Charles University in Prague

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MASTER THESIS

Determinants of Residential Water Demand in Hawassa, Ethiopia

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Academic Year: **2013/2014**

Declaration of Authorship

The author hereby declares that he compiled this thesis independently; using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

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Prague, May 16, 2014

Signature

Acknowledgments

I would like to acknoweldge with sincere gratitude to my supervisor Mgr. Milan Ščasný PhD for his guidance through this master thesis and for the course environmental economics and consumer behavior, in which I am initiated to do with this interesting thesis topic.

My special thanks go to Mr Mulugeta Asfaw, senior expert at SNNPR Water Resource Bureau, Mr Desalegn Wolde, Resource mobilization director at Hawassa University, for the efforts and collaboration in data collection process.

Finally and most importantly, special thanks to my lovely wife Mangudo Mekuriya and kids, for their support throughout this journey which I greatly appreciate.

Abstract

This empirical study is aimed to analyze the determinants of residential water demand and performed water use practice at household level in Hawassa. This study will fill the research gap and information on factors affecting household water demand in regions being water scarce and will provide useful information for policy-makers and water utility planners in order to use scarce drinking water resource more efficiently. In this study the proposed potential factors determine household water demand in Hawassa were; Socioeconomic and demographic characteristics, the average monthly household expenditure, use of water appliances and household water use patterns for various purposes, and household awareness towards water source conservation. The cross sectional survey was done in 169 rondomly selected households. The collected Data was analyzed using multiple regression models with different functional forms (linear, semi-log) and heteroskedaticity corrected model was also used in each of functional forms to examine the structural relationship between the quantity of water demand and explanatory variables. The gretl statisitcal software package was used. The descriptive statistics analysis was also followed to present results in tables, charts and graphs (mean, median, minimum, maximum, frequency distributions). The analayzed result indicates, socioeconomic and demographic variables (age of the respondents, household size, education, occupation or income sources from private business) were found to have statistically significant predictors with the expected signs, while hh education level with unexpected sign. The other variables; household head type, gender, and housing were not statistically significant in predicting household water demand in Hawassa. Monthly expenditure (the proxy to income & welfare), use of normal appliances (flush toilet, flow tap, shower and dishwasher), and garden were found to have significant predictors of household water demand. The sign for the variable water appliances is not as expected. Household awareness towards water source conservation was found to have statistically significant predictor of water consumption with the negative sign as expected.

Key Words: Residential water demand, determinant factors, multiple regression models, Hawassa, Ethiopia.

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List of Abbreviations

ADD	Average Daily Demand
CIWD	Commercial and institutional water demand
CSA	Central Statistical Authority
E.C	Ethiopian CalendarE
ETB	Ethiopin Birr
DWD	Domestic Water Demand
EWSDS	Ethiopian Water Strategy
FDRE	Federal Democratic Republic Of Ethiopia
HH	Household
Iid	independently and identically distributed
IWD	Industrial Water Demand
Mower	Ministry of water Resources
MDD	Maximum daily demand
lpcd	litress per capita day
SL	System Loss
SUWASA	Sustainable Water and Sanitation for Africa
WSDP	Water Sector Development Program
WSSA	Water Supply Service Authority
UN	United Nations

Master Thesis Proposal

Author:	Tarekegn Mamo Legamo
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Defense Planned:	June 2014

Proposed Topic:Determinants of Residential Water Demand in Hawassa, Ethiopia

Topic Characteristics

In this thesis work we will attempt to analyze the determinants of residential water demand at household level in Hawassa. In the study area, most of existing studies have given emphasis for the current water scarcity and the increased consumption by residential sectors and mainly they focus on supply side approach. In developing countries like Ethiopia, mostly water demand management information about household water consumption is reported in aggregate figures for total annual water consumption or in the form of access coverage that contained the information about existing problems. There appears to be no specific information about household water using behavior and/or recent information about factors affects residential water consumption. Factors of water demand at household level should be analyzed based on the current information on different uses (drinking, cooking, and washing, and so on)

This study will focus to examine potential factors influences household water demand. Relying on relevant literature reviews andAuthor's household survey information, factors such as; socioeconomic and demographic characteristics, household water use appliances, water use patterns, and household awarness towards water source conservation will be investigated. A survey from individual household consumption patterns will be collected dividing the sample selection area in to sub-city and kebele. Moreover, this study will attempt to identify water saving potential at the household's level, assess the existing residential water demand and forecast the future household water quantity demand applying multiple regression models.

Hypotheses:

1. Household expenditure and water use behavior are expected to have a positive correlation
2. Socio economic and demographic variables affects household water demand
3. The use of water saving technologies may have expected negative relations with household water consumption
4. Household awrness towards water source conservation may be expected to have a negative sign

Methodology:

An overview of theorethical and empirical knowledge contributions interms of household based water demand management approach in developing countries will be focused. Appropriate data collection techniques will be followed in order to generate information about potential explanatory factors such as household monthely expenditure, use of water saving techonlogies, type and quality of water sources,household atitude on water source protection, socio economic and demographic variables related to the household water consumption behaviour in the study area. Primary data will be used from sample of 200 household in eight cluster of the city. using sructured survey questionaire the data will be conducted in the month April, 2014. To analyse the cross section survey data we use multiple regression models with different functional forms will be used. As there is no prior basis for choosing a functional relationship, the model is provided with the options to analyze water demand using several functional forms being used in empirical literature, including linear, semi logarithmic, and other forms of models such as heteroskedasticy corrected model will also be used. The variation of water use in the sample household data will also be edited, coded, and analyse using statistical software packages.

Outline:

1. Introduction
2. Back ground policy and institutional information
3. Litrature review on residential water demand
4. Data description, Methodology of the study and model
5. Empirical result
6. Conclusions and policy recommendation

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Introduction

Water demand management, particularly in urban areas is a challenging issue for developing countires. The increasing water demand and lack of access to water sources have adversely affected the lives of billions of people in developing countries. This has aggravated in urban areas of less privilaged nations combined with population growth in alarming rate (UN-HABITAT, 2004). White and others (1972), Katzman (1977), and Hubbell (1977) conducted the first pioneered study on the analysis of domestic Water Use in East Africa where they found water demand management is an important concern. However, the problem related to water demand analysis in developing countries in this aspect is still remain there. Two reasons have been mentioned; one is lack of attention that analyses of household water demand is more challenging to undertake. This fundamental problem is believed to be such conditions with regard to water source choice and the water access vary to each household. The water source variability makes difficult to undergo detailed analysis of household water demand using secondary data from the water authority. That has not been easy to obtain the specific water source in a typical household in developing countries as though a variety of water sources, including piped and non piped sources with different characteristics and levels of services (price, distance to the source, quality, reliability, so on).

Similarly, in least developed economies, domestic water consumption depends on different sources that might be used for different purposes (Nauges and Whittington, 2008). Other sources of research contributed in presenting the limiting factors in accessing water sources and demand in developing country, the case of 69 households from Ukunda (Kenya), followed a single demand equation with dummy to control for type of water access and OLS estimation techniques. Unlike developed countries single piped sources, in developing countries households' access of water is from various sources. The heterogeneity of water source has brought about the significant impact directly in monetary terms, costs related to collection expenses, waiting time, and loss of energy in travelling to access from long distance sources. The variability of the household water source is one of big challenges hindering water demand studies in developing economies. However, one can imagine in similar situation in poor nations with large number of families living under poverty line might have challenged in a existing water pricing or costs related in different forms like waiting time, energy and income (the proxy to welfare) predicts the household water source choice as well as water consumption patterns(Mu and others, 1990).

The objective of this study is to analyze determinants of residential water demand in urban Ethiopia, case of Hawassa. There have been potential factors affecting the water consumption at household level in least developing countires including study region. Among these, rapid population growth coupled with urbanization in Ethiopia has been enforcing rapid socioeconomic changes placed high pressure on residential water use. The water systems maintenance and replacement cost needs huge financial and technological capability to upgrade the water system functionality to make sure sustainable services for the residents. The weather condition significantly changes the amount of rainfall to vary and seasonal fluctuation in precipitation and temperature patterns, affecting the availability of water sources. The water utilities in many of the Ethiopian cities including Hawassa are facing problem to meet water demand with the available water supply, while the increasing household water demand pressurized the need to find the substantial solution in short and long term plans. In this case, most studies have given more emphasis on the current water scarcity and the increased consumption by residential sectors and mainly they focus on the supply side approach. As a matter of fact, water demand management information about household water use is reported in aggregate figures for total annual water consumption or in the form of access coverage that contained the information about existing problems. There appears to be no specific up to dated information on the details of household water demand factors supported by practical scientific research investigations. Moreover, factors influencing water consumption for different uses at the individual household level (drinking, cooking, bathing, etc.) has been a crucial issue that has not yet been studied in a particular locality of this study area and in the cities of same socioeconomic levels in the region. To deal with the aformetioned problems and considering the scientific research gap in a particular topic, this empirical study is aimed to analyze the possible factors influencing residential water demand in Ethiopia, case of Hawassa. We use the empirical model applying multiple regression analysis to examine the relationship between the household water demand and possible explanatory variables relying on the information from household cross section survey.

The organization of the thesis is presented as follows; Chapter one: provides back ground policy and institutional information, such as water demand management policy in the context of Ethiopia from past to present, water management policy and strategy at various water demand sectors; Domestic, industrial and institutional frames in urban, rural contexts and so on. Chapter two presents literature reviews in similar research works in the past on water demand factors, pricing and non- pricing factors such as socioeconomic factors, household water use patterns, and water saving technologies, water conservation effects on water demand, micro and macro policy relevant issues. Chapter three provides the basic methodological framework of the study. It presents the description of the data and the econometric models used to test the stated hypothesis in this study, description of the variables and expected signs proposed in the hypothesis section. Chapter four presents empirical results relying on the designed research methods and models used for the analysis. This part includes both descriptive statistics and regression coefficient analysis and discussion on the main results and finalizing study contribution. Chapter six gives due attention on summarizing overall study results in conclusion and the way forward in policy recommendation.The last part of the paper annexes Appendixes of test results and survey quesionnaire.

Chapetr ONE:Back ground policyand institutional information

Thompson et al., 2001 and (IWA, 2013) points that a daily water supply rate in the developing countries is very low compared to the industrial world against the increasing demand. This can be evidenced from the comparison of Reginal water consumption in different sectors in which the sub Sharan Africa‘s household consumption is the lowest average compared to Europe, Asia, North and Latine America. The mean daily per capita water supplied by piped and un-piped systems, and the mean daily per capita water used for different purposes in East Africa is lower than 20 litres per day. This implies that water scarcity problem in developing countries is not only the current situation that the poor are suffering in it, rather it will also be predicted the upcoming future relying on various estimated variability of potential factors. Scientific research suggests that future challenge of water demand management predicts as cities of the future developing countries will experience difficulties to manage efficiently scarcer and less reliable water resources. The population growth and urbanization, Climate change and deterioration of existing water infrastructure adversely affects the availability of water sources (Khatri, K. et al, 2007).

Moreover, the current trend in water scarcity in many of developing countries is not only as a result of shortage of water supply rather there have been other determinant factors such as poor distribution efficiency through the utility networks or water losses from the distribution system and inequalities in service provision between the rich and the poor, the growing population number, global hydroclimatic change, the socio demographic characterisitics, the required investment cost of water supply projects and technolgy, water pricing and economic growth(Brockerhoff, 2000), (UN, 2006), (Misiunas, 2005).

Water infrastructure investment cost is the other considerable institutional factor in residential water demand management and planning. As a result the municipality of developing countries is experiencing a confrontation with increasing cost of water supply which is much more expensive than before (Grafton, Kompas, To, & Ward). Further water demand study pointed out, water resources management policy design requires thoroughly understanding of consumer behavior. In line with this, responsiveness of water demand to price, household wealth measured in terms of expenditure or income changes are important factors influnce household water consumption. Authers further examines that non-pricing policies, such as restrictions on water usage and education programs, are also influnces water use behavior (Worthington & Hoffman 2007). There are some alternative ways of water resource management strategy that suggests, as the water demand management and water reuse opportunities are real and increasing through time, a combination of end-use efficiency, system efficiency, storage innovations (using different managed aquifer recharge options), and reuse strategies would reduce water demand. (Khatri, K. et al and 2007)

A number of factors affect the development and management of the water sector in Ethiopia. These issues are discussed in detail in a recent review of the water sector development strategy carried out by the Ministry of Water Resources (MoWR). In order to address these issues, the Mower has pursued a three-prong sector reform agenda in the water sector with an aim to secure the basis for sustainable development and management of a country's water resources. The three agenda's were; first, establish effective institutions to secure sound institutional basis for sustainable development and management of water resources. Second, develop and implement capacity building programs at all levels (federal, regional, zonal, woreda, private sector and grass root level) on the relevant areas of water resources management. Third, formulate appropriate and essential water legislation required to expedite water resources development and management.

According to the Ethiopian water management policy (MoWR, 1999) Water resource management strategies can be viewed in terms of economic and non-economic measures. Pricing policy and allocation of property rights over the use of water is considered economic measures, in demand-oriented approach. Whereas the use of regulations to control water demand, promotion of public awareness about the importance of water, reduction of reticulation and other losses of water production, and the use of water efficiently in a sustainable manner are included in non-economic measures. But these measures have with certain limitations particularly associated with the pipe connection. In this aspect the rural areas have minimal applicability in both economic and non economic measures in Ethiopia as for most of the water sources are non pipe connection. On the other hand, urban areas, there have been pricing policy applied to less extent so as to promote a distributional efficiency of the use of water.

The Water Sector development strategy, says more commitment to the use of non-economic measures of water demand management than the previous supply-oriented plan. It suggests that the use of water tariffs to reduce water demand must be complemented by educational campaigns on water conservation and the use of water saving technologies. (EWSDS, 2001)

1.1 Urban water demand in Ethiopia

Evidence from Ethiopian water sector development program reveals, Communities with a population of at least 2,500 in the base year 2001 were considered as urban. At, regional, zonal, and *woreda* level capitals were automatically classified as urban communities irrespective of their population. Urban communities were further categorized as: (a) large towns, with a population equal to or greater than 50,000; (b) medium towns, with a population equal to or greater than 10,000 and less than 50,000; and (c) small towns, with a population equal to or greater than 2,500 and less than 10,000.(*WSDP, 2002)*

Urban water demand was projected by estimating: domestic water demand (for residential units); commercial and institutional water demand (for commercial and public institutions); and industrial water demand (for industrial establishments).

1.2 Domestic water demand

Daily per capita water consumption is generally very low throughout the country. DWD is suppressed in almost all towns in the country because of supply shortages. Actual demand is expected to be greater than present consumption if greater supplies were available to the community. In estimating DWD, general design standards were adopted: 30 to 50 litres per capita daily (lpcd) for urban centers and 15–25 lpcd for rural areas. Since the majority of the urban population uses public fountains, a ratio of 60 per cent (of public fountain) to 40 per cent (of house or yard connections) is assumed. The urban DWD per day is thus projected as being: 30 lpcd for short term, 40 lpcd for medium term and 50 lpcd for long term. Water demand for small towns (with fewer than 10,000 inhabitants) was estimated applying the rural standard.

1.3 Commercial and institutional water demand

In addition to those of household consumers, the water requirements of towns include the needs of such commercial and institutional consumers as public schoOLS, clinics, hospitals, offices, shops, bars, restaurants, and hotels. CIWD is usually linked directly to population size. For small- and medium-sized towns, it was estimated at 5 percent of the DWD. For larger towns, the CIWD estimate was 10 per cent of DWD. Those allowances were applied to all towns. Industrial water demand (IWD): For planning purposes, a reliable IWD indicator was assumed to be the following percentages of DWD: 30 per cent of DWD in large and medium towns; and 10 per cent of DWD in small towns. Those allowances should cover all water uses for large, medium, and light industrial units. As far as possible, large- and medium-sized industries are assumed to provide water supply from own sources

1.4 water System losses

Losses from water supply systems vary considerably according to diverse factors. SL is a function of the quality of construction, the type and age of the pipes in the distribution network, and pressure within the system. SL can also originate in treatment plants. For *urban schemes*, SL equivalent to 25 per cent of the total domestic, commercial and institutional, and industrial water demand was assumed. For *rural schemes*, a nominal 5 per cent allowance was made to account for spillage at hand pumps. SL from treatment plants was considered negligible in rural areas, since groundwater sources supply most of the raw water there and the only treatment that might be required is disinfection.

