floors of houses of HHs using other water sources are made from cow dung or dung mixed with soil, the floors of 39% of private pipe users and 3% of other water source users is made from concrete/stone/cement while 9% of floors of houses of private pipe users are made of tiles/bricks. None of the floors of the houses of HHs who obtain water from other sources is made from tiles/bricks (Table 7).

3.1.2 Water Sources, Use practices and Access to Sanitation

3.1.2.1 Water Sources and Use Practices of Households

Of the surveyed HHs, 71% obtain water from private piped connections, while the rest (29%) use other water sources. From among HHs who use other sources, more than two third (78%) use public stand pipes while the remaining 22% use water from vendors as the primary source of water supply for the HH. This shows that in Merawi, public stand pipes are the main sources of water for HHs who do not have private piped water services. As far as distance of the primary sources of water of users of other water sources is concerned, 21% reported distances of up to 10 meters, 7% from 10-100 meters, and 40% from 100-200 meters while the remaining (33%) reported distances from 200-500 meters from their residence (Table 8).

Households were also asked about how they supplement/complement water when water from their primary water source is unavailable referred here as secondary source of water. Around 42% of HHs from private pipe users and 24% of HHs of other water source users reported water from a spring, 44% of private pipe users and 72% of other water users from a river while the remaining supplement/complement water from hand dug wells. All of the surveyed HHs who have private piped connections explained that the system of payment for having private connections is payment in advance. However, there were differences in the amount of payment required for the service. About 23% percent reported that they paid less than five hundred ETB, twenty one percent paid between 500-700 ETB, and the remaining twenty eight percent paid from 700-1000 ETB to establish the connection (Table 8).

Table 8: Water sources and use practices of the households

Variable and responses	Private piped water users (N=142)		Other water source users (N=58)		Total (N=200)	
	N	%	N	%	N	%
Primary Water Source for the HH	142	100.0	58	100.0	200	100.0
Private connections	142	100.0	0	0.0	142	71.0
Public stand pipes	0	0.0	45	77.6	45	22.5
Water vendors	0	0.0	13	22.4	13	6.5
Distance in Meters of Primary water source	142	100.0	58	100.0	200	100.0
tap in residence	142	100.0	0	0.0	142	71.0
0-100m from home	0	0.0	16	27.6	16	8.0
100-200m	0	0.0	23	39.7	23	11.5
200-500m	0	0.0	19	32.8	19	9.5
Secondary Source of Water for the HH	142	100.0	58	100.0	200	100.0
Spring	60	42.3	14	24.1	74	37.0
River	62	43.7	42	72.4	104	52.0
Hand dug wells	20	14.1	2	3.4	22	11.0
System of payment to private connections	142	100.0	58	100.0	200	100.0
Advanced pay	142	100.0	0	0.0	142	71.0
Not applicable	0	0.0	58	100.0	58	28.0
Initial Payment (in ETB) for Having Private Connections	142	100.0	58	100.0	200	100.0
<500	47	33.1	0	0.0	47	23.5
500-750	40	28.2	0	0.0	40	20.0
750-1000	55	38.7	0	0.0	55	27.5
Not applicable	0	0.0	58	100.0	58	29.0
Why HH don't have Private Connections	142	100.0	58	100.0	200	100.0
Not want the service	0	0.0	2	3.4	2	1.0
Inability to afford service payment	0	0.0	48	82.7	48	24.0
Thinking the service is expensive	0	0.0	4	6.9	4	2.0
Service is not available around	0	0.0	4	6.9	4	2.0
Not applicable	142	100.0	0	0.0	142	71.0
Main source of Drinking water supply	142	100.0	58	100.0	200	100.0
Private connections	142	100.0	0	0.0	142	71.0
Public stand pipes	0	0.0	45	77.5	45	22.5
Water vendors	0	0.0	13	22.1	13	6.5
Type of Toilet used	142	100.0	58	100.0	200	100.0
Pit latrine	135	95.1	58	100.0	193	96.5
Flash toilet	7	4.9	0	0.0	7	3.5
Open defecation	0	0.0	0	0.0	0	0.0
Boil water	142	100.0	58	100.0	200	100.0
No	142	100.0	58	100.0	200	200.0
Have garden	142	100.0	58	100.0	200	200.0
No	142	100.0	58	100.0	200	100.0

HHs who do not have private connection were asked reasons for not having the service. Eighty-one percent of respondents who do not have private connections responded that the primary reason was their inability to afford the connection payment, whereas the remainder indicated other reasons, such as thinking the service (connection) payment is expensive, the service is not available around their residence or do not want the service.

Seventy-two percent of households obtain drinking water from their private connections, 21% from public stand pipes and the rest (6.5%) from water vendors. When these sources are limited due to a service scramble, HH supplement with water from a developed spring found in the south west of the town.

Ninety-three percent of the surveyed HHs reported pit latrines as the type of toilet used, whereas the rest (7%) have flush toilets. There was no HH that reported open defecation (go to the field or jungle). However, none of the surveyed HHs reported that they boil water nor have garden/lawn in their compounds.

3.1.2.2 Households' Satisfaction with Their Water Sources

Households' satisfaction with their current water sources was assessed from the point of reliability of quantity (availability) and rating of quality of water from the sources used using a five scale Likert scales.

None of the HHs rated as excellent the reliability of the quantity of the primary source of water. Similarly, only 4% of HHs of private water users rated the quantity of their primary water source as very good while none of other water source users rated very good (Table 9).

