DETERMINANTS OF HOUSEHOLD PARTICIPATION IN WATER SOURCE MANAGEMENT: ACHEFER, AMHARA REGION, ETHIOPIA

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ABSTRACT

Access to safe drinking water supplies and sanitation services in Ethiopia are among the lowest in Sub-Saharan Africa. While governmental and non-governmental organizations have been implementing water supply and sanitation projects in recent years, many fail shortly after construction due improper management. In this study we examine socio-economic, institutional and exogenous factors which affect households' participation in the management of water sources. A survey was carried out involving 16 water supply systems and 160 households within Achefer area, in Amhara, Ethiopia. In addition, the water quality of eight water points was tested. The results show that households' demand for sustainable water services are positively affected by users' participation during the project design and implementation, advocacy provided by the project and greater household income. Thus, for drinking water systems to be sustainable these factors should be included in planning water supply projects.

BIOGRAPHICAL SKETCH

Aschalew Demeke Tigabu was born in Bahir Dar, Ethiopia to his father, Kindu Mersha Shenkorie, and his mother, Zeritu Yiradu Ayele, on February 23, 1982. He received his Bachelor of Science Degree from Alemaya University in Ethiopia at 22 years of age. After working in an agricultural college for about three years, he continued his studies in a Master's program offered to him by Cornell University. The enormous passion, hard work, and encouragement from his renowned professors have subsequently inspired him to continue further to his PhD… if God allows.

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ABBREVIATIONS

ADF	African Development Fund
CSA	Central Statistical Agency
DRA	Demand Responsive Approach
ETB	Ethiopian Birr
IWRM	Integrated Water Resource Management
MDGs	Millennium Development Goals
MoWRs	Ministry of Water Resources
ORDA	Organization for Rehabilitation and Development in Amhara
WAE	Water Aid Ethiopia
WASH	Water Supply Hygiene and Sanitation
WHO	World Health Organization
WTP	Willingness-to-pay
WUCs	Water use committees

CHAPTER ONE

INTRODUCTION

Despite many years of development efforts, access to safe water supplies and sanitation services in the world continues to be extremely marginal. Over 1.2 billion people worldwide (Klawitter and Qazzaz, 2005); the majorities living in developing nations, particularly in sub-Saharan Africa, still do not have access to clean water facilities (Prokopy, 2005). The national safe water coverage of Ethiopia is among the lowest in sub-Saharan Africa. As of 2004, the national coverage of Ethiopia was estimated at only 36.7%, with a rural coverage, 24.2 % and urban coverage about 82.5% (ADF, 2005).

As part of the solution to the lack of coverage, governmental, non-governmental, international and local organizations from all over the world have tried to promote safe water supply and sanitation programs for many years (Prokopy, 2005). However, these endeavors in most areas are constrained by a lack of sustainability[1] of the water supply infrastructures (Harvey and Reed, 2007; ADF, 2005; Lockwood, 2002, and Kleemeier, 2000). For instance, the recent figures of operational failure rates from individual African countries are indicated to be 30 to 60% (Sutton, 2005). The problem is even worse in Ethiopia, where it is quite a common phenomenon to observe non-functional water sources without adequate protection, such as fencing, in every part of the country. In the Oromiya region, for example, about 35% of the rural water systems are not properly functioning at this time (WAE, 2008). ADF (2005) predicts that by the end of 2015, about 26,300 hand-dug wells, and 18,900 protected springs will be developed in Ethiopia. If the current

[1] "Sustainability", within the context of this study, is defined as the length of the useful life of water supply infrastructures. More specifically, it is the capacity of the improved water supply sources in providing continued beneficial services over time.

trends are allowed to continue, a minimum of 15,820 rural water facilities will be completely non-functional which significantly lowers the effective coverage.

The administrative structures and institutional support levels to rural areas in most parts of the world are often too weak to address advocacy, encourage citizen engagement, and facilitate finance and management initiatives for the community. Consequently, water sources become non-functional after a few years of functional service (Lockwood, 2002). As a result of this, some scholars have given emphasis to addressing institutional and administrative issues, along with community water education initiatives, to enhance the sustainability of water supply sources (Bhandari *et al*., 2007). Gleitsmann (2005) suggested that sustainability of water supply systems is dependent upon the degree to which the technology corresponds to the needs of the users and the users' ability and willingness to maintain and protect it over time. According to Harvey and Reed (2006), low sustainability rates are related to community issues such as limited demand, perceived lack of ownership, limited community education, and limited sustainability of community management structures, such as water use committees (WUCs). Besides, water supply projects have been strongly criticized for their planning approaches, which have focused excessively on physical construction and increasing coverage targets, but largely ignored what happens at the water sources after construction (Lockwood, 2002). For the last few decades, literature in the water supply sector has shown that sustainability of rural water supply structures has become positively associated with small-scale initiatives, which maintain public participation. Thus, the key to sustainability is to meaningfully involve the users in the planning, implementation, operation, protection and maintenance of water supply systems according to their needs and potentials (Davis and Liyer, 2002).