1.5 Average Daily Demand

Urban ADD is considered to be the combined total of demand from domestic, commercial and institutional, industrial, and system losses. Rural ADD for water supply is the combined total of domestic demand, livestock demand and system losses.

1.6 Maximum daily demand

Daily water consumption in a town varies according to time of day, season, and climatic conditions. Within the entire country climatic conditions vary, although not to a wide extent. Variation in MDD is accordingly not very wide. To allow for increasing water consumption during the dry season, therefore, MDD was assumed to be 1.15 times the ADD for all towns. The MDD sets the water requirements from the sources within the system. Thus, the water demand for each urban center was calculated according to the above formula. (*WSDP, 2002)*

1.7 The existing Water supply of Hawassa

The water supply system consists of an intake structure with the river “CADO” which is located 17 km south of the town, two spring sources(Loke and Ambo spring) and 10 borehole (deep well) are the main water sources(WSSA, 2011).

Table 1: Water consumption by different sectors

No	water use	connection	Annual production(m3)	Consumption in m3	Water loss	served population	Total Population
1	Domestic	17510	-	1798497	-	-	-
2	Institution	428	-	280729		-	-
3	Commercial	393	-	165665	-	-	-
4	Industry	31	-	100639	-	-	-
5	others			543516			
	Total	**1362**	**3294461**	**2889046**	**405415**	**236700**	**292533**

Source: water utility office report (2011)

From these water sources the optimum amount of water production per annum is 3294461 cubic meters (m3). The total annual loss rate is 405415. The total domestic consumption of the town per annum in 2011 is 1798497 m3/year.

In June 2012, SUWASA supported the utility to develop and implement an improved tariff regime that covers operation and maintenance costs, and which gradually lead to full cost recovery and encouraged efficient water usage. The city administration approved the tariff in which the utility suggests to start its implementation. The new tariff provided subsidies to the poorest and generated revenues to expanded water services.

A Flat water tariff is used currently, but after the new project of an increasing block tariff model will be implemented sooner. The proposed water price in five blocks is shown in Table 2. The water utility hopes the new tariff model can be used to improve Water shortage and reduce waste (Hawassa water utility, 2012).

Table 2: Hawassa city water tariff rate (2012)

Category	0-5m3	6-10m3	11-25m3	26-40m3	>40m3
domestic	3.75	4.50	8.25	8.25	8.25
Public enterprise	4.50	5.25	8.25	8.25	10.5
Government	4.50	5.25	8.25	8.25	10.5
Commercial	4.50	5.25	8.25	8.25	12.00
Industrial	4.50	5.25	8.25	10.5	12.00
Standpipes(Bono)	3.00	3.00	3.00	3.00	3.00

Source: water utility office report (2012)

Chapter Two: Literature review

2.1 Residential Water Demand factors

The existing large body of literature reveals as residential water demand studies in developing countries have been started long ago. However, as can be elaborated in this literature review it is still a lot of research problems that has to be investigated at household level. Indeed, in this study we focus on the assessment of theoretical and empirical informations that contributes to the development of accurate research methods to investigate the major determinant factors in household level water consumption analysis, most importantly in developing countries context, and some important contribution from rich nations, having parallel implication to the study area are also suggests to be assumed.

Many empirical studies have shown that residential water demand has been analyzed at household level in developed countries, particularly in terms of price and income elasticity of water demand. These studies considered a uniform water source or tap connection in their econometric model of demand estimation techniques. If it is the case, in developing countries may or may not be applicable in fully or in part, where there is household water sources variability (Mu and others, 1990, Nauges and, Ščasný, 2012). In later case it can be achieved to estimate residential water demand by usingAuthor's household survey at particular study area to cope with data availabiltiy constraint and source variablities. This implies that in developing ccountries water source choice and variability is strongly associated with household water demand estimation.

Most importantly, inaccessibility of relevant information in appropriate time and size determines the decision of what methodology should have been followed by researchers who are willing to undertake micro level household water demand studies in developing countries. By doing so researchers can have datasets that allow them to go with household level consumption data with socio demographic and economic data of the people and house associated with a household water account. As a result, different studies to date have been suggests their contribution on household water demand variation, mainly determined by various factors depending on the objective realities and in each study contexts is associated with differences in water pricing, income, expenditure or changing lifestyle, changing socioeconomic and demographic factors, water infrastructure functionality and water utility management efficiency, household preference towards water use and conservation

(Hankeand de Mare, 1982; Jones and Morris, 1984; Lyman, 1992; Renwick and Green, 2000).

Nauges and Ščasný (2012) have done an empirical study on residential water demand in Czech Republic using 16 years annual household data. They found that the price elasticity is estimated -0.6 and the effect of price changes differ over time and across the population, depending on household's characteristics. This analysis indicates the income elasticity is +0.4 and other non pricing factors(more related to this study) such as the number of dependent children, retired members and use of washing machines have a positive effect on household water use, whereas households property ownership, live in smaller cities and better educated have consume less water, on average.

Espey et al. 1997, Dalhuisen et al. 2003,in their meta-analysis study have point out the contributions of other empirical studies and reveals that, the price elasticity of residential water demand is mainly inelastic. Water tariff is also an important determinant factor afftects residential water demand in least developed countires. It is mainly related to valuing of water as a scarce good, whose consumption needs to be efficiently priced (Arbues, Garcia-Valinas, & Martinez-Espiniera, 2003).

Other source of empirical study conducted in Chongqing, China considers the effect of water pricing variable in water demand and WTP analysis. Based on the household survey containing water pricing information reveals that urban municipality water pricing policy determine residential water demand in terms of willingness to pay for the improved water services(Hua WANG et al, 2010).

Further empirical contribution in cross country analysis of ten thousand sample study in ten OECD countries shows that households pays high water charges have on average a quarter less Water consumption than those that do not, households in all ten countries have a lower water consumption, the higher is the average volumetric price of water. In the same study factors other than price and income have the effect on residential water demand. Household socioeconomic characteristics that include household size, education level and household income all have a statistically significant and positive effect on household water consumption, households incurs higher water charge have a higher likelihood that they will undertake water saving behaviors. The same study reveals that the use of water saving technology and age of residence (years) have effect on water consumption; and high income households are less price elastic than low and medium-income households (Grafton et al, 2009).

Similar to the OECD countries analysis, more feasible household water demand study conducted in Sirlanka, focus on both piped and non piped water supply services applying the probit model with the Maximum-likelihood estimation technique in 1,794 households. Accordigly, those households with a higher income, more educated head and larger household's size are more likely to have a private connection (Nauges and Berg, 2008). But other study elaborates that household water demand has less correlated to family size as for economies of scale in discretionary and non discretionary water usage, such as cooking, cleaning, car washing and gardening as there is an optimum household size beyond which these economies of scale diminishes (Arbués et al.2000). Other empirical evidence also shows that, keeping other variables constant, income and price elasticity are more likely have prediction power of water demand. Households belongs to higher income group are believed to use more water than the households with lower income or poor groups. The price elasticity also matters with the level of income the households belongs. So that high income families have likely to be less price elastic in terms of their water use comparing to less income families(Dalhuisen et al. 2003).

The compiled study document by Arbués et al, (2003) reveals the common explanatory variables that can affect residential water demand mainly are water price or tariff rate, income, household size, climate change, water system functionality or efficiency. This Meta analysis study confirms, most of empirical studies are using a linear water demand model (in order to specify the function as for the simplest estimation methods). However, the linear functional form did not escape from critics, as for inelastic water demand. Likewise, one study in Chiness city suggests that income and water pricing affects household water demand in developing countries (Lu, 2007). The same study also reveals that socio economic factors determine the urban household water consumption behavior in developing countries. Contrary, Henry et al (2004) argues that, water price and income do not have the expected impact on household water use and consumption. However, both studies have a similar stand from the demand management point of view.

Further study sources points, the use of water efficient appliances (toilet, shower, taps and washing machine) changes the household water Demand through installation of water efficient appliancess and promotion of water conservation behaviors. These water saving technologies are the effective method of demand management to OLS used before implementation of other alternative options, since it is low cost demand side alternative approach to adopt measurement of end use consumption. With this application, higher household water stock efficiency reduced water demand by up to 25 % (Fider et al 2010). Similarly, the four years longitudinal study confirms households with extra water saving technology are likely to have higher water savings. Its implication is consistent with the work of Mayer in which Residential water demand mainly determined by appropriate water demand management strategies like water metering, water restrictions, and installations of water saving technologies(Lee et al 2011). Similar study illustrates commitment and environmental attitude affects water and energy saving regularly (Gilg and bar 2006).

Likewise, Nancarrow and syme (1989), CSIRO (2002), Henrich (2007) have suggest, that water conservation awareness and practice involves understanding the efficiency, opportunities and impacts of water saving activities to reduce consumption. However, the contradicting finding indicates as there is no longer direct correlation between household knoweldege on environmental conservation and water consumption but argues environmental attitudes do not affect overall household water use rather it increase the tendency of responsibility somehow to the specific water saving behaviors(Nancarrow et al, 1996, Grafton et al, 2009).

Fontein, M (2007**)** indicates, that household water use pattern affects household demand. The out door water use activities such as multiple use of water.

There are several other factors influencing household water demand, among these population increase, economic growth (GDP) and lifestyle changes can adversely impact the water demand (Mohammed, 2000, Krinner and Lanllana, 1999)

An other important residenntial water demand factor is household expanditure. Living standard measurement study and poverty analysis in developing countires shows household expenditure is believed to be a better proxy indicator of living standards or welfare than income(Hentschel and Lanjouw,1996). Infact, behavioural economics tells us consumers are most likely to buy and consume normal commodity and services given the budobtain constraint. However, an other household survey study indicates mostly consumers are likely to understate their incomes than expendiure(Deaton, 1997)

The difference in household demand estimation could affect water demand for univariate classification, while few significant differences in multivariate classification based forecasting of residential water demand (Fox et al 2009)

Household water demand is further illustrated by the poverty and education status. As clearly has shown by BRUCE.L et al(2006), the household livelihood economy and schooling level influence household water supply technologies; which in turn affects the quantity of water used by households (Income and education levels) are important determinants of a household's water supply/choice situation, have a large price effect on willingness to pay for service improvements).

Other authers illustrate that the rainfall and weather condition can also affect household water demand by alerting the need for watering and other outdoor activities (Marshallsay, 2003). Conversely, opponents argued that the raise in temperature can result in an increase in household water demand and do have a positive correlation (Good Child, 2003)

There have been various problems related to household level studies in least developed economies. Two basic questions about household water demand studies are yet not answered For example, the first and for most fundamental problem is the exiting data. Since, the existing data lacking reliablilty to estimate household water consumption behaviour, that is the analyses of household water use for various purposes could be a first step. Second, wealth or income analysis following changes in the conditions of water supply to the household in developing countries remain a challenging question, in which the use of block pricing for connected households and non connected public sources (Nauges and Whittington 2008)

Few comparative studies on the Residential water demand in the urban households were carried out in Ethiopia. Study conducted long ago in wider scope of water sectors including domestic, institutional, industrial, and commercial uses in same study area indicates that time and seasonal variation are considerable effects and these variables are included in the water consumption and peak factors that have influence on household water consumption patterns(Mesfin,1988).

The recent emprical analysis on cross sectional household survey at Merawi, Northern Ethiopia, reveals that socioeconomic and demographic variables, household expenditure, employemnt, primary source of water and household head have positive relationship, while age and sex of household head found to have negative relationship with water demand (Dagne, 2012).

Other recent study in Addis Baba, the Capital of Ethiopia indicates, management efficiency and effectiveness of utility in the municipality affects the residential water demand and institutional functionality does so (Woldmariam, 2009).

Similarly, the water demand study conducted in Mekele Northern Ethiopia, shows family size, education, water source and distance from the water sources have the power to predict household water demand (ABDU, 2012).

2.2 Summary of literature review

There are important highlights of theoretical and empirical work has been assessed thoroughly to have abasic foundation on the determinants of residential water demand in both developed and developing countries. Accordingly the following points have been traced out.

Findings from the existing body of knowledge contribution on the analysis of household water demand functions have been given more emphasis on changing socioeconomic characteristics, water pricing, income, expenditure, water saving technologies or appliances , household water use practices, household water saving habit and conservation measures were among the most relevant issues discussed in this review. Moreover, policy-relevant issues particularly in the context of a growing economy at comprehensive and macro level economic growth and the increased hydrologic variability brought about climatic factor such as temperature and rainfall are placing new pressures on the water sources used by urban residents in developing countries and elsewhere described in this literature. In developing countries with rapid urbanization coupled with population growth and variability in the raw water supplies increases, providing a reliable supply to households become more challenging. Governments and other donor organizations throughout the world are also facing increasing demand and distributional efficiency of water resources among different users. Both climate change and intersectoral competition for water brings demand management increasingly important in developing countries including the study region, Ethiopia. Thus, strengthening the need for a better understanding of the urban household water demand issues, knowledge about determinant factors and information for further improvement and decision making on water demand management as well as an urban water services expansion for domestic uses in different circumstances are the prime issues attempted to address by number of researches in most reviewed studies in this thesis.

Chapter Three: Methods and data description

3.1 Study Area

Ethiopia is one of the oldest locations of human life known to scientists and is widely considered the region in the horn of Africa from which Homo sapiens first set out for the Middle East, a center of ancient state formation and civilization. According to the national census of 2007, the total population of the country is estimated to be more than eight millions, which makes it the second most populous nation in Sub-Saharan Africa.

The FDRE has a total area of 1,221,480 square kilometers. The economic main stay 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 (CSA, 2009).

There are nine contitutional regional states under the Federal Democratic republic of Ethiopia (FDRE). Among these federal states, the Southern Nations Nationalities and Peoples Regional State (SNNPR) is the third largest regional state with the total estimated population of over 15 millions of inhabitants next to Oromia and Amhara regional states.

In this aministrative region more than 56 ethnic groups have been situated and the regional state is consitiued by fourteen administrative zones and three woreda or district level administrations (CSA, 2007)

The study area, Hawassa is a capital of the Southern Nation's Nationalities and Peoples Regional State and located on the shores of Lake Hawassa in the Great Rift Valley; 273 km south of Addis Ababa via Debre Zeit and 1125 km north of Nairobi. The City lays on the Trans-African High Way-4 an international road that starched from Cairo (Egypt) to Cape Town (S.Africa). Geographically the City lays between 7^{0}3' latitude North and 38^{0} 28' longitudes east.

The city administration has a registered population of 316,842, with the annual growth rate of 4.02% and covers an area of 157.2km2 (CSA 2007). The city is divided in to eight Sub-Cities and 32 Kebeles, These Eight sub Cities are Hayek Dare, Menehariya, Tabore, Misrak, Bahile Adarash, Addis Ketema, Hawela-Tulla and Mehal Ketema Sub-City.