Table 9: Households' satisfaction with their current water sources

Variable and responses	Private piped water users (N=142)		Other water source users (N=58)		Total (N=200)	
	N	%	N	%	N	%
Rating the reliability of Quantity of Primary Source	142	100.0	58	100.0	200	100.0
Excellent	0	0.0	0	0.0	0	0.0
Very good	5	3.5	0	0.0	5	2.5
Good	81	57.0	5	8.6	86	43.0
Fair	42	29.6	29	50.0	71	35.5
Bad	14	9.9	24	41.4	38	19.0
Rating of the Quality of Primary Source of water	142	100.0	58	100.0	200	100.0
Excellent	0	0.0	0	0.0	0	0.0
Very good	108	76.1	3	5.2	111	55.5
Good	31	21.8	27	46.6	58	29.0
Fair	3	2.1	28	48.3	31	15.5
Bad	0	0.0	0	0.0	0	0.0
No of days in a week the primary source of water Scramble in the last 6 month	142	100.0	58	100.0	200	100.0
No	5	2.5	0	0.0	5	2.5
Once	66	33.0	1	1.7	67	33.5
Twice	53	26.5	25	43.1	88	44.0
Three or more times	8	4.0	32	55.2	40	20.0
Existence of water rationing in the last one month	142	100.0	58	100.0	200	100.0
Yes	137	96.5	58	100.0	100	100.0
No	5	3.5	0	0.0	0	0.0
Occurrence of water related health problems in the family within the last one year	142	100.0	58	100.0	200	100.0
Yes	0	0.0	0	0.0	0	0.0
No	142	100.0	58	100.0	200	100.0
Household Water Storage facility	142	100.0	58	100.0	200	100.0
"Gan"	21	14.8	8	13.8	29	14.5
"Bermiel"	34	23.9	18	31.0	52	26.0
Large/medium plastic jars	41	28.9	15	25.9	56	28.0
Many clay "ensera"	46	32.4	17	29.3	63	31.5

The majority of HHs using private pipes rated the quantity of their primary water source as good (57%) and fair (30%) whereas the remaining 10% rated water quantity as bad. However, HHs without access to piped water had much less positive assessments of water quantity (Table 9). Only 9% of HHs using other water sources rated as quantity as good, the majority of this group rated quantity as fair (50%) and 41% rated quantity as bad.

Households were also asked to rate the quality of their primary sources of water. None of the interviewed households rated the quality of water from their primary sources as excellent or bad. However, 76% of private pipe users and 5% of other water source users rated quality as very good, 22% of private pipe users and 47% of other source users rated quality as good while the remaining respondents for each group of HHs rated quality as fair. The rating of quality also shows that more of HHs from private pipe users are much more satisfied with the quality of water than HHs using other water sources. In relation to these ratings, HHs were also asked about the occurrence of water-related health problems in the family within the last year and there was no report of the problem. This may reflect actual good water quality, or the attribution of any health problems to causes other than water by respondents.

Both users of private pipes and other water sources responded that they use HH water storage facilities such as “gan”-large clay jar, “bermiel”-large metal vessel, large and medium plastic jars and by using many small clay jars and there was any HH using water tankers such as “roto”-a large plastic tanker common in modern residential buildings in larger Ethiopian cities.

3.1.2.3 Female Members who Make “Tella” and “Arekie”

Respondents were asked if there is/are female member/s of the family generating income from making and selling “Tella” or “Arekie” or both so as to assess the impact of income generating activities in the home on residential water use. Around 33% of private pipe users and 72% of other water source users responded the existence of female family members making Arekie/Tella, and the majority of them undertaking this activity once

per week. More of HHs whose members participate in HH income generating activities that require water to a great extent do not have private piped water services (Table 10).

Table 10: Existence of females who makes “Tella” and “Arekie”

Variable and responses	Private piped water users (N=142)		Other water source users (N=58)		Total (N=200)	
	N	%	N	%	N	%
Female family members making Arekie/Tella	142	100.0	58	100.0	200	100.0
Yes	47	33.1	42	72.4	89	44.5
No	94	66.2	15	25.9	109	54.5
Not applicable	1	0.7	1	1.7	2	1.0
Total working capital ("Woret") of the Business	142	100.0	58	100.0	200	100.0
<500 ETB	3	2.1	13	22.1	16	8.0
500-1000ETB	19	13.4	14	24.2	33	16.5
1000-1500ETB	15	10.6	9	15.5	24	12.0
1500-2000ETB	5	3.5	3	5.2	8	4.0
above 2000	5	3.5	1	1.4	6	3.0
Not applicable	95	66.9	18	31.0	113	56.5
Duration of Making "Arekie"/ "Tella"	142	100.0	58	100.0	200	100.0
Twice per week	2	1.4	2	3.4	4	2.0
Once per week	45	31.5	38	65.5	83	41.5
Not applicable	95	66.9	18	31.0	126	63.0
Primary Source of Water for the Business	142	100.0	58	100.0	200	100.0
Private Connections	113	79.6	0	0.0	113	56.5
Public stand pipes	0	0.0	27	45.9	27	13.5
Water vendors	0	0.0	13	22.1	13	6.5
Not applicable	29	20.4	18	31.0	47	23.5

The primary source of water for the business was assessed. All of the HHs that have private connections and have female family members making tella and Arekie obtain water for their Tella and Arekie from tap in residence while 27% and 13% of other water source users obtain water respectively from public stand pipes and water vendors for making Tella and Arekie.

