Households Willingness to Pay for Reliable and Sustainable Water Supply in Addis Ababa

Bizuayehu Gossa[1] and ***Zerayehu Sime***[2]

Abstract

Though the Addis Ababa city administration has been undertaking a number of initiatives, the existing potable water supply of the city could not satisfy the growing demand for water. The debate that arise from this unmet demand is whether households are willing to pay for the improved and reliable water supply if projects come with a full coverage of cost of water supply. Therefore, the objective of this study is to estimate the household willingness to pay for reliable and sustainable water supply and its determinants in Addis Ababa. Primary data were collected from 384 randomly selected households using Contingent Valuation Method through Double Bounded Dichotomous Choice format and discussed via interval regression analysis. The calibrated mean willingness to pay is 56.66 cents/ jerrycan (a 2o lit. plastic jar) for a reliable and sustainable water supply. This is higher than the current water tariff in Addis Ababa and driving forces of such willingness should be considered well to enhance households' willingness to pay for reliable and sustainable water.

Keywords: Household, willingness to pay, urban water supply, Addis Ababa, Contingent Valuation Method

1. INTRODUCTION

Among natural resources, water is one of the indispensable requirements for life as it is used for a variety of purposes. Although, it covers two-third of the world surface, around one percent of water is obtainable as fresh water. Therefore, it is widely acceptable to improve sustainability and service quality of water. Due to rapid urbanization and population growth, water resources, in particular, are under constraint that results in a severe problem

[1]MSc in Development Economics, bizugossa@yahoo.com, Yom Institute of Economic Development, Addis Ababa, Ethiopia

[2] PhD in Economics, zerayehu.sime@aau.edu.et Addis Ababa University, Addis Ababa, Ethiopia.

of sanitation and health. The SDG goals, in this regard, underline that above 40% of the world population is expected to be affected by the scarcity of water which is expected to rise with rising temperature. Therefore, a declining supply of water for safe drinking becomes a major problem nowadays since only around a third of the world population has enjoyed access to improved water since 1990 (WHO, 2015).

Some sources show that many countries in Africa have faced water stress problem and thus a larger proportion of Africa's population is expected to be adversely affected by water stress problem mainly due to poor water management. In this regard, Ethiopia is a good example to show the severity of the problem in Africa. Though the country is considered as a water tower of East Africa, Ethiopia uses around 3% of its water resources, of which only about 11% is used for domestic water supply (IWMI, 2010). Only 57% of the population of Ethiopia had access to safe drinking water at the end of the year 2015, one of the lowest coverages globally (UNICEF and WHO, 2015).

Taking this into account, the UN SDGs document gives a great attention to ensuring the accessibility and affordability of drinking water for all by 2030. To do so, there must be quality sanitation facilities and adequate infrastructure in order to promote hygiene of the society. The Ethiopian water resource policy, in this regard, takes position and promotes all unreserved efforts in order to scale up efficient, equitable and optimum utilization of the water resources at fair price. However, there are daunting challenges to achieve this objective, in particular, in Addis Ababa, which has been affected by lack of reliable water supply as the other urban centers in the country. The city administration has been undertaking a number of initiatives to address this challenge at fair price and has achieved undeniable changes by expanding the supply of water through Word Bank funded Projects of developing water wells (WB, 2018). The pace of such changes, however, is slow when compared to the severity of the problem, mainly due to the financial constrains and governance problem.

The existing potable water supply of the city could not satisfy the demand of its fast-growing population. This shortage also affects the quality of water and the life of the city dwellers in various ways: transaction cost to fetch water, education, health status and career development, in particular, for women. When shortages occur in service provision, poor households are the most affected, as the alternative sources are too costly, both in terms of money and time. As a result, the spending on water from vendors is higher than the tap water price as explained in the report of Addis Ababa Water and Sewerage Authority (AAWSA, 2016). This is also aggravated by frequency and duration of water service interruptions, as the city administration failed to expand the service along with the growing population and urbanization. Public service delivery in Addis Ababa also suffered highly from poor capacity, responsiveness and accountability system, making the problem daunting and leave the society in the mire of poverty (UN-HABITAT, 2003; Teshome et al., 2013; Desalegn, 2012).

To address water crisis, it is believed that huge investment is required for enhancing water supply. But, this brings another fear and challenge to government about the source of funds. If funded by loan, how does the country pay back loan with interest rate as the water project is not designed to generate an income that compensates loan? If the City administration shifts the cost to the society via increasing water tariff, the questions coming into the picture is affordability for the society.

Literature shows that financial resource is the fundamental factor in the improvement and sustainability of water supply services. The cost recovery, which is a very critical precondition for water utilities to be financially strong, is one of the key determinants of sustainability for urban water supply. The presence of poor cost recovery and budget constraint are hindering a lot the expected smooth performance of the water supply provision in the city. The development of water supply projects requires huge investment and operational and maintenance costs are also increasing from time to time, while the water tariff of the city is too low to cover these costs. The revenue and expenses of the Water and Sewarage Aauthority show imbalance. This situation forces it to depend on a third party to finance water projects. Its capital investment is totally covered by government treasury and aid.

Currently the authority's financial situation does not allow it to pursue capital investment required to facilitate the service provision. Even it cannot properly cover all its costs. The provision of an improved water supply is neither cost free nor sustainable unless the costs are recovered. Sustainability can only be ensured if tariffs generate enough resources to operate the system, finance the expansion of the service to new customers and ultimately replace the infrastructure after its useful life (IRC, 2001).

The authority currently has a tariff structure which cannot recover the full cost of water supply. That small tarrif is against the country's tariff setting guideline, which forces urban water authorities to finance their own cost including investment costs. As to the revenue data and the official's suggestion, in addition to the prevailing low water tariff, the payment culture of the communities is at low level. Bill collection data show on average only 75-80% of the water bill was collected on monthly bases. Better methods of revenue collection need to be put in place. Not only collection efficiency, but also accurate reading meter quality can contribute to enhanced revenue.

The current tariff system is not only unable to cover the cost of water supply expansion project, but also it does not cover the current operational and maintenance costs. The questions center on the extent of the society's willingness to pay for sustainable and improved water in Addis Ababa. Once the mean value of willingness to pay and its determinants are identified, it helps the City administration and/or donors to compute water tariff which could cover the cost of water supply and enable the society to access sustained and improved water supply. The main objective of the study was, therefore, to estimate the level of households' willingness to pay for reliable and sustainable water supply and examine the major factors that influence their willingness through a contingent valuation survey and an interval regression model. Findings may help the government to design a range of policies to promote safe drink water supply. There is a need for the adoption of a comprehensive policy framework and treatment of water as an economic good, combined with designing a key strategy for enhancing its implementation.

