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**ADDIS ABABA UNIVERSITY
SCHOOL OF ECONOMICS
FACULTY OF BUSINESS AND ECONOMICS
DEPARTEMENT OF ECONOMICS**

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**HOUSEHOLD WILLINGNESS TO PAY FOR IMPROVED WATER
SERVICE IN BAHIR DAR TOWN OF AMHARA REGIONAL
STATE: THE APPLICATION OF STATED AND REVEALED
PREFERENCE METHODS**

**A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES
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THE MASTERS SCIENCE DEGREE IN ECONOMICS (NATURAL
RESOURCE AND ENVIRONMENTAL ECONOMICS)**

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SCHOOL OF GRADUATE STUDIES**

**“Household Willingness to Pay for Improved Water
Service in Bahir Dar Town of Amhara Regional State:
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Methods.”**

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Table of Contents

ACKNOWLEDGEMENT	ii
LIST OF TABLES	v
LIST OF FIGURES	vi
LIST OF ANNEXES	viii
ABSTRACT	ix
CHAPTER ONE	1
1. BACKGROUND OF THE STUDY	1
1.1. Statement of the Problem	1
1.2. Objective of the Study	6
1.3. Research Hypothesis	7
1.4. Significance of the Study	8
1.6. Organization of the Study	9
CHAPTER TWO	10
2. BACKGROUND OF THE STUDY AREA	10
2.1 Description of the Study Area	10
2.2. Water Supply Situation of the Town	11
2.2.1. Mode of Service and User Categories	12
2.2.3. Water Production and Consumption	14
2.2.4. The Existing Water Tariff	15
2.2.5. Revenue and Expenditure of Bahir Dar WSS Service	16
CHAPTER THREE	17
3. REVIEW OF THE LITERATURE	17
3.1. Theoretical Literature Review	17
3.1.1. Measure of Welfare Change	17
3.1.2. Theory of Environmental Resource Valuation	21
2.1.3. Valuation Techniques for Non-Marketed Goods	22
3.2. Empirical Literature Review	29
3.2.1. Water Related CVM Empirical Studies	29
3.2.2. Water Related ABM Empirical Studies	34
3.2.3. The Ethiopian Experience in Water Related CVM Empirical Studies	36
CHAPTER FOUR	40

4. METHODOLOGY	40
4.1. Data Source and Type	40
4.2. Sampling Design and Procedure	40
4.3 Questionnaire Development.....	41
4.4. Model Specification	42
4.4.1. Model for Contingent Valuation	43
4.4.2. Model for Averting Behavior	49
4.5. Description of Explanatory Variables, Their Expected Sign and Rationale.....	52
CHAPTER FIVE	57
5. ANALYSIS OF SURVEY RESULTS AND DISCUSSION.....	57
5.1. Descriptive Analysis	57
5.1.1. Socio Economic Characteristics of the Surveyed Household.....	57
5.1.3. Current Water Use Patterns and Practices.....	60
5.1.4. Starting Bids and Willingness to Pay for Improved Water Service	61
4.1.5. The Averting Behavior Strategies	63
5.2. Econometrics Analysis	64
5.2.1 Analysis of Probit Model	64
5.2.2 Analysis Regression model	70
4.2.3. Analysis of Multinomial Logit Model	74
5.2.4 Estimating Aggregate WTP and Aggregate Potential Revenue.....	78
5.2.5 Comparison of Averting Expenditure with WTP.....	81
CHAPTER SIX	83
6. CONCLUSIONS AND POLICY IMPLICATIONS.....	83
6.1 Conclusions.....	83
6.2 Policy Implications	86
REFERENCE	89
ANNEXES.....	94

LIST OF TABLES

Table 2-1: - Distribution of Household by Sources of Water, 2008/9.....	12
Table 2-2: - Mode of Service and User categories.....	13
Table 2-3: - Levels of Service of Potable Water Provision.....	14
Table 2-4:- Production, Consumption & UFW in M ³	15
Table 2-5: - Existing Water Tariff.....	15
Table 3-1: - Summary of the relationships between WTP/WTA compensation and the CV/EV measures for price change.....	19
Table 3-2: - Summary of the relationships between WTP/WTA and the CS/ES measure for change in quality/ quantity of environmental goods.....	19
Table 4-1: - Variable included in the estimation, their expected sign and rationale.....	53
Table 5-1: - Household rank for social service	59
Table 5-2: - Summary of MWTP for the improved water service.....	62
Table 5-3: - Estimated parameters and marginal effects from the probit model.....	67
Table 5-4: - Results of linear regression model.....	72
Table 5-5: - Marginal effect from multinomial logit model.....	75
Table 5-6: - Total WTP and aggregate revenue expected from the improved system.....	80
Table 5-7: - Current tariff, averting expenditure and WTP for different Household in Bahir Dar.....	81

LIST OF FIGURES

Figure 1: - Household demand for the improved water services at different prices.....80

Figure 2: - Current tariff, averting expenditure and WTP.....82

LIST OF ABBREVIATIONS

ABM: - Averting Behavior Methods

ABS: - Averting Behavior Strategies

CS: – Compensating Surplus

CSA: – Central Statistical Authority

CV: – Compensating Variation

CVM: - Contingent valuation method

ES: – Equivalent Surplus

EV: – Equivalent Variation

GDP: - Gross Domestic Product

HH: – Household

MCS: – Marshall Consumer Surplus

MDG: - Millennium Development Goal

RUM: - Random Utility Model

TEV: – Total Economic Value

UFW: - Unaccounted for water

UN: – United Nations

UNICEF: – United Nations Children Fund

WHO: – World Health Organization

WTA: – Willingness to Accept

WTP: – Willingness to Pay

LIST OF ANNEXES

Annex I: - English questioner.....	94
Annex II: - Pire-wise correlation matrix of the explanatory variable.....	105

ABSTRACT

Adequacy and quality are crucial for household water supply. One of the major problems with public utilities such as drinking water in developing countries is intermittent, insufficient and unreliable supply. Bahir Dar is no exception to this. To combat these problems, household engage in a variety of averting behaviors. Some of the major strategies are storing, treating and purchasing. The study uses the combination of contingent valuation and averting expenditure approaches to examine the relationship between selected socio-economic characteristics of household and their willingness to pay for the improved water service and for water quality improvement. A single bounded close ended followed by open ended question was used to obtain Household's WTP for the improved water service. The study used survey data from 246 Household randomly selected from Bahir Dar town and the Probit, OLS and Multinomial Logit regression technique was used to estimate the effects of selected exogenous variables on willingness to pay. The survey result also shows that mean willingness to pay for one bucket or for 20 liter of improved water service is 14.21 and 14.96 cents according to the dichotomous choice and open-ended survey responses respectively. The total willingness to pay for one bucket or 20 liters of improved water services is Birr 4,160.52 per day or Birr 1,518,588.41 per year. The results of the econometrics model show that household income, quality and type of water source, children age less than or equal to three and level of education, and age of the head of the household are the principal factors influencing willingness. This suggests that, any government policy which increases factors that will increase household's willingness will increase their willingness to pay. In addition, because consumers' income is associated with their willingness to pay, it is suggested that policy on user fees recognize income inequalities when determining the amount that household should pay.

CHAPTER ONE

1. BACKGROUND OF THE STUDY

1.1. Statement of the Problem

Adequacy and quality are crucial for household water supply. Safe and affordable supply of drinking water is basic need for human life. There is positive correlation between increased national income and the proportion of population with access to improved water supply. A 0.3% increase in investment in household access to safe water is associated with a 1% increase in GDP (World Bank 1994). Unreliable supply, shortage of water and poor quality of water affects life of human being in various ways. Of the 6 billion people on earth, more than one billion i.e. one sixth lack access to safe drinking water. Goal 7, target 10 of Millennium Development Goal (MDG) aims at reducing the proportion of people without sustainable access to safe drinking water and basic sanitation to half by 2015 (United Nation 2007). Thus household water supply has become an important public policy issue.

The lack of water supply and sanitation services for the urban poor represents daunting challenges and multiple strategically targeted initiatives will be required to meet the MDGs. During 2000 to 2006, the proportion of the population with access to an improved drinking water source in developing regions rose from 74 percent to 84 percent. However, nearly 1 billion people were still using water from unimproved sources such as shallow wells, rivers, streams, ponds and drainage ditches with their attendant health and safety risks. Large numbers of those who lack access to improved water supply infrastructure live in urban areas. Even those who have access to improved water supply infrastructure do not necessarily get adequate service.

Water from standpipes and kiosks, key sources of access for the poor, is not always available 24 hours a day (WSP practical guide 2009).

A full service water supply system delivers water at the consumers tap with continuous flow. Most of the water utilities authorities in developed countries supply continuous and potable drinking water for 24 hrs a day. Continuous supply and enough pressure available in the system are not only convenient but also help to prevent water borne diseases. One of the major problems with public utilities such as drinking water in developing countries is intermittent, insufficient and unreliable supply. Water is not supplied round the clock, pressure is insufficient to pump it to the tap and the amount of water made available to the public, whatsoever, is not directly potable. To combat these problems, Household engages in a variety of averting behaviors strategies. Some of the major strategies for averting with intermittent and unreliable water supply are collecting, pumping, storing, treating and purchasing. As a result women, especially, spend hours fetching water and must frequently adjust their work schedules and sleeping patterns, sometimes staying up late at night (WSP practical guide 2009).

Various research findings pointed out that to substantial health and economic benefits for household and individual as a result of improved water supply and sanitation. Yet data compiled by the Water Supply and Sanitation Collaborative Council at the end of the last millennium revealed a large service gap in low-income countries. In Africa, for example, a continent with an estimated population of 784 million people in the year 2002, only 62% had access to 'improved' water supply, while 60% were served by 'improved' sanitation (WHO/UNICEF 2000).

Ethiopia like any other developing countries has many constraints to make potable water easily accessible. The country is not able to solve fully the potable water problem of its people. According to Global water and sanitation assessment 2000 report only 24% of the total population, 73% of urban population and 13% of the rural population have access to safe and clean water. As a result, in most parts of the country many people loss most of their time to fetch water from rivers, natural springs and other sources.

According to the water supply and sewerage service of Bahir Dar town the total numbers of connection is 17,365 and potable water coverage is 100 % urban residents. However, there are problems associated with water supply service standards. Like reliability of water service which is interruptions of provisions ranging from 10-20 % due to serious water shortage in the affected parts of the city and daily service is 20 hours/day. Moreover, low pressure is frequently observed particularly in some kebeles such as 11 and 14 and unaccounted for water (UFW) is very high reaching 32%-38% (five years figure).

Thus, national governments and water sector professionals in low-income countries, together with their development partners, are thus faced with a daunting task to improve the management of water resources and accelerate water supply and sanitation coverage to all the people. The task of ensuring service delivery is greater in urban areas of low-income countries, where it is projected that 88% of all the increase in global population will live by 2015 (WHO/UNICEF 2000). In order to meet these challenges, there is need to recover costs of services delivered. Although most consumers have low levels of income, research carried out in low-income countries has shown that cost recovery leads to more efficiency, higher effectiveness and greater

sustainability (Evans 1992). Therefore, to increase levels of cost recovery, utility managers in low-income countries need to gain a deeper understanding of what factors influence customers' willingness to pay (WTP) for water services (Boham et.al 1994).

Like other nation the government of Ethiopia has also prepared water and sanitation policy document as an integral part of the Country's water management policy to improve access to safe clean water. This document clearly indicates the right of every Ethiopians to get access to adequate and quality water to satisfy their basic needs. In this policy document to improve the financial bases needed for water development projects and other public undertakings cost recovery is cited as one of the basic water law policy of the country. In this regard two tariff structures are shown in this policy document: urban tariffs and social tariffs. The structures of urban tariffs are progressive and based on the basis of full cost recovery while social tariff rates designed for the poor communities to cover only operation and maintenance costs.

One of the central issues in economics is that the purpose of economic activities is to increase the wellbeing of individual who constitute society, in other words economics should focus on maximizing social welfare (Freeman 1993). Consumer welfare gives a measure of society's welfare. Policy design for improving household water supply needs evaluation of social benefits and costs. Even being one of the major areas of economics, not much focus has been given to analyze consumer welfare due to improvement in water quality, especially in the context of developing countries.

Consumption of goods and services available in market is a determinant of the welfare that consumer attains. And the relation between amount of good consumer desires and price consumer pays is given by downward slopping demand curve. Demand curves for market goods are derived from the equilibrium price and goods demanded from which consumer surplus can be calculated. Such demand curve showing price quantity combinations are generally associated with goods for which market exists (Freeman 1993). But for the goods that do not come under market transaction such as water, demand curve cannot be derived from the equilibrium in the market.

Thus, two basic approaches are used to estimate household's WTP for improvement in quality of water. First one is indirect approach, which uses revealed preference i.e. observed behavior for averting the effects of insufficient and unsafe water services to estimate WTP. If water is not sufficient and reliable, household will develop various averting strategies to satisfy their needs and averting expenditure is the amount of additional money consumer would pay for an improved service. Thus it gives an estimate of how much additional money people are willing to pay for an improved service (Abdalla et al. 1992). Second approach known as direct approach uses stated preference i.e. consumer's direct response to estimate willingness to pay for better service. Most of the studies have utilized a contingent valuation method (CVM), whereby a hypothetical market is specified for a non-market commodity, and individual household are asked, through various methods, about the value placed on the commodity (Boham et.al 1994).

Therefore, to improve the water supply situation of the town the construction of additional boreholes is needed to fulfill the current demand, construction of new pipe line to replace the old

line and to expand the service. The service beneficiaries are required to pay for the improved water services for all these activities which require high capital outlays. Thus, to improve the water supply situation of the town demand side information is highly required. Because this demand side information enables policy makers to design appropriate water tariff that is consistent with government policy and enhance the long-term viability of the service. Therefore, the focus of this study is to estimate the household's WTP for the improved water service and to determine factors that affect household averting behavior strategies and their WTP for the improvement of water service from their averting expenditure by taking Bahir Dar town as a case study.

1.2. Objective of the Study

Effective policy and planning must take in to account what consumers want and prepared to pay for an improvement in the quality of an environmental good. Many recent studies based on CVM consider overestimation of demand as a very significant factor for the failure of development project (Zarah, 2000). Moreover, CVM, based on hypothetical scenarios are biased (Cummings et al., 1986). Thus, this study attempts to go one step further and estimate WTP for improved water supply using stated preference method and compare it with the value obtained from revealed preference method. The main objective of the study is to link some selected socio-economic characteristics of household on averting behavior strategies and willingness to pay for improved water services.

The specific objectives of the study are:

- To determine factors that affects household WTP for improved water service using CVM.
- To elicit households' willingness to pay /WTP/ responses for the improved water services from hypothetical market scenario.
- To determine factors that affects household WTP for averting behavior strategies (ABS) for water quality improvement using ABM.
- To draw the policy implication, from the study, as a source of effective policy that can increase the demand for improved water service in Bahir Dar town.

1.3. Research Hypothesis

In this study the following hypothesis will be tested.

- Incomes of household have positive relationship with their WTP for the improved water services and for the improvement of water services.
- Socio-economic and demographic factors of household such as household head education level, gender of the household head, age of the household head, etc, influence their WTP for the improved water services and for the improvement of water services.
- Service characteristics of the current water source is being used such as quality, reliability, pressure, etc, that determine the household WTP for the improved water service and for the improvement of the existing water service.

1.4. Significance of the Study

Due to high investment, operation and maintenance costs it is difficult for the Government to provide safe potable water services free of charge. The services users are required to pay for the water service they get from the improved source. Thus information on the amount of money the service users are WTP for the improved service is essential for potable water development projects. In this study the amount of money the household are WTP for water services they get from the improved system and the amount of money the household spent to the averting strategy they used for the improvement of the current water source and factors that determine their willingness to pay for the improved water and for the improvement of the current water source. Therefore the findings of this study give useful information for policy makers that may be very important for water development project of the town.

The study will also be an additional contribution to the number of studies done in the past to evaluate improved water services. While there have been few studies on the subject in Ethiopia, none has been done for Bahir Dar town. As Griffin et al (1993) indicated, any attempt to estimate the behaviors and benefit in particular communities and in other settings can lead to serious, misleading and erroneous conclusions, even when natural conditions between communities and the services to be offered are quite similar. In relation to this, there is a need to prove the relevance of the contingent valuation and averting expenditure methods in the town. Moreover, this study will differ from the previous studies done on WTP for improved water service issues for it is aimed at the averting behavior of household for the quality improvement of the current water supply service by analyzing their willingness to pay for the water service in addition to CVM.

1.5. Scope and Limitation of the Study

The scope of this study is limited to the analysis of the demand side information about water supply service to household of the town for domestic purposes from a cross-section data of Household at a given point in time. However, the water use by public bodies, commercials, and industrial sectors in the town are not addressed in this study. This work has used methods of economic valuation, mainly contingent valuation and averting expenditure methods which are frequently used in developed countries. There are constrains and biases in their application, but they are a first step towards valuation of environmental quality and will help for making decisions on investment with more and better information in developing towns like Bahir Dar.

Furthermore, time and financial constrains prevent the possibility of a more rigorous approach for data collection. Therefore, the sample survey carried out for this study is limited in both size and coverage. The sample size is limited to 250 household and the coverage of the study is limited only the urban part of the town administration of which only 9 kebeles were used in this study. Therefore, the data generated for the study should be used with care.

1.6. Organization of the Study

The rest of the paper is organized as follows. The second chapter deals background of the study area which like the existing water supply situation and existing tariffs structures of Bahir Dar. Chapter three deals with theoretical and empirical literatures will be reviewed followed by the fourth chapter, which is devoted to the data and research methodologies. Chapter five provides descriptive analysis, estimation results and discussion. Finally in chapter six, the study provides conclusion and policy implications.