The respondent females who said there is family member who makes Tella and Arekie were asked to what extent their Income earning activity requires /accounts for their water uses. Most of them responded and ranked that their largest demand is for Tella and Arekie, whereas those households

who do not make Tella /Arekie said that cooking and dish washing account their largest share of water demand.

3.1.3 Awareness on Water Saving and Conservation

Respondents were also asked about their awareness, knowledge and practice of water conservation. Almost all of the interviewed heads were in one way or another aware of the notion of water conservation. When asked about what water conservation means, they responded that water conservation is a concept related with economic, disciplined use of water or it is avoiding waste of water.

The sources of information about water conservation to the HHs include people around them like relatives, friends, family members and employees of water supply office of the town. None of the respondents mentioned media as their source of information about water saving.

Respondents who have private piped connections were further asked if they encounter pipe break/leaks in their supply. Thirty percent of the respondents encounter leaks or pipe breaks.

Respondents were also asked about water wastage and recycled use of water. Twelve percent of the respondents said they feel there is water wastage in the HH, whereas 55% of the HHs responded that they recycle or reuse water, which was evident in almost all households who make “Arekie” because they use water for the ‘condensation’ process and can use water by cooling after it is used once.

3.1.4 Perceived Responsiveness to Price Changes and Awareness on Current Water Prices

HH awareness of the prices (expenditures) they pay for water and their responsiveness to water prices was assessed even though the tariff of the piped water of the town has been roughly constant for the last eleven years, according to sources from the water supply office. Some 43% percent of the respondents said that their water consumption will remain the same whether the current price of water increases or decreases. About 30% said they would reduce by an unknown amount if the price was to increase, but they would increase consumption if the price falls. The remaining 39% of the respondents said that they cannot reduce even if the price increases but they think might increase the amount consumed if incase the price decreases.

The HHs were also asked to compare their monthly bills of electricity and telephone bills (both fixed and mobile if they have) with their monthly bill or expenditure for water. Two-thirds of respondents indicated that their telephone bill was the largest, followed by electricity expenditures. Water was the smallest of utility expenditures.

Nearly three-fourths of HHs with private pipes said that they do not know how their monthly water bill is calculated, while the rest said they know that part of what they pay is for the meter rent (which is a fixed portion of the monthly payment) and the rest is for the amount of water used.

3.2 Econometric Analysis of Water Source Choice and Demand

3.2.1 Analysis of Water Source Choice Decisions of Households

Logistic regression was used to assess the impact of a number of factors on the likelihood that respondents had private piped connections. The model contained seven independent variables (primary employment of the HHH, housing ownership, age of the HHH, educational status, monthly expenditure (in thousands), family size, sex of the household head).

The full model containing all the predictors was statistically significant, with Chi-square of χ^2 (7, N=200) 104.501, P<0.0005, indicating that the model was able to distinguish between respondents who reported having and not having private piped connections as the primary source of water. The model as a whole explained between 50.7% (Cox & Snell R Square) and 68.1% (Nagelkerke R Square) of the variance in the choice of primary source of water and correctly classified 81.0% of the cases.

From among the variables included in the analysis monthly expenditure of the HH, housing ownership and educational status of the HHH and primary employment of the head were found to have a statistically significant impact on the likelihood of a HH having a private piped connection (Table 11).

Table 11: Logistic Regression Results for Reporting Private Piped Connections as the Primary Source of Water

Variable	B	S.E.	Wald	df	P	Odds ratio	95.0% C.I.for EXP(B)	
							Lower	Upper
EMPLOYMENT(1)	-1.7	0.9	4.0	1	0.04	0.2	0.0	0.9
OWNHOUSE(1)	1.3	0.5	5.3	1	0.02	3.5	1.2	10.0
AGEHH	0.0	0.0	1.7	1	0.19	1.0	1.0	1.1
EDUCATION	0.1	0.1	5.6	1	0.01	1.2	1.0	1.3
EXPENDITURE	2.0	0.6	12.5	1	0.00	7.4	2.4	22.6
FAMILYSIZE	0.3	0.2	3.2	1	0.08	1.4	1.0	2.0
SEX(1)	1.1	0.8	1.6	1	0.20	2.9	0.7	14.5
Constant	-6.3	1.7	14.6	1	0.00	0.0		
a. Variable(s) entered on step 1: Dummempt, dummyhousingown, AGEHH, edu, EXP in thousand, FSIZE, sexdummy								

The odds ratio value of 7.4 for expenditure implies that a one-unit increase in the independent variable expenditure of the HH (here one unit equals 1,000 ETB) is 7 times more likely that the HHs will report private pipe as the primary source of water to the, controlling for all other factors in the model. This is probably due to the fact that HHs with larger expenditures are HHs with better livelihoods and these HHs are able to pay the advance connection payments required by the water supply utility of the town.

Housing ownership has an odds ratio of 3.5, implying that HHs who own the house they are currently living in are more than 3 times more likely to report private piped connections as their primary source of water than HHs who do not own their house, controlling for all other factors in the model.

Educational status of the head has an odds ratio of 1.2. This means that a one-unit increase in the educational status of the HHH (1 year of additional formal years of schooling) makes more than a proportional increase in the

likelihood of HHs to have private piped connections as a primary source of water.

Primary employment of the HHH has an odds ratio of 0.2. This implies that having a HHH that sells Tella or Arekie as a primary employment greatly reduces the likelihood that the HH has private piped water.

Other independent variables like family size, age and sex of the HHH are not statistically significantly different from zero, indicating that they cannot be considered as having an effect on the likelihood of HHs to have private piped water as their primary sources.