Gleick (1996) argues that sustainable development and sustainable water management (SWM) are inherently related due to the requirement of water for development. According to UN-Water, “Water is at the foundation of sustainable development as it is the common denominator of all global challenges: energy, food, health, peace and security, and poverty eradication” (UN, 2014). Mays (2006), defines sustainable water management as meeting current water demand for all water users without impairing future supply. More specifically, SWM should contribute to the objectives of society and maintain ecological, environmental, and hydrologic integrity (Loucks, 1999).

On the other hand, reliable water supply can be shortly stated as a regular, steady or uninterrupted safe water supply. The uninterrupted stream of potable water that flows from an urban consumer’s faucet is, perhaps, how most people perceive and understand water supply reliability (Hawk, 2003). Similarly, perceptions on reliability are common to other types of demand/supply context and engineers have formalized this perception by defining reliability as the probability that system does not fail, or conversely, it is the probability of system failure subtracted from one (Ibid.).

Sustainable development in urban areas requires reliable, equitable, and easily accessible water. But, providing water to the rapidly growing urban populations in developing nations creates a complex logistic and economic problem. Some of the critical factors for the urban water supply shortage are population growth, rapid urbanization, lack of capacity, technological capacity, institutional capacity, inadequate financing, increasing global water scarcity, high level of water loss/leakage, climate change, and poor water infrastructure and distribution systems Khatri (2007), Yimer (1992), Grover (2008), (WSP, 2009), (Montgomery and Elimelech, 2007), UN-HABITAT (2006) and (Oyebande, 2001).

Generally speaking, cities all over the world are facing a range of dynamic global and regional pressures (see Figure 1). They are facing difficulty in efficiently and transparently managing ever scarcer water resources, delivering water supply and sanitation services.

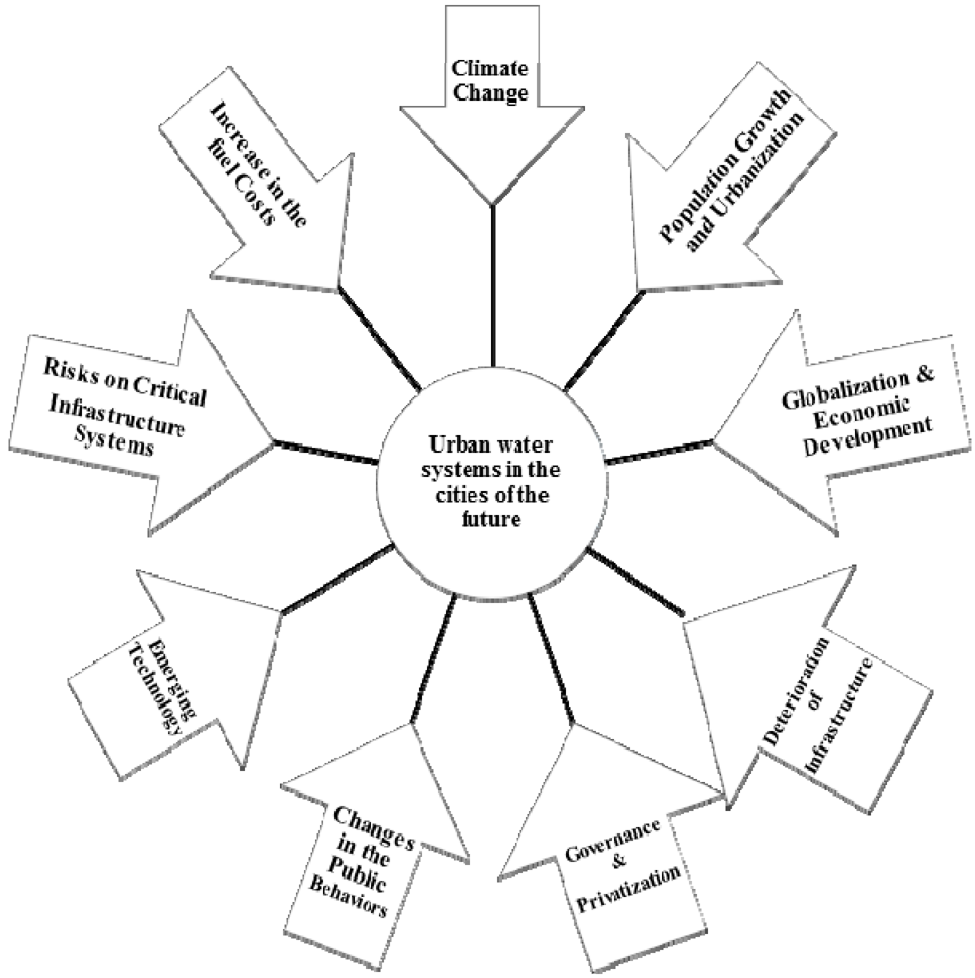

Figure 1. Global Change Drivers of Urban Water Systems
Source: Khatri (2007).

These global and regional pressures must be recognized and used to drive the design and management processes of urban water systems. However, there is significant disagreement over the approach to addressing the problem. As to World Summit on Sustainable Development/WSSD/ water efficiency can be improved using many approaches; including investing in physical improvements in infrastructure and technology, fostering changes in user behavior, and developing integrated improvements in water management (WSSD, 2002). WSSD two important approaches of improving water supply: improving infrastructure and impacting user behavior.

The supply-oriented approach focuses on technical elements and monopolistic public service delivery. This had failed to deliver the required levels of services and adherently resulted in the use of several alternatives to substitute and augment piped water supply. It is now realised that the conventional "supply oriented" planning has aggravated the gaps in service delivery; but, it is found to be economically-inefficient and socially inequitable (Rousseas 2015; Mazerov 2018; Bartlett 2014). The demand-oriented approach, however, focuses on service consumers' needs and WTP full costs of services, competitive markets, and broader participation of the private sector, Non-Governmental Organisations (NGOs) and Community-Based Organizations (CBOs) is now being incorporated into water supply and sanitation strategies. It is expected that this approach could be economically more efficient as social responsibility will be increased and environmental degradation minimised.

According to WB (1993), governments need to adopt a "demand-driven approach" in which utilities "deliver services that people want and for which they are willing to pay". There are two key ideas underlying the demand-driven approach (Gulyani, 2001). First, utilities can and should charge the full costs for water and use the revenues to improve service and expand coverage. Second, to do so, utilities and planners need to understand and respond to demand. In other words, by pricing the water, effecting demand, and then responding to effective demand for water, governments and planners are well on their way to solving the problem.