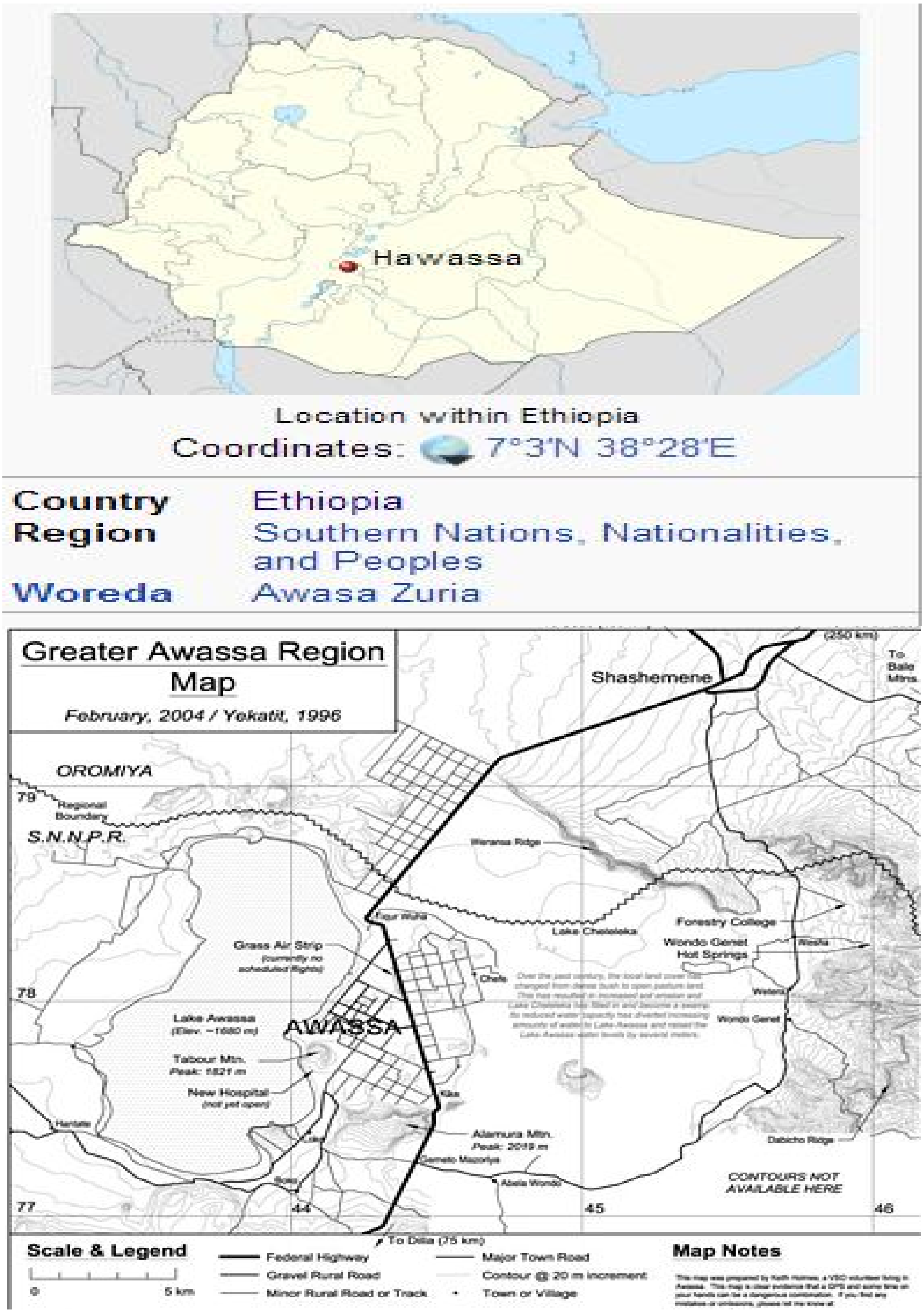
Table 3:1 Population by Sub-City /2004 E.C/ 2012

NO.	Sub-cities	Population size by sex		
		Male	Female	Total
1	Hawassa	103,646	97,381	201,027
1.1	Addis Ketema	11,435	11,432	22,867
1.2	Hayek Dar	11,488	10,809	22,297
1.3	Mehal Ketema	9,541	9,242	18,783
1.4	Bahile Adarash	9563	9487	19050
1.5	Misrak	15620	14142	29762
1.6	Menehariya	16082	15351	31433
1.7	Tabor	29433	26468	55901
1.8	Tulla Town (Kebele 01)	484	450	934

Source: CSA, 2007 census result projection

The mean annual precipitation is 72.21mm. Temperature varies between 6°C in winter and 34°C in summer. The City experiences sub humid-called 'Woina Dega' in Amharic type of climate. In 2011, the highest and the lowest monthly average Temperature of 22.6 and 18.8 (°C) respectively. The average annual temperature is 20.6^{o}c. . Hawassa obtains rainfall twice in a year. It falls during 'Spring ' and 'summer'. Mostly; the first rainfall falls from 'March' to the mid of 'May' and the next comes from 'June' to the mid of ‘September’. Due to the City‘s location in rift valley and nearby lake, there is weather condition varying from day to night.

Figure 3:1 Location and map of the study area



Source :(CSA, 2009)

3.2 Research questions

This study expected to answer the following key research questions:

1. Do socio economic and demographic factors affect household water demand in Hawassa?
2. Does household expenditure have a positive relationship with water consumption?
3. Does the use of water saving appliances have effects on household water use?
4. Does household's water use pattern determine water demand in the study area?
5. Does households awareness to wards the water source conservation improves the quantity of water consumed?

In order to answer the research objectives and questions the following hypothesis to be tested:

Hypothesis One (H1): Socioeconomic and deomographic variables affect household water demand in the study area.

Hypothesis two (H2): household expenditure may have a positive correlation with water demand:

Hypothesis three (H3): use of Water saving appliances reduces household water consumption in the study area

Hypothesis four (H4): Household water use pattern (outdoor use) expected to have a positive relation ship with water consumption

Hypothesis five (H5): Household awarness towards water source conservation improves water consumption with expected negative sign

3.3 Survey description

Residential water demand factors such as household socio-economic and demographic information, estimated monthly income, household monthly expenditure, water expenditure (water meter reading), and ownership and frequency use of water appliances, water use for various purposes, and household awareness towards water conservation were the major inequries in the survey questionaire.

The structured survey questionnaire was designed in line with the research questions. There are several questions asked such as respondent's age, gender, household type, occupation, income, water consumption and use patterns, water saving behavior, sources accessibility and quality, water use patterns, affordability of water price, possession of water appliances, and household attitude on water conservation were the main questions included. Three enumerators, who graduate in water supply and sanitation from technical and vocational school, were asigned to conduct the household survey in person pencil use approach based on their previous experience. Two collaborators, one senior planning expert from regional water resourse development Bureau and the other from Hawassa University staff member, have took a lead during data collection and recording the collected survey in spread execel sheet.

The questionnaire was pre tested and revisions were made and corrections were incorporated in the original survey. The designed questionnaire was translated in to Amharic language for simplicity and divided into sections to elicit the respondents easily. One day training were given for recruited enumerators by two of collaborators on how to fill up questionnaire and make them understand the subject in depth during pretest and after pretest before tha start of the original survey.

The total of twenty-nine closed ended questions was provided. As closed ended questions are more specific than open ones and they could detect differences among respondents more accurately and easy for the respondent to answer. The survey was conducted from 01 to 15 April, 2014.

Additional secondary information was gathered from water utility for back ground information like annual water production, total demand, tariff rate and the total number of water network connectection, and access coverage.

3.4 Survey sampling

A multiple stage sampling procedure is used for the selection of observation units. First, seven sub-cities were purposively taken out of eight administrative sub-cities (Menhariya, Bahile addrash, Tabore, Hayk dare, Addis Ketema, Misrak k. ketema and mehal ketema). Second, we randomly selected 14 kebeles (two kebeles per sub-city). Finally, we randomly drew 169 households from 14 kebeles.

As indicated in the above (table 3:1), the total population of Hawassa, excluding Rural community (Tula Sub-city) is 201,027, and the total household number is approximately 40,000. The sample size was determined considering the limited time and resources to represent the population of the study area.

The list of residents was obtained from the population census report of the water utility for each sub-city. The proportion of number of households in each kebele to the total number of households in the kebele was calculated and this proportion was used to determine the number of sample households to be included in the sample. The selection criteria were simply qualifying water system connection from the source by pipe networks. Maping of the survey households was simply managed by trained enumerators as they have rich skill on GIS maping from technical school and they had already experiences working in similar condition in the study area previousely. Accordingly the survey team visited the ranodomly selected sample house and make a contact to responsible person in that household, mostly head of the household either male or female.

Exclusion; Households using additional water sources were not included, non-piped connected households and other primary source users were also excluded from sample. Seasonal variable is also excluded due to limitation in time and resources.

Chapter Four: Water consumption and its determinants

4.1 Summary of descriptive data

A total of 169 sample households were interviewed in the survey. Out of the total sample respondents, 110(65%) are head of the household, and 59(35%) were spouse of household headed. As for the composition of gender of respondents, 88(52%) were male and 81(48%) female.

The education level of the respondent ranges from minimum of read and write to the maximum of college graduate. From the total respondents 10(5.9%) can read and write, 18(10.5%) primary education complete, 26(15%) completed secondary and the majoity 115(68%) are college educated.

The average age of the respondent household is 38 with the range of the minimum of 20 and the maximum of 72 with the median 37.

The average family size of the survey household is five, and it ranges from 1 up to 12 members. This is some how bigger than country average (4.7) and nearly equal to the Southern reginal average 4.9 (CSA, 2007)

The other socioeconomic survey result illustrates, occupation of the study households, 58(34.32%) are employed in private business, the simple majority 98(56%) are salaried employees both in government offices and other organizations, the remaining 13 (7.69%) were survive in remittance and other informal sectors.

As to possession of the current living house by the respondents, 167 (98.8%) of the respondents live in their own house, only two (1.18%) rent from private individuals.

Table 4.1 Characteristics of Heads of the surveyed HHs

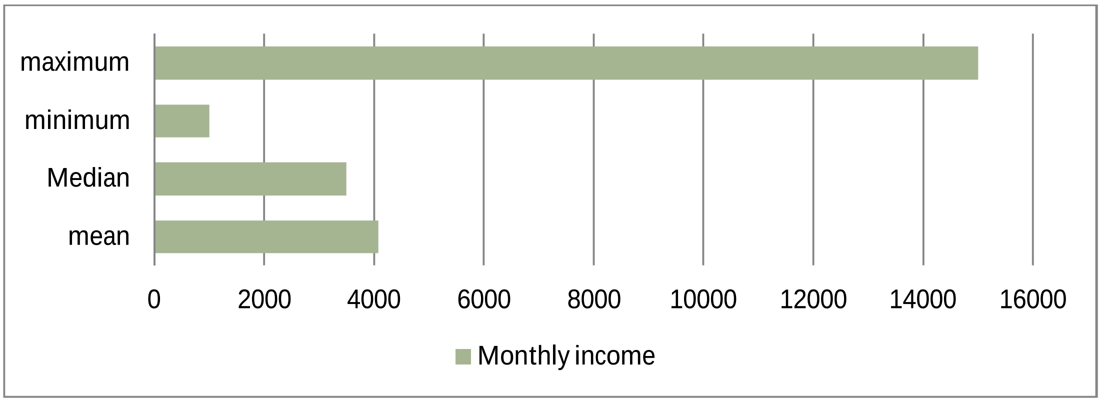
Variable	frequency	Percentage
Gender of HHH		
Male	88	52
Female	81	48
HH head type	N=169	
HH head	110	65
Spouse HH head	59	35
Children	-	
Education	N=169	
Read and write	10	5.9
Primary complete	18	10.5
Secondary complete	26	15
College education	115	68

Sources of income/occupation	n=169	
Private business	58	34.32
Salaries	98	56
Remittance and others	13	7.69
Current house HH lives	N=169	
Private house	167	98.8
Rented from other individuals	2	1.18

Household income

The descrptive statistics result indicates the average monthly income of the household is Birr 4078.8 ranging from minimum of Birr 1000 to the maximum Birr 15000. The median income is birr 3500.

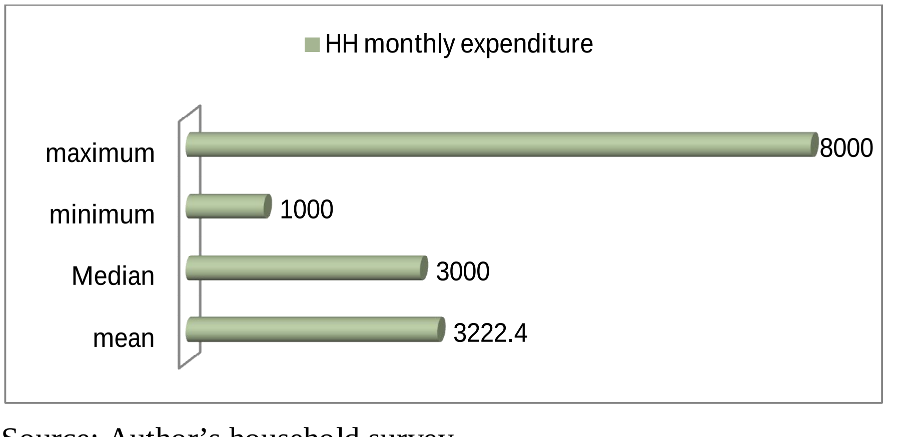
Fig 5 monthly household income



Source: Author's Author's household survey

Household expenditure

The average monthly expenditure of the household is birr 3222.4 ranging from the minimum birr 1000 to 8000 maximum and the Median 3000.



Source: Author's household survey

According to the survey data the average monthly water expenditure of the household is 34.67 birr.

When we compare the average monthly water expenditure to the average monthly income of a household (birr 4078.8), an average household spends only 0.85% of his or her monthly income on water services. This is the lowest cost of household water expenditure rate as compared to the World Bank's recommendation, which states a household should spend up to a maximum of 5% of its monthly income on water. This implies a household living in the study area can afford to spend more if he or she is provided with improved water access.

Household water source and consumption

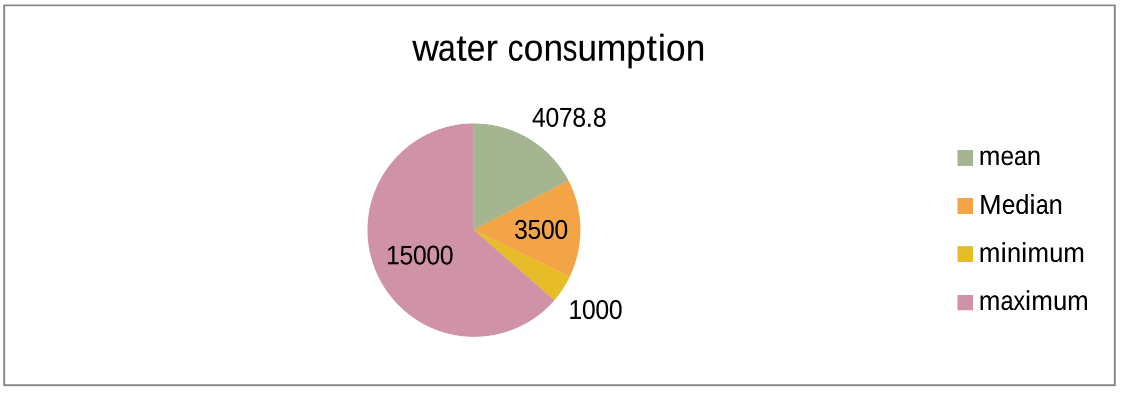
All sample survey households 169(100%) were connected to a private water connection to the piped network. It is the main source of the study households. In our assumption those households using additional water sources were excluded in order to avoid biasness in the study result. Thus, this study assumes only households connected with water sources provided by the city water utility with bearing water expenditure in monthly water bill. Among the 169 private connected households 137 (81%) were in house tap connected and the rest 32(18.93%) households are yard connected. The combined (both tap and yard connected) monthly average household water consumption translated in to daily per capita consumption in litress, taking the average five family size in to account is, 54.6 lpcd.

In- house connected households (tap connected) average monthly water consumption is 9,166 litress, while for 32 of yard-connected households average monthly consumption is 4,029 litress, which indicates the later household consumes by double less than the tap connected ones. If we convert in to litress per capita consumption, given five family members in the house, estimated tap connected household average consumption is 61.1 lpcd and yard connected household do in average 26.86 lpcd.

We can see a big variation in both households water consumption pattern that is almost more than double. The possible explanation for the observed trend is that the use of water-saving appliances or those connected households have more access to water system leading to the huge variation in consumption. In addition, we tried to analyze income and expenditure effect in comparison of both taps connected and yard connected households so as arrive at accurate justification for the variation. The descriptive survey analysis shows that the mean variation of monthly income is 1847 Birr. This indicates tap connected households belongs to higher average income family by large. However, the maximum income family belongs to yard connected households, and both households have equally minimum total monthly income (1000 Birr). Similarly, monthly expenditure analysis shows the variation in average monthly expenditure is 1436 Birr, still tap connected households were more than yard connected households' average monthly expenditure(by 1436 Birr). Thus, both income and expenditure may have association with household possession for water use appliancess. In fact, in developing countries it is common in which only wealthy households can afford to buy such equipments. Further investigation of the dependence is left to research work in the study area.