3.2.2 Analysis of Factors Affecting Residential Water Demand

Standard multiple regression was used to assess the ability of independent variables (Employment of the HHH, housing ownership, age of the HHH, education of the HHH, HH expenditure, water source, family size and sex of the HHH, average age of family members and female members in the family) hypothesized to predict the dependent variable (daily per-capita water consumption).

Preliminary analyses were conducted to ensure that model variables are not too collinear. All the above-mentioned variables were entered to the regression analysis at the same time using the forced-entry method. The correlations between variables included in the model are checked for that the independent variables show at least some relationship with the dependent variable (above 0.3 preferably) as described by Pallant (2010).

Correlation analysis indicates that all variables (sex of the HHH, primary employment HHH, Monthly expenditure of family members, age of the HHH, housing ownership, family size, educational status of the head,

average age of family members and females in the family making Arekie/Tella) correlate substantially with the dependent variable, daily per-capita water consumption. In addition, the correlations between each of the independent variables included in the model were checked so that their correlation is not too high.

A general guideline is that two variables with a bivariate correlation of 0.7 or more should not be included in the same analysis. If such situation happens, there is a need either omitting one of the variables or forming a composite variable from the scores of the two highly correlated variables. The results here all show a correlation of less than 0.7. Therefore all the variables were retained in the analysis (ibid, 2010).

The value of the R^2 indicates how much of the variance in the dependent variable (Daily per-capita water consumption) is explained by the model. The explanatory variables in the model explain 41.1 percent of the variance in Daily per-capita water consumption (Table 12). According to the guidelines provided in Pallant (2010), this is a respectable result for household-level cross-sectional data.

Table 12 : Model Summary of the standard multiple regression analysis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.644[a]	0.414	0.399	14.56

a) Predictors :(constant), sex, own house, education, expenditure, age, employment, family size, average age of family members, female members in the family.
b) Dependent Variable: Daily per capita water consumption (Liters per day) of the household members.

The Adjusted R^2 statistic 'corrects' the value of R^2 statistics to provide a better estimate of the true population value. For small samples it is better to report the adjusted R^2 rather than the normal R^2. The adjusted R square

also indicates that the model explains 40 percent of the variance in the dependent variable.

The ANOVA result tests the null hypothesis that multiple R in the population equals 0. The model reaches statistical significance (sig. =.000; this really means p<.005). Each of the variables included in the model were also examined to see which of them contributed to the prediction of the dependent variable.

Both standardized and unstandardized coefficients are reported (Table 13). In order to compare the effects of different variables, it is appropriate to look at the standardized coefficients, rather than the unstandardized ones. 'Standardized' means that these values for the coefficients correspond to the expected change in the dependent variable given a change in the independent variable equal to its standard deviation. Thus, in a sense, each of the coefficients has been converted to the same scale so that one can compare them. A larger standardized coefficient implies that a change of one s.d. in the variable will result in a larger change in per capita water consumption. However, there is no particular reason to expect that a one-unit change in s.d. for the variable is that much more relevant than a one-unit change in the variable itself, and the use of one s.d. change is not applicable for binary variables in this case there is a need to use unstandardized beta coefficients.

The statistically significant variables are employment, age of the HH head, expenditure and sex of the household head (Table 13).

Table 13: Standard multiple regression analysis of the factors affecting residential water demand

Variable	UnSTD Coefficients		STD Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	32.0	7.9		4.1	0.00
EMPLOYMENT	14.3	4.6	0.4	3.1	0.00
OWNHOUSE	3.0	3.1	0.1	1.0	0.34
AGEHHH	-0.4	0.1	-0.3	-2.9	0.01
EDUCATION	0.1	0.2	0.1	0.6	0.58
EXPENDITURE	4.4	1.4	1.2	3.1	0.00
FAMILYSIZE	1.3	1.2	0.1	1.1	0.27
SOURCE	8.5	2.9	0.2	2.9	0.00
SEX	-14.6	4.5	-0.4	-3.3	0.00
AAGEFAM	0.3	0.2	0.1	1.7	0.10
FEMALES	0.9	1.5	0.1	0.6	0.54

The results indicate that variables like primary employment of the HHH, monthly expenditure of the family, sex and age of the HHH and source of primary water for the household each make their own strong unique contributions in explaining the dependent variable, daily per capita water consumption. The variables such as housing ownership, educational status of the head family size, average age of family members and female members in the family were not statistically significantly different from zero and thus made no statistically significant contribution in explaining the dependent variable, daily per capita water consumption.

More specifically, the interpretation of the coefficients for primary employment of the heads is that households who make Arekie and Tella will consume, on average, 14 liters more water per capita per day than those HHs whose primary employment is different from Tella and Arekie. This is due to the fact that HH employment activities such as making Tella

and Arekie require water to a greater extent as the production process of the traditional alcoholic drinks use water in every stage.

Expenditure of the HH has an unstandardized beta value of 4.4 indicating that a one unit increase (1,000 ETB) in the monthly expenditure of the HHs results in a 4.4 liters increase in the amount of daily per capita water consumption of the surveyed HHs when the influence of other variables in the model is controlled for.

Similarly primary source of water has a beta value of 8.5 indicating that households whose reported private pipe as the primary source of water supply were found to have 9 liters more daily per capita water consumption than households who use other sources as the primary source of water.

However, age of the HH head has shown a standard beta value of -0.3 implying that for a one-unit increase in age (1 year) the daily per capita water consumption of the HH will decline by 0.3 liters.

Similarly, sex of the HHHs has an unstandardized beta value of -14.6 implying that female-headed HHs will have lower daily per capita water consumption than male-headed households.