Depending on various circumstances, economists place Total Economic Value (TEV) on either stocks or flow of natural resources. TEV can be divided into two main components: namely, use value and non-use value. Use value arises from direct or indirect physical benefits human beings obtain from environmental resources. It also includes the option value which reflects the value individuals give to the future uses of environmental resources. Non-use value is obtained without actually using the resources/services, which reflects that people are willing to improve or preserve environmental resources that they do not use and will never use. So, total WTP for environmental resources is the sum of use value and non-use value (Tietenberg, 2003). According to the Canadian Council of Ministers of the Environment (2010), the TEV of water is comprised of its use and non-use values.

On the other hand, the non-market valuation techniques for environmental goods also received a great attention as environment resources are not traded; thus, their value cannot be determined in the market. We therefore require non-market valuation techniques to value improvements and/or reduction in environmental goods and services including water. Economists have made considerable efforts over the past few decades for valuing environmental goods and services. As a result, nowadays various valuation methods are available to value non-marketed economic resources such as water. Thomas and Callan (1996) grouped these methods broadly as indirect (revealed preference) method and direct (stated preference) methods. The indirect method involves inferring the unobservable demand, and hence value of environmental goods and services, based on observable demand for related marketable goods and services. The direct method refers to the direct expression of individuals' willingness to pay/accept in compensation for any change in environmental qualities, quantities or both. It involves direct estimation of environmental value based on the responses of individuals to the hypothetical valuation questions, and hence it does not depend on market information (Freeman, 1993).

Contingent Valuation Method (CVM) is the earliest method of non-market valuation approaches. It is superior to other valuation methods as it is able to capture use and non-use values. It is also easy for data collection and requirement compared to other valuation methods. (Young, 2005). So, CVM is chosen for this study. The application of the method, in fact, requires extreme care to avoid bias and get reliable result, such as by triangulating methods, pre-testing instruments, and deplying well-trained and experienced interviewers (Whittington, 2002).

The CVM, was employed in many studies of valuing public goods like water resources. For example, Khuc (2013), used CVM to explore consumer behavior of households for drinking water in Hanoi and Hai Duong in the north of Vietnam and Hochi Minh in southern Vietnam with the application of binary Logit regression. Ibrahim A. and Robert H. (2009) used CVM to estimate WTP for improved domestic water supply services in Ramallah Governorate, Palestine. Farolfi (2007) employed CVM and Tobit model to study the determinants of households WTP for improving water quality and quantity in Swaziland. Samuel (2005) used the CVM with an open-ended elicitation method to determine the economic value of basin protection to improve the quality and reliability of potable water supply in Ecuador.

In Ethiopia, Fisseha (1997) used a CV survey to estimate the WTP for improving water quality in Maki town; Genanaw (1999) employed CVM to assess the determinants of households WTP for improved water services in Harare town; Alebel (2002) studied determinants of WTP for improved water service in Nazareth Town and looked into whether it was possible to introduce full cost recovery program; Gossaye (2007) employed the CVM to investigate the WTP for improved water supply services in Debre Zeit town; Fekadu (2011) assessed households' WTP for improved water supply services in Holeta town; Dessalegn (2012) studied determinants of residential water demand in Merawi town; Belaynesh (2013) on households demand for improved water services in Sodo town; Tamirat (2014) used CVM to estimate households' WTP for improved water services in Dilla town and to identify factors that potential affect their WTP. All of them employed CVM with value elicitation method of close ended formats like single-bound dichotomous choice as well as open-ended questions.

The present study, employed interval regression model and Double Bounded Dichotomous Choice (DBDC) method of estimating WTP for urban water services.

2. Materials and Methods

2.1. Sampling and Sample Size Determination

This study was undertaken in Addis Ababa. Both primary and secondary data sources were used to get the necessary information for conducting this study. Primary data was collected using questionnaire and key informant interview. Structured contingent valuation (CV) questionnaire was used to gather information from households.

The sample size in this study, determined as in Cochran (1963), was 384. The study also used a multistage sampling technique. First four sub-cities were selected, then one wereda from each sub-city as a second stage sampling, and finally households within the selected wereda as the third stage. The selection was carried out mainly based on the current situation of water supply. To easily test their impacts, the socioeconomic diversity of households was also taken in to consideration in selection of sampled areas.

The study used Double Bounded Dichotomous Choice (DBDC) question format (Hanley, 1997) in line with the National Oceanic and Atmospheric Administration (NOAA) panel guidelines for every CV study (Haab and McConnell, 2002). Hence, the study has three basic parts, namely: household's socioeconomic characteristics, existing water supply situations of the city, and household's willingness to pay for improved water supply questions. Pre-testing (pilot survey) was also conducted with randomly selected 50 household heads to strengthen the final survey questionnaire. On top of that it was used to set the starting bid for the CV elicitation part of the questionnaire, where during the pilot survey the WTP part was open-ended in this study.

The initial bid values were determined based on the result of pilot survey. As the pilot study was undertaken with open-ended questions, the range of response varied between 10 cents and 2 ETB. To fit the observed data points to an underlying probability distribution, the researcher used non-parametric kernel density estimation. Based on this method, five starting bids of 30, 40, 50, 60 and 70 cents were selected and randomly allotted to 384 sampled households in the final survey. The follow-up bids were the double of the initial bids if the respondent answered "Yes" and half of the initial bids if he/she answered "No". For simplicity purpose, the WTP questions were asked per jerrycan which commonly has a capacity of about 20 liters of water.

Table 1. Alternative Bid Values Used in the Study

bid_1 (Initial)	30	40	50	60	70
bid_2 (Higher)	60	80	100	120	140
bid_2 (Lower)	15	20	25	30	35

2.2. Model Specification and Estimation Method

The WTP varies across households depending on the household socio-demographic characteristics, income and the existing status of water services.

$$WTP_i = f[X_i, \varepsilon_i] \quad \text{(1)}$$

Where, Xi includes Source Attribute (existing water supply practices and problems); Socioeconomic and demographic variables and ε_i is the error term. Thus, the econometric model for WTP can be specified as:

$$WTP_i = \beta_i X_i + \varepsilon_i \quad \text{(2)}$$

Where: WTP_i is dependent variable, representing the ith household maximum WTP for the proposed water service; X_i is a set of independent variables/vector of explanatory variables; β_i *is* the coefficient of variables that affect household maximum WTP, that is vectors of unknown parameters of the model, and ε_i is the error term, representing the unobserved other factors.