The survey result describes the differences in household water consumption in the study area presented in the figure 1.

Fig 4.2 household monthly water consumption

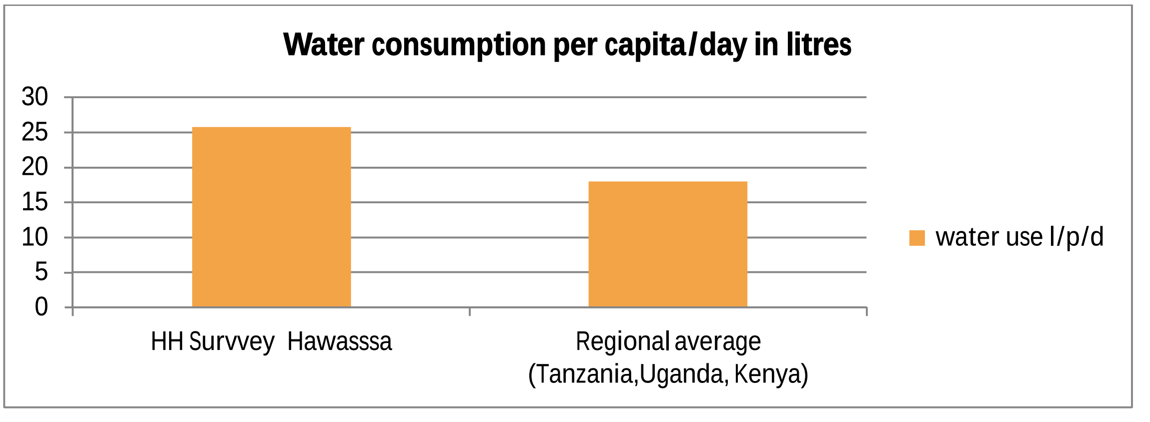


Source: Author'sAuthor's household survey

The combined (both tap and yard connected) households average monthly water consumption was 8193.3 litress, ranges from a minimum of 500 litress to the maximum of 62500 litress per month with median 6563. If we consider this into per capita per day it is about 54.6 litress. This figure indicates significant differences as compared to the minimum daily water consumption per person recommended by UN for developing nations as a social minimum which describes clean water is part of the social minimum, with 20 litress per capita per day as the minimum threshold requirement. However, this result is nearly matches to the maximum of national per capita/per day standard figure in which 30 litress to 50 litress per capita per day for those households connected to private water networks. However, this result did not include the rest of households whose water sources were from public fountains and private vendors in which below the minimum threshold of UN standard and even less than average of the national standard as calculated in per capita per day parameters.

If we compare the result with the regional average to that of East Africa, the average daily per capita water consumption, which was 55 to 60 litress per capita per day for connected households (Thompson et al., 2001). The survey results (54,6litress) were consistent with the regional average. Surprisingly, compared to 18 years back with similar geographic area the average water consumption was 65 litress per capita/day for the same average family size 4 – 6 (Mesfin, 1988).

Fig4. 2 Comparison of the study result with nation average and regional average



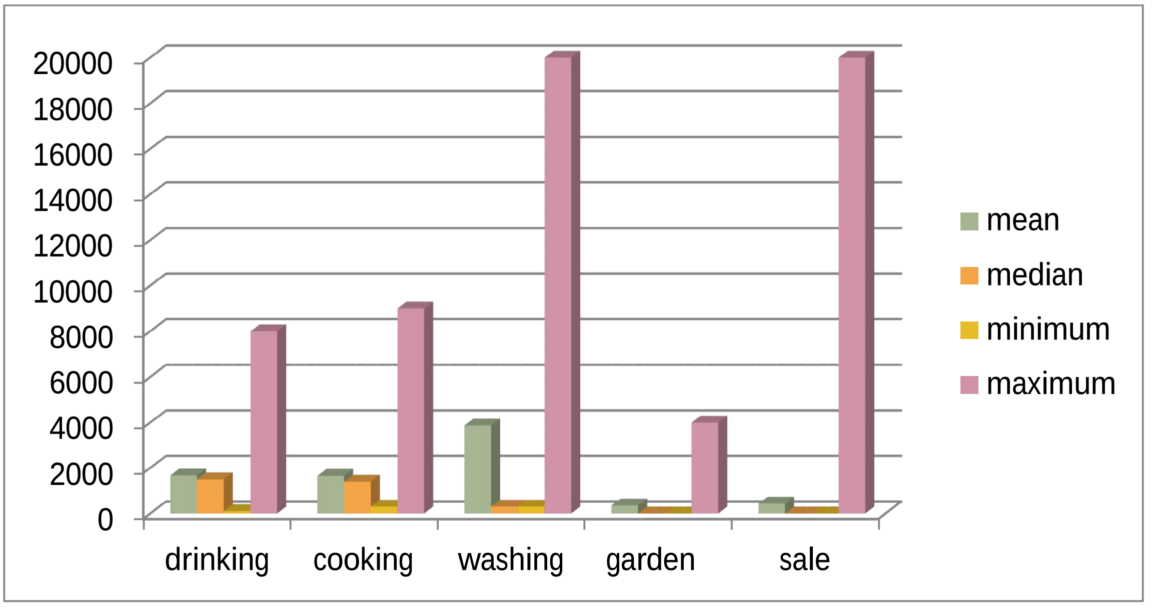
Source: Author's household survey & Thompson et al., 2001

Water use patterns

The total amount of the household water allocation goes to indoor uses. Drinking, cooking, washing, and part of these used by outdoor activities such as watering and for private vendor were the main distribution of water supply in the study area.

The study household uses a monthly average quantity of water for different purposes presented in (figure 4:2) below. The average monthly allocation of water for drinking is 1671.4litress ranging from the minimum amount of 100litres to 8000 litres with the median of 1500. The average monthly distribution for Cooking is 1651.2 litres, washing 3871.4litress, gardening 348.37litres, and 428.99 litres per months for sale.

Figure 4:2 shows monthly household water use for different purpose



Source: Author's household survey

In this section as we can see the survey analysis shows, the minimum water consumption is 500 l/p/month, the maximum is 62500 l/p/month (Figure 1). There is big variation between the minimum and maximum water consumption. Water use for various purpose could be considered as one of the components contributes for the greatest variation. The highest mean consumption per month observed is the use of water for washing, drinking and cooking placed in respective rank order.

When we compare the mean daily water use for different purposes again to that of regional average of East africa(Uganda, Kenya and Tanzania), bathing (about 18 litress), washing(approximately 16litress), drinking and garden is below 10 litress each. In same manner the study result mean daily per capita for drinking is 11.14, 25.8 for washing and 2.85 litress for garden respectively. The comparision shows consistent results except washing use is observed higher use than previous study result.

Household satisfaction on water services

The question asked about the water quality referring the specific water source currently respondent's household consumes reveals, 34 (17%) were very satisfied, 125(62.5%) satisfied, 39(19.5%) less satisfied, only two (1%) are confirmed not satisfied at all.

As to the accessibility of water sources, the result shows 2(1.05%) responds difficult to access, 16(8.38) less accessible, 127(66.49%) accessible, 46(24%) rank more accessible.

In fact as can be presented in the above describtion we can conclude that, there is reasonable association between the type of drinking water source the households have been using and their reported satisfaction. In general, majority of households were more satisfied with both accessibility and quality of water. However, household satisfaction with the quality of water is lower than satisfaction with accessibility.

Affordability of water price

Despite the water price is not included as the main variable in this study as there is no significant variation in water pricing, we are interested to analyse the household perception on the current price whether the household affords. Accordingly, all of the respondents were provided with questions of affordability in the current price and with the probability of changing price. 171(86%) of the total respondents confirmed the current water price is affordable (fair) and the rest reveals they are not afford the price of water they use.

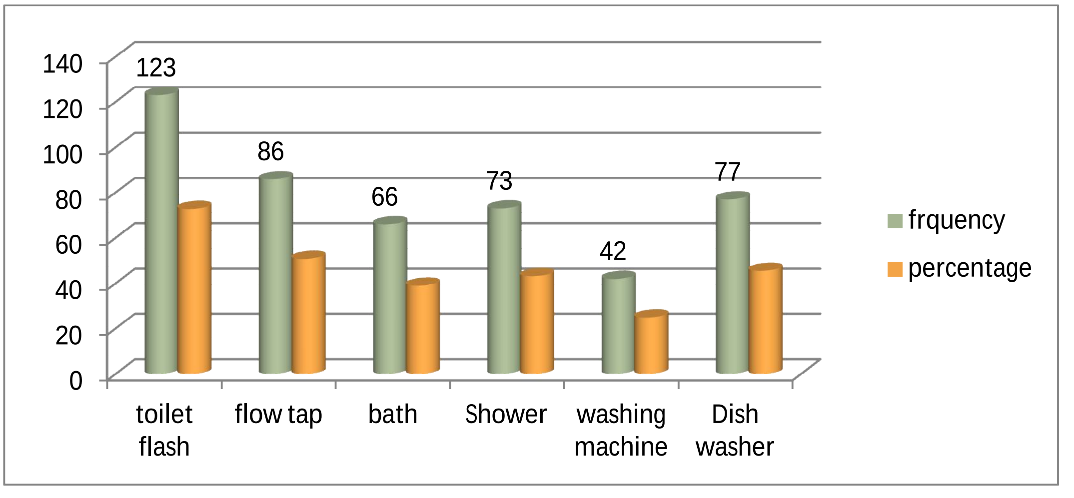
The opinion exploratory question asked to the respondents in case the current water price increases by 20% in the study area. 46(23%) answer the quantity of household water consumption will not be affected, 22(11%) reduce consumption by 5%, 14(7%) reduce consumption by 10%, 55(27.5%) reduce consumption by 20% and the other 63 (31.5%) could not be able to estimate the change in water consumption. In contrast, the parallel question were provided to the same respondents with the probability of the decrease in 20% at the current water price, and 43(21.3%) were responds the quantity of water consumption will not be changed, 19(9,5%) will increase the current water consumption by 10%, 12(6%) increase consumption by 20%, 49(24.5%) increase consumption by half and the rest majority 77(38.5%) could not estimate whether there will be change in consumption or not.

Ownership of water saving appliances

Possession of water appliances and frequency use of these appliances is one of an important variable hypothesized to influence household water consumption. The questions were asked regarding the the possession of a typical water use facilities whether the respondent household installed or not, 137(81.08%) have installed water appliances and the other 32(18.93%) have no water appliances.

Respondents were asked about the type of water facility they have, after the explanation of each type to the respondents. Out of 137 households having water appliances,the most commonly used appliances are a toilet flush installed by 123(72.78%) of the total respondents, flow tap 86(50.81%), bath(bagno) 66(39.05), shower installed 73(43.2%), washing machine 42(24.85%), and Dish washer possessed by 77(45.56%) of surveyed households in the study area.

Figure 4:3. household possession of water using appliances and the types



Source:Author's household survey

Household appliancess use frequency

Appliances use frequency could be a good indicator of household hygiene and to understand household water consumption pattern as well. Considering the average family size in the study area household appliancess use frequency is presented.

The household survey result indicates, some water appliancess such as toilet flushs and dish washer, flow tap are used very frequently each day and for these appliancess daily use frequency is added to weekely bases per respondent. How ever, washing machines, showers and baths were not used each day in the study areas, so weekely use frequency per respondents is presented as follows:

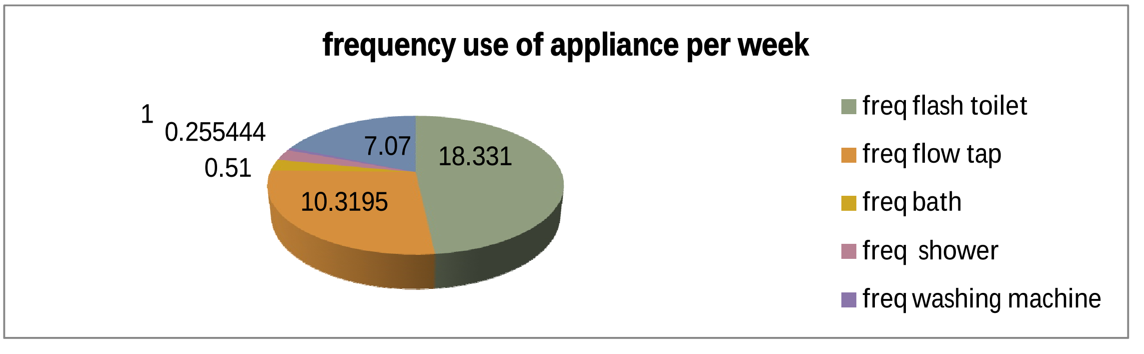
The average toilets flush use frequence per week is 18.33, which is the highest frequency use with the range of the minimum zero to maximum of 35 frequency use per week and median of 21. The households did not have an accurate count of toilet frequency use. People use the toilet frequently but not regularly. The result may be affected by personal habits.

Tap use frequency and dish washer use frequency are follwed the next rank by 10.31 and 7.07 times per week respectively.

The household survey shows the frequency use of shower by the respondents in average was 1 times per week with the lowest zero and highest three times in a week. Thus, one can imagine that shower use pattern varies across households. In this study we controlled weather variable, temperature remained nearly the same during the survey time so the reason for the variations in shower frequency could be personal habit.

Weekly frequency use of bath(bagno) and washing machine with average frequency of 0.5 and 0.25 frquency times respectively are relatively the lowest of other appliances types of the study results. It is well understood that in the study area households wash their cloths by hands mentioning that the frequent use of washing machine consumes more power and water as well. Same is the case for bath frequency use or in Amharic bagno. Despite the ownership of washing machines, they are not used very frequently by the households in Hawassa.

Figure 4:4. weekly frequency use of water appliances in the household



Source:Author's household survey

Household water using behaviour in daily life

Household water saving behaviour in daily life were asked in this survey. The respondents water saving practice when teeth brushing indicates 83(49.11%) say do not applicable, 23(13.61%) do occassionally, 18(10.65%) do oftenly, 45(26.63%) do very often. Whether the household uses shower instead of bath to save water consumption, 96(56.8%) say not applicable, 25(14.79%) responds use occassionally, 33(19.53%) answered use oftenly and the rest 15(8.88%) confirms they practice very often. As to the plug sink when washing dish, 92(54.44%) of the total respondents answered do not applicable, 27(15.98%) occassionally, 31(18.34%) oftenly, 19(11.24%) very often.

Out door activity question were also asked to explore the household opinion whether they choose the coolest time in a day to reduce evaporation so as to save water, the bulk of respondents reveals 124(73.37%) does not applicable, 9(5.33%) occassionally, 18(10.65%) do oftenly, and 18(10.65%) are responds do very often.

Household awarness

The fifth main variable in this study is the environnmental awarness of the study household. The five environment related water source conservation questions were asked using five qualitative opionon exploratory questions to the selected survey households. It is adminsterd by the given five likret scale elicitation methods.

The five water source protection related issues were (1) environmental protection (2) Household responsibilty in reducing water consumption, (3) concern of environmental pollution, (4) Household willingness to contribute money for water source protection, and (5) joint responsibility to ensure sufficient water supply.

We classify the respondents in to two main categories, first categorical question was, yes and no, about the general awarness level to the water source protection and environment as a whole. The vast majority 141(83.43%) answered yes and the remaining 28(16.57%) answered no. The second category is the indepth exploration by presenting individual quesions. The first quesion asked was the concern of household on reducing water consumption so as to contrribute the water utility demand mangemnt measures. Accordingly, Over 147(86.98%) households rated stongly agree, 16(9.47%) rated agree, 6(3.55%) rated in between. The second quesion is related to water scarceity in the study area(Hawassa), 124(73.37%) of the respondents view was strongly agree, 31(18.34%) rated agree, and 14(9.28%) rated as nither agree nor dis agree.Third, willingness to pay in cash to contribute water source protection, 135(79.88%) rated strongly agree, 23(13.61%) say agree, and 9(5.33%) rated disagree.