CHAPTER TWO

2. BACKGROUND OF THE STUDY AREA

2.1 Description of the Study Area

Bahir Dar town is located at the southern tip of Lake Tana at 110 36" latitude and 370 25" longitudes, stretching over a flat land with less than 2 % slope imperceptible slope (with the exception of small rises at some of the peripheries). The average altitude of Bahir Dar is 1830 meters above sea level and its elevation varies from 1,786 m.a.s.l. to 1,886 m.a.s.l. It has also a poor natural drainage features. Moreover, the city has a tropical type of climate with an average temperature of 17.5 °c.

The Population and Household Census conducted by CSA in 2007 gave the population of Bahir Dar as 220,344. When disaggregated by place of settlement, the rural population of Bahir Dar constituted 40,250 while the urban population is 180,094. In terms of gender composition the female population of Bahir Dar is slightly higher than the number of male population. Accordingly the female population is 51% (112,766) whereas the male population is 49 % (107,578) and the urban population composition of Bahir Dar in terms of gender composition the female population is 51.64% (93,005) and the male population is 48.36% (87,089).

The town has cotton and oil factories, polytechnic and pedagogical colleges (Bahir Dar University), other private colleges, growing number of Banks (government and private), Insurance Companies, Modern Shops, Government Offices, Business Organizations, Tour and Travel Agents, Hotels, Airport, road, Pensions and Restaurants display considerable socio-economic activity in the town.

2.2. Water Supply Situation of the Town

According to the information from the town's water supply and sewerage service of Bahir Dar the dominant water sources of Bahir Dar town are the two springs that is Areki and Lomi with combined production rate of 162 l/s. Additional two boreholes are being drilled at Gudo Bahir and Ashraf intended to manage the water shortage. There are boreholes which are abandoned from the system due to quality problems. The water from the springs is pumped to kotita reservoirs where disinfection is taking place to provide potable water to the customers. Water then flows by gravity to Abbay booster station from where water is pumped to Gabriel reservoirs situated beyond the Abbay Bridge.

The Kotita reservoirs feed the distribution net work to the airport side of the Abbay Bridge while the Gabriel reservoirs feed the other side of the town. The water is being distributed to the consumers via private (yard/house) connections and public fountains. The service incorporated 17,329 connection and 36 public fountains of which 17 are outsourced to private entities and 10 are outsourced to groups. Water shortage is the major problem of the existing system. According to the data obtained from the water and sewerage service of Bahir Dar town especially in kebele 11 and 14 have severe water supply shortages problem. Leakage from the old pipelines and theft contributed greatly to the high figure of unaccounted for water in Bahir Dar. According to the information from the water service, the recorded unaccounted for water for the last five years ranges from 32-38 % of production. An average of 35% could be taken for the year 2009.

2.2.1. Mode of Service and User Categories

According to the Water Supply and Sewerage Service of Bahir Dar Town water customers are classified in to five broad categories, namely

- 1) Private (Residential)
- 2) Commercials
- 3) Governmental & Public
- 4) Industrial
- 5) Public Service (Public fountain managed by private)
- 6) Private Grouped (owned by group)

Based on the five years average consumption records of the WSS, residential clients consumed 17.45% of the total consumption through house connections. 50% of the total consumption is through common yard connections while 24.74 % of the water distributed is consumed through private yard connections. 5.48 % of the consumption is by public tap users and those getting water from vendors. 2.33% of the consumers get water from unidentified sources which could be dug wells, illegal connections etc. The summary of the consumption records that show distribution of household by sources of water being used is given in Table 2-1 below.

Table 2-1: - Distribution of Household by Sources of Water, 2008/9

Source of water	Percent
House connection	17.45
Private connection(yard)	24.74
Common yard connection	50.00
Public fountains and vendor	5.48
Unidentified sources	2.33
Total	100

Source: - Bahir Dar WSS Service, 2009

The modes of service and water demand are depicted in table 2-2 below. As shown in the table, private household, companies/businesses NGOs public organizations cover about 70 % of the total consumption, governmental and public entities cover 29.24 % of the total consumption whereas the industry covers about 1.21 of the total consumption.

Table 2-2: - Mode of Service and User categories

Provided service	Users and Beneficiaries	Modes of Service	Level of Coverage
Potable Water Provision	Private Household Companies Businesses NGOs Public Organizations	Direct Private Connection (household or yard) (Piped Water)	69.21 % of Consumption
	Government and Public	Government and Public	29.24 % of Consumption
	Industry	Industrial sectors)	1.21 % of consumption
	Water Points	Water Points (vendor, Water Tap, Private)	0.33% of Consumption

Source: - Bahir Dar WSS Service, 2009

2.2.2. Levels of Potable Water Service Provision by Water Supply and Sewerage Services

The total numbers of connections in Bahir Dar are 17,365. Potable water coverage in Bahir Dar is reported to be 100 % for urban residents of the city and 82.18 % for the rural communities as shown in table 2-3. There are interruptions of provisions ranging from 10-20 % which cause serious water shortage in the affected parts of the city. Low pressure is frequently observed particularly in some kebeles such as 11 and 14. The WSS has been concerned about the declining pressure. UFW in Bahir Dar is very high reaching up to 38 % (32-38) in 2006. Out of the total, technical water loss is negligible.

Table 2-3: - Levels of Service of Potable Water Provision

Service Level Criterion (Standards)	Definitions	Current Levels
Coverage	Percentage of Served Population	82 % for rural and 100 % for Urban% of population
	Number of Connections	16,965
Reliability/Continuity of Service	Interruptions of provision	Estimated as 20 % due to shortage of Water
	Daily Service	20 Hours/day
Pressure	Pressure at household/tap	Low pressure especially kebele 11 and 14
Water Quality	Treated potable water provided	Regular treatment Deficient Control
	Frequency of Analysis	Randomly
Metering	Coverage of water meters	100 % of connections
UFW	Difference of production and Consumption	32-38 % (five years figure). 32 % 2008

Source: - Bahir Dar WSS Service, 2009

2.2.3. Water Production and Consumption

The annual water production in year 2008 (2000 EC) was 4,578,330 M³, while the water consumption (billed water) was 3,113,264 M³. Unaccounted for water therefore is 1,465,066 M³ or 32 % of production. On the average, it has been observed that 35 % are commercial losses while the technical losses are negligible. 10 % of commercial losses are due to poor billing efficiency as per review of data obtained from the utility. The production and consumption figure of the water supply service are examined based on the past five years record. The production figures are taken from the water meter installed at the source and the consumption is read from the water meters put in for the customers and public fountains. The five years actual production and consumption figures obtained from the city water supply service are presented in Table 2-4.

Water production volume has been increasing from year to year in the past five years. Nonetheless demand for water in Bahir Dar is increasing due to fast development of the city along all sectors of the economy. Many segments of the population are complaining due to the prevailing shortage of water supply so created.

According to Bahir Dar water supply and sewerage service, water service coverage is reported to be 100 % for urban proper and 82 % for rural part of Bahir Dar. However, in general the volume of water delivered is very far from being satisfactory as compared to the current water demand which is very high. There is, however, a complaint of acute shortage in the city in general.

Table 2-4:- Production, Consumption & UFW in M³

NO	Year	Production(M ³)	Consumption (M ³)	UFW	
				M ³	Percent
1	2004	3,502,414	2,275,569	1,226,845	35.03
2	2005	3,513,510	2,199,051	1,314,459	37.41
3	2006	3,816,520	2,360,630	1,455,890	38.15
4	2007	4,049,239	2,647,732	1,401,507	34.61
5	2008	4,578,330	3,113,264	1,465,066	32.00

Source: - Bahir Dar WSS service, 2008

2.2.4. The Existing Water Tariff

As can be seen from table 2-5, the tariff rate in Bahir Dar is one of the lowest in the Amhara region. The tariff is particularly low for the poorest group of people that are using public taps. Connections consuming less than 5 M³ are charged 1.50 ETB/ M³, a consumption category of 5.1M³-10M³ are charged 1.75ETB/M³... which implies a progressive tariff structure.

Table 2-5: - Existing Water Tariff

Consumption	Price ETB Per M ³
Up to 5M ³	1.50
5.1-10M ³	1.75
10.1-25M ³	2.00
25.1-40M ³	2.25
>40M ³	2.50
Public fountain	1.25

Source: - Water supply services of Bahir Dar, 2009

2.2.5. Revenue and Expenditure of Bahir Dar WSS Service

The total annual revenue of the water utility has grown exponentially in the last 5 years. The annual revenue in 2000 EC (2007/8) amounts to 9.7 million ETB while expenditure in the same year was 5 million ETB. Net cash flow for the year, therefore, is 4.7 million ETB. The positive cash flow in the last three years is steadily rising despite a large quantity of UFW mentioned above.

CHAPTER THREE

3. REVIEW OF THE LITERATURE

3.1. Theoretical Literature Review

3.1.1. Measure of Welfare Change

The individuals' utility function is not observable and there is no direct way of measuring individuals' gain or loss from policy change. The indirect methods are used to measure welfare change resulted from policy change, such as welfare gain due to improved water project. The classical tool for measuring such welfare change is consumer's surplus. When consumer's preference is represented by quasi-linear utility function consumer's surplus is an exact measure of welfare change. However, even if utility is not quasi linear consumer's surplus may be a reasonable approximation to more exact measure (Varian 1992, pp.163-164). Consumer surplus transforms the unobservable utility gains of consumers obtained from policy change into observable monetary units (Johanson 1991, pp.40-41).

French Engineer J. Dupit first introduced the concept of consumer surplus in around 1850. Alfred Marshall did the first systematic analysis of the concept. Marshall took the triangular area under the demand curve and above the rectangle representing consumers' actual money expenditure as consumer surplus (Ng Yew-Kwang 1985, p.84). Hence according to Marshall Consumer surplus is the difference between the maximum amounts of money a consumer is willing to pay and the amount actually paid for the commodity (Ng Yew-Kwang 1985, p. 86).

Sir John Hicks introduced more precise measure of consumer surplus. Hicks introduced four measures of welfare change: compensating variation (CV), compensating surplus (CS), equivalent variation (EV), and equivalent surplus (ES).

The compensating variation (CV) and equivalent variation (EV) of utility change are associated with price change. The compensating variation (CV) can be defined as the change in income that would compensate for price change. Whereas equivalent variation (EV) can be defined as the change in income that would be equivalent to the proposed price change (Perman et al. 2003, P.405). Unlike the Marshall Consumer surplus (MCS), the CV and EV measures do not rely on any assumption about the constancy of the marginal utility of income (Freeman 1993, PP.55-56).

If the change in price and/ or income increases the welfare of the consumer both the EV and CV measures have positive signs. On the contrary, if the change in prices and / or income reduces the welfare of the consumer both the EV and the CV measures have negative signs (Johanson 1991, p.51)

The CV, EV and MCS measures are equal if the utility function is quasi linear and when the income elasticity of demand for the good under question is zero, so that $CV=EV=MCS$. On the other hand if the utility function is homothetic do not generate such equality. In such cases when the good under question is normal good for the fall in price $CV<MCS<EV$ or $WTP<MCS<WTA$, and for the rise in price $CV>MCS>EV$ or $WTA>MCS>WTP$ (Johanson 1991, p.41, 53; Perman et al. 2003, 407). The relationships between the CV/EV welfare measures and the WTP/WTA are shown in Table 3-1.

Table 3-1:- Summary of the relationships between WTP/WTA compensation and the CV/EV measures for price change:

	CV	EV
Price fall	WTP for change Occurring	WTA compensation for change not occurring
Price Rise	WTA compensation for change occurring	WTP for change not to Occur

Source: - Perman et al. p. 407

The other two-consumer welfare measures of Hicks are the compensating surplus (CS) and equivalent surplus (ES). These measures unlike the CV and the EV measures are not associated with price change but with quality or quantity change.

The compensating surplus (CS) can be defined as the amount of money taken or given to leave an individual just as well off as before the change. It measures the maximum amount of money the individuals' are willing to pay for welfare gain and the minimum amount of compensation the individuals' are willing to accept for welfare loss if the change is implemented.

Whereas, the equivalent surplus (ES) can be defined as the amount of money taken or given to make the individual as well off as he/she would be with after the change occurred. It measures the minimum amount an individual would be willing to accept compensation to forgo the change and the maximum amount an individual would be willing to pay to avert the change (Ng Yew Kwang 1985, p.87). The relationships between the CS/ES welfare measures and the WTP/WTA are shown in Table 3-2.

Table 3-2: -Summary of the relationships between WTP/WTA and the CS/ES measure for change in quality/ quantity of environmental goods:

	CS	ES
Improvement	WTP for change Occurring	WTA compensation for the change not occurring
Deterioration	WTA compensation for the change occurring	WTP for change not to Occur

Source: - Perman et al.p.409

Which consumer surplus measure (MCS, CV, EV, CS or ES) is appropriate for welfare measure? It depends on the types of the problem. When the change in environmental preference is chosen by third party welfare change is corresponds to either compensating or equivalent surplus rather than equivalent variation or compensating variation (Hanley et al. 1997 P.383).

Third party such as government provides the supply of improved water supply. The compensating surplus- the reduction in income that would maintain utility at same level as before the improvement- is used to measure the welfare gains from the improved water supply project (Young 2005, p.280).

The compensating surplus (CS) can be defined by using the indirect utility function or by using the expenditure function. The compensating surplus (CS) using the indirect utility function can be defined implicitly as a solution to the following expression:

$$V(P, M - rq^0, q^0) = V(p, M - rq^1 - CS, q^1) \quad (1)$$

Where p is the price of private good, q^0 environmental goods and services at the status quo level, q^1 environmental goods and services after improvement, r is price of environmental goods and services and M is level of money income. Where as in terms of expenditure function using the restricted expenditure function the compensating surplus (CS) can be defined as follows:

$$CS = e(P, r, q^0, U^0) - e(p, r, q^1, U^0) \quad (2)$$

$$= M - e(P, r, q^1, U^0) \quad (3)$$

(Freeman, 1993, p.75).

3.1.2. Theory of Environmental Resource Valuation

Theory of environmental resources valuation has encouraged economists, both in intensity and scope, in valuing an increasing number of environmental goods and services around the world (Hanley et al. 1997). The term value has many meanings, which may be used in different sense. The theory of value in economics attempts to explain the worth of goods and services. Classical economists believed labor as true measure of value. For them value equals the amount of labor embodied in the commodity (Srivastava, 1996, p. 140). The neoclassical economists did not agree with classical concepts of value. They defined value as marginal concept. Since then the theory of value developed along this line. The neo classical economists used marginal utility gained by individuals from the last unit consumed to explain the market prices of the given commodity. They also replaced the classical notions of absolute scarcity with relative values as determined by the forces of supply and demand (Perman et al. 2003, p. 6).

Ideally all values would be expressed in monetary terms. Tradable goods since they have only use values their value can easily expressed in monetary terms. Environmental resource provides a complex set of values, such as life support service, amenity services, material resources for the production of goods and services, and used as sink of wastes generated by household and firms.

The value of environmental resource such as improved water resource consists both use and non-use values. Use values, which can be broken down into direct and indirect use values arise from the actual use of environmental resources. The non-use value (or passive use value) arises from independent use of resources. The non-use value comprises three separable components- option values, bequest value, and existence value. Therefore, total economic value (TEV) of

environmental resource can be cited as the sum of use and non-use values (Hussen 2000, pp.300-301).

As a result of the complexity of environmental resources many environmental resources have no market price. We therefore, require non-market valuation techniques to value environmental goods and services. In the following section we discuss the non-market valuation techniques.

2.1.3. Valuation Techniques for Non-Marketed Goods

In a market economy goods and services are allocated by the price mechanisms. Market price reflects people's willingness to pay for marketable goods and services. However, this approach is difficult for environmental resources, for market failures often occur in providing environmental resource due to externalities. Many environmental resources are not traded in markets. The market rarely exists for environmental goods and services (Pearce, et al 2002, P.6). We therefore, require non-market valuation methods to value improvements and /or reduction in environmental goods and services including water resource.

“Although water is increasingly allocated by market mechanism its unit attributes makes it a classic example of the markets potential failure to achieve an economically efficient allocation. Externalities, public goods, decrease costs in supply, and high transaction costs among reasons why markets will not always best serve society in allocating water resources. Thus we use the non market valuation techniques to provide measures of value and scarcity for economic policy making related to water” (Young, 2005, p.22).

Two types of methods are currently used for the valuation of environmental goods and services; revealed and stated. Since water quality cannot be measured through market system, various non- market valuation methods have been developed to assess the benefit of water quality (Casey et al. 2006, Whittington et al. 2002). Both revealed as well as stated methods have been used to estimate the benefit of water quality. The most widely recognized revealed preference and the stated preference valuation techniques are discussed below.

3.1.3.1. Revealed Preference Methods

The revealed preference methods infer the value of environmental goods by studying their actual or revealed behavior in closely related markets through the application of some model of relationships between marketable goods and environmental services. The great advantage of the revealed preference methods is that it dependence on the actual behavior of environmental goods (Bockstael et al. 2005, P.538). That is, using information on market transactions for related private goods and services, economists try to infer the demand for environmental goods and services (Freeman 1993 and Tietenberg 2003)

The revealed preference methods that are in use in relation with water resource valuation are, the travel cost method (TCM), defensive (averting) behavior method and hedonic pricing method (HPM) (Young, 2005, pp. 47; 119-134).