As the DBDC method was applied in this study, an interval regression model was used to determine influencing factors and to calculate a mean WTP. The DBDC could have four possible interval outcomes. That is if the responses are:

- Yes and Yes, then $WTP \geq B^H$, that is B^H will be used as the lower bound;
- Yes and No, then $B^F < WTP \leq B^H$, that is B^F will be used as the lower bound and B^H becomes the upper bound;

- No and Yes, then $B^L < WTP \leq B^F$, that is B^L will be used as the lower bound and B^F becomes the upper bound;
- No and No, then $WTP < B^L$, that is B^L will be used as the upper bound. Where B^F stands for first bid, B^H stands for higher bid, and B^L stands for lower bids.

That means based on the responses to the opening bid and follow-up questions, the respondent's latent WTP may be placed in one of four regions: $(-\infty, B^L)$, (B^L, B^F), (B^F, B^H) or (B^H, ∞), see the figure below:

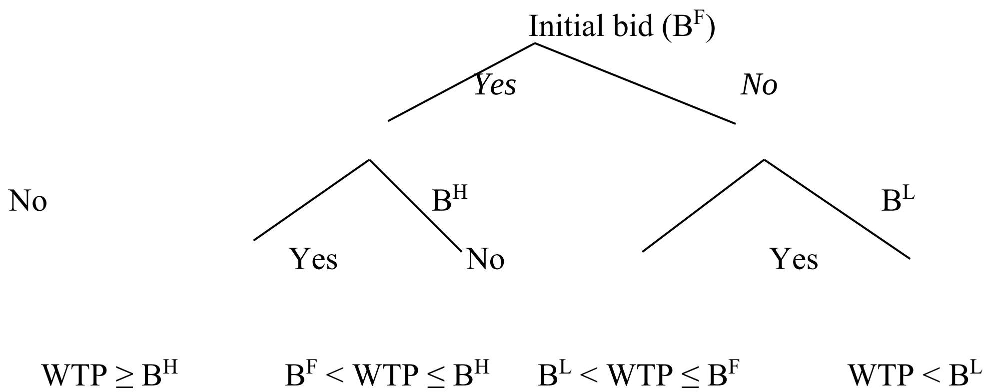

Figure 3. The DBDC Questioning Sequence and formation of bounds

In this study, an interval regression model was applied as in Cameron, (1988) to estimate the WTP for improved water supply and its determinants in Addis Ababa case.

In the context of CV surveys, respondents may be uncertain about their WTP because they are uncertain about the provision of a public good or because they are uncertain about their future income (Wang, 1997). Therefore, we need to implement tools that mitigate hypothetical bias in CV surveys conducted. In this study, therefore, both ex-ante and ex-post approaches were used to mitigate hypothetical bias. In the ex-ante approach, people were asked to consider their income and it was explained to them that the survey will be made available to policy makers. In the ex-post approach, Follow-up Certainty Questions (FCQ) were used. So, "Yes" respondents were asked to affirm how certain they were regarding their answer to the WTP question. Here the 7-point scale of certainty was used.

On a scale ranging from 1 to 7, where 1 means "Very uncertain" and 7 means "Very certain", the respondents were asked how certain they were to pay the given amount if the program was actually implemented. Additionally, an open ended question was asked to give participants last chance to tell their maximum WTP. It was used to consolidate the certainty calibration by observing whether that maximum amount of WTP lied in the interval. When it was outside the interval, the calibration was readjusted considering that maximum WTP value.

Table 2. The Calibration Strategy and WTP Bounds in DBDC Elicitation with Calibration

Response to First bid (B^F)	Response to second bid (B^L, B^H)	Certainty level to first bid	Certainty level to the second bid	Outcome	WTP bound ($WTP_{lower\ bound}$, $WTP_{upper\ bound}$)
Yes	Yes	-	>= 5	Yes-Yes	$(B^H, +\infty)$
Yes	Yes	-	< 5	Yes-No	(B^F, B^H)
Yes	No	>=5	-	Yes-No	(B^F, B^H)
Yes	No	< 5	-	No-No	$(-\infty, B^L)$
No	Yes	-	>=5	No-Yes	(B^L, B^F)
No	Yes	-	< 5	No-No	$(-\infty, B^L)$
No	No	-	-	No-No	$(-\infty, B^L)$

Note: for yes- yes responses, only the second higher bid response was calibrated because it seemed logical that these respondents, at least, could certainly pay the first bid.

3. Results and Discussion

3.1. Demographic and Socioeconomic Characteristics of Households

The response rate of 97.7%, 194 (51.73%) were female respondents, while 181 (48.27%) were males. The average age of the respondents is 40.6 years, which ranges from 19 to 80 years of age. The average family size of the households who uses the water tap is about 4.78 individuals with a minimum of 1 person in the house to a maximum of 12 household members. The education figures reveal that 356 (95%) were attending their formal education while the rest 19 respondents are illiterate. the average educational level of the household heads' is 13 which range from illiterate/zero to a maximum of 24 years of schooling. Regarding the employment, about 88% of the surveyed households are engaged in different income generating occupations. The average monthly income of sampled respondents is Birr 7,720.62 with minimum monthly income of Birr 300 and maximum of Birr 80,000. 163 (43.5%) of the respondent owns the house they live in whereas 212 (56.5%) do not have.

More than half of respondents (57.3%), did not use any type of water purification method for the following reasons: about 50% believed that the water they used was clean for drinking; 12.1% thought that, even if not pure, it had no side effect on health; 33% believed that water purification was costly and time taking; 1.4% used bottled water for drinking; and 3.7% did not know whether the water should be purified before drinking. Those households (42.7%) who felt the water quality was not good treated water using some form of water purification methods, including water filter (1.2%) and boiling (17.1%). In general, 83.5% of the respondents said that the existing water supply was unreliable while the rest believed that it was reliable.

3.2. Water Supply Service Availability

Of the respondents, 30.1% said water supply service was available both day and night, 26.4% said that water was available only during the daytime, and 18.9% said that water was available only during the night time. The remaining respondent (24.5%) said that the time of water availability was unpredictable. Thus, when water was not available in their tap, households bought water either from water vendors (27.2%) or from public tap (3.5%). A few of the respondents (2.4%) used their own private water well. The majority of the households (66.1%) stored water in tankers/containers to meet their water requirements while the remaining (0.8%) used bottled mineral water for drinking.