Other independent variables such as education, housing ownership and family size, average age of family members and females in the family are not statistically significant predictors of water usage.

CHAPTER FOUR

4 SUMMARY AND CONCLUSIONS

4.1 Summary

Understanding the factors that affect residential water demand and water source choice decisions is important for a variety of planning purposes in the residential water supply sector as a result of a recent shift in the orientation of residential water management from supply driven to a demand driven approach of demand management.

This study examined the different factors that affect water source choice decisions and residential water demand of households in Merawi, near Lake Tana, north western Ethiopia.

Based on econometric models that control for multiple factors, demographic and socio-economic factors were found to have significant effect on both HHs' choice of water sources and the amount of residential water use of the HHs.

From among the variables that were hypothesized to significantly affect HHs' water source decisions, four were statistically significant: primary employment of the head, owning of the house in which the family reside, monthly expenditures and educational status of the household head. Factors not affecting the likelihood of piped water included age and sex of the HH head and family size.

Households whose heads are employed in making Arekie and Tella are more likely to have private piped connections than those households who are not making Arekie and Tella.

Households who own the house they are currently living in were more likely to obtain water from taps in their residence because the existing directives of the water supply office of the town require tenure certification as a perquisite to obtain the permission and the service of piped water. It might be also because of the length of time of stay at the current home, as HHs who own the house are more likely not having tenure problems and thus are supposed to stay at the house for indefinite amount of time in the future, that induces them to have private piped connections where as HHs who do not own the house they are living in are uncertain about their future which doesn't encourage them to have private pipes by themselves unless the owners have connections before they rented it out.

Households with higher monthly expenditure were more likely to obtain water primarily from private pipes. This is probably due to the fact that better-off HHs are likely to be able to pay the service and connection charges required in advance by the water supply office of the town hence expenditure is considered as a proxy for HH income and livelihood.

Similarly, educational status of the HHH was also found to affect the decision of HHs to have private piped connections. This could be related with the better awareness and understanding of educated HHs on the positive returns in improved health and sanitation associated with piped water.

Four factors were found to have a statistically significant impact on the daily per capita water consumption by HHs of Merawi: Primary employment of the head, expenditure, age and sex of the HHH.

From among the factors that were assumed to affect the quantity of residential water demand of the HHs, monthly expenditure of the family and

primary employment of the HHH were found to be factors positively related with the dependent variable, daily per capita water consumption. Male headed HHs and age of the HH head had negative impacts on daily per capita water consumption of the surveyed HHs.

Monthly expenditure was found to have a positive relation with daily per capita water consumption of the HHs because family members of better of HHs are more likely to have frequent bath and showering, frequent washing of clothes and more water for washing dishes and cooking water as compared with worse of HHs taking in to consideration the HH lifestyles and sanitation preferences of better off households.

Households whose heads' primary employment is making traditional alcoholic drinks called "Tella" and "Arekie" were also found to have more per capita daily water consumption than those HHs whose heads are employed in other activities. This is because Tella and Arekie production requires water to a greater extent, and may in part explain why female-headed HHs do exhibit more daily per capita water consumption.

Housing ownership, educational status of the head, family size average age of family members and number of female members in the family did not have statistically significant effects on household water demand.

4.2 Conclusions

One of the most important significant activities in the effort of demand management of residential water demand is trying to understand the factors that affect residential water demand. Understanding of the factors that affect HHs' water source choice decisions and the respective quantity demanded is of a good interest for institutions and individuals charged with residential water supply. Based on the findings of this study and review of relevant literature it is concluded that:

- Demographic and socio-economic factors were found to be a significant determining factor in both residential water demand and HHs water source choice.

- If water supply utilities are planning to implement proper demand management strategies, they have to give due emphasis for the changes in the demographic and socio-economic factors that affect demand or should explore and identify those factors that are called shift variables in the demand curve. Taking the existing population of Merawi which is 18,246 (see source from the study area section) and the country's' population growth rate of 2.7% (PCCE, 2008), the population of Merawi will increase, on average, 474 people per year. If it is assumed that current average daily per capita water consumption trend remains the estimated 38.8 LPCD, the towns' water consumption will increase by 6,712,788 liters (6712.8 cubic meters) per annum. This is around 5% of the current production capacity of the town's water supply office, indicating that the water supply office needs to satisfy the demand as a result of population growth. Having the current population growth rate of 2.7% and a simple arithmetic growth rate of water

demand, by 2020 the water demand of the town will grow by 45% which is a great indicator for the water supply office of the town that the demand for water as projected by the UN will grow at an alarming rate by the year 2020.

- An increase in income (with expenditure as a proxy) has lead HHs to have more water demand related with change in the life styles of better off HHs is a signal for water supply office in that increase in come leads to more water demand. Considering the GDP growth rate of the country in 2008 (11.3%) continues for the coming years, and assuming that income grows proportionally, the current demand for water would double within 8 years or by the year 2020, there would be around 100% increase in water consumption, considering other things constant (ceteris paribus).

- Household income generating activities such as making of “Tella” and “Arekie” demand more water. Thus, water planners should give due emphasis in the type of employment of the residents so that these HHs would be served by more cheaper and reliable services as water is not only a consumable good but also means of earning livelihood for these HHs. Future studies need to properly assess the impact of HH income generating activities on the quantity of water demanded.

- A very significant share (81%) of respondents who do not have private connections responded that their primary reason not to have private pipes was their inability to afford the connection payment, clearly indicating that Policies like subsidizing connection costs and supplying credit facilities for connection payment could enable HHs to get piped connection, although the capacity of the piped water system would need

to be adequate so that this would not increase the number of days in which HHs experience a service scramble.