1. Travel Cost Method (TCM)

Travel cost method is originated with a letter sent to the U.S.A national park by Harold Hotelling. It is the oldest environmental valuation technique and is used to assess the value

people place on recreational activities such as parks, lakes and other areas which host a good deal of recreational activities. The travel cost method estimates the demand function of recreational site and the site's consumer surplus. The site's consumer surplus found by this way, however, is only use value. It does not include non-use values. The method failed to estimate non-use values. The other drawback of the method is that its application is limited only for valuation of recreational sites (Seller, Christine, et al 1985).

2. Averting (Defensive) Behavior Method (ABM)

The method is used to infer value from household expenditure to avert environmental problems, such as water pollution. The method is used to measure peoples' willingness to pay for welfare gain from the improved environmental resource such as from clean water. The general premise of the method is that a rational person will adopt defensive or averting behavior as long as the value of the damage avoided is greater than aversive expenditure. The method is used for valuation of water quality improvements to protect against polluted drinking water (Young 2005, p.133; Hussen 2000, p.298).

3. Hedonic Pricing Methods (HPM)

The hedonic pricing method is one of the revealed preference non-market valuation techniques. It is derived from the characteristics theory of value and seeks to explain the value of commodities as a bundle of valuable characteristics. The method indirectly measure people's willingness to pay for change in water attribute when housing prices can be affected by the availability of improved water supply. The hedonic pricing method for it is based on actual market prices its application is straight forward and uncontroversial (Young 2005, p.256). The

main shortcoming of the method is that it requires real property markets and does not capture non-use values of environmental resource (Bockstael et al. 2005, PP.558-563).

3.1.3.2. Stated Preference Methods

The stated preference methods refers to the direct expression of individuals' willingness to pay or willingness to accept in compensation for any change in environmental quantities, qualities, or both. That is, direct valuation method 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).

The stated preference methods used for valuing both use and non-use values of environmental resources. Stated preference methods include contingent valuation methods(CVM), conjoint analysis, choice experiment, contingent ranking, and contingent rating (Bockstael et al. 2005, pp.539-540) Therefore, only the contingent valuation method is discussed because it is the most widely used stated preference methods for valuation of water resource.

1. Contingent Valuation Method (CVM)

The contingent valuation method is the earliest technique of the stated preference method of non-market valuation approaches. The CVM involves asking people directly what they would be willing to pay or willing to accept compensation for change in preferences. This method is called contingent valuation because it is contingent on the hypothetical market. The contingent valuation method is preferred to the revealed preference methods because it deals with both use and non-use values and survey responses to willingness to pay or willingness to accept

hypothetical questions go directly to the monetary measures of utility change (Perman et al. 2003, P.420).

S.V Ciriacy-Wanstat (1947) first proposed the contingent valuation survey method as a method of valuation for non-marketed environmental public good. However, Robert K. Davis (1961) did the first empirical research in valuing out- door recreation. Since then the method become one of the widely used valuation approach in water and sanitation services, urban air pollution, soil erosion, deforestation, biodiversity, water shed management and ecosystem valuation (Whittington 2002, p.345).

In designing good CVM study literature suggests that the following methodological procedures (FAO, 2007). They include:

1) Creating survey instruments. This can be seen as having three components:

- a) Designing hypothetical scenario;
- b) Deciding whether WTP or WTA questions have to be asked; and
- c) Creating hypothetical scenario about the means of payment or compensation.

(Perman et al. 2003, p. 421)

2) The service of environmental good to be valued must be limited geographically and should be defined in terms of characteristics that can enter respondents' utility function

3) Methods of asking questions. The elicitation methods can be open ended, iterative bidding approach, the payment card approach and dichotomous choice format. To improve the precision of the estimates in recent years researchers have introduced dichotomous choice format followed by the dichotomous choice format. Some researchers to get the advantage of both dichotomous

choice format and the open ended format they use the dichotomous choice format followed by open ended format (FAO 2007, pp. 6-7; Shyue-Cherng Liaw and Wan Jiun Chen 2006).

4) Data collection technique. Survey responses can be gathered by face-to-face interview, telephone interview or mailed questionnaire. Face to face interview method is superior to telephone interview and mailed questionnaire, but the use of the face to face interview method is very expensive as compared to telephone and mail survey.

5) Analyzing survey responses. This includes estimating average WTP/WTA of the population, computing total WTP/WTA of the population, and assessing the survey result so as to judge the accuracy of the estimates

The CVM despite its wide application it suffers from number of biases. Such as hypothetical bias, information bias, strategic bias, sampling bias, circumstantial bias, present generation bias, instrumental bias, bias arise from respondents to please the interviewers and bias due to partials (Tisdell 1993, p.101). These potential biases make the reliability of the method questionable. However, well-designed and soundly executed CVM studies can provide high quality and policy relevant information. So to minimize the potential biases of the method and to get reliable information from the CVM studies it is advisable to design survey instruments including the use of focus group discussion and pre-testing carefully and to use well-trained and experienced interviewers (Whittington 2002, p.304).

In general, all methods we discussed have their own strengths and weakness and appropriateness to special type of water use. The revealed preference methods – travel cost method, hedonic pricing method and defensive behavior- used to estimate peoples' willingness to pay for environmental public good from actual consumer behaviors. The revealed preference methods failed to capture the non-use values of environmental resources. The methods are also inadequate for assessing new policy initiatives (Young 2005, p.156).

While the stated preference methods such as the CVM used to estimate both use and non-use values. Moreover the method is also used to estimate values of proposed new policies (Young 2005, P.152). Thus, the CVM can measure the total economic (use and non use) values of improved water projects. That is why in 1979 the U.S.A water resource planning councils recommended the CVM as an acceptable method for estimating the benefits of water resource projects (Young 2005, p.135).

However, two theoretical approaches are used for making reliable estimates of household's WTP for improvement in service and quality of water (Abdallah et al.1992).

- 1- The direct approach uses stated preference, which simply directly asks individual how much he or she would be willing to pay for the improved water service. This is called contingent valuation method (CVM).
- 2- The indirect approach uses data on observed water use behavior (revealed preference) for averting the effects of inefficient and unsafe water qualities to estimate WTP. To survive the issue consumers develops various averting strategies. The averting expenditure gives

an estimate of how much additional money people are willing to pay for an improved quality.

Therefore contingent valuation method (CVM) and averting (defensive) behavior method (ABM) are the appropriate method for valuing the improved water service in Bahir Dar town.

3.2. Empirical Literature Review

Until the 80s, the application of valuation techniques were limited in Developing Countries, nonetheless, the few available studies suggest they can successfully be applied in these countries as well (Whittington et al. 1990 a, b, 1991). With the rising awareness of the cost of environmental degradation in Developing Countries, together with pressures from donor organizations about the inclusion of environmental impact assessment in project designs, valuation techniques are now being used extensively to evaluate the benefits of improved water, tourism and forestry projects.

The above-mentioned methods of valuation techniques in the theoretical review part have been employed in many studies of valuing public goods like water resource both in developed and developing countries. This study has also employed the combination of CVM and ABM few empirical studies that are relevant to the study will be reviewed in this section.

3.2.1. Water Related CVM Empirical Studies

Whittington et al. (1991) carried out a CVM study to estimate household's willingness to pay for drinking water in Onitsha, Nigeria. Bidding game to elicit household' willingness to pay for improved drinking water was used in the study. In this study 235 sampled households were interviewed in person to elicit household's willingness to pay for improved water services. The

findings of this study showed that households have both ability and willingness to pay for improved public water system. The study also indicates that if the improved public water system constructed water services can be provided to the people at lower prices below private vendor's price and social welfare would be increased.

Whittington et al (1992) used CVM to estimate the WTP for public taps and private connections to the improved drinking water system in three Ibgo villages: Edem, Ekwegbe and Umunko- in the Nsukka district of Anambra state of Nigeria. All these three villages were predominantly agricultural communities and at the time of the study none of them had operational water supply system. In this study the household' response was analyzed in three ways: interval estimate, ordering of the alternatives, and as choice to a single decision about the availability of water system. To analyze survey responses the ordinary least square (OLS) and Multivariate models were employed. The findings of the study indicates that the coefficients of attitudes, assets, education, housing type, storage capacity and the qualitative variable for the starting point had expected sign and statistically significant and determines household' willingness to pay for the improved services.

Mitchell and Carson (1989) conducted a study to determine the national benefits of fresh water pollution control in America. The authors estimated the aggregate benefits of meeting the goals of the clean water act using data from a national contingent valuation survey. They regressed total WTP on water quality level, disposable income, taste variable of water-based recreational use (dummy) and environmental attitude (dummy). The result shows that all the coefficients are

reasonable in sign and are all significant, confirming the importance of people's attitude towards their WTP for improvement in public good.

Kyeong Ae Choe *et al.* (1996) employed the CVM to investigate the benefits of surface water quality improvements in Davao city, Philippines. The article examined the question of the magnitude of household demand for environmental quality improvement in the context of a specific proposal; the cleanup of the river and sea near Davao city. A total of 581 in-person interviews were conducted in which referendum kinds of questions were asked about a citywide plan for an improvement in water quality. Statistical methods were used to examine how different randomly assigned monthly fees influenced respondents' answers to the referendum questions. They observed that, the support for the water quality improvement falls drastically as the monthly fee increases. Multivariate techniques were also used to estimate the mean WTP of different types of household. The results depicted that; household' WTP for water quality improvement was low, both in absolute terms and as a percentage of income.

Chowdhury (1999) uses the contingent valuation method to estimate Dhaka Slum-dwellers willingness to pay for safe drinking water. The finding of the study illustrate that slum dwellers are willing to pay enough for water to cover the costs of providing it, suggesting that higher water charges would be a financially feasible to generate funds for water system investment. Secondly the study shows that contingent valuation is an effective tool for estimating willingness to pay for a Varsity of public services.

James F. Casey et al. (2004) used CVM to determine how much citizens are willing to pay for universal access to water service in the home, the University of Amazonas, Center for Environmental Sciences had conducted a survey of over 1600 residents, collecting information on current water needs, health concerns, household socioeconomic characteristics, and, from a contingent valuation (CV) experiment, how much they would pay for access to improve water service in the home. From four elicitation formats; (1) open-ended, (2) open-ended with a “pre-qualifying” statement, (3) descending bid dichotomous choice, and (4) ascending bid dichotomous choice 1479 observations were used. Results suggest that residents are willing to pay (WTP) more than R\$12 (US\$6.12) per month.

Fujita et al. (2005) used CVM to assess the WTP for the improved water supply and sanitation service in Iquitos city, the Republic of Peru. In this study double bound CVM format was used and to analyze survey responses the survival analysis and Weibell models were employed. The research finding indicated that age of the respondent, household income and current water usage practices determine household’ willingness to pay for the improved water supply service. The findings of the study in particular indicate that the younger the age of the respondent, the higher the monthly income, and the shorter the availability of time to fetch water from the existing source the higher the household’ WTP for the improved water services.

James N. Mbata (2006) uses the contingent valuation approach to examine the relationship between selected socio-economic characteristics of household and their willingness to pay for private water connection. An iterative bidding method was used to obtain survey data from 135 household randomly selected from Kanye in southern Botswana and the OLS regression

technique was used to estimate the effects of selected exogenous variables on WTP. According to his estimate household income, level of education and employment status of the head of the household and level of consumers' awareness are the significant factors that determinant of WTP. He suggests that any government policy that increases these factors will increase household' WTP and because consumers' income is associated with their willingness to pay, and also he suggests that policies on connection and user fees recognize income inequalities when determining the amount that household should pay.

Stephanie. A et al. (2008) used the standard contingent valuation method aiming at assessing population willingness to pay for groundwater protection in the Upper Rhine Valley (URV) aquifer, France. The study was used elicitation format of payment card and a sample size of 668 questionnaires. Values are elicited for two scenarios consisting of restoring drinking water quality (scenario 1) and eliminating all traces of polluting substances (scenario 2). Factors determining WTP are investigated using various multivariate analyses such as Logit and OLS model. The result of Logit model shows that the main significant variables are the realism of the described scenarios, the number of children in the household, the income and the number of known polluting substances. The frequency of tap water consumption does not appear as a significant variable. And the result of OLS, unlike the Logit model, the significant variables are income, knowledge of water bill, concern about groundwater pollution, practice of water activities (leisure), and use and non-use values of groundwater advocated as motivations to pay. Stated WTP amounts are on average equal to respectively 42.6 € and 77 € per household per year (for a ten years period during which remediation measures are implemented). Finally, the total

benefits associated with each scenario are estimated at the regional level: 31.3 and 49.3 millions € per year are found for scenarios 1 and 2 respectively.

3.2.2. Water Related ABM Empirical Studies

Abdalla, Charles W., et al. (1992) used the averting expenditures method for valuing environmental improvements to approximate the economic costs of groundwater degradation to household in a southeastern Pennsylvania community. Survey results indicate that household knowledge of contamination, perception of risk, and presence of children are important determinants of household' decision to undertake averting actions, while the factors that influence the level of averting expenditures included the presence of young children in a household and income levels. Averting expenditures were estimated to range from \$61,313.29 to \$131,334.06 during an 88-week period of contamination. Results of this study imply that policy analysts should consider using studies to measure averting expenditures when examining policy alternatives because estimates obtained through averting expenditures analysis have a sound theoretical basis and are of sufficient magnitude that they merit consideration in groundwater policy decisions.

Whitehead, *et al.* (1998) surveyed Gaston County, North Carolina, and use the averting behavior approach and find that respondents who are concerned about risks to Paying for Safe Drinking Water in Abbottabad 1139 health from ground water pollution are 1.67 times more likely to use a water filter. Respondents who rate their water quality as fair or poor are 2.4 times more likely to use water filter. While Collins, *et al.* (1993) examined the actions taken by household in rural West Virginia in response to test that revealed several contaminants in drinking water supplies. The most common types of action was to clean and /or repair the water system, haul water,

install treatment systems, boil water, use a new water source, and /or correcting the contamination source. The average household cost of defensive behavior ranged from \$32 and \$36 per month for bacterial and mineral contaminants. The total household cost related to organic contaminants was \$109 per month.

Abrahms, *et al.* (2000) use the multinomial model of averting behavior in response to water contamination risks for Georgia residents. According to his estimation that perceived risk from tap water, concern about water quality (taste, odor, and appearance of tap water), race and age are the most important determinants of bottled water selection. Information's regarding current or prior problems with tap water, perceived risk from tap water, and income are the most important determinants of water filter selection. Adjusting for quality differences between tap and bottled water, he show that averting costs estimates using bottled water expenditures would lead to an overstatement of avoidance costs by about 12 percent. Smith and Desvousges (1986) find that Boston residents are more likely to install a water filter and purchase bottled water if they perceive that drinking water contamination risks associated with hazardous waste pollution are high.

Haq et al.(2007) use both contingent valuation method and averting behavior method to estimates household's WTP for improved water services and quality improvement of water service by using multinomial logit model of willingness to pay and averting behavior in response to the improved and improvement of water services respectively in Abbottabad district. For the household' WTP for improved water services, the study estimates that there are statistically significant determinant like location that in urban area, source of water and

education level which have a positive effect on WTP for safe drinking water. And in averting behavior strategies for quality improvement, the study find that there are statistical significant determinants like education in all water purification behaviors, higher income quartile, source of water in tap or fetch from outside in boiling and chemical but tap in filter use, water quality in all strategies and awareness have a positive effect on averting behavior strategies.

3.2.3. The Ethiopian Experience in Water Related CVM Empirical Studies

Fisseha Abera (1997) employed CVM to analyses the household WTP for improved water service in Meki town. In this study multinomial ordered Probit model was used to analyze the household' response. Similar to other studies in this study socio economic and demographic factors and water problems and household water consumption practices used as explanatory variables. The findings of this study showed that the coefficients of household income and the time household takes to fetch water from existing source were found statistically significant and determine the household' willingness to pay for the improved water supply. The coefficients of household size and domestic animal (domestic animal was taken as proxy for wealth) had expected sign but their impact on demand for water service were not so strong and rejected. The coefficients of occupational status (i.e., agriculture and small business) and education were not significant and rejected.

Assefa Chaka (1998) used the CVM to assess the WTP for improved water supply of Addis Ababa by taking four kebeles as a case study. In this study Probit models was employed. Two models were specified to analyze the household' responses. In the first model, the probability of the household who wish to connect to the improved water supply was taken as dependent variable while in the second model the respondents WTP for improved service falls within

specified interval was taken as dependent variable. The coefficients of income, household size, sex of the respondent, level of education, and time required for fetching water, and household' attitude towards the responsibility for supplying improved water were found statistically significant and had expected signs. The coefficients of age of the respondent, house (taken as proxy for wealth) and employment in the formal sector though they had expected sign they were not significant and rejected. According to the finding of this research female respondents had more willingness to pay for the improved water service as compared to male respondents.

Genanew Bekele (1999) employed CVM to analyze the household's WTP for improved water service in Harrer town. In this study the ordered Probit and ordinary least square (OLS) models were used to estimate the relationships between the household responses with the set of hypothetical determinants. Like others the explanatory variables used in the study were socio economic and demographic factors and the status of water exist at the time of the study. The findings of the study indicates that the coefficients of income, education, gender of the household head, location of the study area, starting point bid game and quality of the water exist during the survey time statistically significant and determines household' willingness to pay for the improved water services. The coefficients of family size and employment in the formal sector were not significant. The surveyed household show their WTP about 15 times more than the existing tariff if they get improved water service.

Alebel Bayrau (2005) analyzed the affordability and willingness to pay for improved water supply of the Nazareth town. The CVM method was employed to examine the determinants of WTP for improved water service. The bidding game was used as elicitation method in the study.

The censored least absolute deviation (CLAD) estimator and the Probit models were estimated to analyze the determinants of household' willingness to pay for the improved water services. The findings of this study indicate that male respondents showed more willingness to pay for improved water supply than the female respondents. The coefficients of water expenditure, household perceptions of existing water quality, monthly income, and time taken to fetch water had expected sign and statistically significant. The coefficients of family size, respondents' age, water consumption, reliability of existing water system, household water source, wealth, occupation, and education had expected signs, but they were not statistically significant and rejected.