Moreover, 62.7%, of the respondents said that only female member of the family fetched water from outside source; only 21.9% said the male was responsible for water collection, and 12% said it was the duty of either female or male, and the reremaining 3.5% said they used other mechanisms, mainly daily laborers, to bring water from other sources.

3.3. Households Consumption and Expenditure of Water Supply

The average monthly consumption of water for a household was 4.38 m^3 and average monthly expenditure of a household was Birr 40.51. Out of the average monthly income of a household (ETB 7,720.62), a household spends 0.52% of its monthly income on water supply on average. This is far below the World Bank's recommendation, which states a household should spend a maximum of 5% of its monthly income on water. Since water is not available at the required time and amount, relative to the other area, these households usually buy water from venders (whose price is higher than the official tariff) and some of them incurred additional labor and transportation cost to fetch water.

Table 4. Households Average Monthly Water Consumption and Expenditure in the Study Area

No	Name of surveyed sub-cities	Average No of days they get piped water in a week	Average Monthly water consumption in m^3	Average Monthly water Expenditure in Birr
1	Bole	7 days/week	7.23	14.10
2	Arada	5-6 days/week	4.43	27.66
3	Yeka	2-4 days/week	3.58	35.86
4	Gulele	$\leq$1 day/week	3.12	68.05
Total Average as of survey result			**4.38**	**40.51**

Source: own computation from field survey result, 2016

The survey result shows that when tap water was not available households spent, on average, Birr 1.56 for a jerry can of water they fetch water from water vendors. Hence, excluding their water bill payment, on average these households were spending Birr 43.45 per month to buy water from water vendors.

The survey result indicates that, on average, women and children spend 27 minutes, with minimum of 8 minutes up to a maximum of 2.40 hours per day. The majority of the respondents said that, on average, two members of the household go to fetch water at a time and also fetch water more than once per day. The above points help us to understand that water supply problem results in multi-dimensional socioeconomic crisis for the households. Thus, improving the water supply helps the population to save their money, energy and time as well as to be a healthy and productive labor force. Despite that importance, 306 (81.6%) of the respondents were not satisfied with the existing water supply service. Regarding the main causes of their dissatisfaction, 268 (88%) of them said it was because of unreliability of supply, and 220 (72%) of them said scarcity of water (Fig. 3). The rest responded low pressure, poor quality, and higher volume charge were problems of the current water supply.

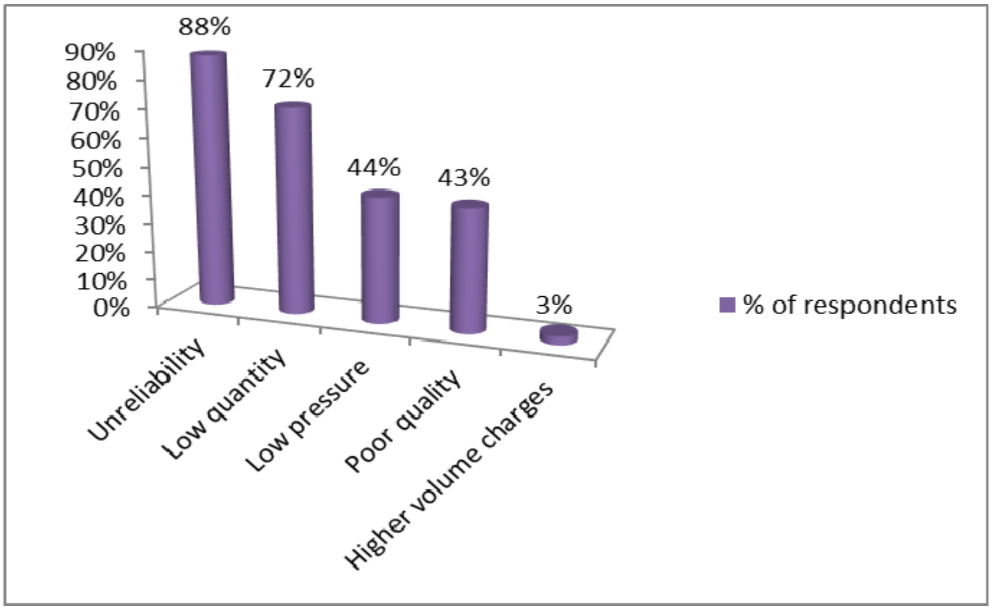

Figure 3. Reasons for dissatisfaction of households on the existing water supply service

Source: own computation from survey result

3.4. Demand and WTP for Reliable and Sustainable Water Supply

As clearly explained in the methodology part, the selected CV elicitation technique of the study was DBDC question format. Five starting prices for the corresponding valuation question were used to inquire households' possible maximum WTP for one jerrycan (20 liter) of water they got from the hypothetical reliable and sustainable water sources. Questions relating to the five initial bids were randomly assigned to each household in the first step. Then, households were asked questions dealing with the second bids contingent upon his/her response to the opening bid one jerrycan. Double or half of the initial bid values were asked if he/she answered “yes” or “no’’ to the first questions respectively.

Since most households were not satisfied with the existing source, 380 (99%) were willing to participate in the improvement of water supply scheme. Figure 4 shows the summary of the households’ responses to the DBDC questions.

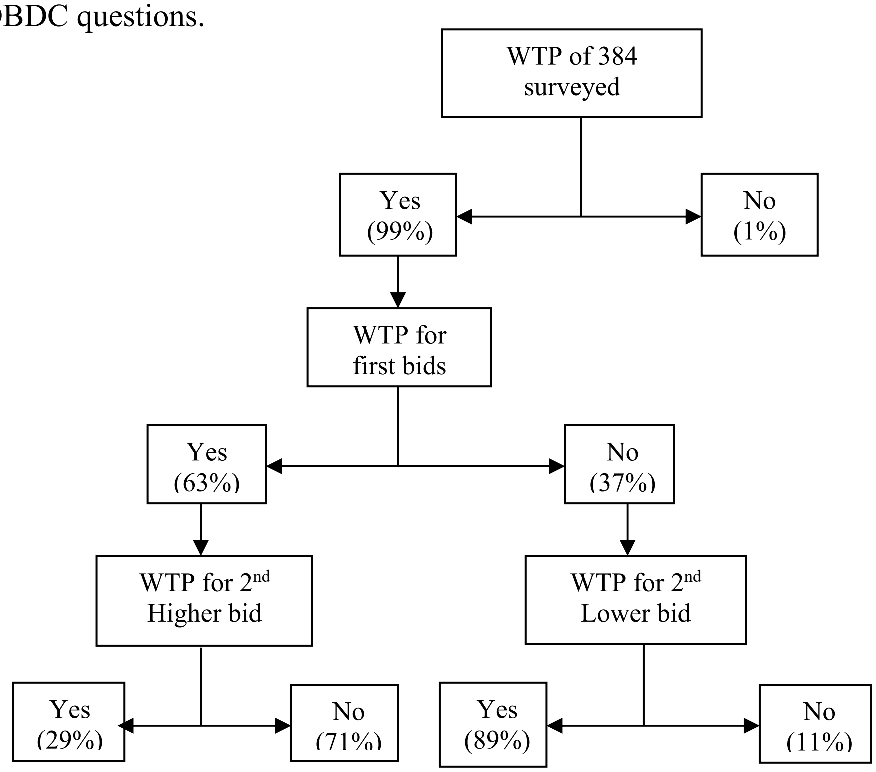

Figure 4. Summary of household’s responses to DBDC questions of WTP for reliable and sustainable supply