- Because a significant number of HHs in the town are obtaining water from public stand pipes, mechanisms such as cross- subsidization of prices by better off HHs who obtain water from private pipes to the worse off HHs who obtain water from public stand pipes of the municipality would enable the poor HHs to obtain cheaper services.

- Last but not least, there should be extensive and detailed studies done by the Ministry of water resources development and the respective regional bureaus to have a clear picture of the factors that affect consumers decisions of water source choice and residential water uses at a HH, municipal, regional or national level in order to implement proper demand management strategies and policy options in the face of growing demand for improved water services in the supply sector of Ethiopia. This is particularly relevant for the impact of pricing, because available data did not allow this study to estimate the price elasticity of demand and the effect of pricing on both water source choice decisions and the quantity of water demanded because economic theory suggests that pricing can be used as a mechanism of demand management as far as the price elasticity of water is different from zero.

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APPENDIX A

RESIDENTIAL WATER DEMAND SURVEY, 2010

HOUSEHOLD SURVEY ON FACTORS DETERMINING RESIDENTIAL WATER DEMAND IN THE TOWN OF MERAWI, NORTH WESTERN ETHIOPIA

Master's thesis Survey

Dessalegn Chanie

Cornell University

The objective of this study is to assess the factors determining residential water demand and water use practices in the town of Merawi, North western Ethiopia. Such studies enable the concerned bodies in the water supply sector to acquire pertinent information for sound and informed decision making in their efforts of demand management and expanding services with increased demand. To this end, your willingness and cooperation to give honest information is valuable for the success of the research project. Thank you in advance for your time, help and cooperation!!!

Name of the interviewer: _____ (this information is important to validate survey responses and will be used to crosscheck unusual observations during the editing of the data).

Date of interview _____

Name of the supervisor _____

Date checked: _____

Households survey identification number: _____

Time interview started (time and date) _____

Time interview ended (time and date) _____

Kebelie _____

RESIDENTIAL WATER DEMAND SURVEY

TABLE OF CONTENTS PAGE

Module 1, Section 1: ***Module 1, Section 1: HH Demographics, Current HH Members and their Educational Status***

Codes for Module 1, Section 1: Module 1, Section 1: HH Demographics, Current HH Members and their Educational Status

Code (a), relationship to head	**Code(b),**Marital status	**Code(c),** Occupation
1 Head	**1** Married, single Spouse	**1** professional (teacher, government worker, administration, health worker, clerical)
2 Wife/ Husband/ partner	**2** Single	**2** skilled laborer(tailor, wood work, metal work ,masonry)
3 Son/ Daughter / Grandchild	**3** Divorced	**3** Trader /own business
4 Father/ Mother/ Grandparent	**4** Widowed	**4** unemployed/not working/pensioned
5 Sister/ Brother	**5** Not Together for any reason	**5** Daily laborer/unskilled labor
6 Other related Persons	**6** Married, more than one spouse	**6** "Tella" and "Arekie" selling
7 Not Known	**7** Not known	**7** others
9 Response refused	**9** Response refused	**8** not applicable
		9 Response refused

Module 1, Section 1: HH Demographics, Current HH Members and their Educational Status

ID Code	1 Name of the household members	2 What is the Relationship of [NAME] to the Head? Code (a)	3 What is his /her age? (year Completed)	4 What is his/her sex? 1 male 2 female	5 Marital status Code (b) (leave out if age is less than 13)	6 Current primary occupation Code (c) (leave out if age less than 7)	7 Highest grade of Schooling (years completed so far)
1							
2							
3							
4							
5							
6							
7							
8							
9							
1 0							
1 1							
1 2							
1 3							
1 4							
1 5	Sex-composition Of the family	M					
		F					
		Total					
1 6	Average age of family members						

CODES FOR Module 1, Section 2: Characteristics of the HH and HHH

Code (a), sex of the household head	**Code (b),** Reasons for coming to the town	**Code (c),** Mother tongue of the head	**Code (d),** Religion
0 female	**1** Came to live with the spouse	**1** Amharic	**0** None
1 male	**2** to look for employment	**2** Oromiffa	**1** Orthodox Christian
	3 to look after / to be looked after	**3** Tigrigna	**2** Muslim
	4 sick or old , came to be looked after	**4** Guragegna	**3** Protestant
	5 returned from army	**5** Others (Specify) ------	**4** Catholic
	6 Others (Specify)----	**7** not known	**5** Traditional
	7 not known	**8** not applicable	**6** Others (Specify)----
	8 not applicable	**9** No response/Ref used to respond	
	9 No response/Refused to respond		

Module 1, Section 2: Characteristics of the HH and HHH

1. Sex of the household head? code (a)	
2. Was the household head born in this town? 1= Yes 2= No	
3. If was NOT born in this town, why did the household head come to this town? Code (b)?	
4. Was the spouse of the head born in this town? 1=Yes 2= No 8= NOT APPLICABLE	
5. If was NOT born in this town, why did the spouse of the head come to this town? Code (b)?	
6. Ethiopian Language fluently spoken by the household head (allow up to four responses) Code (C)	
7. What is the religion of the household head? code (d)	