Gossaye Fanta (2007) examined household willingness to pay for improved water service in Debere-Zeite Town. The CVM method was employed to examine the determinants of WTP for improved water service. The single bound close ended and open ended was used as elicitation method in the study. The Probit model and OLS model were estimated to analyze the determinants of household' willingness to pay for the improved water services. The coefficients of age, household size, volume of water used , reliability of existing water source, the starting bid price and household average monthly income had expected sign and statistically significant. The coefficients education dummy variable , gender dummy variable , house dummy variable responsibility dummy variable satisfaction dummy variable and quality dummy variable had expected signs, but they were not statistically significant and rejected. The coefficients number of adult children and time taken to fetch water from the existing water source had unexpected signs and statistically insignificant and rejected.

Therefore, from the above literature review on both CVM and ABM it can be conclude that household' willingness to pay for the improved water service influenced by socio economic and demographic characteristics such as education, income, household size, age and gender and characteristics of existing water supply situation like water pressure, water availability time, water charges or prices and satisfaction with existing water service, and household water use practice. To analyze the determinants of household' willingness to pay for the improved water service the CVM can be estimated through Logit, Tobit and OLS models depends on the data type and the ABM can be estimated through multinomial Logit model

In Ethiopia, some studies were done on improved water service and quality through CVM. But studies on improved water services and quality using ABM were not done. Therefore in this study, I will try to use the combination of stated and revealed preference method (i.e. CVM and ABM).

CHAPTER FOUR

4. METHODOLOGY

4.1. Data Source and Type

This study mainly relies on primary cross sectional data for the year 2010. The main data source is a contingent valuation survey, which was conducted in Bahir Dar town. Using simple random sampling 250 face-to-face personal interview using CV questionnaire were conducted, out of which 246 of them were found usable. The study has also used relevant secondary documents from the office of Bahir Dar town water supply and sewerage service and from the kebele administration.

4.2. Sampling Design and Procedure

The town of Bahir Dar has classified in to 17 administrative kebeles, from which 7 kebele were selected based on simple random sampling and the remaining 2 kebeles were selected purposely. Then to obtain the sample size, we have used the list of the household live in the selected kebele, which is collected from the kebeles administration, and get the total number of household live in each kebele and calculate the proportion of the household to be sampled on each kebele. And then sampled household were selected using simple random sampling procedure and finally randomly selected household were asked questions related to their socio-economic and demographic characteristics, water use practices, and problems with existing water services system and their averting behavior strategies and some general questions.

4.3 Questionnaire Development

Before designing the contingent valuation survey method we went to the study area and did focus group discussion in the early August 2009. This focus group meeting allowed us to identify the water supply problems of the town and to come up with first draft questionnaire. The draft questionnaire was pre-tested on 20 randomly selected household at the end of September 2009. This pre testing helped us to formulate final survey questionnaire and to set starting bid price for the contingent valuation scenario.

The final version of the survey questionnaire designed for this study has three parts (See Annex I). In the first part of the questionnaire questions related with socio- economic and demographic characteristics of the household such as sex, age, occupation, education level and age of the household head and the household member, family size, average monthly income and the like were stated.

The second section deal with the household water use practices, present status of water supply situation, water supply period, total time required to collect water from existing source, volume of water used by household, status of water born disease, household evaluation of existing water supply situation such as quality and reliability and household averting behavior strategies and amount of averting expenditure.

The third section consists of contingent valuation question. In this section hypothetical market scenario was designed as one of the most basic component of the survey questionnaire based on the improvement of existing water supply situation. In this section of the questionnaire to elicit household' willingness to pay the single bound dichotomous choice question followed by open

ended question, and general questions such as opinions on how the existing water supply situations were stated. The final version of the questionnaire was translated into Amharic language.

4.4. Model Specification

Water being non-market good, many water quality benefits cannot be estimated through the market system and thus non market valuation method is required to estimate the WTP. Two basic approaches have been frequently used for making reliable estimate of WTP for household water use: revealed preference and stated preference approach. The revealed preference method uses data on the observed behavior of water user specially data on averting expenditure. In case of water services WTP consists of current bill as well as investment made to improve quality and quantity of water. In stated preference method individual are asked the maximum amount they are willing to pay for improvement in corresponding service (Freeman 1993).

To consider the first two objectives “WTP for improved service level” CVM were applied. Contingent Valuation (CV) is a method of estimating the economic value of non-market environmental goods through survey questions that bring out individuals preferences regarding such goods (Carson 1989). And in this study the respondents will asked single bound close ended 'yes' or 'no' questions followed by open-ended questions to elicit household' willingness to pay for the improved water services.

And also to consider the third objective of the study “WTP for water quality improvement” ABM were applied. Averting behavior model suggests that WTP depends on any variable that

affect the marginal product of pollution, mitigating activities or avoidance cost (Freeman 1993). The economic effect of unsafe drinking water include change in the expenditures and well being in terms of medical costs, earning lost, lost production in the home, lost leisure time, and mitigating expenditure. Averting behavior begin with the assumption that people make choices in order to maximize their level of well-being when faced with exposure to unsafe drinking water (Corpper and Oates 1991).

Thus, to analyze survey responses three different econometrics models will be specified: for the single bound close ended survey response, for open ended survey responses, and for averting behavior survey response.

4.4.1. Model for Contingent Valuation

4.4.1.1. Specification of Econometric Model for the Single Bounded Survey Responses

Hanemann (1994) developed the basic econometrics model to analyze dichotomous single bounded close ended survey responses based on the random utility theory (RUM). The central theme of this theory is that although an individual knows his/her utility certainly, it has some components, which are unobservable from the view of the researcher. As a result, the researcher can only make probability statement about respondent's 'yes' or 'no' responses to the proposed scenario. In his approaches, we start by specifying the indirect utility function (V).

Let us denote household income by Y_i and all other factors that influence household WTP for the improved services by vector Z_i and, the water services at the status quo level by W^0 and after the improvement level by W^1 .

So that household utility (U) function for water services at status quo level is given by (U^0):

$$U^0 = U (W^0, Y_i, Z_i) \text{_____} (1)$$

And household utility function for water service after the improvement level is given by (U^1):

$$U^1 = U (W^1, Y_i, Z_i) \text{_____} (2)$$

In RUM it is assumed that each individual know his/her utility function or preferences with certainty, and there are some components that cannot be observed by the researcher and treated as random variable (W.M. Hanemann and B.Kanninen, 1998 P.5). Let us denote this stochastic disturbance term by ϵ , and the household indirect utility function for water service at the status quo and after the improvement level by $V^0 (W^0, Y_i, Z_i)$ and $V^1 (W^1, Y_i, Z_i)$ respectively. Thus, household utility function for water services at the status quo level can be written,

$$U (W^0, Y_i, Z_i) = V^0 (W^0, Y_i, Z_i) + \epsilon_0 \text{_____} (3)$$

While, the household utility function for water services after the improvement can be written,

$$U (W^1, Y_i, Z_i) = V^1 (W^1, Y_i, Z_i) + \epsilon_1 \text{_____} (4)$$

Where the random terms ϵ_0 and ϵ_1 are assumed to be independently and identically distributed with zero means. Household are faced with two choices: either to maintain at status quo level,

W_0 , or at after the improvement level, W_1 . To get water from the improved services respondents will be asked to pay some amount of money. Let us denote the amount of money household would pay for the improved water services by ' M_i '. Thus, the household will choose the improved water services if the utility with CV program, net of the required payment, exceeds utility of the status quo:

$$V^1(W^1, Y_i - M_i, Z_i) + \epsilon_1 > V^0(W^0, Y_i, Z_i) + \epsilon_0 \quad (5)$$

The household know which choice maximizes their utility. However, the researcher observes 'yes' or 'no' responses. The household responses treated as random variable with probability distribution given by:

$$\Pr. (V^1 > V^0) = \Pr. \{V^1(W^1, Y_i - M_i, Z_i) + \epsilon_1 > V^0(W^0, Y_i, Z_i) + \epsilon_0\} \quad (6)$$

$$= \Pr. \{V^1(W^1, Y_i - M_i, Z_i) - V^0(W^0, Y_i, Z_i)\} > \epsilon_0 - \epsilon_1 \quad (7)$$

And,

$$\Pr (V^1 \leq V^0) = 1 - \Pr. (V^1 > V^0) \quad (8)$$

Let us define $\eta = \epsilon_0 - \epsilon_1$ and $F_\eta(.)$ be cumulative distribution function. In the Probit model, $F_\eta(.)$ follows the normal cumulative distribution functions, while in Logit model $F_\eta(.)$ follows the logistic cumulative distribution function. Both the Probit and the Logit models give similar parameter estimates (Timothy C. Haab and Kenneth E. McConnell 2002, p.28). The choice

between the Probit and the Logit model is only for mathematical convenience. Assuming the normal cumulative distribution following (Oni, O.A. and et al 2005) the probit model can be expressed as follows:

$$Y^* = F(X\beta + U_i)$$

Where Y^* is unobservable latent variable = 1 if the response is yes, = 0 if the response is no, X is the explanatory variables, β is unknown regression parameters and U is the random error term.

The single bound close ended survey responses, which is the ‘yes’ or ‘no’ response, estimated by the maximum likelihood procedure. Following the convention in statistics we can denote the response probabilities using the notation $P(Y_i/X_i, \Theta)$. Where Y_i denotes the response of the individual, we can think of $Y_i=1$ if yes and $Y_i=0$ if no, X_i explanatory variables, and Θ unknown regression parameters. With single bound close ended approach, the likelihood function can be expressed as a series of Bernoulli trials:

$$L = \sum_{i=1}^n \{Y_i \ln P_i + (1 - Y_i) \ln(1 - P_i)\} \quad (10)$$

Where $P_i = P(Y_i/X_i, \theta)$ i^{th} individual’s response probability, and Y_i is dummy variable indicating an individual choice 1 for yes and 0 for no (Hanemann, W. M and Kanninen B. 1998, pp.23).

Based on the above justification, we specify the probit model for household’ preferences for the improved water service as follows:

$$WTP_i = \beta_0 + \beta_1 (H_i) + \beta_2 (S_i) + U_i \quad (11)$$

Where WTP_i is response to the bid price =1 if the respondents respond is yes, = 0 if the respondents respond is no, β_i is regression parameters, H_i is household characteristics, S_i is service characteristics and U_i is the error term. The regression parameters are estimated by Maximum likelihood technique by using the standard econometrics STATA software.

4.4.1.2. Specification of Econometric Model for Open Ended Question Survey Responses

When dichotomous choice format is followed by open-ended question format finally produces open value of the respondent. In this case the use of binary response models such as the Probit or the Logit is not appropriate. The household willingness to pay survey response from the open ended are estimated as censored model such as the Tobit model if the dependent variable takes non-negative values with some zeros or by using linear regression model (OLS) if the dependent variable takes none zero positive numbers (Siglman, L. and L. Zeng 1999 p.5).

Based on our survey result, we will decide which model is used for the household WTP survey response from the open ended question format. Based on this theoretical background we specify the linear regression model (OLS) for the improved water services empirically as follows:

$$MWTP_i = \theta_0 + \theta_1 (H_i) + \theta_2 (S_i) + U_i \quad (1)$$

Where $MWTP_i$ is reported maximum willingness to pay by the surveyed household in cents per bucket of improved water services, θ is regression parameters, H_i is household characteristics, S_i

is service characteristics and U_i is the error term. This model is estimated by using the standard econometric software such as STATA.

Alternative method to OLS when the dependent variable response is zero for a significant fraction of the observation is the so-called Tobit model. Let MWTP be a latent variable which is not observed when it is less than or equal to zero but is observed if it is greater than zero.

Following Long (1997), the Tobit model for observed MWTP is given by

$$\begin{aligned} \text{MWTP}_i &= \beta_i' X_i + \epsilon_i, & \text{if } \text{MWTP}_i > 0, \\ &= 0, & \text{otherwise} \end{aligned} \quad (3)$$

Where MWTP_i is reported maximum willingness to pay by the surveyed household in cents per bucket of improved water services, β_i is regression parameters, ϵ_i is the error term and X_i is the explanatory variables defined under the variable description sections.

Based on the above explanation the Tobit model for household' preferences for the improved water services is given as

$$\begin{aligned} \text{MWTP}_i &= \theta_0 + \theta_1 (H_i) + \theta_2 (S_i) + U_i, & \text{if } \text{MWTP}_i > 0 \\ &= 0, & \text{otherwise} \end{aligned} \quad (4)$$

Where MWTP_i is reported maximum willingness to pay by the surveyed household in cents per bucket of improved water services, θ is regression parameters, H_i is household characteristics, S_i

is service characteristics and U_i is the error term. This model is estimated by using the standard econometric software such as STATA.

4.4.2. Model for Averting Behavior

Change in welfare due to change in water quality can also be measured indirectly through market for related goods. Individual engage in various averting behavior to avert with unreliable water service. Thus averting strategy appears as logical response to inadequate and unreliable water supply. Averting behavior model suggests that WTP depends on any variable that affect the marginal product of pollution, mitigating activities or avoidance cost (Freeman 1993). Averting expenditure depends on the averting behavior of consumers. It is based on the assumption that people make choices in order to maximize their wellbeing i.e. utility when faced with the threat of risk. Thus averting expenditure that would be needed to counteract the harmful effect is theoretically correct measure of WTP to avoid the scarcity and decline in water quality. Theoretical explanations of averting expenditure are based on the household production function theory of consumer behavior (Abdalla et al. 1992, Freeman 1993).

According to Abdalla et al (1992) the estimates obtained through averting expenditure analysis have a sound theoretical basis and are of sufficient magnitude that they can be used for ground water policy decisions. There have been various studies that compared estimates obtained from averting expenditure method with that of the estimates obtained from other non market valuation methods (Abraham et al. 2000, Carson et al. 1996). Carson et al (1996) carried out an analysis of 83 studies and concluded that mean ratio of contingent valuation to reveal preference method is 0.89 with a 95 percent of confidence interval. Thus averting expenditure provides conservative estimate of benefit of change in water quality.

Suppose household engage in variety of averting behavior to avert with unreliable water service. Consumer's utility depends on market goods, healthy time, averting behavior and water quality.

$$U = U(X, H(A, W)) \quad (1)$$

Where U is the utility, X is composite market good, H is health production function, A is averting behavior and W is water service. Total expenditure is given by

$$e = X + C(H, P_A, W) \quad (2)$$

Where $C(H, P_A, W)$ is cost function associated with health production function from drinking water, P_A is averting price.

Consumers' problem is either to maximize utility or minimize expenditure. Here expenditure minimization problem is followed. Consumer minimizes expenditure $e = X + C(H, P_A, W)$ subject to initial level of utility

$$U = U(X, H(A, W)) \quad (3)$$

The Lagrangian is given by,

$$L = X + C(H, P, W) + \lambda [U - U(X, H(A, W))] \quad (4)$$

Above minimization problem can be solved to obtain minimum expenditure necessary to reach utility level U.

$$e^* = e (P_A, W, U) \quad (5)$$

Change in welfare due to change in water quality is given by compensating variation which is obtained by integrating Hicksian demand curve.

$$CV = e (W_0, U_0) - e (W_1, U_0) \quad (6)$$

Averting expenditure is given by the change in cost associated with original level of health with change in water service,

$$AE = C (H_0, P_A, W_0) - C (H_0, P_A, W_1) \quad (7)$$

Averting expenditure is equal to change in minimum expenditure to achieve initial level of health even after change in quality (Bockstael and McConnell 1999).

$$C (H_0, P_A, Q_0) - C (H_0, P_A, W_1) = e (P_A, W_0, U_0) - e (P_A, W_1, U_0) \quad (8)$$

Now CV can be written as,

$$CV = e (Q_0, U_0) - e (W_1, U_0; H_0) + e (W_0, U_0; H_0) - e (W_1, U_0) \quad (9)$$

$$CV = AE + e(W_0, U_0; H_0) - e(W_1, U_0) \quad (10)$$

$$WTP = AE + e(W_0, U_0; H_0) - e(W_1, U_0) \quad (11)$$

The difference of third and fourth terms is necessarily greater than zero for improvement of quality. Therefore averting expenditure underestimate the compensating variation for improvement in quality and averting expenditure is lower bound to the WTP.

In averting behavior model Multinomial Logistic model is used to estimate the effects of explanatory variables on the dependent variables i.e. (filter, boiling, chemical) respectively.

Based on the above justification, we specify the multinomial logit model for household's averting behavior strategies (ABS) like Filters, Boiling and Chemical for quality improvement as follows:

$$ABS_i = \beta_0 + \beta_1 (H_i) + \beta_2 (S_i) + U_i \quad (12)$$

Where ABS_i is reported averting behavior strategies used by the surveyed household, θ is regression parameters, H_i is household characteristics, S_i is service characteristics and U_i is the error term. This model is estimated by using the standard econometric software such as STATA.

4.5. Description of Explanatory Variables, Their Expected Sign and Rationale

Variables used in estimation of factors that determine the household's willingness to pay for improved water service and averting behavior strategies for water quality improvement and their

expected sign on household' preference and rationale behind are described under Table 4-1 below.