The following table gives the structure of 375 answers to the DBDC questions, where identified protest bidders are excluded. As expected, the frequency of "yes" and "yes/yes" respondents decrease with the initial bid. On average, 4.27% of the total responses were "no/no", meaning that their WTP is below the lower bids, that is $(-\infty, B^L)$. Among the remaining, the

WTP stated by 77.34% of the respondents were somewhere in the interval between the lower bid and the starting bid (33.07%), that is $B^L < WTP \leq B^F$ or (B^L, B^F) and between the starting bid and the upper bid (44.27%), $B^F < WTP \leq B^H$ or (B^F, B^H). While about 18.40% were willing to pay more that the higher bid, $WTP \geq B^H$ or $(B^H, +\infty)$.

Table 5. Details of Households answers to the alternative bids

Bid cards	Bid cards Statistics		Answers to initial bids /B^F/		Answers to all bids			
					Frequency		%	
			Yes	No	YY	NY	YY	NY
$B^F/B^H/B^L$	Frequency	%			YN	NN	YN	NN
30/60/15	84	22%	82%	18%	33	13	8.80%	3.47%
					36	2	9.60%	0.53%
40/80/20	77	21%	80%	20%	16	13	4.27%	3.47%
					46	2	12.27%	0.53%
50/100/25	78	21%	70%	30%	12	19	3.20%	5.07%
					43	4	11.47%	1.07%
60/120/30	74	20%	43%	57%	8	39	2.13%	10.40%
					24	3	6.40%	0.80%
70/140/35	62	17%	27%	73%	0	40	0.00%	10.67%
					17	5	4.53%	1.33%
Total	**375**	**100%**			**69**	**124**	**18.40%**	**33.07%**
					166	**16**	**44.27%**	**4.27%**

Note: B^F = Starting bid; B^H =Higher bid; B^L = Lower bid

Source: Own computation from Survey Result

The next figure shows the relationship between the probabilities of accepting different alternative bids of WTP. The downward sloping graph shows an inverse relationship between price and acceptance rate and indicates that the probability of accepting the given bid decreased as the bids are increasing. Here we note from the figure below that the demand curve is negatively sloped indicating that, like most economic goods, the demand for reliable and sustainable water services will decrease with increasing water use charges, keeping all other things constant.

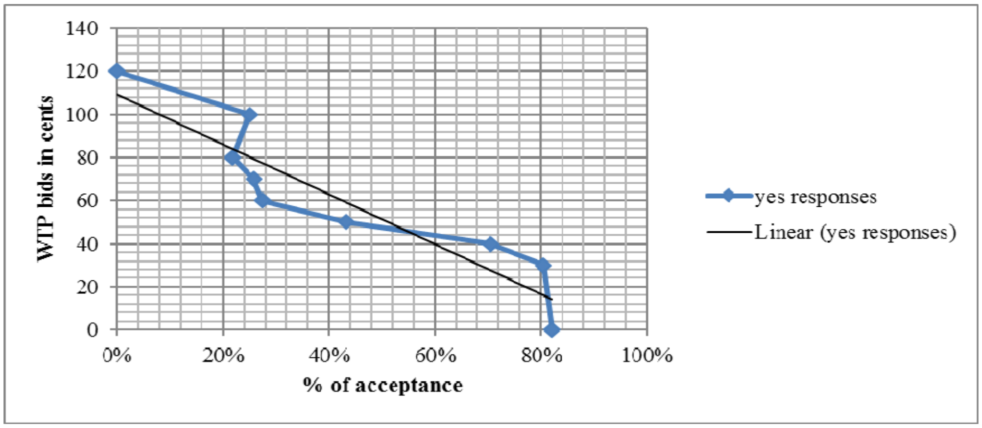

Figure 6. Household acceptance rate of different WTP bids.

4.2. Econometric Results and Discussion

4.2.1 Estimation of Households' Average WTP for Reliable and Sustainable Water

The mean estimation can be done using either linear prediction, Delta-method or by computing the interval regression by removing the explanatory variables. The later one is chosen by the researcher as the former has a disadvantage of overestimating the value to some extent which is not advisable for policy issues like water. The results show that without calibration the mean WTP of the sampled households is 62.15 cents for a jerrycan (20 liters) of water if they will be provided with a safe water supply service in regular and sustainable manner. While, the calibrated mean WTP is 56.66 cents/jerrycan. When comparing the two means, it comes out that the difference between the two means is 5.49 cents/jerrycan. As it is stated in detail in section 3 of this paper, using CV to estimate the WTP could have hypothetical bias that most often leads to an overestimation of WTP so that results may not be fully reliable for policy purposes.

Since the provision of potable water for the society, which is the concern of this study, is one of the critical policy issues for the local government the researcher applied both ex-ante approach (by asking respondents to consider their income and explaining that the survey will be made available to policy makers) and ex-post approach, mainly the Follow-up Certainty Questions

(FCQ) with a scale ranging from 1 to 7, where 1 means "Very Uncertain" and 7 means "Very certain", so as to mitigate the threat of hypothetical bias.

The above results of the study show that the mean WTP decreases when applying the calibration approach, which suggests the presence of hypothetical bias. This indicates to us that some respondents are not truthful when revealing their WTP because they do not fully consider their budget constraint or as (Li C. and Mattson, 1995) stated respondents had incomplete knowledge about their true valuation of a commodity and might give wrong answers to the valuation question, that is their answers do not match their true WTP. The policy being valued in this study is the provision of reliable and sustainable water supply to the households in Addis Ababa which could be considered and adopted by policymakers. Therefore, the researcher takes the calibrated mean (we call it a mean value of households' WTP afterwards) for the analysis and interpretation of the study.