The fourth question is about the joint responsibilty among the community and water utility to make sure longer sustainable water supply in the study area, 127 (75.15%) rank strongly agree, 22(13.02%) rated agree, and 20(11.83%) respondents view rated in between.

Fifth, household awarness related to environmental pollution, 103(60.95%) consider the water shortages and evironmenta pollution as very serious problems facing residents in the city, 41(24.26%) of respondents rated agree that environmental pollution is the concern of all, 25(14.79%) are under category of in between.

Table 4:2 Summary Statistics, using the observations

Variable	Mean	Median	Minimum	Maximum	Std. Dev.
age	38	37	20	72	9.51127
Dummy_head	0.670157	1.00000	0.000000	1.00000	0.471392
Dummy_male	0.534031	1.00000	0.000000	1.00000	0.500152
Dummy_business	0.335079	0.000000	0.000000	1.00000	0.473258
Dummy_employed	0.575916	1.00000	0.000000	1.00000	0.495502
Dummy_remitance	0.0890052	0.000000	0.000000	1.00000	0.285500
hhsize	5.07330	5.00000	1.00000	12.0000	2.25719
D_education	0.633508	1.00000	0.000000	1.00000	0.483112
D_house	0.905759	1.00000	0.000000	1.00000	0.292931
income	4078.8	3500.0	1000.000	15000.0	2431.29
hhexpend	3222.4	3000.00	1000.000	8000.00	1491.24
waterCONS	8193.3	6000.00	350.000	62500.0	7735.22
waterexpend	34.067	26.250	2.00000	250.000	33.9438
drinking	1671.4	1500.00	100.0000	8000.00	1235.17
cooking	1651.2	1400.00	100.0000	9000.00	1251.20
washing	3871.4	300.00	300.000	20000.0	3621.48
gardening	348.37	0.000000	0.000000	4000.00	789.335
sale	428.99	0.000000	0.000000	20000.0	2034.89
Quality of tap	2.9408	3.00000	1.00000	4.00000	0.623967
Accessibility of tap	3.1183	3.00000	0.000000	4.00000	0.595784
Affordability of price	0.899	1.00000	0.000000	1.00000	0.301681
20 % Price increase	3.3787	4.00000	1.00000	5.00000	1.52706
20% Price decrease	3.5385	4.00000	1.00000	5.00000	1.54303
D_connected	0.810651	1.00000	0.000000	1.00000	0.392950
flush toilet	0.72781	1.00000	0.000000	1.00000	0.446410
flow tap	0.508876	1.00000	0.000000	1.00000	0.501407
bath	0.39053	0.000000	0.000000	1.00000	0.489320
shower	0.24852	0.000000	0.000000	1.00000	0.496820
Washing machine	0.24852	0.000000	0.000000	1.00000	0.433440
Dish washer	0.45562	0.000000	0.000000	1.00000	0.499507
luxuryapp	0.597633	0.000000	0.000000	2.00000	0.758441
normalapp	2.06509	2.00000	0.000000	4.00000	1.45628
Frequency toilet flush	18.3314	21.0000	0.000000	35.0000	12.1722
Frequency use of flow tap	10.3195	10.0000	0.000000	35.0000	10.9574
Frequency bath	0.514793	0.000000	0.000000	3.00000	0.740869
Frequency of shower	1.00000	0.000000	0.000000	5.00000	1.29560
Frequency of washing M	0.254438	0.000000	0.000000	2.00000	0.475965
Frequency of Dish W	7.07101	0.000000	0.000000	30.0000	8.88389
saveI	2.14793	2.00000	1.00000	4.00000	1.28476
saveII	1.80473	1.00000	1.00000	4.00000	1.04242
saveIII	1.86391	1.00000	1.00000	4.00000	1.07976
saveIV	1.58580	1.00000	1.00000	4.00000	1.04939
D_awarness	0.834320	1.00000	0.000000	1.00000	0.372898

Chapter Five: Model and Estimation results

5.1 Econometric model

In order to analyse household water demand in developing countries, multivariate econometric approach is considered to be a suitable method(Billings et al (1998), Lahlou et al (2000) and Babel et al (2003).

The water demand function can be specified using multiple regression models with the different options to analyze water demand in several functional forms have been used in empirical literature, includes linear, semi-log or logarithmic specification of the econometric model.

They can be represented in the following equations;

General model:

yi $= \beta_0 + \beta_1 x_{i1} + \beta_{2x_{i2}} + \cdots \beta_{pxik+} \mathcal{E}$i for i= 1, 2,…n………(1)

yi = f ($x_1, x_2, x_{3,}$,..., x_n) (1) where, y is the quantity of water demand (dependent variable); and x_1 to x_n are relevant factors influences water demand.

Coefficients β_0, β_1, β_2, β_3, ,..., β_n, are estimators.

Linear model:

$y = \beta_0 + \beta_1 x_1 + \beta_{2x_2} + \beta_{3x_3} \cdots \beta_{n(xn)}$……………………(2)

semi-log model:

$lny = \beta_0 + \beta_1 x_1 + \beta_{2x_2} + \beta_{3x_3} \cdots \beta_{n(xn)}$……………………(3)

The regression coefficients indicate the proportional change in water demand as a function of the unit change in each respective independent variable.

In most econometric analysis Linear demand functions are often chosen by many reserchers because linear models can easly or simply used for estimation. However, these models do not yield constant elasticities at all points of the demand functions(M. S. Babel et al, 2006). So the use of combination of other better consistent estimation models are needed. In this case, the transformation of linear models in to non linear would be a good alternative and else where.

The semi- log functional form provides direct estimates of the respective elasticities of the independent variables with respect to the dependent variable(Garcia et al., 2001). So our study focus on both linear and non linear, transformed forms estimation models.

Based on the above theoretical model, we use following empirical models to analyse the household cross sectional survey. The models are estimates the correlation analysis of the varables(dependent and explanatory).

Thus, the empirical models for this study are given by:

Linear model

waterCONS= f(household socio economic and demographic characteristics, household monthly expenditure, water appliances, gardening, household knowledge of water source conservation)

WaterCONS = $\beta_0 - \beta_1 age + \beta_2 hhsize - \beta_3 D\_education + \beta_4$ hhexpend+ $\beta_5 D_{business} + \beta_6 garden + \beta_7 normalapp - \beta_8 awarness + u$……………………………………(1)

Semi-log model

Log of water consumed(waterCON)= f(household socio economic and demographic characteristics, household monthly expenditure, water appliances, gardening, household knowledge of water source protection)

$log(waterCONS) =$

$\beta_0 - \beta_1 age + \beta_2 hhsize - \beta_3 D\_education + \beta_4$ hhexpend+ $\beta_5 D_{business} + \beta_6 garden + \beta_7 normalapp - \beta_8 awarness + u$……………………………………(2)

Where,

WaterCONS= Average monthly quantity of water consumed

log (waterCONS)= log of average monthly quantity of water consumed

age= age of the household

$hhsize$= average household size

$D\_education$ = Dummy education level of the household

β_4 hhexpend = Average monthly expenditure

$\beta_5 D_{business}$ =Dummy variable of private business

Garden= household water use for watering purpose

D_awarness=dummy representing household knowledge in water source conservation

u= error term

5:1.1 Variables in the models, description and expected signs

Household Water Demand: The quantity demand for household water consumption is a key dependent variable in this study. It can be measured by the combination of monthly water consumption obtained from the information on water meter (Birr/m3). The survey collected price data for the system in each household was critically checked. For all connected households consumer pays monthly service charges. The price per unit consumed is considered to quantify the volume of water used in monthly tariff rate and the water bill is given by the quantity of water used multiplied by the unit tariff rate set by the water Utility or provider.

Socio-economic variables: The differences in household water demand is influenced by socio demographic factors as confirmed by previous litrature. Family size is positively correlated to household water consumption. Age , occuption, educationm family size could affect household water use.

Household expenditure: It is believed to be a better proxy indicator of living standards or welfare than income. In this study income is expected to have positive correlation with household water demand

Household housing charactersitics :A measure of wealth often is included in addition to income or expenditure; is the ownership of the house that the household used to live in. In this study the current house ownership of respondents is expected to have positive effect on household water demand

water appliances: are defind as water facilities used to save the quantity of household water uses by installing flush toilet, flow tap, bath, washing machine, shower, and dish washer and so on. In this study use of water appliances is expected to have negative correlation with water consumption.

Water use pattern: Is the household water use characterisitc defined interms of water use for different purposes.

Household awareness towards water conservation: water conservation awareness and practice involves understanding the efficiency, opportunities and impacts of water saving activities reduce consumption. In this research household awareness on water conservation improves water efficiency and expected to have negative sign with water use

Table 5.1 Estimated Variables, definition and expected signs

variable	definition	Expected sign
age	Age of HH head	negative
D_female	Dummy= one, if respondent sex is women, zero if man	Positive/negative
hhsize	total family number	positive
D_education	D_eduacation=one, if formal education level, zero if read and write only	Positive/negative
D-head	D_head =one, if household head, zero if spouse of household head	Positive/negative
income	monthly HH income	positive
hhexpend	Monthly HH expenditure	positive
D_house	D_house =one, if resondent HH currently live own house, zero if rent	positive
D_connected	D_connected=one, if water system in house connected, zero otherwise	negative
luxury	continues variable(0,1,,2)	positive
garden	Continues variable	positive
normal	Continues variable(0,1,2,3,4)	positive
D_awarness	D_awarness=1 if respondent have awarness on water source protection with strongly agree or agree, zero otherwise	negative

5.2 Estimation result

The economtric results obtained from regression estimation are presented in this section. Initially before the model estimation, we explored selected variables. Here, we examine the distribution of each variable including the mean, median and other percentiles and the skewness and kurtosis of each variable. And then, we run multiple regression models for the analysis of the household crossesctional survey.

After dropping outliers from the analysis, 169 sample dataset was plugged into the linear model first, and then semi-log model, and finally heteroskedaticity corrected model was employed simultaneousely for both forms of models. Non connected households were not included in this regression equation as the water sources vary across households. For instance, water from private owned well in the study area usually is free of charge, or perhaps could have initial investment costs. Moreover, if we incorporate,such survey data obtain water from various non tap sources, some cross-sectional variation will likely be observed. As the non piped water consumption iformation is more likely depnd on individuals opinion.

F-test and t-tests were applied to check the suitability of the functional relationship and the use of the explanatory variables in the model with the available dataset. We applied Ramsey RSET test for model specification, following a standard stepwise procedure to eliminate the insignificant variables from the analysis. To make sure whether our model selection is good enough and according to the assumptions of multiple regression we follwed the following regression dignossis prodecures one by one.

Regression dignosis

F test was used to check whther the variation in reponse variable (dependent) is measured by the power of multiple explanatory variables in the beta coefficients to explain the behavior of the dependent variable in our empirical model we use. We are basically have repeatedly tried to examine the tests in all independent variable setting to zero sum of regression coefficients. Meaning, the tests of all coefficients of explanatory variables against the dependent key variable in this case, quanitity of water consumption. We have;

The null hypothesis : $H0: \beta1 = \beta2 = \beta3 ...= \beta n =0$

The alternate hypothesis :$H1: \beta1, \beta2, \beta3... \beta n$ are different from zero

The F distribution at specific significant level of 0.05 sginginficane level is used as the bench mark to check whether the null hypothesis in the multiple regression coefficients are all zero.

The F value can be computed by:

$F=(SSR/k)/(SSE/(n-(k+1)))$

where,n=number of samples used;

k=number of independent variables used;

SSR=sum of square for regression

SSE=residual sum of square or sum of square for error.

If the computed F value is greater than the critical F value, the null hypothesis is rejected and the alternative hypothesis is accepted.

We checked whether the residuals are normally distributed or not using Jack-Bera test for normality in gretl software packages, the result shows the residuals were normally distributed since the P.value we obtained for the calculated Test statistic: Chi-square(2) = 39.3683 with p-value = 2.82669e-009, which is sufficiently higher than P value and we reject the null hypothesis that the residuals are normally distributed.

multicollinearity

The estimated regression result from water demand model was checked to detect if the problems of multicollinearity is encountered incase it might have felt the correlation of explanatory variables since a number of socio-economic variables were used to characterize households themselves being correlated. A simple technique, which involves calculating the simple correlation coefficient matrix for the independent variables, was used to test the multicollinearity.

Our resgression result shows that multicollinearity is not a serious problem in our models since the coefficents of beta does not show collinarity any more. As can be presented (Table5:2), no value whose R2 is greater than or equal to 0.8, a common rule off thumb and further deviation from the stated value mean, a signal for the existence of multicollinearity problem(Mason et al., 1999).

Table 5:2 covariance matrix

Correlation coefficients, using the observations 1 -169

5% critical value (two tailed) = 0.1510 for n = 169

age	hhsize	D_education	hhexpend	D_busines	garden	normal	D_awarness	
1.0000	0.3063	-0.1609	-0.0283	-0.1222	-0.0918	-0.0113	-0.0416	age
	1.0000	-0.1904	0.3182	-0.2746	0.0020	0.1532	-0.2638	hhsize
		1.0000	0.2888	0.5994	0.2356	0.1802	-0.0018	D_education
			1.0000	-0.0887	0.3159	0.3684	-0.2292	hhexpend
				1.0000	-0.0315	-0.0010	0.0246	D_busines
					1.0000	0.3253	0.0424	garden
						1.0000	-0.0256	normalapp
							1.0000	D_warness

Source: Author's computation

Hetroskedasticity test and possible measures

With cross section data, the most likely departure from iid is hetroskedasticity(non-constance variance). In some cases one may arrive at decision regrading the likely form of hetroskedasticity, and hence to apply specific correction. The more common case, however, is where the hetroskdasticity is of un know form. We need an estimator of the covariance matrix of the parameter estimator that retains its validity, at least asymptotically , inface of unspecified hetroskdasticity(white, 1980).

A test for the presence of heteroscedacitincty problem in our model was also done applying white test. The test result shows that the null hypothesis of homoskedacitincity is not rejected since the calculated $\chi2$ we obtained from the estimated model is 102.79 with p. value of 0.000. This implies that there is heteroskedacitincity problem in our model, which is expected from survey data.(see AppendixA_6)

The use of OLS in this model estimation does good results. But , it does not guarantee to have more feseaible results as in most cases the estimator may suffer with efficency problem with asymptotic normality. To obtain asymptotic properties, we simply use full set of results from OLS and apply it to other transformed model, called we have heteroskdatisicity corrected model, which is the alternative model to reach more convienent estimate (white, 1980, and Deaton, 1997).

The result of all the regression diagnossis acertains that the significance of the F-value in all forms of models was below 0.05, so the model was significant, except the variable expenditure with 0.0516 with equivalent result. There were no systematic biases in the plot of standardized residuals and no problematic collinearity between independent variables in the regression equation. Signs of coefficients for variation in household monthly water consumption with respect to the explanatory variables were also as expected, except the water appliances and education variables.

Linear Model

Table 5:3 linear model 1 OLS estimation

Model 1: OLS, using observations 1-169					
Dependent variable: waterCONS					
	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	7494.54	4488.23	1.6698	0.09696	*
age	-85.4071	46.8307	-1.8237	0.07010	*
D_head	201.897	901.167	0.2240	0.82302	
D_female	-66.602	865.626	-0.0769	0.93877	
D_education	-964.883	1291.44	-0.7471	0.45611	
D_busines	2176.22	1178.21	1.8471	0.06663	*
D_employed	334.259	1775.96	0.1882	0.85095	
D_house	-6237.49	3973	-1.5700	0.11845	
hhsize	860.372	220.547	3.9011	0.00014	***
hhexpend	0.528733	0.365813	1.4454	0.15036	
garden	5.83507	0.589526	9.8979	<0.00001	***
normal	894.128	432.513	2.0673	0.04036	**
D_awarness	-1117.86	1197.49	-0.9335	0.35200	

Mean dependent var	8193.266	S.D. dependent var	7735.218
Sum squared resid	4.49e+09	S.E. of regression	5367.124
R-squared	0.552953	Adjusted R-squared	0.518565
F(12, 156)	16.07970	P-value(F)	8.44e-22
Log-likelihood	-1684.417	Akaike criterion	3394.834
Schwarz criterion	3435.523	Hannan-Quinn	3411.346

Source: Author's computation

The dummy variables D_head, D_female, D_employed were found to have insignificant with smallest absoulute t –statististics, and then eliminated from the model as they accept the null hypothesis of the individual test result from the regression out put (table 5:4) and sepecification test result on (Appendix A_1)

The OLS estimation was repeated with the remaining variables, and we found the improvement in siginificancy of the variable age, hhsize, D_business , garden and normalapp, while the rest of variables still remain insignificant(D_house, D_eduaction and D_awarness).