Table 4-1: - Variable included in the estimation, their expected sign and rationale

No.	Variable	Description	Expected Sign	Rational
1	RAGE-Age of respondents	Continuous variable in years	Negative	Since older people are traditionally used to free water services so that they may be less WTP and may have low preference for improved source that requires fee.
2	HEDUC-Highest level of education of the household head	Continuous variable in years	Positive	This suggests that there is greater awareness and rationality in the household who have some sort of education for the improved source and WTP for it.
3	HGEN-Gender of the household head	Dummy variable 1 male 0 female	Indeterminate	Because the relation between sex and his/her WTP for the improved water source depends on specific cultural context.
4	HHSIZ-Size of the household	Continuous variable in number	Indeterminate	It is difficult to determine the sign of this variable because when the family size is large it is negative whereas when the family size is small it is positive.
5	HOWN-House ownership. it is a proxy for wealth	Dummy variable 1 if owns house 0 otherwise	Positive	Since richer household demand for the improved services and quality of water are high because they have no resource constraint.
6	RESPO-Responsible organ of the provision of water services	Dummy variable 1 if the respondents said government 0 otherwise	Indeterminate	Because respondents who said government is less WTP than private institution/community is responsible organ for the provision of water services
7	SAT-Satisfaction to the existing water service	Dummy variable 1 if HOUSEHOLD satisfied 0 otherwise	Negative	Since household is not satisfied with the existing water service has more WTP for the improved water service and for the improvement of water quality.
8	VLUM-Volume of water used by household	Continuous variable in number	Indeterminate	Because household whose water consumption is high has less likely to support the improved water service whereas high income household even if they consume high volume of water which the price of the improved water service is high they pay because they do not have financial constraint.
9	QUAL-Quality of the existing water is being used.	Dummy variable 1 if the existing water quality is good to drink before improving the quality 0 otherwise	Negative	If the existing source is not reliable the household have more WTP for the improved water service and for quality improvement water.

10	RELIB-Reliability of the existing water service being used	Dummy variable 1 if the existing water source is reliable 0 otherwise	Negative	If the existing water source is not reliable household WTP for the improved water service will be high.
11	SOUR-Source of water being used	Dummy variable 1 private connection water source 0 otherwise	Indeterminate	Because household who have their water source from the dummy variable 0 up to 6 which is improved source less WTP for the improved water source whereas household whose water source from unimproved water source more WTP for the improved water service.
12	CHUN 3-child under the age 3 in the household.	Dummy variable 0 if no children under 3 years of age are present 1 if at least one child under 3 years of age is present	Positive	If there is child under the age 3 in the household, WTP pay for the improvement of water service is high as compared to those, who have not.
13	CHID 3-17-Children age 3-17 in the household.	Dummy variable 0 if no children ages 3-17 are living in the household. 1 if at least one child age 3-17 is living in the household.	Positive	If there is child age 3-17 in the household, WTP pay for the improvement of water service is high as compared to those who have not.
14	TIME-Time taken to fetch water from the existing water source	Continuous variable in minute	Positive	In areas where there is inadequate amount of water compared to its demand, people may spend much time to fetch water. One benefit of providing improved and adequate water service is saving time, which has an opportunity cost of using the time for other activities. Besides, consumer demand theory suggest that household would pay more for an improved supply when costs in terms of time of obtaining water from the existing sources are higher than if this cost were low.
15	PRESS-Pressure of the existing water service is being used.	Dummy variable 1 if the existing water service has enough pressure 0 if the existing water service has low pressure	Negative	When the existing water service has low pressure household WTP for the improved water service will be high.

16	INCOM-Household income.	Continuous variable in birr	Positive	Based on empirical results done in similar areas and economic theory that shows quantity demanded and income are positively related in case of normal goods
17	AWBD-Household awareness about waterborne diseases	Dummy variable 0 if household has no awareness about waterborne diseases. 1 if household has awareness about waterborne diseases.	Positive	Household with higher awareness about waterborne diseases is more WTP for the improvement of water and for the improved water service.
18	BID-Initial bid price			To be tested

4.6. Welfare Measure

The mean and the median measures are the most widely used measures of welfare change. The critical issue is the choice between the mean and median measures. Statistically the median measure has a smaller sampling error than the mean estimate. The mean estimate is more sensitive to skewness or kurtosis (Hannemann, W.M and Kanninen, B., 1998, PP.18-19)

However, in the cost benefit analysis the median measure is not the appropriate measure. The median measure is appropriate when the decisions are based on voting. The mean measure is the appropriate method of welfare measures in cost benefit analysis and it reflects the Kaldor-Hicks compensation criterion (Hannemann, W.M and Kanninen, B., 1998, P. 23). Because of this fact to calculate the total benefit of the improved water services in this study the mean measure is employed.

For the Probit model specified above once the Probit regression model of the dependent variable of the yes/no indicator on constant and an independent variables including bid regressed the mean willingness to pay will be obtained by dividing the intercept by the negative of the bid coefficient.

That is,

$$\text{Mean WTP} = \frac{\beta_0}{-\text{End coefficient}}$$

Where WTP is willingness to pay and β_0 is the intercept (FAO Corporate Document Repository, 2007, p.12).

For the open ended contingent valuation survey responses the maximum willingness to pay figures reported by the respondents can be simply be averaged to produce an estimate of mean willingness to pay:

$$\text{Mean WTP} = \Sigma y_i / n$$

Where n is the sample size and each y is a reported willingness to pay amount by surveyed household (FAO Corporate Document Repository, 2007, p.9). By this we conclude our model specifications.

CHAPTER FIVE

5. ANALYSIS OF SURVEY RESULTS AND DISCUSSION

In this chapter we discuss the empirical findings of our contingent valuation survey, and discuss the results obtained. Both descriptive and results of econometric models will be discussed. In particular the amount of money surveyed households are willing to pay for the improved water services and the amount of money surveyed households are cost to avert from the current water service problem and socio-economic and demographic factors and water attributes that influences household willingness to pay for the improved water services and household averting strategies for the improvement of the existing water service, and total potential revenue of the improved water system and finally comparing averting expenditure WTP for water quality improvement with WTP from CV survey is discussed.

5.1. Descriptive Analysis

5.1.1. Socio Economic Characteristics of the Surveyed Household

As previously stated a total of 250 household responses were obtained from different kebele of Bahir Dar. Of all the sample population, 4(1.6%) responses were dropped for some of them lacked the required information and others gave unreliable and inconsistent answers. As a result 246 questionnaire were found usable of these, 30(12.20%) of the household head are female and the cross tabulating revealed that household head whose head gender is male more willing to pay than the female. The average household size is 5.41 with a minimum of 2 household members and a maximum of 11 household members. The data on age of household head shows a wide range of responses where the average is found to be 47.90 years with a minimum of 20 years and a maximum of 78 years.

The education figure reveals that 20(8.1%) of the household head can't read and write, which is 0 year of schooling while 19(7.7%) have attended primary level education, which is 1-6 year of schooling. The household head that attended secondary level of education is 73(29.7%) which is 9-12 years of schooling while the majority of the household head 125(50%) have attended higher education, which is 13-18 years of schooling. The cross tabulating shows that as the household head education level increase their willingness to pay also increase.

Concerning the occupation of the household head the survey result show that, 121(49%) are employed in formal wage labor, 60(24.39%) are engaged in trade, 29(11.79 %) are employed in informal wage labor, and 36(14.63%) are self employed. And regarding the house ownership situation of the household, 185(185.20%) are currently live in their own house and the remaining 61(24.80%) live in rent house rented from government, kebele and private. The cross tabulating shows that household that have their own house is more willing to pay for the improved water scheme.

The most difficulty during the survey was the investigation of average monthly income the household earns. Most of the household surveyed was not interested to state their earnings and others don't really know their average monthly income. However, emphasis was given in the training session to this part and the data collectors were able to come up with a fair estimate of household' average monthly income. The average monthly income of the sample household is birr 2004.98 with a minimum of birr 167 and a maximum of birr 7000 per month and the cross tabulating result revealed that household that have high average monthly income are more willing to pay for the improved water service intended to supply.

To cross check the income figure, respondents were asked to state their major average expenditures in a month. The data shows that, food expenditure constitute the major expenditure share, then comes education and expenditure on other expense like EKUB, EDIR etc. Of the interviewed household 93.1% have radio, 84% have tape recorder, 87.8% have television, 44.3% have refrigerator, 91.9% have TV, 10% have car and 16.3% have stove in their house.

Regarding children in the household, 56/22.76%/ of the household have children whose age is less than or equal to three and the remaining 190/77.24%/ have not. And household who have children age greater than three and less than or equal to 17 are 218/88.62%/ of the total surveyed household's.

5.1.2. Rank for Various Social Services

To explore household's preferences in terms of priority, they were asked to rank different social service in accordance to their need. Seven different social services were listed: health, water, education, toilet, electricity, road and telephone. The survey result shows that, 69.1% of the respondents reveal health service as their first priority. Then water service with 23.6% of the interviewed respondents saying that it is their first need. 3.3% said that education is their prior need. 1.3% said that toilet is their prior need. Electricity, road and telephone were ranked from fifth to seven respectively.

Table 5-1: - Household Rank for Social Services

Service Type	Rank	Total (%)
Health	1 st	69.1
Water	1 st	23.6
Education	1 st	3.3
Toilet	1 st	1.3
Electricity	1 st	1.2
Road	1 st	0.8
Telephone	1 st	0.4

Source: - Survey Result

5.1.3. Current Water Use Patterns and Practices

The survey result about the type of water source the household used shows that, all the surveyed household 246 /100%/ use pipe water for their daily consumption. Of the total surveyed household 220/89.43%/ household have private connections to the system and the remaining 26/10.57%/ of the household have not a private connection to the system which means they fetch water from public tap and private vendor. The average volume of water consumption of the household is 8.260163 bucket or 165.20326 liters of water per day with average per capita consumption of 30.536659 liters per capita per day which is calculated using the average family size of the household 5.41 obtained from our survey result. The cross tabulating result of WTP and volume water used shows that as the volumes of water consume increase their willingness to pay is also increase.

The satisfaction of the respondents with the existing water service is extremely low. Only 56/22.76%/ of the respondent said they are satisfied with the existing water service delivery with the status quo level. The remaining 190/77.24%/ of the respondents revealed their dissatisfaction with existing systems. The cross tabulating result confirms that those who have not satisfied are more willing to pay for the improved water service.

Of the total surveyed household 178 /72.36%/ respondent said the existing source is unreliable and the remaining 68(27.64%) of the household response is reliable. The cross tabulating result confirms that those who have unreliable water source are more willing to pay for the improved water service.

The household having low pressure water source are 161/65.45%/and the remaining 85/34.55%/ household said they are having high pressure water from the pip. The cross tabulating result shows that, those having low pressure water from their source are more willing to pay for the improved water service.

The survey result shows regarding awareness about water born disease, 193/78.46%/ of the household have awareness about water born disease and the remaining have not. The cross tabulating result tells us household that have awareness about water born disease are more willing to pay for the improved water service. Regarding the quality of water, 139/56.50%/ of the household perceived the quality of water (unfavorable test, smell or appearance) is poor and 107/43.50%/ of the household said well. The cross tabulating shows household who perceived the current water source is poor is more willing to pay.

Regarding the responsibility in the provision of improved water supply for the town 216 /87.80%/ of the household said government should provide the improved water services and the remaining 30/12.20%/ of the household said community, private sectors and NGOs should be responsible to the provision of improved water service.

5.1.4. Starting Bids and Willingness to Pay for Improved Water Service

In the final survey, three starting bid prices for the corresponding valuation question were given. These were set following what we have obtained from the pilot survey. Starting from household who were asked for willingness to pay for the improved system, the data revealed that 163/66.26%/ have said “yes” to the first price that they have been given and the rest have refused and gave a lower bid than the initial price. In the open ended question we asked the sampled

household to state the maximum amount they would like to pay for a bucket or 20 liter of water they get from the improved services. All interviewed persons stated the amount of money they are willing to pay for a bucket or 20 liter of water in cents. Summary of maximum willingness to pay for the improved water services reported by the surveyed household is shown in table 5-2.

Table 5-2: - Summary of MWTP for the improved water service

MWTP Report	No. of Surveyed household	Percentage	Cum.
5	55	22.36	22.36
10	49	19.92	42.28
15	38	15.45	57.72
20	51	20.73	78.46
25	53	21.54	100
Total	246	100	

Source: Survey Result

As we can see from the table if the improved system is implemented for a bucket or 20 liters of water 55/22.36%/ of the households expressed their willingness to pay 5 cents, 49/19.92%/ of the households expressed their willingness to pay 10 cents, 38/15.45%/ of the households expressed their willingness to pay 15 cents, 51/20.73%/ of the households expressed their willingness to pay 20 cents and 53/21.54%/ of the households expressed their willingness to pay 25 cents. If we multiply the reported maximum willingness to pay (column1) by corresponding number of household (column2) and divide the sum by total surveyed household of 246 we get of 14.9594 cents, which is the surveyed households are willing to pay on average, for a bucket or 20 liters of improved water services they can get from the improved scheme. If we multiply the average willingness to pay of surveyed household of 14.9594 cents for a bucket or for 20 liters of water they will get from the improved services by household average daily consumption of 8.260163 bucket or 165.2033 liters of water per day and then if we multiply the results by 30 days we get average monthly willingness to pay of sampled household of Birr 37.07. This average monthly willingness to pay of the sampled household accounts for 1.85% of average monthly income of

the surveyed household of Birr 2004.98, which is below 5% generally believed ceiling for the ratio of water and sanitation tariffs to total household expenditures (Fujita et al, 2004, p.81).

When we see the current tariff structures of the town water supply office, at the time of survey the price of one bucket or 20 liter of water was 0.6 cents for consumption from 0 to 5 m³, 0.7 cents for consumption from 5.1 m³ to 10 m³, 0.8 cents for consumption from 10.1 m³ to 25 m³, 0.9 cents for consumption from 25.1 m³ to 40 m³ and 1 cent for consumption above 40 m³ at private connections and 0.5 cents at public tap. This shows that the current tariff structure is much more below the household willingness to pay. Thus if the improved system is introduced in addition to addressing the water need of the town the authorities can also collect more fund from water sale which can be used for water expansion projects.

4.1.5. The Averting Behavior Strategies

When we see the averting behavior strategies the households use to make the water safe to drink, 153/62.20% of the household use one of the three averting behavior strategies that is 34/13.82% of the households use boiling, 78/31.71% of the households use adding chemicals and 41/16.67% of the households use water filter as an averting strategies. The remaining surveyed household which is 93/37.80% of the household did not use any kind of averting behavior strategies. The cross tabulating shows that household who have awareness about water born disease use an averting action than who have not and household who said the responsibility of water supply is government take one of the three averting action. Regarding the quality of water perception household's who said the quality is poor take more action and household who are not

satisfied on the current water supply service of the town take more averting action as compared to those who is satisfied.

Household who have water source from their private connection take more averting action as compared to those who have not private connection. Regarding children whose age greater than 3 and less than or equal to 17 years old, the cross tabulating shows that household who have children age greater than 3 and less than or equal to 17 take less action as compared to those who have children age less than or equal to three. The cross tabulating result implies that as the age of the household head increase their action to the averting action decrease. Finally as the average monthly income of the household increase their action to avert from the current water problem increase.

5.2. Econometrics Analysis

5.2.1 Analysis of Probit Model

As we have discussed in the methodology sections Probit model is employed to analyze factors that determine household' willingness to pay for the improved water services for single bound dichotomous choice questions survey responses. Note that where the explanatory variables are highly inter- correlated it is difficult to separate the effects of explanatory variables on the dependent variables (Maddala, 1992, PP. 269-270).

And hence to minimize the problem we did multicollinearity test. The result indicated that the correlation matrix among the explanatory variables is below 0.8. According to the rule of thumb multicollinearity is a serious problem if the correlation matrix is in excess of 0.8(Gujirati, D., 1988, p.299). Thus multicollinearity problem is not a serious problem in our data (see annex II).

Likelihood Ratio Test for Probit Model

The likelihood ratio test is a test against the null hypotheses that all the slopes coefficients are equal to zero (Johnson, & Dinardo, 1997, P. 422; Loomis, 1988 P. 53). This test is given by:

$$LRT = 2[L(\beta_0, \beta_1) - L(\beta_0, 0)]$$

Where $L(\beta_0, \beta_1)$ is the maximized value of the log likelihood of the model being estimated, $L(\beta_0, 0)$ is the value of the log likelihood estimated only with constant term, β_0 is regression constant and β_1 the slope coefficients. The null hypothesis of all slopes are equal to zero will be rejected if $LRT \geq$ critical χ^2 value. In our model the maximized log likelihood value is -42.137518 and the value of log likelihood with only constant term is -157.2665. Therefore the likelihood ratio test

$$\begin{aligned} LRT &= 2 (-42.137518 - (-157.2665)) \\ &= 230.257964 \end{aligned}$$

The critical value $\chi^2(13)$ at 5% level of significance is 24.9958. Thus the null hypotheses that all the slope coefficients are equal to zero are rejected. Thus the model has some explanatory power.

Measures of Goodness of fit

The use of conventional R^2 for goodness of fit when the dependent variable takes either 1 or 0 is not appropriate. A summary measure used similar to the conventional R^2 that have been suggested for models with qualitative dependent variable is calculated based on likelihood ratio as follows:

$$1 - \frac{L(\beta_0, \beta_1)}{L(\beta_0, 0)}$$

Where $L(\beta_0, \beta_1)$ is the maximized value of the log likelihood of the model being estimated
 $L(\beta_0, 0)$ is the value of the log likelihood estimated only with constant term.

This measure has value 0, when the entire slope coefficients are zero, and value 1 when the model is perfect predictor. In our probit model this summary measure is:

$$1 - (-42.137518) / (-157.2665) \\ = 0.732063$$

This result shows that, our probit model explains about 73.21% of the variation of the dependent variable, WTP.