The mean value of households' WTP amount (56.66 cents/jerrycan) is surprisingly higher than the current water tariff structure of the city. The mean WTP found in this study is two and half times the present maximum tariff rate and it is more than four times the mean of the existing tariff of the city which is 13 cents/jerrycan (refer from Table 4). This shows that the households are willing to pay for reliable and sustainable water service much more than what they are currently paying for the existing water supply service. From its natural definition, demand is not only the willingness but also the ablity to pay. Beyound assessing households' WTP, it is also important to see whether they can afford to pay by assessing their ability to pay for the service improvements. Hence it is necessary to check the affordability of the mean households' WTP. From this, the average monthly expenditure for water is 2.7% of their average monthly income. This ratio is less than the 5% (based on the World Bank recommendation) of the average monthly income of the household. This implies that a household living in the study area is willing and able to spend more if provided with reliable and sustainable water supply.

The surveyed households expressed their WTP not only above the existing tariff structure in Addis Ababa, but also above the cost of providing the service. Households are willing and able to pay more than twofold of production and distribution cost of water.

4.2.2 Determinants of WTP for Sustainable Water Supply

The level of significant difference was observed during the survey between households in their WTP for the provision of improved water service. This variation was observed on households due to the existence of differences in their socioeconomic and demographic backgrounds and the water service.

Table 6. Interval regression result for the determinants of WTP

Explanatory variable	Coefficient	Robust Std. Err.	P>z
SEX	1.489436	2.033034	0.4640
Age*	-0.2130679	0.1019236	0.0370
EDU*	0.6391822	0.2573228	0.0130
OCC	0.493152	2.787901	0.8600
MINC*	0.0015486	0.0003563	0.0000
FSZ*	-0.9098825	0.4406752	0.0390
WLTZ*	10.93778	2.032012	0.0000
WC	-0.2585033	0.2069043	0.2120
WEXP	0.0163425	0.0202647	0.4200
QLTY*	8.48401	2.468525	0.0010
PRSUR	3.307189	2.808972	0.2390
REWS*	8.321632	3.616867	0.0210
SAT*	8.697711	3.347202	0.0090
RESP*	-6.056457	2.162568	0.0050
TARIF*	5.623755	2.036821	0.0060
Constant	33.69833	6.248452	0.0000
Number of observations	375		
Prob > chi2	0.0000		

Source: Regression Result

* Significant at the 5 % and 1% level of significance

The data in Table 6 presents the estimated coefficients of the explanatory variables (determinants) and their impact on the amount of household's WTP for reliable and sustainable water supply.

Reliability, quality, perception and attitude towards current price and responsibility of improving water service are statistically significant and positively influence the willingness to pay for reliable for water service. Out of the three hypothesized demographic variables, only age and family size are statistically significant and have a negative impact on the value of households' willingness to pay. Regarding socioeconomic factors, monthly income, wealth, occupation, and educational level of the respondent have a positive effect on the level of their WTP as expected. The diagnostic statistics reveal that the chi square value for the model is perfectly significant at the 1% level of significance which means that the explanatory variables jointly influence household's WTP. Finally, the study confirms that the findings adequately fit with the hypothesised expected signs which based on theories and empirical literatures of water economics.

5. Conclusion and Recommendations

The existing water supply in Addis Ababa is not able satisfy the fast growing demand of the community and has become a daunting challenge to the society, requiring a sustainable and reliable water service in the City. This study then focuses on estimation of the average value of willingness to pay for a reliable and improved water service and examines the major determinants that influence households' willingness to pay using non-market valuation method and interval regression estimation method as explained in the study.

The surveyed households receive water supply only for four days in a week on average. In conclusion, the present water supply in the city of Addis Ababa is grossly inadequate, unreliable, and has made the majority of the household (82%) not to be satisfied with the present supply. The calibrated mean WTP of the sampled households is 56.66 cents for a jerrycan (20 liters) of water if they will be provided with a safe water supply service in regular and sustainable manner. The study has revealed that the surveyed sample households expressed their WTP not only above the existing tariff structure, but also above the cost of providing the service. Generally, households living in the study area are willing and able to spend more if it is provided with more reliable and sustainable water supply. Variables concerning service delivery such as satisfaction, reliability, quality, households' attitude towards the current water tariff and the responsibility of improving water service are statistically significant. Regarding demographic variables age and family size have negative impact on the value of households' WTP. While from socioeconomic variables income, wealth, and level of education have a positive effect on it.

The higher willingness to pay may lead to derive a new and an important policy implication for the city to expand the availability and accessibility of reliable and sustainable water. Hence, policy makers need to consider the demand side of the market for water as opposed to the supply side in service providing development programs. Thus, based on the empirical evidences, the water authority and policy makers should give attention to variables which are found to be statistically significant in designing policies related to water supply services so as to provide reliable and sustainable water supply services. The decision makers should also give more attention for managing water demand through pricing mechanisms in the intervention areas for securing sustainable and reliable water service.

References

AAWSA. 2016. Semiannual and Annual physical and financial plans, Reports and other unpublished documents prepared for different purposes from 2003- 2009 E.C.

Alebel, B. 2002. Affordability and WTP for Improved Water Supply in Urban Areas, strategy for full cost Recovery: Case of Nazeret town, Ethiopia. A.A.U.

Bartlett, B. 2014. "Supply-Side Economics: 'Voodoo Economics' or Lasting Contribution?" Reprinted in *The Impact of Supply-Side Economics*. The Laffer Center. pp. 167 - 210.

Belaynesh, T. 2013. Households Demand for Improved Water Supply Service in Ethiopia: Case of Sodo Town. Paper Presented at 11th Annual Conference of EEA.

Bishop R. and Heberlein T. 1979. Measuring Values of Extramarket Goods: Are Indirect Measures Biased? *American Journal of Agricultural Economics*, vol. 61 (5): 926 – 930.

Cameron, T. 1988. A new paradigm for valuing non-market goods using referendum data: Maximum likelihood estimation by censored logistic regression. *J. Environ. Econ.Manag.* 15(3): 355 - 379.

Canadian council of Ministers of the environment. 2010. Water Valuation Guidance Document.

Cochran, W. G. 1963. *Sampling Techniques,* 2nd ed. New York: John Wiley and Sons, Inc.

Desalegn Berhane, A. 2012. Assessing causes and challenges of urban water supply problem, The Case of Mekelle City.

Dessalegn, C. 2012. Factors Determining Residential Water Demand In North Western Ethipoia, Case Of Merawi. MSc thesis, Cornell University.