Table 5:4 model 2 OLS estimation

Model 2: OLS, using observations 1-169					
Dependent variable: waterCONS					
	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	7666.06	4380.7	1.7500	0.08205	*
age	-85.5604	45.9437	-1.8623	0.06441	*
D_education	-955.69	1271.21	-0.7518	0.45329	
D_busines	2098.99	1120.72	1.8729	0.06292	*
D_house	-6180.99	3884.69	-1.5911	0.11357	
hhsize	862.174	218.124	3.9527	0.00012	***
hhexpend	0.514817	0.351593	1.4642	0.14510	
garden	5.8224	0.581749	10.0084	<0.00001	***
normal	882.354	425.45	2.0739	0.03970	**
D_awarness	-1131.07	1167.39	-0.9689	0.33407	

Mean dependent var	8193.266	S.D. dependent var	7735.218
Sum squared resid	4.50e+09	S.E. of regression	5317.615
R-squared	0.552723	Adjusted R-squared	0.527405
F(9, 159)	21.83160	P-value(F)	9.18e-24
Log-likelihood	-1684.460	Akaike criterion	3388.921
Schwarz criterion	3420.220	Hannan-Quinn	3401.623

Source: Author’s computation

We repeate running the regression after eliminating the variables D_education and D_house with the smallest t-values, we loss the previous siginificance(P-values). See on (appendixA_2) for model sepcification test. Removing the variable do not be a good decision rather we are suggested to remain it and then, we run the variables with other models, which may improve our result. Accordingly, we use Heteroskedasticity-corrected model to find better predicted values, surprisingly, we got all our regression results were found to have significant predictors of dependent variable, water demand.

Table 5:5 Heteroskedasticity-corrected model estimation of linear model

Model 3: Heteroskedasticity-corrected, using observations 1-169					
Dependent variable: waterCONS					
	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	2531.07	1136.56	2.2270	0.02735	**
age	-67.158	23.2708	-2.8859	0.00444	***
D_busines	2222.9	736.487	3.0183	0.00296	***
hhsize	657.446	128.844	5.1026	<0.00001	***
hhexpend	0.509243	0.259667	1.9611	0.05160	*
garden	4.27799	0.805176	5.3131	<0.00001	***
normal	1004.83	271.489	3.7012	0.00029	***
D_awarness	-1589.06	679.334	-2.3391	0.02056	**
D_education	-1799.44	758.406	-2.3727	0.01885	**
Statistics based on the weighted data:					

Sum squared resid	692.2329	S.E. of regression	2.080013
R-squared	0.434695	Adjusted R-squared	0.406430

F(8, 160)	15.37914	P-value(F)	1.21e-16
Log-likelihood	-358.9476	Akaike criterion	735.8952
Schwarz criterion	764.0643	Hannan-Quinn	747.3268
Statistics based on the original data:			
Mean dependent var	8193.266	S.D. dependent var	7735.218
Sum squared resid	4.88e+09	S.E. of regression	5525.463

Source: Author's computation

Semi-log model estimation

The multiple regression analysis was carried out on same previous variables done for linear model, was also followed for semi log functional form. we have the following results presentd in (table 5:6)

Table 5:6 semi-log model 4 OLS estimation

Model 4: OLS, using observations 1-169					
Dependent variable: l_waterCONS					
	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	8.12021	0.546973	14.8457	<0.00001	***
age	-0.012096	0.00570717	-2.1194	0.03564	**
D_head	-0.0427054	0.109824	-0.3889	0.69791	
D_female	-0.00235438	0.105492	-0.0223	0.98222	
D_education	-0.10883	0.157386	-0.6915	0.49029	
D_busines	0.288833	0.143587	2.0116	0.04599	**
D_employed	-0.0226767	0.216434	-0.1048	0.91669	
D_house	-0.101554	0.484183	-0.2097	0.83414	
hhsize	0.100897	0.0268777	3.7539	0.00025	***
hhexpend	6.80024e-05	4.4581e-05	1.5254	0.12919	
garden	0.00040825	7.18445e-05	5.6824	<0.00001	***
normal	0.134785	0.0527096	2.5571	0.01151	**
D_awarness	-0.130627	0.145936	-0.8951	0.37211	

Mean dependent var	8.692078	S.D. dependent var	0.820467
Sum squared resid	66.74045	S.E. of regression	0.654082
R-squared	0.409857	Adjusted R-squared	0.364461
F(12, 156)	9.028555	P-value(F)	5.03e-13
Log-likelihood	-161.2927	Akaike criterion	348.5854
Schwarz criterion	389.2741	Hannan-Quinn	365.0977

Source: Author's computation

As compared to the previous linear model the estimated result has shown same result but some improvement in p value of age and private bussiness vaariables in case of semi-log model.

Running again semi-log regression analysis, if variables D_head, D_female,D_employed and D_house were removed, as they are with the smallest t-value, which is usually lower than the critical value(P-value) as to accept the null hypothesis indicated in the regression output (table 5:7) and model specification test (AppedexA_3)

We run reapted analysis of the remaining variables to find if any improvement in variables coefficient and R2 , we got slight improvement in adjusted-Rsquared and significance level in variable normal. But still the result was not satisfactory somehow an important variables are not yet to have significant prediction on dependent variable. The estimation is presented in the following (table 5:8)

Table 5:7 semi-log model 5 OLS estimation

Model 5: OLS, using observations 1-169					
Dependent variable: l_waterCONS					
	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	7.97983	0.268878	29.6782	<0.00001	***
age	-0.0119193	0.00558057	-2.1359	0.03421	**
D_education	-0.114563	0.153553	-0.7461	0.45671	
D_busines	0.292929	0.136101	2.1523	0.03287	**
hhsize	0.100484	0.0264427	3.8001	0.00021	***
hhexpend	6.80162e-05	4.27273e-05	1.5919	0.11339	
garden	0.000409556	7.05925e-05	5.8017	<0.00001	***
normal	0.138908	0.0512335	2.7113	0.00743	***
D_awarness	-0.135409	0.14166	-0.9559	0.34058	

Mean dependent var	8.692078	S.D. dependent var	0.820467
Sum squared resid	66.83034	S.E. of regression	0.646289
R-squared	0.409062	Adjusted R-squared	0.379515
F(8, 160)	13.84450	P-value(F)	3.51e-15
Log-likelihood	-161.4065	Akaike criterion	340.8129
Schwarz criterion	368.9820	Hannan-Quinn	352.2444

Source: Author’s computation

Further regression was carried out to check if the elimination of D_education(with the smallest t-value and no significant p-value) could give better results. we obtained in estimation out put (table 5:8) that the adjusted-Rsquared in this case improved to 0.38, whilst there is also smaller coefficents of dummy variables(D_business and hhexpend). However, still an important variables(hhexpend and D_awarness) are not found to be siginificant, then omitting education variable will not gurantee for goodness of our model. The test result for these estimation has shown in section (appendixA_4)

we need to remain D_education in the model and run other hetroskedasticity free model incase to have sensible results(Table 5:9)

Table 5:8 semi-log model 6 OLS estimation

Model 6: OLS, using observations 1-169					
Dependent variable: l_waterCONS					
	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	7.96257	0.267512	29.7653	<0.00001	***
age	-0.0117658	0.00556909	-2.1127	0.03617	**
D_busines	0.22852	0.105072	2.1749	0.03110	**
hhsize	0.103417	0.0261126	3.9604	0.00011	***
hhexpend	5.61902e-05	3.96237e-05	1.4181	0.15810	
garden	0.000400322	6.94034e-05	5.7681	<0.00001	***
normal	0.137207	0.0511123	2.6844	0.00803	***
D_awarness	-0.138332	0.14141	-0.9782	0.32943	

Mean dependent var	8.692078	S.D. dependent var	0.820467
Sum squared resid	67.06284	S.E. of regression	0.645399
R-squared	0.407006	Adjusted R-squared	0.381224
F(7, 161)	15.78624	P-value(F)	1.10e-15
Log-likelihood	-161.6999	Akaike criterion	339.3998
Schwarz criterion	364.4390	Hannan-Quinn	349.5612

Source: Author's computation

Thus, the use of OLS with this model estimation does not guarantee to give better results. To obtain asymptotic properties, we simply use full set of results from OLS and apply it to transformed model with heteroskdatisicity corrected model, which is the alternative model to obtain more convienent estimate (white, 1980, and Deaton, 1997)

Table 5:9 Heteroskedasticity-corrected model estimation of semi-log model

Model 7: Heteroskedasticity-corrected, using observations 1-169					
Dependent variable: l_waterCONS					
	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	7.96637	0.222954	35.7310	<0.00001	***
age	-0.00991908	0.00481345	-2.0607	0.04095	**
D_busines	0.207728	0.102765	2.0214	0.04491	**
hhsize	0.103864	0.0175073	5.9326	<0.00001	***
hhexpend	7.41466e-05	4.02836e-05	1.8406	0.06753	*
garden	0.000420152	3.82731e-05	10.9777	<0.00001	***
normal	0.112217	0.0417705	2.6865	0.00798	***
D_awarness	-0.252397	0.122628	-2.0582	0.04119	**
D_education	-0.0855917	0.118197	-0.7241	0.47004	

Statistics based on the weighted data:			
Sum squared resid	653.9863	S.E. of regression	2.021735
R-squared	0.702575	Adjusted R-squared	0.687703
F(8, 160)	47.24374	P-value(F)	2.40e-38
Log-likelihood	-354.1450	Akaike criterion	726.2899
Schwarz criterion	754.4590	Hannan-Quinn	737.7215
Statistics based on the original data:			
Mean dependent var	8.692078	S.D. dependent var	0.820467
Sum squared resid	67.71376	S.E. of regression	0.650547

Source: Author's computation

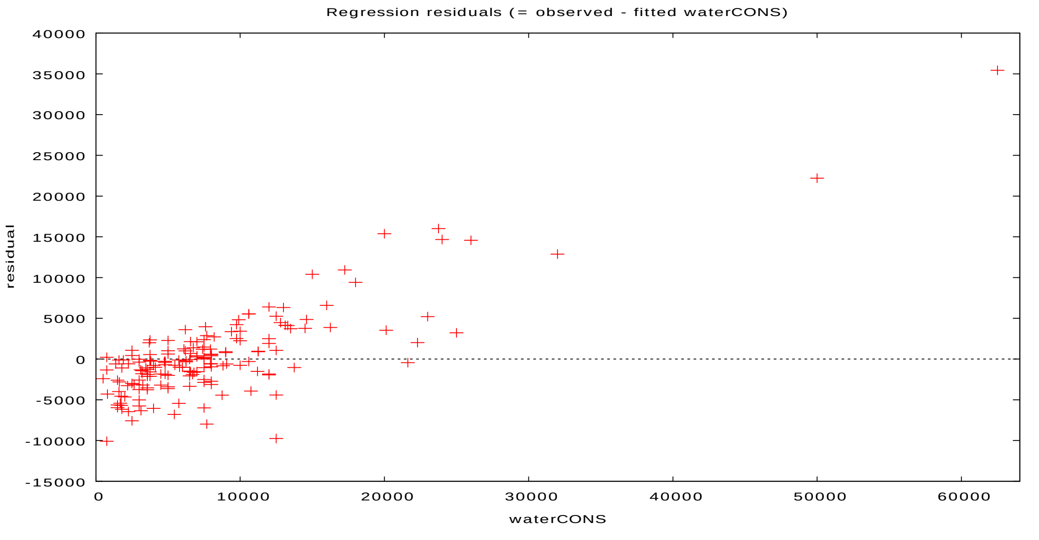
As can be seen in the table 7 further analysis of the variables with transformed, hetroskdastcity corrected model, reveals that all variables are significant at 0.05 significance level, execpt D_education. The coeffiecient of variation in this model can explain 70% variation in water consumption with adjusted-Rsquared of (68%). The beta coefficient indicates the proportional change in monthly household water consumption as a function of the corespponding unit of changes in explanatory variables.

The multiple regression results from the above three empirical models are found to have relevant regression results from the cross-sectional one point in time survey. All the regression models shows, household water demand variation is predicted by age, household size, education, household occupation (private business), average monthly household expenditure, hh use of water appliances(normal appliances), hh water use for garden and household awarness towardess water source conservation. There have been certain variation in this water demand estimation models with its different functional forms is represnted by the intercpt for potentially unexplained effects it may have.

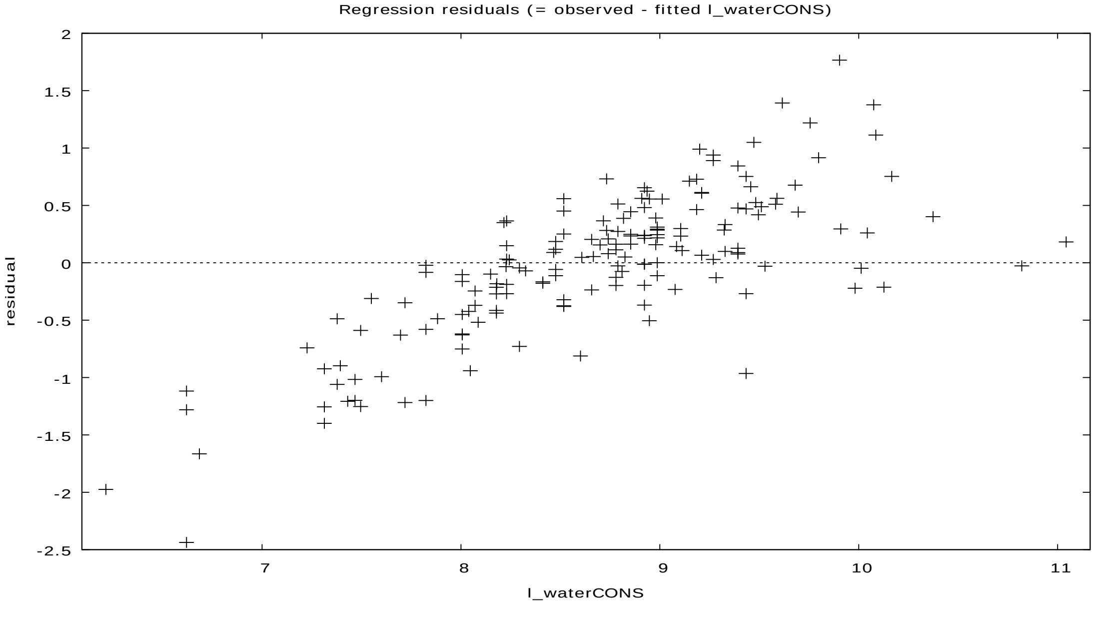
When we compare both models(linear and semi-log) with respect to the hetersoskdasticity corrected modelling out come, the Linear model with seven explanatory variables including (D_education) is more likely represents the prediction in household water demand than semi-log functional form. However, semi-log model with the transformed, heteroskdastic corrected model graunted with the exception of education variable(D_education), the rest of variables were statistically significant with highr R squared, smaller standard errors, and the least percentage errors in predicting household water demand over linear form of model(Table 7). In our case we considered the use of both regression models with their satisfcatory out come in this aspect.

However, the residual plots of the dependent variable against explanatory variables from regression results of both models suggests the importance of transformation of the dependent variable, water demand in semi-log form. The plots in fig 4.8 and 4.9 shows that semi-log transformation of dependent variable provides more feasible out come. We can conclude that transformed functional form of semi-log model has superior predicting power on household water demand in the study area.