4.2.1.1 Results of Probit model

In survey and cross sectional data heteroscedasticity is a serious problem. The robustness to heteroscedasticity is a compelling virtue (Greene, 2005, p.226). The method was proposed first for linear regression models but has subsequently been extended to nonlinear regression models (Hanemann, W. M and Kanninen B., 1988, p.32). Thus to correct for heteroscedasticity problem we estimated the robust standard errors. The coefficients of probit model only give the significance and the direction of the effect and the marginal effects give the size of the response probabilities. Thus we estimate both regression coefficients and the marginal effects. The STATA output for the probit model is shown in table 5-3.

Table 5-3: - Estimated parameters and marginal effects from the Probit model

Variables	Marginal Effect	Std. Err. of marginal Effect
Initial bid price	-.0414624***	.01401
Household volume water consumed (in 20 liters baldi/insira)	.021136*	.0121
Household perception to the quality of the current water source	-.0506026	.05984
Reliability of the current water source	.0258076	.04525
Pressure of the current water source	-.3933082***	.12108
Type of water source the household use	.061714	.10627
Household head gender	-.055338	.04202
Household size (in number)	.0262126	.02085
Household head education (years of completed)	.0473668***	.01514
Household head age (in years)	-.0149439***	.00528
Average household monthly income (in Birr)	.0000545**	.00003
Children age less than or equal to three	.1913242***	.05265
Constant	-	-

Source: Estimation Result Loglikelihood = -42.137518 Pseudo R² = 0.7321 N=246

***Significant at 1%level of significance

** Significant at 5%level of significance

* Significant at 10%level of significance

The coefficient of starting bid price has negative sign and significant at 1% level of significance.

The negative sign of this coefficient implies that as the starting bid price increases, the probability of household willingness to pay for the improved water services reduces by 4.15 percent, which is logical.

The variable volume of water the household consume has positive sign and significant at 10% level of significance which implies that household whose volume water consumption increase by one baldi the probability of their willingness to pay for the improved scheme increase by 2.11 percent.

The pressure of the existing water source of the household dummy variable has negative sign and significant at 1% level of significance. The study result shows that remaining other thing

constant, if the pressures of the existing water source the household used increases by 1 % the probability of household' willingness to pay for the improved water services decrease by 39.33% percent. This implies that, if the existing source has not the required pressure and households have more willingness to pay for the improved services.

The education level of the household head has a positive sign and significant at 1% level of significance. Holding other things constant, change in education level of the respondent from illiterate to formal education (primary, secondary, graduate and postgraduate) increases the probability that household head willing to pay for the proposed bid by 4.74 percents. This indicates that as people get more educated their awareness for the environment and health impacts of improved water system will also increase.

The variable age of household head, it has negative sign and significant at 1% level of significance. The negative sign of the marginal effect implies that older household head, which used to live with more free water and less price and less willing to pay for it.

Household average monthly income has positive sign and statistically significant at 1% level of significance. The significance and positive sign of the income variable is consistent with economic theory. The result shows that remaining other thing constant if average monthly income of the household increases says by 1% the probability of households' willingness to pay for the improved water services increases by 0.00545 percent. Thus, household average monthly income is one of the major determinants of willingness to pay for the improved water services in Bahir Dar town.

The dummy variable children whose age less than or equal to three has positive and significant at 1% level of significance. The result shows that remaining other thing constant, if household who have children age less than or equal to three the probability of their willingness to pay for the improved water services increases by 19.13 percents.

The coefficient of the remaining variables such as, the household perception to the quality of water they use, reliability of the current water source, the type of water source the household use, household head gender and household size have sign which is expected but they are insignificant even at 10% level of significance.

The mean willingness to pay for single bound dichotomous choice Contingent Valuation survey response for Probit model can be calculated by dividing the regression constant (intercept) by the negative of the bid coefficient as we discussed in the methodology section.

Thus, the mean willingness to pay is calculated as follows: -

$$\begin{aligned}
 MWTP &= \frac{\beta_0}{-Bid\ coefficient} \\
 &= 3.879416 / -(-0.2730049) \\
 &= 14.21006
 \end{aligned}$$

That is according to the results of the probit model the mean willingness to pay for one bucket or for 20 liters of improved water service is 14.21006 cents.

5.2.2 Analysis Regression model

The F-test for Regression model

The F- test is a test against the null hypotheses that all the slopes coefficients are equal to zero in linear regression model (Hill R. C. et al 1997, p.158). Consider the following regression model:

$$Y = \beta_1 1 - \beta_2 x_2 - \beta_3 x_3 + \dots - \beta_K x_K - u_i$$

Where Y is the dependent variable $x_1, x_2, x_3, \dots, x_k$ are explanatory variables $\beta_1, \beta_2, \beta_3, \dots, \beta_k$ are regression parameters, b_1 intercept and u_i is the error term.

To test the relevance of the explanatory variables we set the null hypothesis,

$$H_0: b_2=b_3=\dots=b_k=0$$

And the alternative hypothesis

$$H_1: \text{at least one of the regression parameters is non-zero.}$$

If the null hypothesis is true none of the explanatory variable influence the dependent variable and the model has no relevance. On the other hand if the alternative hypothesis is true the null hypotheses of all slopes are equal to zero will be rejected and it is concluded that the model has some explanatory power.

The F- test can be given by,

$$F = \frac{R^2/(k-1)}{(1-R^2)/(n-k)}$$

Where R^2 is the value of the coefficient of determination, k is number of parameters; n is sample number (Intriligator, M.D, 1997, p.128). In our regression model the value of R^2 is 0.6831, the

number of regression parameters (k-1) is 11, and sample number is 246. In the F- test the null hypothesis of all slope coefficients are equal to zero will be rejected if the calculated F value exceeds the critical value. Therefore the F- test for regression model is:

$$F = [0.6831 / (11)] / [(1-0.6831) / (246-12)] \\ = 45.8549625$$

At 5% level of significance the critical value F (K-1, n-K) is 2.08. That is, the calculated F test exceeds the critical value. Thus the null hypotheses that all the slope coefficients are equal to zero are rejected and it can be concluded that the model has some explanatory power.

Measure of Goodness of fit

The R² value of 0.6831 indicates that the linear regression model explains about 68.31% of the variation.

5.2.2.1 Results of Linear Regression Model

As we have tried to explain in the methodology section to see the effects of household characteristics and existing water use practices and problems on household' willingness to pay for the improved water services in addition to the Probit model we estimated the linear regression model. The STATA output of the linear regression model coefficients are shown in table 5-4.

Table 5-4: -Results of Linear Regression model

Variables	Coefficient	Std. Err.	t-ratio
Initial bid price	.0506897	.0716117	0.71
Household volume water consumed (in 20 liters baldi/insira)	.4670864***	.137306	3.40
Household perception to the quality of the current water source	-.6960464	.6665813	-1.04
Reliability of the current water source	-1.087525	.6769185	-1.61
Pressure of the current water source	-4.854314***	.6242285	-7.78
Type of water source the household use	.643104	.9766373	0.66
Household head gender	.3032267	.9001664	0.34
Household size (in number)	.1100831	.2081885	0.53
Household head education (years of completed)	.3420886***	.0704322	4.86
Household head age (in years)	-.1748302***	.0362461	-4.82
Average household monthly income (in Birr)	.0011379***	.0002487	4.58
Children age less than or equal to three	3.773426 ***	.7198108	5.24
Constant	12.52612	2.241894	5.59

Source: - Estimation Result

$R^2=0.6831$

Adj. $R^2=0.6668$

N=246

***Significant at 1% level of significance

** Significant at 5% level of significance

* Significant at 10% level of significance

The volume of water the household used has positive sign and significant at 1% level of significance. The positive sign shows that, the household whose water consumption is high have more willing to pay for the improved water service. Thus volume of water used by the household is one of the determinants of household' willingness to pay for the improved services in the town.

The pressure of the existing water service dummy variable coefficient has negative sign and significant at 1% level of significance. The negative sign implies that, household' that have high pressure water supply service currently used have less willingness to pay for the improved water service than that have low pressure water supply currently used.

The education level of the household head has positive sign and significant at 1% level of significance. This indicates that as people get more educated their awareness for the environment and health impacts of improved water system will also increase.

The age of the respondent has negative sign and statistically significant at 1% level of significance. The negative sign and significance of the age variable shows that as the age of the household head increases their willingness to pay for the improved water services decrease. Thus, age of the house head is one of the major determinants of households' willingness to pay for the improved services in Bahir Dar town.

The coefficient of the household average monthly income has positive sign and significant at 1% level of significance. The positive sign and the significance this variable show that household's willingness to pay fo

4.2.3. Analysis of Multinomial Logit Model

As we have discussed in the methodology sections multinomial logit model is employed to analyze factors that determine household's averting behavior strategies. Like the probit model, we did the multicollinearity test on the multinomial logit model. However, multicollinearity problem is not a serious problem in our data and the result shows that the correlation matrix among the explanatory variables is below 0.8.

Likelihood Ratio Test for Multinomial Logit Model

Like the probit model the likelihood ratio test for the multinomial logit model is also tested. In our model the maximized log likelihood value is -197.55998 and the value of log likelihood with only constant term is - 320.8038. Therefore the likelihood ratio test

$$\begin{aligned} \text{LRT} &= 2 (-197.55998 - (- 320.8038)) \\ &= 246.48764 \end{aligned}$$

The critical value $\chi^2(24)$ at 5% level of significance is 43.7729. Thus the null hypotheses that all the slope coefficients are equal to zero are rejected. Thus the model has some explanatory power.

Measures of Goodness of fit

Like the probit model, the goodness of fit for the multinomial logit model is also measured. In our multinomial logit model the summary measure is:

$$\begin{aligned} &1 - (-197.55998) / (- 320.8038) \\ &= 0.384172 \end{aligned}$$

This result shows that, our multinomial logit model explains about 38.4172% of the variation of the dependent variable, ABS.

5.2.3.1 Result of Multinomial Logit Model

Like what we did in the probit model, in survey and cross sectional data heteroscedasticity is a serious problem. Thus to correct for heteroscedasticity problem we estimated the robust standard errors. The coefficients of multinomial logit model only give the significance and the direction of the effect and the marginal effects give the size of the response probabilities. Thus we estimate both regression coefficients and the marginal effects. The STATA output for the multinomial logit model is shown in table 5-5.

Table 5-5: - Marginal effect of multinomial logit regression

Independent Variable	Dependent Variable Averting Strategies		
	Boiling	Chemical	Filter
Household perception to the quality of the current water source	-.2547216*** (0.000)	-.3250706 *** (0.000)	-.006965*** (0.001)
Type of water source the household use	-.1354278* (0.066)	-.0938285 (0.202)	.0044968*** (0.000)
Household head gender	-.0141339 (0.833)	-.0099751 (0.886)	.0009404*** (0.001)
Household size	.0100807 (0.258)	.0477353* (0.071)	.0004671*** (0.000)
Household head education (in years of completed)	.0007161 (0.292)	.0291021** (0.029)	.0001466*** (0.006)
Household head age (in years)	-.0026668* (0.078)	-.0107464** (0.022)	.000022 (0.773)
Average monthly income of the household (in Birr)	-.0000257 (0.459)	.0000153 (0.944)	8.91e-07*** (0.000)
Children age between three and seventeen	-.0556722 (0.245)	-.1652212 (0.125)	-.0021732* (0.060)
<i>Source:</i> -Estimation Result Pseudo R ² =0.3842		Loglikelihood=-197.55998	N=246

***Significant at 1% level of significance

** Significant at 5% level of significance

* Significant at 10% level of significance

The empirical result revealed that for the first strategy (Boiling), the coefficient water quality (taste, smell, appearance) has negative sign and significant at 1% level of significance. This implies that when the quality of water consumed decrease by 1% the household use of the

averting strategy boiling increase by 25.47216 percent relative to not to use any action. So households are unsatisfied with this source of water and are therefore using more of boiling technique to counter it. The coefficient of household head age has a negative sign and significant at 10% level of significance. This implies that, as the age of the head increase by 1% their action to the averting strategy boiling decrease by 0.26668 percent relative to not to use any averting strategies. The coefficient of source of water type the household used has a negative sign and significance at 10% level of significance. This can be reasoning that households who have their water source from their own private connection are mostly satisfied from the quality and therefore, not adopt boiling for safety of water they used.

Household head gender, household size, household head education level, average monthly income of the household and household who have children age from 3 to 17 years old have insignificant effect on the household water boiling strategy as compared to none use of the averting action.

In the case of the second strategy (Chemical), the results for the quality of water has negative sign and significant at 1%, which suggests that if household who perceived the quality of water is poor they would use more of averting behavior technique adding chemical. Hence household's feel that the quality they are receiving is not safe and resultantly they adopt certain measures for the safety of water. The household head education level has a positive sign and significant at 5% level of significance, which implies that, the household head education level have a positive influence to the household decision to adopt the averting strategy adding chemical. The household size has a positive sign and significant at 10% level of significance, which suggest

that, as the household size increase by 1 person the household decision to use the averting strategy adding chemical increase by 4.77353 percent relative to not to use any of the averting strategies. And the household head age has a negative sign and significant at 5% level of significance, which implies that as the age of the head increase their action to the averting strategy to adding chemical decrease relative to not to use any of the action.

Like the strategy (Boiling), household head gender, household's head education level, average monthly income of the household and household who have children age from 3 to 17 years old have insignificant effect on the household use of adding chemical strategy compared to not to use of any action to make the water safe to drink. Unlike the strategy (Boiling), the source of water the household used has insignificant effect to use the averting strategies (Chemical).

In the case of the third strategy (Filter), the water quality has a negative sign and significant at 1% level of significance, which implies that, like the above two strategies, the quality of water the household use have a significant effect on the household's decision about filter which shows that in case of poor water quality (poor taste, smell or appearance) use of filter is high. The coefficient of source of water type the household used has a positive sign and significance at 1% level of significance. This can be reasoning that household who have their water source from their own private connection are mostly unsatisfied from the quality of water they used and therefore, adopt filter for safety of water they used. Unlike the above two strategies (Boiling and Chemical), average monthly income of the household has a positive sign and significant at 1% level of significance. This is quite acceptable as filters are considered as a bit costly and require regular maintenance.

The household's head gender, unlike the above two strategies, have a significant effect on the decision household's take filter as an averting strategy relative to not use any action. And the household size and head education have a significant effect on the use of filter, like Boiling and Chemical. While, unlike the above strategies, household who have children age greater than 3 and less than or equal to 17 has a negative sign and significant at 10% level of significance, which implies that, the children age greater than 3 and less than or equal to 17 their action to the averting strategy filter decrease relative to not to use any strategy. It is generally believed that household is more conscious in water purification if they have children age less than or equal to 3 years old. The result is also supporting this perception.

Household head age is also insignificant effect to use water filter. This suggests that there are other variables which are more important to determine the use of water filter.

5.2.4 Estimating Aggregate WTP and Aggregate Potential Revenue

5.2.4.1 Estimated Aggregate WTP:

The main purpose of this study was to estimate household willingness to pay for the improved water services. The total willingness to pay for the improved water services as shown in table 5-6 can be obtained by multiplying the mid points of willingness to pay interval (column 2) by total number of household (column 4). As shown in the table total willingness to pay for one bucket or 20 liters of improved water services is Birr 4,160.52 per day or Birr 1,518,588.41 per year.

5.2.4.2 Estimated Aggregate Potential Revenue:

As we have introduced in the previous sections the implementation of the improved scheme is not only reduces the water problem of the town but also increases the revenue collected from water sale. If the improved scheme is introduced by increasing water tariff the authorities can collect more funds that can be used for the expansion of water development projects. The potential revenue of the improved scheme can be estimated through using the reported maximum willingness to pay by the households and the reported average daily consumption. To make aggregation over the whole household class intervals for maximum willingness to pay are employed.

Thus, the aggregate revenue that can be expected from the provision of improved services as shown in table 5-6 is calculated by multiplying the mid points of the willingness to pay interval (column2) by total number of household' willingness to pay for the improved services at least minimum amount (column6). The aggregate revenue expected from the provision of the improved water services if each household consumes only one bucket or 20 liters of water from the improved source is shown in the table (column 7).

As we can see from the table if the price of one bucket or 20 liters of water is 2.5 cents 33,289 household will pay for the improved water services and the expected aggregate revenue is Birr 832.23 per day or Birr 303,763.95 per year. When the price of one bucket or 20 liters of water is 7.55 cents 25,846.34 households will pay for the improved water services and the expected aggregate revenue is Birr 1,951.40 per day or Birr 712,260.53 per year. When the price of one bucket or 20 liters of water is 12.55 cents 19,215.60 households will pay for the improved water

services and the expected aggregate revenue is Birr 2,411.56 per day or 880,218.60 Birr per year. When the price of one bucket or 20 liters of water is 17.55 cents 14,073.40 households will pay for the improved water services and the expected aggregate revenue is Birr 2,469.88 per day or Birr 901,506.82 per year. When the price of one bucket or 20 liters of water is 22.55 cents 7,172.02 households will pay for the improved water services and the expected aggregate revenue is 1,617.29 Birr per day or 590,310.92 per year.

Table 5-6: -Total WTP and aggregate revenue expected from the improved system.