Module 2: SOCIO-ECONOMIC CHARACTERSTICS OF THE HHs

Section 1: Codes for Sources of HH Income-employment

Code (a), type of employment	Code (b), place of employment
1 Professional (teacher, government worker, administration, health worker, clerical)	1. In the town
2 Skilled laborer (tailor, wood work, metal work, masonry)	2. Nearby (surrounding villages)
3 Trader/own business	3. Nearby towns
4 unemployed /not working/pensioned	4. Regional center
5 Daily laborer/unskilled labor	5. Addis Ababa
6 “Tella” and “Arekie” selling	6. other(please Specify)
7 Others	7. Not Known
8 not applicable	8. not applicable
9 Response refused	9. Response refused

Section 1: Sources of household income-wage employment

1) What is the primary employment of the household head? (Code a)	
2) What is the primary employment of the spouse of the head? (Code a)	
3) Are there family members (out of the head or spouse) who are generating income? 0=No 1=Yes 8=Not applicable	
4) place of employment of the household head (Code b)	
5) place of employment of the spouse (Code b)	
6) additional employment of the household head (if any)? (Code a)	

Section 2: Income from Own business activity

1) On average, how much (in birr) does the household head earn from employment/own business per month?	
2) On average, how much (in birr) does spouse earn from employment/own business per month?	
3) How much (in birr) is the total monthly income is from employment/own business/gift of the Household?	
4) How much (in birr) is the average annual income of the Household from employment/own business/gift of the Household?	
5) How much (in birr) is the average monthly expenditure of the Household?	
6) How much (in birr) is the average annual expenditure of the Household?	

Section 3: Code for income apart from employment-Transfers

Code (a), type of gift received or given	code (b),Source of Gift	Code(c), Location	Amount of transfer (in birr)
1 remittance	1. non-resident household member	1. in the town	1. less than 100
2 gift	2. relative/ friend/ neighbor	2. nearby towns	2. 100-500
3 inheritance	3. “equib”/“edir”	3. nearby villages	3. 500-1000
4 donation/aid	4. gift from church /mosque/ religious organization	4. regional center	4. 1000-1500
5 other transfer	5. government/ ministry/kebelie	5. Addis Ababa	5. 1500-2000
6 compensation	6. NGO	6. Abroad (from Diaspora)	6. above 2000
7 others(specify)	7. others (specify)	7. not known	7. not known
8 not applicable	8 not applicable	8. not applicable	8. not applicable
9 response refused	9. response refused	9. response refused	9. refused to respond

Section 3: Income apart from employment-Transfers

1. Is there any transfer to the household within the last one month? 1=Yes 2=No	
2. Is there any transfer to the household within the last one year? 1=Yes 2=No	
3. if the answer to the above question is yes, type of gift received is? (code a), (allow more than one answer)	
4. the source of the gift/transfer is ? (code b), (allow more than one answer)	
5. location of the source of transfer? (code c), (allow more than one answer)	
6. total average monthly income of the household from transfers is (code d)	

Code for section 4: Housing ownership and quality

Code (a), the house in which the family lives belongs to	Code(b), the material from which the house is made(type of roof)	Code (c) the material from which the house is made (type of floor)	Code (d), use of toilets
1 Owner-occupied	1 Thatched roof	1 Earth	1 Flush toilet shared
2 Rented from individuals	2 Corrugated metal roof	2 Cow dung or cow dung mixed with soil	2 Flush toilet private
3 Rented from kebelie	3 Stone / concrete etc…	3 Concrete/ stone/cement	3 Pit latrine shared
4 Obtained for free (Not purchased but does not pay rent either)	4 Plastic sheeting	4 Tile/bricks	4 Pit latrine private
5 Under mortgage	5 Others (please specify)	5 Others (please specify)	5 Pan/Bucket
6 Others (please specify)			6 No toilet/(uses outdoor/field)
8 Not applicable			

Section 4: Housing ownership and quality

1. To who does the house you are currently living in belongs? Code (a)	
2. What materials have been used to construct the roof of the main house you live in? Code (b)	
3. What materials have been used to construct the floor of the main house you live in? Code (c)	
4. In the last two years, did you spend anything on building a new house or improving your house and other buildings? 0= No 1=Yes	
5. Do you have rooms that are rented? 0=No 1=Yes 88=Not Applicable	
6. Do the household own extra house (residential or commercial) in the town? 1=Yes 2=No 8=Not Applicable	
7. Do the Household Own house in Bahir Dar? 0=No 1=Yes 7=I Don't Know 8=Not Applicable	
8. If your answer to the above question (no.8) is Yes, is it rented? 0=No 1=Yes 8=Not Applicable	
9. Type of toilet used (code d)	

Module 3: RESIDENTIAL WATER DEMAND AND USE PATTERNS OF THE HH

Codes for module 3, Section 1: Sources of and Access to water

Code (a), primary source of water for the household	Code (b), secondary source of water for the household	Code (c), reliability of the water source
1 Private connections	1 Private connections	1 excellent
2 Public stand taps	2 Public stand taps	2 very good
3 Stream	3 Stream	3 good
4 River	4 River	4 fair
5 Hand dug wells	5 Hand dug wells	5 bad
6 Water vendors	6 Water vendors	
7 Rain water	7 Rain water	
8 Others (please specify)	8 Others (please specify)	