Fig 4.8 Residual plot of HC1 (waterCONS) linear model



Residual plots of HC1 (semi-log waterCONS)



Source: Author's computation

5.2.1 Coeficient analysis of significant variables

The variable hhsize, household monthly average expenditure(hhexpend), garden, normalapp, private business(D_business) were as expected positive sign and significantly correlated to dependent variable water demand, while the respondents age and D_awarness were also as expected negative sign and significant correlation with the dependent variable. The semi-log model with these variables, explains 70% variation in the water use, as shown by the R square (Table 7)

The other variables such as household head type, gender of respondent household, D_employed, D_remitance, D_house, D_flow tap were not statistically significant.

Age variable is as expected negative sign and significant at 5% siginficance level. This result indicates strong correlation with water consumption. As people obtainting older they are expected to reduce water consumption . Meaning, household respondents one more years obtainting older or aged consumes 0.99% less quantity of water compared to youngsters do. The possible explanation is as childeren grow up they consume more water and the younger the household member , the more they consume water as youngisters requires extra access for water for frequent sanitation for beauty with lesser care or water saving behaviour (Lman, 1992, Nauges and Thomas, 2000). However, there are other argueing result ashows more aged people may have incentive to stay home and consumes more water for various uses such as watering vegatation(Schleich and Hillenbrand, 2008)

In this study to specify the variable education (D2_education) of the respondents, we categorize the response into read and write, primary complete, secondary complete, college education and test the mean difference. The result indicates that there is a mean difference only between those who are read and write and formal education level (primary, secondary and college education). Thus, we give a dummy variable zero for those read and write and one for those who obtain formal education. The regression result shows the variable education unlikely expected, has negative sign and is significant in linear model. Based on this result, we can say that respondent‘s education level is one of importanct explanatory variable influencing variation in household water consumption in the study area. As one additional educational level of the respondent household he or she has, the average mothly water conumption reduced by 1799 litress. The possible explanation for big variation in predicting response variable, water demand is more educated households may have more knoweldege about water saving habits and water conservation practices in their house. This result is also supported by previous study (BRUCE et al,2006)

The variable household size (hhsze) is as expected positive sign with 1% significant level have strong correlation with household water consumption. As big is number of family size, the household average monhly water use increases proportionally. This implies the percapita per person consumption may reduce. Thus, households with one additional member in their family consume 10.38 percent more quantity of the average monthly water in litress. This result is supported by Nauges & Thomas (2000) Hoffmann et al. 2006; Renzetti (2002).

The variable private business (D_business) is the demographic variable statistically significant at 1% significance level and positive sign as expected. This variable is the proxy to household occupation categorical variable influences household water demand positively. Households whose occupation is private business were consumed 20% more average monthly water than the rest of occupations (employed and remittent) households. This result is consistent with the empirical cross sectional survey in Marawi town, Northern Ethiopia. Respondent households, who are engaged in private business activities and retails business, usually consume more water than the other occupation (Dagne, 2012).

The variable expenditure is as expected with positve sign and significant at 10% level of significance. The beta coeffiecient of the expalantory variable expenditure can be interpreted as households with one unit of additional average monthly expenditure consumes 0.074% additional quantity of water. Meaning, households with higher monthly expenditure spents on monthly average for additional water consumption per unit of birr.

The variable household water use charateristics for out door use(garden), is an important and significant variable with expected positive sign and sgnificant at 1% siginificance level. The result shows that those who have private garden in their compound or surrounding their house consumes 0.042% more average monthly water than the households with out garden in their compound. This strong correlation shows watering plants and veobtaination usually consumes additional water that affects the variation on household water demand .

In order to specify the variable household water use charateristics (normalapp) we use as the proxy of possession and the use of basic equipment includes flush toilet, installation of flow tap, shower installation, and dish washer in their house were considered in this variable. Household using at least one of this equipment in this study are considered as normal water equipment users. The variable normal is statistically significant at 1% significance level. This result indicates respondent household's who are using the normal water equipments in their house consumes 11% more average quantity of monthly water than the households with out normal water appliances. This regression result is consistent with the rsult of the descrptive statistics in the previouse section. The frequency use of toilet flush, flow tap, shower and dish washer were the highest average compared to the other luxury appliances (Bath and Washing machine). we can see that greatest variation among surveyed households in water demand is the use of an estimated normal water use equipment frequently by the households in the study area. This result is supported by previous study of (Thompson and Porras,2001). The variable household awarness towards water source conservation and management(D_awarness) is found to have strong correlation with water consumption. The estimated regression result is significant at 1% seginficance level and negative sign as expected. The negative beta cofficient indicats there is inverse relation with water consumption and houshold awarness. Respondents having better knoweledge of water source conservation reduce water consumption. This indicates such household members have developed water saving behavioure in their household. They reduce the average quantity of water consumption by 25% compared to households with less or no awarness on water source protection in the study area. The result is supported by previous studies that the knowledge on environmental awarness influences water conservation leads to reduce consumption (Nancarrow et al 1996).

Chapter Six: Conclusion and Policy Recommendation

6.1 Policy recommendation

The findings of this study should be interpreted with due consideration of certain potential factors and limitations, such as limited secondary information for comparision of survey result with the official statistics, some variation in water metering, income and expenditure information from respondents have substantial variability, and price elasticity and weather variable analysis limited by a lack of time-series data are among others. The time limit allowed us only to depend on survey result indicates water demand and household using pattern during study time. For example water use frequency could vary with weather condition in different season (Marshallsay, 2003). So the climate could influence household water demand. As a result some unexplained portion of the variation could be the exclusion of such important variables in the error terms, so that further study is indeed recommended in the study area in this context.

Most importantly, the result shows unlike developed countries, the use of water appliances such as (use of flush toilet, shower, dish washer, flow tap) consumes extra monthly water compared to traditional use patterns. This could be the water appliances used by the household are either inefficent or individual household‘s less water saving habits. In this aspect, the water utility should focus on promoting water efficient appliances and working to make sure accessible in the market so as affordably to low and average income families in one hand, and on the other side policy based non-economic measures of water demand management than the previous supply-oriented plan need to be strengthen. The use of water tariffs to reduce water demand must be complemented by educational campaigns on water conservation and the use of efficient water saving technologies at household level is more expected to be done.

- water use charcteristics particularly water use for garden should be considered as domestic and productive demands of the poor in more comprehensive manner. If the water distribution system is appropriately planned, designed and managed, they have a much greater potential to reduce poverty, to lesson health hazards and to cope up livelihood vulnerability, incresed recreational values and so on. As this study shows, water conservation awarness reduce household water consumption. This implies, if efforts to be made by policy makers, household water consumers and water provider to promote integrated water resource management that focuses on sustainable water resource development and efficient use of water on an equitable basis ensure sustainable water demand problem in the study area and elsewhere in similar situations.

- The provision of household water supply should not only depend on public provider as it needs a huge capital commitment, but also the policy environment should encourage private providers to participate in water market since only 1% of monthly income spending on water expenditure. With this, it could be reasonable the price and income elasticity of consumer to afford up to 5% of their income as suggested by World Bank for developing countries.
- Water value as economic good or services may affect household water use pattern and induce saving behavior. In the same talken it increases the revenue to water utility that inhances expansion of improved water supply to less privileged section of the society. Moreover, the differences in income and expenditure among the poor and wealthy household, in service provision will raise more equity issues. The poor should be subsidized by implementing in different block rate in current water tariff may have strong impacts on the water demand management.
- Most importantly, the municipality's water policy should prioritize the socio economic changes, most importantly rapid population growth, (in which "the household size explaind by strong effect on variation in household water demand in this study'') is the annual growth rate of 4.02% should be considered. The water utility should also work on a rapid and ongoing urbanization to provide water services in equitable manner. Water demand management, water conservation, and efficiency should lead policy in municipal water supply planning and demand management in the context of Ethiopia.

6.2 Conclusion

The main objective of this study is analysis of factors affecting the residential water demand in, Ethiopia. Hawassa city is our case study area, to do so, 14 kebeles were selected randomly out of 7 sub-cities. The households connected with improved water system were considered in sampling procedures. A total of 169 households were randomly selected and cross sectional survey was made in April 2014, one point in time survey was used.

We use multiple regression analysis with various functional forms(linear, semi-log) and both models were finally controlled by the solution model called heteroskedaticity corrected model used to carry out the correlation between dependent variable, quantity of monthly water demand and explanatory factors. The needed regression diagnosis and tests were employed to make sure the correctness of the empirical demand model.

In contrast to findings of other several empirical studies, this study contributes that water price and income; do not have direct effect on water demand prediction in the study area. However, a new set of variables have been found to be important in predicting the variation in household water consumption in Hawassa. Such variables contribute to this difference among others, are age, household size, education level, and expenditure as revealed by high rates of possession of water using appliancess, outdoor activities (gardening), private business activities leading to changing livelihood, normal appliances use frequency (that is. more frequent use of flush toilet, flow tap use, dish wash, shower use) as well as concern about water source conservation were factors that lead to the variation in residential water demand.

- Age and occupation are the main siginificant variables influences the variation in household water consunmption. As people obtainting older or more aged, the lesser the quantity of water consumed in the household. In contrast, if there is large number of young pepole in the household, expected to consume more water as suggested in the previous analysis section.
- People whose occupation is private business activities uses more additional water in their house. This indicates that the study area is becoming a centre of growing business as Hawassa is the home city to more than 56 nations and nationalities of the region and people. The tremendeous increase of migrants from rural area as well as different parts of the country to the city making different private businesss activities so as to improve the livelihood.

- Household expenditure(the better proxy to income and welfare) alters the variation in household water demand. In the descriptive analysis section we see that respondents under category of higher average monthly income are consequently reflected with higher monthly expenditure that leads to higher monthly household consumption than the less income and expenditure categories. We can imagine that the extent of the effect of income proxy, expenditure variable to what extent explains the variation among the study households water use. In the same talken, the study result confirms that income and expenditure has aproxy to have the ownership of water using appliances. As clearly presented in section(4.1) of the data description, household‘s whose monthly average income and expenditure, higher were found to have water appliances in their house. This is explained interms of being either category of in-house connected or yard connected.
- Household water consumption is significantly linked with water source conservation and enviornmental awarness in the study area. This indicates that better awarneed family were likely to saving more and less consumption. This result has an implication to the beautifil nature of Hawassa. There are comparably more environmental recreation sites and green areas that makes unique among others equivalent cities in Ethiopia. So we can conclude that environmental attitude is more closly associated with household water use patterns and saving behaviour.

Further Research:

- Domestic water demand in different time series observation is an important research area to be investigated in various seasonal change factors. It may have unexplained variation in household water demand in this study.
- Household source choice is the other research problem in the study area. Future study may be needed.
- Household water use appliances efficiency, accessibility and willingness to pay for improved appliance should also be the research area.
- Comparative study in similar regions and study areas in same topic may have better inference to understand similririties and differences among urban areas of Ethiopia and else where in developing countries.

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Appendix A: test results

AppendixA_1&2

Test on model 1

Null hypothesis: the regression parameters are zero for the variables D_head, D_female, D_employed Test statistic: F(3, 156) = 0.0267277, p-value 0.994079 Omitting variables improved 3 of 3 model selection statistics.

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	7666.06	4380.7	1.7500	0.08205	*
age	-85.5604	45.9437	-1.8623	0.06441	*
D_education	-955.69	1271.21	-0.7518	0.45329	
D_busines	2098.99	1120.72	1.8729	0.06292	*
D_house	-6180.99	3884.69	-1.5911	0.11357	
hhsize	862.174	218.124	3.9527	0.00012	***
hhexpend	0.514817	0.351593	1.4642	0.14510	
garden	5.8224	0.581749	10.0084	<0.00001	***
normal	882.354	425.45	2.0739	0.03970	**
D_awarness	-1131.07	1167.39	-0.9689	0.33407	

Mean dependent var	8193.266	S.D. dependent var	7735.218
Sum squared resid	4.50e+09	S.E. of regression	5317.615
R-squared	0.552723	Adjusted R-squared	0.527405
F(9, 159)	21.83160	P-value(F)	9.18e-24
Log-likelihood	-1684.460	Akaike criterion	3388.921
Schwarz criterion	3420.220	Hannan-Quinn	3401.623

Test on Model 2:

Null hypothesis: the regression parameters are zero for the variables D_education, D_house Test statistic: F(2, 159) = 1.70138, p-value 0.185735 Omitting variables improved 3 of 3 model selection statistics.

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	1472.36	2213.69	0.6651	0.50693	
age	-81.4643	46.0847	-1.7677	0.07900	*
D_busines	1365.02	869.483	1.5699	0.11840	
hhsize	867.596	216.084	4.0151	0.00009	***
hhexpend	0.401128	0.32789	1.2234	0.22298	
garden	5.67533	0.574319	9.8818	<0.00001	***
normal	956.342	422.958	2.2611	0.02509	**
D_awarness	-1265.07	1169.18	-1.0811	0.28128	

Mean dependent var	8193.266	S.D. dependent var	7735.218
Sum squared resid	4.59e+09	S.E. of regression	5340.731
R-squared	0.543151	Adjusted R-squared	0.523288
F(7, 161)	27.34484	P-value(F)	1.68e-24
Log-likelihood	-1686.250	Akaike criterion	3388.499
Schwarz criterion	3413.539	Hannan-Quinn	3398.661

AppendixA_3 & 4

Test on Model 3:					
Null hypothesis: the regression parameters are zero for the variables					
D_head, D_female, D_house, D_employed Test statistic: F(4, 156) = 0.0525271, p-value 0.994797 Omitting variables improved 3 of 3 model selection statistics.					
	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	7.97983	0.268878	29.6782	<0.00001	***
age	-0.0119193	0.00558057	-2.1359	0.03421	**
D_education	-0.114563	0.153553	-0.7461	0.45671	
D_busines	0.292929	0.136101	2.1523	0.03287	**
hhsize	0.100484	0.0264427	3.8001	0.00021	***
hhexpend	6.80162e-05	4.27273e-05	1.5919	0.11339	
garden	0.000409556	7.05925e-05	5.8017	<0.00001	***
normal	0.138908	0.0512335	2.7113	0.00743	***
D_awarness	-0.135409	0.14166	-0.9559	0.34058	
Mean dependent var	8.692078	S.D. dependent var		0.820467	
Sum squared resid	66.83034	S.E. of regression		0.646289	
R-squared	0.409062	Adjusted R-squared		0.379515	
F(8, 160)	13.84450	P-value(F)		3.51e-15	
Log-likelihood	-161.4065	Akaike criterion		340.8129	
Schwarz criterion	368.9820	Hannan-Quinn		352.2444	