WTP interval in cent per 20 liters	Class mark for WTP	No. of sampled household	Total No. of household	Total WTP in cent for 20 liters (in Birr)	Minimum amount household are WTP	Total Revenue (in Birr)
0 – 5	2.5	55	7,442.66	186.07	33,289	832.23
5.1 – 10	7.55	49	6,630.74	500.62	25,846.34	1951.40
10.1 – 15	12.55	38	5,142.20	645.34	19,215.60	2411.56
15.1 – 20	17.55	51	6,901.38	1211.19	14,073.40	2469.88
20.1 – 25	22.55	53	7,172.02	1617.29	7,172.02	1617.29
Total		246	33,289	4160.52		

Source: - Contingent Valuation Survey Result

The demand for the improved water services at different price level is shown diagrammatically in figure1 below

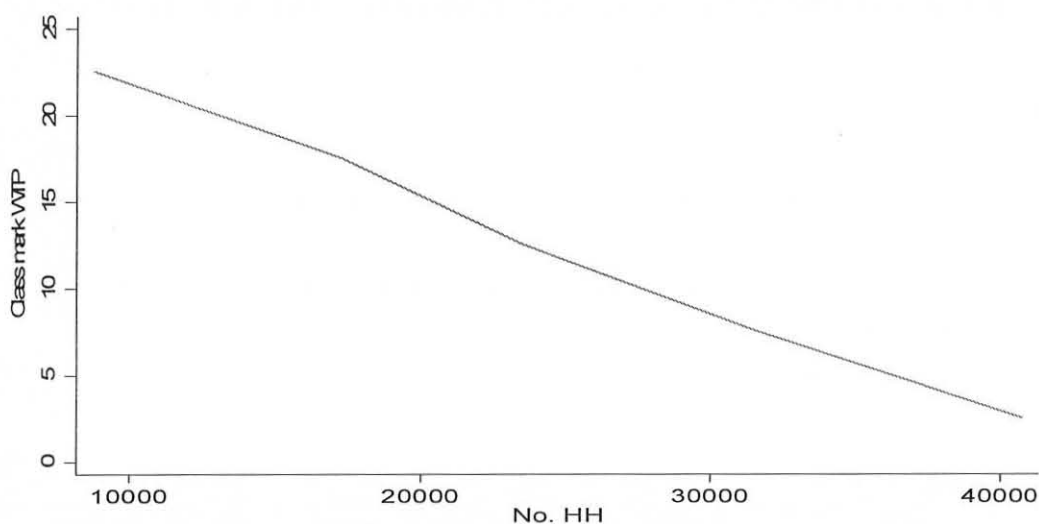


Figure: 1: - Household demand of the improved water services at different prices.

The survey result shows that each household on the average consumes 8.260163 bucket or 165.20326 liters per day. Thus taking this into consideration household average water consumption the maximum revenue can be collected from the improved system at the optimum price of 17.55 cents per bucket or per 20 liter is Birr 20,401.63 per day or Birr 7,446,594.28 per year if the improved scheme is implemented.

5.2.5 Comparison of Averting Expenditure with WTP

Consumers pay in two ways: first, they pay a monthly tariff and the second; they pay indirectly in the form of averting expenditure. Thus total monthly expenditures paid for water comprise of monthly bill and total averting expenditure. Total monthly expenditure = Fees paid to water supply corporation + (money spent on treatment + purchasing). Thus total WTP is sum of current fees plus averting expenditure. Table 5-7 compares current tariff, averting expenditure and WTP.

Table 5-7: - Current Tariff, Averting Expenditure and WTP for Household in Bahir Dar.

Type of Expenditure	Connected	Not Connected	Both
Current Tariff	24.98	0	21.93
Averting Expenditure	8.10	37.69	11.15
WTP from CVM	37.12	36.46	37.12
Total Averting Expenditure	33.07	37.69	33.07

Source: - Survey Result

It is interesting to note from figure 2 that averting expenditure is lower bound to the total willingness to pay for whole sample as explained by theory. WTP for the household that are not connected to the official pipeline is less than their averting expenditure. But for the household connected to the pipeline averting expenditure are not exceeds households WTP.

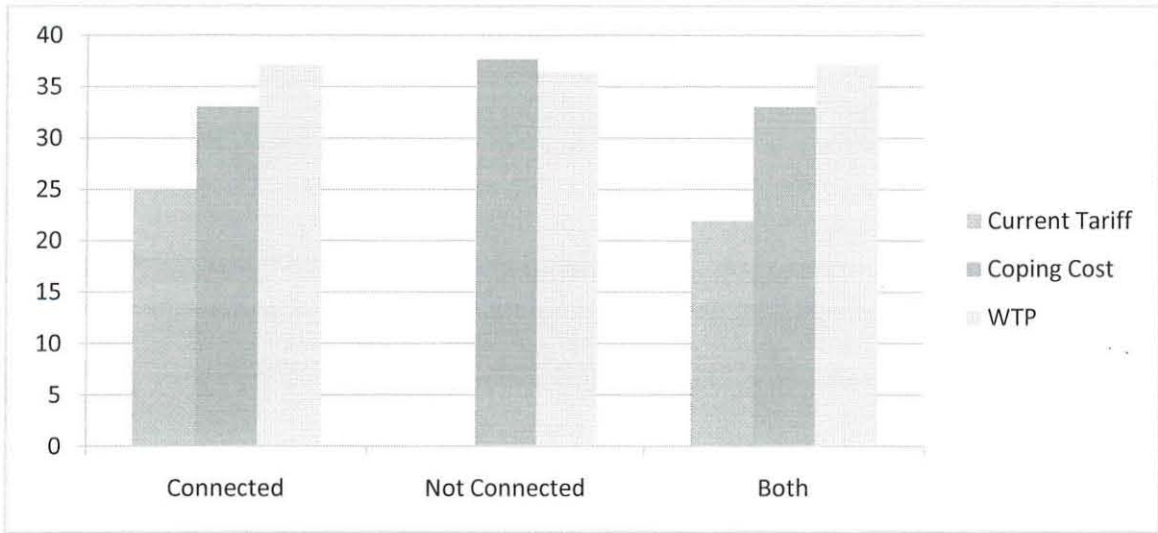


Figure 2: Current Tariff, Coping Cost and WTP

CHAPTER SIX

6. CONCLUSIONS AND POLICY IMPLICATIONS

6.1 Conclusions

This study aims to analyze and determine factors that affect the household's willingness to pay for improved water supply service and the household' averting behavior strategies used to make their current water source safe to drink. The survey used from a total of 17 kebeles in the town, 7 kebele were selected based on simple random sampling and the remaining 2 kebeles were selected purposely because the town water supply authority reported these 2 kebeles have a serious water problem. Then to obtain 250 households from the randomly and purposely selected of 9 kebeles, we used the list of the household in each of the 9 kebeles, which is collected from the kebeles administration and get the total number of household live in each kebele and calculate the proportion of the household to each kebele finally randomly selected household to be interviewed. The sampled households were asked questions related to their socio-economic and demographic characteristics, water use practices, and problems with existing water services system and their averting behavior strategies and some general questions. The surveyed household also asked single bound close-ended dichotomous questions followed by open-ended questions to elicit household' willingness to pay for the improved water services.

To analyze the survey responses contingent valuation method and averting behavior model were employed. The survey responses were analyzed by using STATA 10.0 econometrics soft ware. The survey response analyzed by using both descriptive analysis and econometric models. The survey results disclosed that pipe water is the main source of water for the town. Of the total survey respondents 100% use pipe water. However, only 56/22.76%/ of the households satisfied

with the status quo level and 190/77.24% of the households expressed their dissatisfaction. 139/56.50% of the household perceived the quality of water of their current source is poor and 107/43.50% of the households perceived good. 178/72.36% of the households revealed that the existing source of water is not reliability. The whole surveyed household expressed their willingness to pay for the improved services ranging from 5 cents to 25 cents for a bucket or 20 liters of water they will get from the improved sources. 163/66.26% of the households shows their willingness to pay equal and above the bid price offered to them. 83/33.74% of the households shows their willingness to pay for the improved services but below the bid price offered to them. The total willingness to pay for one bucket or 20 liters of improved water service is Birr 4,160.50 per day or Birr 1,518,589.80 per year. If the improved system is implemented the authorities can collect a total revenue of Birr 20,401.63 per day or Birr 7,446,594.28 per year.

To identify the determinants of household's willingness to pay for the improved water service Probit and OLS econometrics models were estimated. The results of the Probit model show that volume of water used, pressure of the current water source, education level of the household head, age of the household head, average monthly income of the household and children age less than or equal to three variables determine household's willingness to pay for the improved services. Whereas in the OLS model that volume of water used, pressure of the current water source, education level of the household head, age of the household head, average monthly income of the household and children age less than or equal to three variables determine household maximum willingness to pay for the improved water services in Bahir Dar town.

The mean willingness to pay for a bucket or for 20 liters of water in probit model and OLS model is different. The mean willingness to pay for a bucket or for 20 liters of water from OLS is 14.95935 cents. While in Probit model the mean willingness to pay for a bucket or 20 liter of water is 14.21006 cent.

To identify the determinants of household's averting behavior strategies (Boiling, Chemical, Filter) for quality improvement, the study finds that there are statistically significant effects of household head education and household size on the water purification behavior (Chemical Filter) of the household. Income is highly significant in the strategy Filter; while in source of water household getting water from private connection is significant in both boiling and filter.

As expected, the study finds that there is a strong effect of quality (taste, smell, appearance) on all water purification behavior of household i.e. water quality is highly significant in all strategies. Finally age of the household head have significant role to household to use the averting strategies (Boiling Chemical) and household head gender is also significant only to the strategy Filter.

We find that consumer faces two folds problem in drinking water supplies. Water supply is not continuous and at the same time, whatever is supplied is not reliable to drink from the tap. To avert with these problems, household live in Bahir Dar engages in several averting strategies: boiling, chemical and filtering. Averting expenditure is significantly higher than the current bill they are paying to the water supplies authority. Comparative study of WTP from contingent valuation method and averting expenditure method suggests that WTP and averting expenditure

are conceptually related to same underlying preferences. Like the previous studies, we find that averting expenditure is lower bound to the willingness to pay to the household that has private connection.

6.2 Policy Implications

Bahir Dar town suffers from increasing problems of water shortage. The household of the town has enthusiastic to have reliable and improved water services. All the surveyed households expressed their willingness to pay for the improved water services above the existing tariff structures. Thus, the expected revenue from the provision of the improved water services will be high. The findings of this study also clearly show socio-economic and demographic characteristics and water related variables that affect household willingness to pay for the improved water services.

Based on our research findings we can draw the following policy implications:

- 1) An important policy implication from the strong positive relationship between the household head educational level and willingness to pay for the improved water service is that there is a need to educate people about the benefits associated with improved water services, in general, and having private connection to the new improved water supply, in particular.
- 2) The strong positive relationships between the average monthly income of the household's and their willingness to pay for the improved water services indicate that, the policy

makers should consider income of the household when they implement the new water tariff to the improved water scheme.

- 3) The surveyed sampled households expressed their interest to pay above existing tariff structure. Thus, if the improved water supply is provided to the town by increasing water tariff structures the financial viability of the authorities will be improved and at the same time the water need of the household will be satisfied.
- 4) The positive relationship between the volume of water the household consumed and willingness to pay for the improved water service that household whose water usage is more willing to pay for the improved water services. This implies that in designing the improved water tariff policy water volume used by the household should be taken in to consideration.
- 5) The negative relationship between the age of the household head and willingness to pay for the improved water services implies that older peoples have less interest to pay for the improved services. Thus, in designing the improved system for the town policy makers needs to take the age of family heads into consideration as one of the factors that influence household's willingness to pay for the improved services by subsidize the old age household head.

- 6) The negative relationship between the pressure and household's willingness to pay for the improved water services indicate that the existing system is low pressure. This implies that if the household of the town get the improved high pressure water services they would pay for the water services they would get from the improved source. Thus in designing the water system of town policy makers should take the low pressure of existing water source into consideration and emphasis should be given in providing the high pressure water services.
- 7) To conclude, study suggests that household from Bahir Dar are willing to pay significantly more to improve efficiency and quality of water supplies service than what they are paying as current tariff and hence water utility tariff can be increased to improve the water service.

REFERENCE

- Abdallah, C. W., B. A. Roach, and D. J. Epp (1992), Valuing Environmental Quality Changes Using Averting Expenditures: An Application to the Ground—Water Contamination, *Land Economics* 68: (May), 163–69.
- Abrahams N. A, Bryan J. Hubbell, and Jeffery L. Jordan (2000), Joint Production and Averting Expenditure Measures of Willingness to Pay: Do Water Expenditures Really Measure Avoidance Costs? *American Journal of Agricultural Economics* 82: (May), 427–37.
- Alebel Bayrau (2005), Analyses of affordability and willingness to pay for the improved water supply in urban areas of Ethiopia a strategy for full cost recovery, edited by Mulugeta Feseha and Tesfaye Tafesse in Proceedings of the conference on Management of water resources in Ethiopia. Institute Development Journal.
- Amin, M & Khondoker, F, 2004, A contingent valuation study to estimate the parental willingness-to-pay for childhood diarrhea and gender bias among rural household in India.
- Assefa Chaka (1998), Estimating Willingness to pay for water supply in Addis Ababa, thesis presented to the school of graduate studies in partial fulfillment of the requirement for the degree of masters of science in economics, Addis Ababa University.
- Bahir Dar town water supply and sewerage office documents
- Bochstael, Naney and Freeman, M. (2005), *Welfare Theory and Valuation*: edited in the handbook of environmental changes, vol2, edited by Karl – Goren Maller, Jeffrey Vincent, and North Holland.
- Bockstael, Nancy, and Kenneth McConnell (1999), “The Behavioral Basis of Non-Market Valuation.” In: Herriges and Kling, eds. *Valuing Recreation and the Environment: Revealed Preference Methods in Theory and Practice*, New Horizons in Environmental Economics.
- Boham, Peter. 1994, “CVM Spells Responses to Hypothetical Questions.” *Natural Resources Journal* 34(1): 37-50.
- Casey J.F., James R. Kahn, A. Rivas (2006) “Willingness to Pay for Improved Water Service in Manaus, Amazonas, Brazil.” *Ecological Economics* 58; 365 –72
- Carson, R. N. Flores, K Martin, and J, Weight. (1996) “Contingent Valuation Methodologies: Comparing the Estimates for Quasi-Public Goods.” *Land Economics* 72:80-99.
- Chowdhury, N. T. (1999) *Willingness to Pay for Water in Dhaka Slum: A Contingent Valuation Study*, IUCN.

- Collins, A. R. and S. Steinbeck (1993), Rural Household Response to Water Contamination in West Virginia, *Water Resource Bulletin* 199–209
- Cropper Maureen L. and A. Myrick Freeman III (1991), *Environmental Health Effects*,
- Cummings, R.G., D. Brookshire, and W. D. Schulze (1986), *Valuing Environmental Goods An Assessment of Contingent Valuation Method*, Totowa, NJ, Rowman and Allenheld.
- CSA, (1995), *The 1994 population and housing census of Ethiopia: Results for Amara Region*
- CSA, (2007) *Statistical abstract*
- Evans P. 1992, *paying the piper: an overview of community financing of water and sanitation*. The Hague, IRC International Water and Sanitation Centre
- FAO (2007), *Corporate documents repository, “Applications of the Contingent Valuation Method in developing countries” –PDF notes*.
<http://www/fao.org/DOCREP/003/X8955e/X8955e03.htm>
- Fisseha Abera (1997), *Estimating willingness to pay for water: A contingent valuation study on Meki town MSC thesis submitted in (part) fulfillment for degree of masters of Science in economics (economic policy analysis)*, Addis Ababa University.
- Freeman, A.M (1993), *The measurement of environmental and resource values*, Washington Dc, Resource for the future.
- Fujita et al. (2005), *Estimating willingness to pay for water and sanitation services through Contingent Valuation Method, A case study in Iquitos City, Republic of Peru*, JBICI review, NO.10.
- Genanew Bekele (1999), *Analysis of the determinants of household’ willingness- to pay and demand for improved water services: A contingent valuation study in Harar city (Ethiopia)*, MSC thesis Department of Economics, Addis Ababa University.
- Gossaye Fanta (2007), *Household’ willingness to pay for improved water services in Deber-Zeit town, Ethiopia, MSC thesis submitted in (part) fulfillment for degree of masters of Science in economics*, Addis Ababa University Department of Economics, Addis Ababa University.
- Griffiths William E., R. Carter Hill, and George C. Judge (1993), *Learning and Practicing Econometrics*, New York: John Wiley & Sons, Inc.
- Hanemann, W.M and B.Kanninen (1998), *The statistical analysis of discrete- respons Contingent Valuation data*, California Agricultural experiment station, Giannini Foundation of Agricultural Economics

- Hanemann, M.W. (1994), Valuing the Environment through Contingent Valuation. *Methods Journal of Economic Perspectives*, 8(4): 19-43
- Hanley N. F. Shgren and B.White (1997), *Environmental economics in theory and practices*, London, Macmillan
- Haq, Mirajul, Usman Mustafa, Usman and Ahmad, Iftikhar (2008), Household' willingness to pay for safe drinking water: A case of Abbottabad district. Published in: *The Pakistan Development Review*, Vol. 46, No. 4 (2007): pp. 1137-1153.
- Harrington, Winston, Alan J. Krupnick, and Walter A. Spofford (1989), The Economic Losses of Waterborne Disease Outbreak, *Journal of Urban Economics* 25, 116-137
- Hussen A (2005), *Principles of environmental economics* (2nd edition), New York Routledge
- James N. Mbata (2006) Estimating household willingness to pay for water services in a rural economy: The case of Kanye in southern Botswana, Houston Community College, Houston, Texas, USA.
- James F. Casey, James R. Kahn and Alexandre Rivas (2004) Willingness to pay for improved water service in Manaus, Amazonas, Brazil, *Universidade Federal do Amazonas, Brazil*
- Johanson, Per-Olov (1991), *An Introduction to modern welfare economics*, Cambridge University press
- Kyeong Ae Choe, Dale Whittington, Donald T. Lauria (1996), The Economic Benefits of Surface Water Quality Improvements in Developing Countries: A Case Study of Davao, Philippines, *Land Economics*, Vol. 72, No. 4, pp. 519-537
- Long, J. 1997, *Regression Models for Categorical and Limited Dependent Variables*, SAGE Publications India Pvt. Ltd
- Mitchell, R.C and Carson R.T., 1989, *Using Surveys to Value Public Goods: The contingent valuation method*, the John Hopkins university press Washington D.C.
- Ng Yew –Kwang (1985), *Welfare economics: introduction and development of basic concepts*, Monish university press.
- Oni, O.A, Oladele, O.I, Indei, O.F (2005), Consumer willingness to pay for safety labels in Nigeria: A case study of Potassium Bromate in Bread, *Journal of central European Agriculture*, Volume 6(2005) no.3 (381-388)
- Pearce, D. E. Ozdemiroglu, and et al (2002), *Economic valuation Summary guide*.