Module 3, Section 1: Sources of and Access to water

1) What is the primary (main) source of your water supply for the house hold? code (a)	
2) If you have private connections, what is/was the system of payment for having a private water connection? *(If you do not have private connections, skip to # 3)*. 1) Advanced payment 2) long term payment with future water bills 3) in the form of credit 4) free 7) I do not know 8) not applicable	
3) How much cash (in birr) you are/were required spend (paying) in order to have private connections? 0=No payment for any reason 1) <500 2) 500_750 3) 750_1000 4) >1000 5) I do not remember 8) not applicable	
4) If you do not have private connections, why don't you have? 0) not wanting the service 1) inability to pay the connection charges in advance 2) service is expensive 3) Because the service is not available 4) Other reasons (please specify) _____	
5) What is the secondary source of water for the household? code (b)	
6) What is the main source of drinking water supply for the house hold? code (a)	
7) Rank the reliability in terms of quantity of your water source? code (e)	
8) How many days was your primary water supply scrambled in the last one week? 0=never 1=once 2=twice 3=three or more times	
9) Was there shift distribution of water in the last one month? 0=No 1=Yes 7=I do not know	
10) Was there shift distribution of water in the last one year? 0=No 1=Yes 7=I do not know	
11) How do you rate the quality of your water source? Code(e)	
12) Was there any health problem related with water in the family with in last one month? 0=No 1=Yes 7=I do not know	
13) Was there any health problem related with water in the family with in last one year? 0=No 1=Yes 7=I do not know	
14) Do you have shower room? 0=No 1=Yes	
15) How often do you take shower? 1=at least once per day 2=every two days 3=once per week 4=once every two or three weeks or more 88) not applicable 99) response refused	
16) Who most frequently takes shower among the HH members? 16.1 by sex: 1=male 2=female 16.2 by age: 1=young 2=elderly 16.3 by educational status: 1=less educated 2=more educated	
17) Whose clothes are most frequently washed among the HH members? 17.1 by sex: 1=male 2=female 17.2 by age: 1=young 2=elderly 17.3 by educational status: 1=less educated 2=more educated	

18) What is used as a house hold water storage facility? 1) Tankers /such as “roto”/ 2) “gan” 3) “bermiel” 4) large /medium plastic jars 5) using many clay “ensera” or “madga” 88) Not applicable	
19) What is the largest single use of water in the household?	
20) From which water source do you get the greatest share of your water for the above question (no.16)?	
21) What is the distance (in meters) of the water source from your home? 1) Tap in residence 2) Less than 100 meters from residence 3) 100 to 500 meters from residence 4) 500 to 1000 meters from residence 5) More than 1000 meters from residence	
22) Who carries / is responsible for collecting water for the house hold if Tap is not in residence? 1) Woman 2) Man 3) Children aged 5 - 11 4) Female 12 - 17 5) Male 12 – 17 6) Everyone 88) Not applicable	
23) Compare your current (November) collecting practices to your rainy season (Hamlie/Nahase) collecting practices. Does the volume of water collected: a) Increase, by what volume _____b) Decrease, by what volume _____C) Stays the same	
24) Do you collect rain water during the rainy season? 1=Yes 2=No	
25) If your answer to the above question is yes, for what purposes do you use the rain water?	
26) How much do you think is the per capita water consumption of the household for personal uses?	
27) How much litters of water do you think is the daily water use of the household?	
28) How satisfied are you with your Current Primary Source of water supply? Code (e)	

Module 3, Section 2: Gender and water

To be responded by female members of the household? (If your respondent was a male, ask the female members of the household, especially spouse of the head)

1. Is/are there a female member of the household who makes business from the sale of “Arekie”/ “Tella” (hereafter business) or both of these?

1=Yes 2=No 88=Not applicable

2. How much is the total working capital (“Woret”) of the Business……....

3. How often do you make “Arekie”/ “Tella”? 1=once per week 2=twice per week 3=once every two weeks 4=once every three weeks or month 88=Not applicable

4. What is the main source of water for “Areki”/ “Tella”? 1=private connections 2=public stand pipes 3=water vendor 4=River /stream 5=hand dug wells

5. How much “Ensira”/ “Madiga” do you need per week for your business?.....

6. How much is your monthly bill/expense of water...

7. Do you think the “Arekie”/ “Tella” use accounts for much more of your water demand as compared with other household demands for water?

1=Yes 2=No 88)=Not applicable

8. Do you have gardens that you lawn in your compound?

1=Yes 2=No

9. Rank your domestic water uses from the largest to the smallest(a rank of 1 measures the most important water need

1=…… 6=……

2=…… 7=……

3=…… 8=……

4=…… 9=……

5=…… 10=……

MODULE 3 SECTION 3: WATER CONSERVATION PRACTICES

1) Have you heard about water conservation? 1=yes 2=no

2) Would you mind to talk what you know about water conservation ?-------

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3) What are your sources of information about water conservation?

4) Do you encounter pipe break/leaks in your supply?

1=Yes 2=No 3=Not applicable

5) Do you feel that there is water wastage in the household?

6) 1=Yes 2=No

7) Do the Household recycle/reuse water?

1=Yes, how? _____

2=No, why? _____

8) If the current price of water doubles,

What do you think to your demand for water?

1= decreases, by how much_____

2= remains the same

3= increases, by how much_____

9) What if the price is reduced by half?

1= decreases, by how much_____

2= remains the same

3= increases, by how much_____

10) How much (on average) is the amount of your monthly water bills?

(Expenditure) for water…….....

11) If you have monthly electric and telephone (both fixed and mobile) bills, how do you compare and rank with your monthly water bill?

A) _____ (greater monthly bill)

B) _____

C) _____ (smaller monthly bill)

12) Do you/any of the members of the household know how your monthly water bills are calculated? How is it calculated?

Thank you so much for your time again.

Will you be willing to participate in our focus group discussion to be held in the coming week?

Yes (would you give phone/mobile No to call you) ----------

No, I do not (Thank you).