Dzikus, A. 2001. *Managing Water for African Cities: An Introduction to Urban Water Demand*", Regional Conference on the Reform of the Water Supply and Sanitation Sector in Africa – Enhancing Public-Private Partnership in the Context of the Africa Vision for Water (2025), Kampala, Uganda

Farolfi, S. M. 2007. Domestic Water Use and values in Swaziland: A Contingent Valuation Analysis.

Fekadu, M. 2011. 'Assessing Households WTP for Improved Water Supply Services in Holeta Town Using CVM. MA Thesis, AAU.

Fisseha, A. 1997. Estimating WTP for water: A case Study on Meki Town, M.Sc Thesis, Department of Economics, AAU.

Freeman, A. 1993. The Measurement of Environmental and Resource Values: Resource for the Future, Washington DC.

Genanaw, B. 1999. Determinants of Household's WTP and Demand for Improved Water Services: A CV Study in Harar Town, Ethiopia" MSc Thesis, AAU.

Gleick, P. 1996. Basic water requirements for human activities: Meeting basic needs.Pacific institute for studies for Development, Environment and security, U.S.A.

Gossaye, F. 2007. Household WTP for improved water services, an assessment of CVM in Debre-zeit Town, Ethiopia, MSc Thesis, AAU.

Gulyani, S. 2001. *The Demand Side Approach to Planning Water Supply.* WB, Washington, D.C.

Haab and McConnell. 2002. "*Valuing environmental and natural resources, econometrics of non market valuation*", Edward Elgar, Cheltenham U.K.

Hanemann, M. L. 1991. Statistical efficiency of double-bounded dichotomous choice contingent valuation: *J. Agric. Econ.,* 73 . 1255 - 1263.

Hanley, N. J. 1997. *Environmental Economics in Theory and Practice*. Macmillan Press Limited, London.

Hawk, D. 2003. Water Supply Reliability. *Indicators of reliability*. 2.

Ibrahim, A. and Robert, H. 2009. Applying CVM to measure the total economic value of domestic water services: A case study in Ramallah Governorate, Palestine.

IRC. 2001. *Key Factors for Sustainable Cost Recovery*. International Water and Sanitation Centre, Delft.

IWMI. 2010. Water Resources and Irrigation Development in Ethiopia. *Working paper* 123.

Khatri, K. V. 2007. *Challenges for Urban Water Supply and Sanitation in the Developing Countries.* Delft, the Netherlands.

Khuc. 2013. *Household's WTP estimation for safe drinking water: A Case Study In Vietnam.* Colorado State University .

Li C. and Mattson, L. 1995. Discrete choice under preference uncertainty: an improved structural model for contingent valuation. *J. Environ. Econ. Manag. 28:* 256–269.

Loomis, J. B. 2014. Strategies for Overcoming Hypothetical Bias in Stated Preference Surveys. *Journal of Agricultural and Resource Economics, 39(1):* 34-46.

Loucks, D. G. 1999. *Sustainability Criteria for Water Resource Systems*. Cambridge University Press: Cambridge, UK.

Mani Devyani (Ed.) 2000. Investigating a demand orientation in water and sanitation delivery. *Annual journal of the UN Center for Regional Development,* Nagoya, Japan.

Mays, L. 2006. *Water Resources Sustainability.* McGraw-Hill Professional, New York, USA.

Mazerov, M. 2018. Kansas Provides Compelling Evidence of Failure of "Supply Side" Tax Cuts. *Center on Budget and Policy Priorities, January*, 22.

Montgomery and Elimelech. 2007. Water and sanitation in developing countries including health in the equation.

Oyebande, L. 2001. Water problems in Africa—how can the sciences help?, Department of Geography, *Faculty of Environmental Sciences,* University of Lagos,Nigeria.

Rousseas, S. W. 2015. *The political economy of Reaganomics: A critique.* Routledge.

Samuel. 2005. *Economic value of basin protection to improve quality and reliability of potable water supply: Evidence from Ecuador*. Clemson University, Clemson.

Stephens, M. 2010. *Review of Stated Preference and Willingness to Pay Methods.*

Tamirat, M. 2014. Determinant of Households' WTP for improved water supply services in Dilla Town, Southern Ethiopia, Msc Thesis, AAU.

Teshome A., Dirk R., Jan, D. 2013. Financial viability of soil and water conservation technologies in northwestern Ethiopian highlands. *Applied Geography* 37(1):139 – 149.

Thomas and Callan. 1996. *Environmental economics and management: Theory, Policy, and Applications*. Chicago, IL: Irwin McGraw-Hill.

Tietenberg, T. 2003. *Environmental and Natural Resource Economics,* 6th International edition, Pearson Education, Inc.

Tisdell, C. 1993. *Environmental Economics: Policies for environmental management and sustainable development.* Great Britan: Cambridge University Press.

UN. 2014. 'Status Report on Integrated Water Resources Management'.

UN-HABITAT. 2003. *Urban Inequities Report.* Addis Ababa.

UN-HABITAT. 2006. Water and shared responsibility, Water and Human Settlements in an Urbanizing World. pp. 98-99.

UNICEF and WHO . 2015. Progress on sanitation and drinking water – 2015 update and MDG assessment.

Victor, A. C., Douglas, H. J., and Laffer, A. B. 2014. *"Foundations of supply-side economics: Theory and evidence.*" Academic Press, 2014.

Wallace S,Grover and *et al.* 2008. *Safe Water as the Key to Global Health*. United Nations University, International Network on Water, Environment and Health.

Wang, H. (1997). Treatment of don't-know responses in contingent valuation surveys: A random valuation model. *J. Environ. Econ. Manag. 32,*, 219-232.

WB. 2018. Ethiopia - Urban Water Supply and Sanitation Project. World Bank, DC.

WB. 1993. The Demand for Water in Rural Areas: Determinants and Policy Implications.

Whittington, D. 2002. Improving performance of CV studies in developing countries. *Env & Reso Eco* pp.323-367, Kluwer Academic Publishes Printed in Netherlands.

WHO. 2014-15. Water sanitation and hygiene links to health.

WSP. 2009. Water and Sanitation program, Guidance notes on services for the urban Poor.

WSSD. 2002. "Taking an integrated approach to improving water efficiency".

Yimer, M. 1992. 'Factors affecting household water supply and consumption in Nazareth'. M.A. thesis, Addis Ababa University.

Young, R. A. 2005.. Determining the Economic Value of Water: Concepts and Methods. *Resource for the Future*, Washington.