- Perman, R., Y.Ma, J. Mc Gilvray, and M. Common (2003), *Natural Resource and Environmental Economics*, person education limited printed and bounded by Bell and Bain Ltd. 3rd edition.
- Seller, Christine, J.R Stoll, and Jean Paul Chavas (1985), *Valuation of Empirical measures of welfare change: A Comparison of non-market Techniques*, Edited in *land economics*, Vol.61 No.2.
- Shyue-Cherng Liaw and Wan-Jiun Chen (2006), *Adaptive management of water resources*, AWRA summer specialty conference
- Siglman, L. and L. Zeng (1999), *Analyzing censored and sample selected data with Tobit and Heckit models*, the George Washington University.
- Smith, V. K. and W. H. Desvouges (1986), *Averting Behavior; Does it Exits?* *Economics Letters* 20:3, 291–96.
- Smith, V. K. (1991), *Household Production Models*, Chapter III. In John B. Barden and Charles D. Kolstad (eds.) *Measuring the Demand for Environmental Quality*. North Holland.
- Srivastava, O.S (1996), *Economics of growth, Development and Planning*, Printed at Kay printers, Delhi-110007, Vikas Publishing House PVT.Ltd.
- Stephanie Aulong and Jean-Daniel Rinaudoy (2008), *Assessing the benefits of different groundwater protection levels: results and lessons learnt from a contingent valuation survey in the Upper Rhine valley aquifer, France*.
- Tietenberg T.(2003), *Environmental and Natural Resource Economics*, 6th International Edition Pearson Education, Inc
- Tisdell, Clem (1993), *Environmental Economics: policies for environmental management and sustainable development*, Printed in Great Briton, Cambridge University Press.
- United Nations (2007), “*The Millennium Development Goals Report 2007*” United Nations, New York.
- UN-HABITAT (2003), *Water and Sanitation: In the world’s cities, Local action for Global Goals UN human settlement program*.
- Varian, Hal R. (1992), *Micro economics analysis* 3rd edition, printed in United States of America.
- Water and Sanitation Program (2009), *A practical guide for improving water supply and sanitation services, Guidance Notes on services for the urban poor*.

- Whitehead, John C. and George Van Houtven (1998), *Methods for Valuing the Benefits of the Safe Drinking Water Act: Review and Assessment*, East Carolina University Working Paper.
- Whittington, Dale (2002), *Improving the Performance of Contingent Valuation studies in Developing Countries*, *Environmental and Resource Economics* 22: pp.323- 367, 2002. Kluwer Academic publishes printed in the Netherlands.
- Whittington, D., V. K. Smith, A. Okorafor, A. Okere, J.L. Liu and A. Mc Phail 1992), *Giving Respondents Time think in Contingent Valuation studies: A Developing Country Application*, *Journal of Environmental Economics and Management* 22, pp.205-225.
- Whittington, D., D.T, Lauria, and X. Mu (1991), *A study of water vending and willingness to pay for water in Onitsa, Nigeria*, *World Development* 19, pp.179-198.
- Whittington, D., J. Briscoe, X. Mu and W. Barron (1990), *Estimating the Willingness to Pay for Water Services in Developing Countries: A Case Study of the Use of Contingent Valuation Surveys in Southern Haiti*, *Economic Development and Cultural Change*, 38(2): 293–311.
- World Health Organization (2004), *The World Health Report 2002*. Geneva: WHO Switzerland.
- World Bank 1994, “*Infrastructure for Development:*” *World Development Report 1994:* Oxford University press
- Young, Robert A. (2005), *Determining the economic value of water: concepts and methods, resource for the future*, Washington D

ANNEXES

ANNEX- I

CONTINGENT VALUATION SURVEY - HOUSEHOLD QUESTIONNAIRE

INTERVIEWER: Read the following before you start interviewing

This survey is being undertaken by a student of Addis Ababa University, Faculty of Business and Economics in the Department of Economics as a partial fulfillment for the award of M.Sc. in Economics. This questionnaire is designed to obtain information on the current situation of water supply in Bahir Dar town, the problem you face and your reaction to the possible improvement of the existing drinking water service. The information collected is purely for academic purpose and will be kept confidential. And your name and personal information will never be linked with your response. Thus, please answer the questions honestly and as truthfully as you can.

Thank you in advance.

Household ID:

Sub-city.....

Kebele.....

House No.....

Name of interviewer.....

Date of interview: Time:A.M/P.M (Circle)

Length of interview:Minutes

Part -I Questionnaires on demographic and socio economic characteristics

Enter all the members of the household (household member are those that live under the same roof or compound including temporary migrants for not more than 6 months, but excluding *debal*): Students and resettle are considered members of a household even if they are away for one or more years.

Member Id	Name of the household member	Q101 Sex Male=1 Female=2	Q102 Relation to the household (See codes below)	Q103 Age in years	Q104 Literacy Yes=1 No=0	Q105 Are you in school Yes=1 No=0	Q106 Year of schooling completed	Q107 Ma occupation activity(see occupation activity Code below)
1			Head					
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								

Code for: - Relation to the head of household

0=head

1 = Father;

2= Mother;

3=Wife;

4 = Sister;

5 = Son;

6 = Daughter;

7 = Husband;

8 = Brother;

9=Grandson

10=Grand Daughter

11= Other Relative

12=Maid servant/Hired Farm Worker (*Harestay*)
Cattle Herder or Hired 13= Other, specify

Occupation/activity codes:

- 1= In school; 2= Farming;
3=Trade,
4=Informal wage labor (both manual and skilled wage employment),
5=Formal employee (soldier, civil servant, guard, business employee etc);
6=Self employed in non-agriculture (handicraft, blacksmithing, food processing including
brewery, oil extraction, injera, bread, cake, hairdressing, shoe shinning, fuel wood collection,
etc),
7=herding, 8=fuel wood collection/water fetching
9=household chores (home work) 10=too young (children)
11=disabled/old/pensioner 12=unemployed
13=no secondary activity 14, others, specify

108 The house you live in is yours or rented?

- 1 if household owns house 2 if rented from kebele
3 if rented from government 4 if rented from private
5 if others (please specify) _____

109 If rented, from whom do you rent?

- 1 if Kebele 2 if government
3 if private

110 If rented, how much is the amount of rent per month? _____ Birr per month

111 What is the main type of energy source you usually use for lighting?

- 1 if Electricity with private meter 2 if Electricity with shared meter
3 if Kerosene 4 Candle

5 Gas

6 Wood

7 Noon

8 if other (please specify) _____

112 Do you have?

a. Radio 0 if no 1 if yes

b. Tape 0 if no 1 if yes

c. Television 0 if no 1 if yes

d. Refrigerator 0 if no 1 if yes

e. Telephone 0 if no 1 if yes

113 How much do you spend per month on?

1 Food _____

2 Education (fee for pen pencil, exercise book, etc) _____

3 Electricity _____

4 Telephone _____

114 Would you please tell me your household's income per month? (If the respondent cannot tell the household's income please ask his own income) _____

115 Please list the following services in order of importance for you (list as first, second, etc)

1. School _____

2. Water _____

3. Health _____

4. Road _____

5. Power _____

6. Telephone _____

7. Toilet _____

116 Does your household aware about waterborne diseases?

1 Yes

0 No

117 What kind of toilet facility does your household use?

1 if flush toilet

2 if pit latrine (private)

3 if pit latrine (communal)

3 open air

5 if other (please specify) _____

Part-II Questionnaire on water use practices and problems

201 What is your main source of water?

- 1 Pipe water
- 2 other source

If piped water go to question 203 to 231

If other go to question 232 to 244

202 If piped water, what kinds of piped do you use?

- 1 Shared yard connections
- 2 public tape
- 3 Pipe inside the house
- 4 private pipes outside the house
- 5 water from vendor

203 If private piped, is your water meter functional?

- 1 yes
- 0 No

204 For what purpose do you use water?

- 1 Drinking and cooking
- 2 washing of clothes
- 3 Bathing
- 4 Watering livestock
- 5 for 1 2 3 and 4
- 6 for all but _____

205 If shared yard connection, how many household use the yard connection?

_____ Household

206 If public tap, how much time do you spend to fetch water at a time? _____ minutes

207 If public tap, how many times, on average, do you go per day for fetching of water?

_____ Times

208 If public tap, how many persons from the household go at a time to fetch water from this source? _____ Persons

209 If public tap, who often go to the public tape to fetch water?

- 1 Women
- 2 Girls
- 3 Boys
- 4 Men
- 5 1 and 2
- 6 All

210 If your current source of water is public tape why don't you have your own connection or yard connection?

- | | |
|--------------------------------|--|
| 1 High connection cost | 2 the house is not mine |
| 3 Scarcity of water | 4 I do not want to have yard or private connection |
| 5 Other reason (specify) _____ | |

211 How much water, on average, does your household use per day? _____ Bucket
(Note that one Bucket assumes contains 20 liters)

212 How much do you pay per bucket? (For those who buy from vendor) _____

213 How much, on average, do you pay for your water consumption per month from this source? Birr per month _____

214 How do you judge the existing water tariffs of the town's water supply and sewerage office?

- | | |
|-----------------------|----------------------------|
| 1 Too expensive | 2 Too cheap |
| 3 Fair and affordable | 4 It is difficult to judge |

215 Do you get tape water at desired time and quality?

- 1 Yes
- 2 No

216 If no to 215 above from where do you get additional water?

- | | |
|----------------------|--------------------------------|
| 1 From vendors | 2 From rivers |
| 3 From springs | 4 From wells |
| 5 From bottled water | 6 Other source (specify) _____ |

217 How much, on average per month, you pay? (If the additional water source is bottled water) _____ in Birr per month

218 If "from vendors" how do you judge their price as compared to the town's water supply tariffs?

- | | |
|-------------|---|
| 1 The same | 2 Twofold |
| 3 Threefold | 4 Fourfold |
| 5 Fivefold | 6 It is not possible to say this much for their price is flexible |

219 During what time you often face water shortage?

- | | |
|---|-------------------|
| 1 During night time | 2 During day time |
| 3 During morning time | 4 At noon |
| 5 It is not possible to tell the exact time for it has no constant time | |

220 From your experience how often you get piped water within 24 hours? _____ hours.

221 Is there any time where piped water is completely absent?

1 Yes

0 No

222 If your response to 221 above is 'yes' specify the time when water is completely absent _____

223 How do you rate the status of the service of piped water your household use?

223a Quality

1 Good

2 Average

3 Not good

223b Quantity

1 Good

2 Average

3 Not good

223c Reliability

1 Good

2 Average

3 Not good

224 Do you treat your piped water in any way to make it safe to drink?

1 Yes

0 No

225 If "no" what are your main reasons for you for not treating your piped water?

1 The water is clean for drinking

2 The water is not clean, but treating is time consuming and costly

3 The water is not clean, but has no side effect on health

226 If "yes" what do you usually do to the piped water to make it safe to drink?

1 Boiling

2 Add chemicals

3 Use water filter

4 Other (specify) _____

227 How much you pay to treat your piped water to make it safe to drink?

_____ Birr per month

228 Has any one of your household members suffered in connection to the piped water the household use?

1 Yes

0 No

229 If "yes" what was the disease?

1 Diarrhea

2 Typhoid

3 Cholera

4 Other water born disease

230 Generally are you satisfied with the existing piped water service?

1 Yes

0 No

231 If "no" what are the main causes of your dissatisfaction?

1 Poor quality

2 Unreliability

3 low pressure

4 Not enough supply

5 Other reason (specify) _____

232 If your response for (201) above is 'other source' what other source do you use?

1 River

2 Spring

3 Well

4 Other (specify) _____

233 How many times, on average per day, do you go to fetch water from this other source? _____ times

234 How much time do you spend to fetch water from this other source at a time? _____ hours /minutes

235 How many persons go at a time to fetch water from this other source? _____ Persons

236 Who often goes to fetch water from this source?

1 Women

2 Girls

3 Boys

4 Men

5 1 and 2

6 All

237 How much do you pay for one bucket of water you get from this other source _____ cents?

238 Why do you prefer this source (none piped)?

1 Access to pipe water is difficult

2 The pipe water is too cost and not affordable

3 This source is more reliable

4 Collecting water from public tap takes more time

5 This source has better quality

239 Does your household treat your other source water in any way to make it safe to drink?

1 Yes

0 No

240 If "no" what are your main reasons for you for not treating your other source water?

1 The water is clean for drinking

2 The water is not clean, but treating is time consuming and costly

3 The water is not clean, but has no side effect on health

241 If “yes” what do you usually do to the other source water to make it safe to drink?

1 Boiling

2 Add chemicals

3 Use water filter

4 Other (specify) _____

242 How much you pay to treat your other source water to make it safe to drink?

_____ Birr per month

243 Has any one of your household members sick in connection to the other source water the household use?

1 Yes

0 No

244 If “yes” for 243 what was the disease?

1 Diarrhea

2 Typhoid

3 Cholera

4 Other water born disease

Part-III Opening statement on willingness to pay questions for improved water service

Currently there is a big gap between the supply and the demand for clean potable water in Bahir Dar town. There is excess demand over its supply. The main reasons for the shortage of the town’s water supply are: (1) high population growth; (2) the existing boreholes is not enough to supply the current water demand of the population; and (3) there are low water pressure problems.

To improve the water supply of the town, since the existing boreholes are not enough, additional boreholes should be constructed. For the new boreholes to be operational additional water pumps and new water reservoir would still have to be provided. To have public taps at different places in the town pipelines will have to be constructed from the boreholes or other water source to the public taps. In addition to the investment cost it is also necessary to pay for operational and maintenance costs.

I) If the town’s water development investment done accordingly, the water would run all the day and every household that has currently private connections and have interest to have private connections from the improved source would benefited from the improved scheme 24 hours a day during 365 day a year. They could obtain quality water, which can be used for drinking

307 What is the maximum amount of cents do you want to pay for one bucket of water you get from the improved source? Cents

308 If the maximum amount of money you would like to pay for the improved water service you will get from the improved service is ' zero' what is your reason for you do not want to pay?

- 1 Water should be provided free of charge 2 I satisfied with the existing source
3 I do not have enough money 4 I know the money will not be used properly
5 Other reason (specify) _____

General questions to be filled by all respondents

309 Generally, whom do you think responsible for the supply of improved water service for the town?

- 1 Government 2 Communities
3 Private sectors 4 Others (specify) _____

310 What do you recommend regarding the improved water supply for the town?

Thank you

ANNEX-II

Correlation matrix of explanatory variables

	BID	AWBD	VOLUME	RESPO	SAT	QUALI	RELI
BID	1.0000						
AWBD	-0.2415	1.0000					
VOLUME	-0.0311	0.1392	1.0000				
RESPO	-0.0153	-0.0442	-0.0613	1.0000			
SAT	0.0398	-0.1399	-0.0532	-0.0051	1.0000		
QUALI	0.0589	-0.4377	-0.2152	0.1015	0.3254	1.0000	
RELI	-0.0970	-0.1183	-0.0504	0.0359	0.6616	0.3011	1.0000
PRESS	-0.0509	-0.0767	-0.1561	0.0879	0.2375	0.1902	0.2581
TYPESOUR	0.0271	0.1736	0.2610	-0.0473	0.0920	0.0616	0.1238
HGENDER	-0.0765	0.1673	0.1851	-0.0630	-0.0051	-0.0740	0.0915
HHSIZ	0.0604	-0.0221	0.4103	-0.0386	0.0203	0.0027	-0.0801
HEDU	-0.2317	0.7118	0.2809	-0.0724	-0.1041	-0.4384	-0.0977
HAGE	0.1570	-0.3655	0.1175	-0.0271	0.1875	0.2970	0.2238
INCOME	0.1006	0.1038	0.3787	0.0312	-0.1056	-0.1438	-0.1634
HHCHILD3	-0.1154	0.1666	0.1351	0.0838	-0.1560	-0.2612	-0.1838

	PRESS	TYPESOUR	HGENDER	HHSIZ	HEDU	HAGE	INCOME
PRESS	1.0000						
TYPESOUR	0.0552	1.0000					
HGENDER	-0.0949	0.1951	1.0000				
HHSIZE	-0.1577	0.0219	0.1862	1.0000			
HEDUC	-0.2068	0.1951	0.2636	0.0427	1.0000		
HAGE	0.1258	0.1152	0.1131	0.2686	-0.2875	1.0000	
INCOME	-0.2623	0.1516	0.0949	0.2152	0.2794	-0.1061	1.0000
HHCHILD3	-0.1906	0.0605	0.0838	0.1330	0.2187	-0.2918	0.1745

	HHCHILD3
HHCHILD	1.0000

DECLARATION

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university, and that all sorts of materials used for this thesis have been duly acknowledged.

The examiners' comments have been dully incorporated.

Declared by:

Name: Mesfin Ketema

Signature: 

Date: 29 June 2010

Confirmed by Advisor:

Name: Tassew Woldehanna

Signature: 

Date: 25 June 2010

Place and Date of Submission Addis Ababa University