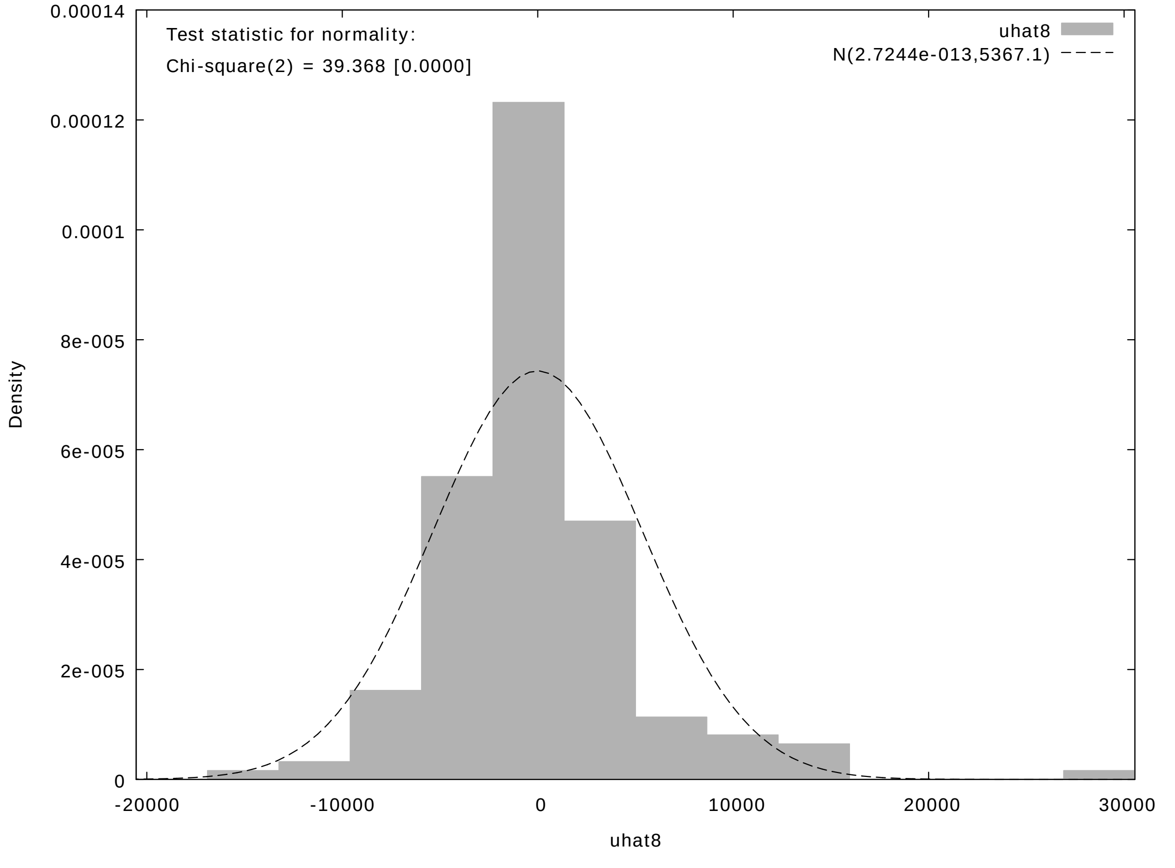
Test on Model 4:					
Null hypothesis: the regression parameter is zero for D_education					
Test statistic: F(1, 160) = 0.556635, p-value 0.456714					
Omitting variables improved 3 of 3 model selection statistics.					
	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	7.96257	0.267512	29.7653	<0.00001	***
age	-0.0117658	0.00556909	-2.1127	0.03617	**
D_busines	0.22852	0.105072	2.1749	0.03110	**
hhsize	0.103417	0.0261126	3.9604	0.00011	***
hhexpend	5.61902e-05	3.96237e-05	1.4181	0.15810	
garden	0.000400322	6.94034e-05	5.7681	<0.00001	***
normal	0.137207	0.0511123	2.6844	0.00803	***
D_awarness	-0.138332	0.14141	-0.9782	0.32943	
Mean dependent var	8.692078	S.D. dependent var		0.820467	
Sum squared resid	67.06284	S.E. of regression		0.645399	
R-squared	0.407006	Adjusted R-squared		0.381224	
F(7, 161)	15.78624	P-value(F)		1.10e-15	
Log-likelihood	-161.6999	Akaike criterion		339.3998	
Schwarz criterion	364.4390	Hannan-Quinn		349.5612	

AppendixA_5 white test

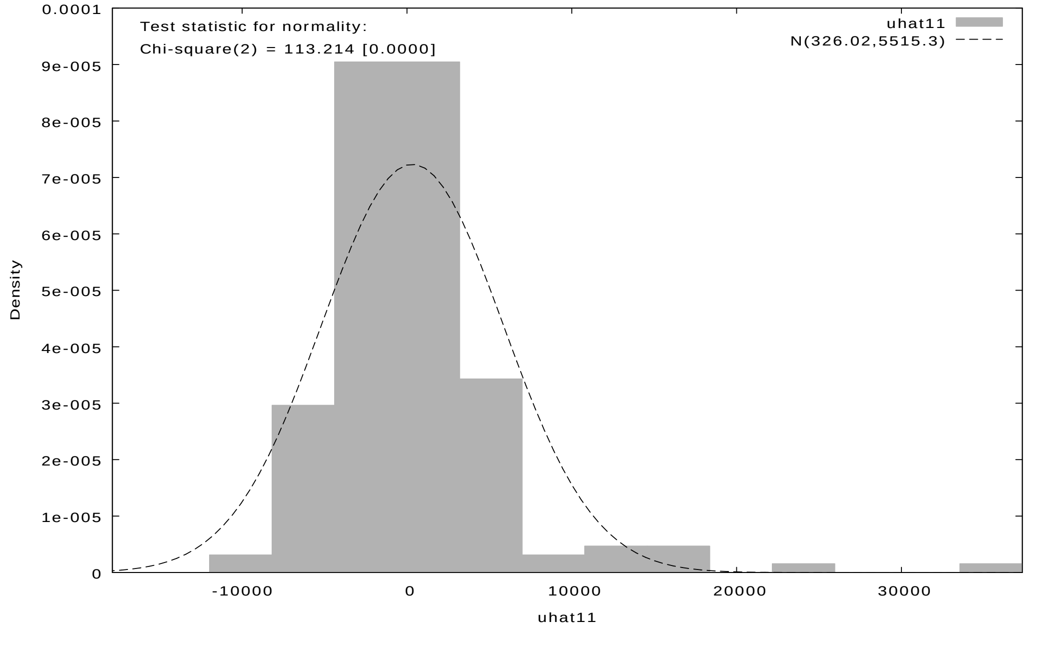
White's test for heteroskedasticity					
OLS, using observations 1-169					
Dependent variable: uhat^2					
	coefficient	std. error	t-ratio	p-value	
const	-8.24536e+07	1.18023e+08	-0.6986	0.4861	
age	6.07232e+06	3.90437e+06	1.555	0.1224	
D_busines	8.87014e+07	8.47115e+07	1.047	0.2970	
hhsize	-2.92149e+06	1.33739e+07	-0.2184	0.8274	
hhexpend	-8154.14	29207.0	-0.2792	0.7806	
garden	-149880	50298.3	-2.980	0.0035	***
normal	2.42418e+06	2.80190e+07	0.08652	0.9312	
D_awarness	7.87367e+07	7.64547e+07	1.030	0.3050	
D_education	-1.16030e+08	9.21303e+07	-1.259	0.2102	
sq_age	-71423.0	40903.3	-1.746	0.0832	*
X2_X3	335266	1.56750e+06	0.2139	0.8310	
X2_X4	-25294.1	304922	-0.08295	0.9340	
X2_X5	-193.089	504.859	-0.3825	0.7028	
X2_X6	-1072.31	835.921	-1.283	0.2019	
X2_X7	-92196.6	557239	-0.1655	0.8689	
X2_X8	-784011	1.56150e+06	-0.5021	0.6165	
X2_X9	455748	1.68006e+06	0.2713	0.7866	
X3_X4	-8.36915e+06	6.48235e+06	-1.291	0.1990	
X3_X5	-9097.37	12363.0	-0.7359	0.4632	
X3_X6	16764.9	18813.1	0.8911	0.3745	
X3_X7	-1.43628e+07	1.44662e+07	-0.9929	0.3227	
X3_X8	-1.75587e+07	4.73275e+07	-0.3710	0.7113	
X3_X9	3.12812e+07	3.73888e+07	0.8366	0.4044	
sq_hhsize	-215554	1.09477e+06	-0.1969	0.8442	
X4_X5	2384.57	2468.01	0.9662	0.3358	
X4_X6	-3905.97	4634.31	-0.8428	0.4009	
X4_X7	-222676	2.67227e+06	-0.08333	0.9337	

X4_X8	-5.86229e+06	9.68857e+06	-0.6051	0.5462	
X4_X9	7.31545e+06	6.32512e+06	1.157	0.2496	
sq_hhexpend	1.54829	2.48885	0.6221	0.5350	
X5_X6	23.3043	7.45704	3.125	0.0022	***
X5_X7	-458.770	4070.56	-0.1127	0.9104	
X5_X8	-22032.5	14871.6	-1.482	0.1409	
X5_X9	-2490.19	13161.8	-0.1892	0.8502	
sq_garden	36.2190	8.86749	4.084	7.77e-05	***
X6_X7	-5401.15	10785.8	-0.5008	0.6174	
X6_X8	33120.4	26271.6	1.261	0.2097	
X6_X9	42376.5	37255.3	1.137	0.2575	
sq_normal	2.55181e+06	5.31342e+06	0.4803	0.6319	
X7_X8	1.09278e+07	1.53253e+07	0.7131	0.4771	
X7_X9	1.94269e+07	1.60505e+07	1.210	0.2284	
X8_X9	3.38095e+07	5.60580e+07	0.6031	0.5475	
Warning: data matrix close to singularity!					
Unadjusted R-squared = 0.608274					
Test statistic: TR^2 = 102.798297,					
with p-value = P(Chi-square(41) > 102.798297) = 0.000000					

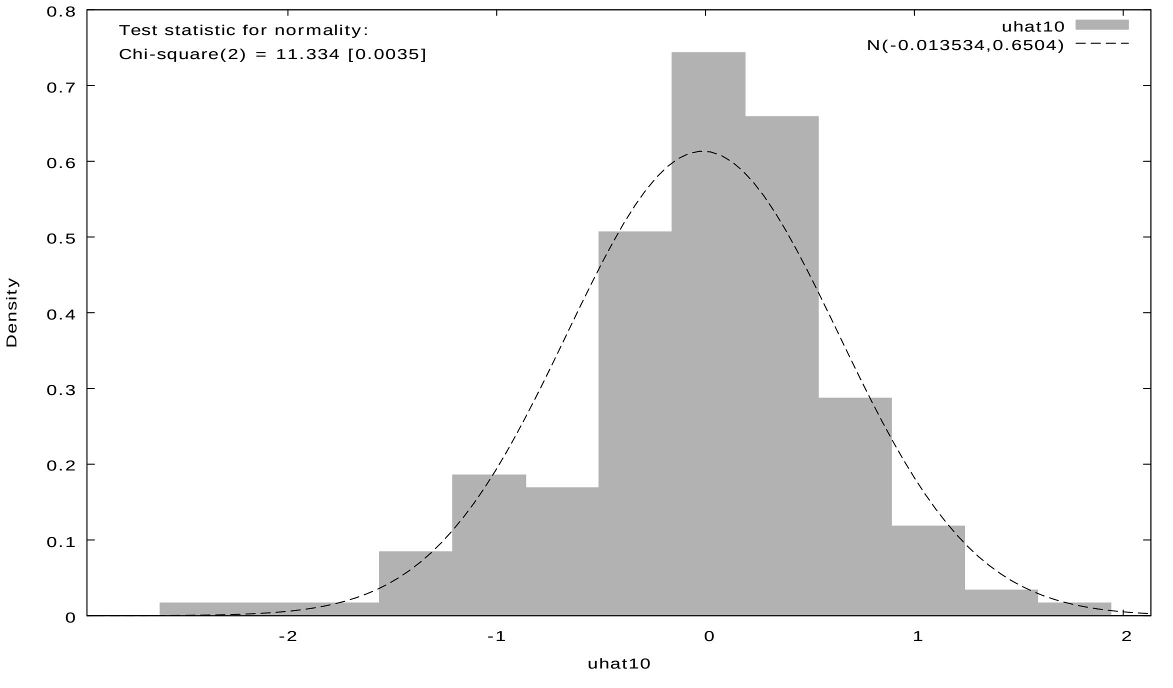
AppendixA_6&7 Normality test



Normality of residuals for HC1 waterCONS



Normality test (HC1 for 1_waterCONS)



Appendix B: survey questionaire

Household No ____. Date____________
Name of kebele_______________________________
HH head name/respondent__________________________________

Part I Demographic & socio economic characteristics

Age of the respondent______________________________________
Gender of the respondent 1. Male 2. Female
Respondent household type: 1. Household head ☐
2. Spouse of household head ☐
3. Other type ☐
Number of HH members________________________________
What is your Education level?
1. Illitresate 2. Litresate ☐
If your answer is litresate,
1. Read and write ☐
2. Primary School complete ☐
3. High School complelete ☐
4. College graduate and above ☐
What is your household occupation?
Private business activities ☐
Employed ☐
Remittance ☐
Other income sources (specify if any)____________________
What is the estimate of your household income per month? __________
What is your monthly household total expenditure in Birr?_______________
What type of housing you are living now? Indicate the one you are currently live:
1. Owen house ☐
2. Rented from other individuals ☐
3. Rented from government agency(kebele) ☐

Part II Water sources and water consumption

Is your household connected to the water supply system (to consume tap water)? **1.** Yes ☐
2. No ☐
If yes, how much volume of water have you been used last month from tap connection?
____________________litress

How much did you pay for tap water last month?

Please, write down the amount from the bill_________Birr

FOR THOSE WHO ARE NOT CONNECTED TO WATER SUPPLY SYSTEM

What are the water sources used by your household? Indicate the only water source currently your household using)

Water source	Yes	No
Public fountain	☐	☐
Rain water	☐	☐
Private well	☐	☐
Water sold by other people	☐	☐

What is (are) the water storage facilities (container) you use most frequently for collecting water? (Indicate one or more currently you are using for)

Container type	Yes	No
Plastic Jar(Jercan)	☐	☐
Rotto	☐	☐
Baldy	☐	☐

How much water did you collect per month/container for the household use?(use the type of container with measured volume in litress)______________________

What is the price of water per container in ETB?_________________________

Household allocation of water for different purposes(Estimate the share amount of water in litress use in your household)

Use of water	Quantity per Litress per day
drinking	
cooking	
washing	
Gardening	
Resale	

Part III Water quality

In the following three questions, you are asked to answer the quality, price affordability and accessibility of water that your household has been using.

Please, rank from the least to highest quality at the 4-point scale.

Consider only water source you have been using.

Are you satisfied with quality of water you have been using?

	Not satisfied at all =1	Less Satisfied=2	Satisfied=3	Very satisfied =4
Tap water	☐	☐	☐	☐
Public fountain	☐	☐	☐	☐
Rain water	☐	☐	☐	☐
Own well	☐	☐	☐	☐
Water sold by other people	☐	☐	☐	☐

How accessible is water for your household?

	Very difficult=1	Difficult=2	Less accessible=3	Accessible=4	Easily accessible=5
Tap water	☐	☐	☐	☐	☐
Public fountain	☐	☐	☐	☐	☐
Own well	☐	☐	☐	☐	☐
Water sold by other people	☐	☐	☐	☐	☐

Part IV Price of water

Is current price of water affordable for you?

	Yes=1	No=0
Tap water	☐	☐
Public fountain	☐	☐
Rain water	☐	☐
Own well	☐	☐
Water sold by other people	☐	☐

Assume due to some reason price of water increased (but your income remain same] by 20 % higher

a. It would remain same

b. we would reduce consumption by 5%

c. We would reduce consumption by 10%

d. We would reduce consumption by 20%

e. I cannot estimate

What do you think your demand for water would be if the current water price is decreased by 20%?

a. It would remain same
b. we would increase consumption by 10%
c. We would increase consumption by 20%
d. We would increase consumption by 50%
e. I cannot estimate

Part V Use of water appliances

Which water-using appliancess and devices your household is equipped with?

	Yes	No
Flush Toilets	□	□
Flow tap water	□	□
Bath(Bagno)	□	□
Separate shower	□	□
Washing machine	□	□
Dish washer	□	□

If your response for the above question is yes, how often your family using the facilities per week?

Appliances type	Average frequency/week
Flush Toilets	□
Flow tap water	□
Bath(Bagno)	□
Separate shower	□
Washing machine	□
Dish washer	□

How often do you use the following in your daily life?

	Not applicable=1	Occasionally=2	Often=3	Very often=4	Not applicable=5
Turn off the water while brushing teeth(Q1)	□	□	□	□	□
Take showers instead of bath specifically to save water(Q2)	□	□	□	□	□
Plug the sink when washing the dishes(Q3)	□	□	□	□	□
Water your garden in the coolest part of the day to reduce evaporation and save water(Q4)	□	□	□	□	□

Part VII. Household awareness on water source conservation

Indicate your thoughts on the statement below by making the appropriate number in the scale.

questions	strongly Agree=1	Agree=2	Nor Agree, Nor Disagree=3	Disagree=4	Strongly Disagree=5	Don't know=6
The household is responsible in reducing water consumption to contribute for Hawassa City water demand management (Q1)	□	□	□	□	□	□
Water is scarce resource in Hawassa we have to conserve it(Q2)	□	□	□	□	□	□
Household is willingness to pay to contribute for water source protection(Q3)	□	□	□	□	□	□
The water utility and community is jointly responsible for ensuring Hawassa City sufficient water supply(Q4)	□	□	□	□	□	□
I am aware of environmental pollution (Q5)	□	□	□	□	□	□

Thank you!