A focal issue in the water supply and sanitation sector in developing countries is gauging the willingness of individuals to manage their water sources through the contribution of time and resources (Schouten and Moriarty, 2003). The rationale is that contributing more time and resources to the protection and maintenance of rural water supply sources is a positive action that may potentially improve the sustainability of water supply infrastructures (Gleitsmann, 2005; Whittington, 1998). Harvey and Reed (2006) strongly argue that community involvement, even at the lower intensities of participation, is a “perquisite for sustainability”. The participation of communities based on their willingness to contribute increases effectiveness, efficiency, empowerment, equity, coverage and the overall sustainability of water supply projects (Narayan, 1995). Similar findings were presented by Sara and Katz (1998), Gross *et al*. (2001) and Kumar (2002), particularly mentioning that a demand-responsive approach (DRA) significantly increases the sustainability of water supply projects.

Community members’ contributions might take the form of money, labor, material, equipment, or participation in project-related decision-making and meetings (Bhandari *et al*., 2007; Mengesha *et al*., 2002). Moreover, Harvey and Reed (2007) described forms of contribution such as the expression of demand for water, selection of the technology and area, financial contributions, provision of labor and materials, and selection of management systems. Lyer *et al*. (2006) explained that about 98% of World Bank-supported Rural Water and Sanitation projects have included some cash contributions from user communities during the period from 1977 to 2003.

Furthermore, the authors indicated that 86% of the projects incorporated labor requirements and 78% advocated material contributions, such as wood, while 100% of the World Bank projects expected operation and maintenance costs to be fully covered by the users. Willingness-to-pay (WTP) in cash, materials, labor, and upkeep can be taken as a useful indicator of the demand for improved and sustained water services (Bhandari and Grant, 2007; Mbata, 2006; Whittington, 1992). According to Mbata (2006), if people are willing to pay for a specific service, then it is possible to conclude that they value the service. Likewise, if households are willing to contribute cash and labor useful for the management of water sources, it is clear that the service that they obtain from a source is valued; and, that they have a positive attitude towards promoting its sustainability.

Bohm *et al*. (1993) indicated that WTP for improved water services increases along with increases in wealth, family size, and the educational level of user households. An analysis made by Bhandari *et al.* (2007) also showed that WTP for water is highly correlated with source reliability, trustworthiness of WUCs, convenience of location, and water quality; on the other hand, there is no significant relationship between the gender, age or economic status of respondents.

Ultimately, improved planning procedures which fully consider the value and demand placed on different levels of service by the community are a necessity for the sustainability of rural water systems (Whittington *et al.*, 1992; Mbata, 2006). However, in spite of the ever-increasing importance placed on the role of participation in development efforts, there have been few quantitative studies to demonstrate the proposition that participation measurably increases development outcomes (Prokopy, 2005).

1.1. Background and Justification

Ethiopia has abundant water resources. It is estimated that per capita renewable fresh water resources total 1,924 m^3 $year^{-1}$. The exact groundwater potential of the country is unknown, but it has been estimated to be approximately 2.6 billion m^3 (ADF, 2005). Despite this abundance, many Ethiopian people have suffered from a lack of access to safe drinking water for centuries. The majority of drinking water sources in rural Ethiopia are still rivers, streams, hand-dug wells, and intermittent springs, none of which are protected from flooding or livestock, wildlife, and human contamination. As open-air defecation continues to be a culturally and socially accepted practice in nearly all rural and semi-urban areas, solid and liquid wastes accumulate at drainage gullies and along riversides, dangerously affecting the quality of the drinking water. Poor households have limited awareness of water quality concerns and often neither consider nor utilize treatment options when using water from these unprotected sources. Partly as a consequence of poor sanitation practices and consumption of contaminated water, over 100 out of 1000 live births die within the first five years of age (WAE, 2008). It is estimated that a large percentage of cases of morbidity and mortality in 70% of rural areas are attributable to inadequate water supply and water and fecal contamination. Consequently, the life expectancy in Ethiopia has declined to the lowest of all nations in the world; currently, bellow 45 years of age (ADF, 2005). Health conditions of people directly affect the socio-economic affairs of individual households (Minten *et al*., 2002). This clearly shows that lack of access to safe water supply has implications far beyond the expected individual health concerns, potentially affecting all sustainable development endeavors.

Although the Ministry of Water Resources (MoWRs), along with the support of many international and local organizations, is actively involved at the grassroots level to improve the situation, clean water supply coverage is still in its infancy in many parts of this country, particularly in rural areas, where 84% of the population lives (ADF, 2005). The ongoing efforts, which are measured based on the performance in achieving short term objectives need to be re-engineered to raise their output by 2000% to meet the water and sanitation Millennium Development Goals (MDGs) by 2015 (WAE, 2008).

If improved water sources[2] exist, they are often far from the majority of user households and are located at inconvenient locations. The topography of Ethiopia is characterized by rugged terrain, and women often are forced to travel long distances, requiring several hours round-trip, walking up and down steep inclines while carrying large containers full of water on their backs. These containers with full water can weigh up to 65 kilograms. The duration of waiting time at the water sources to collect water is also overly lengthy (Mengesha *et al*., 2002). A study carried out in 1997 showed that over one-third of women in some of the Woredas (counties) spent more than two hours for each water collection trip (ADF, 2005). This fact is aggravated by the poor supply efficiency, resulting from disrepair, which cannot satisfy the entire populations from different villages sharing the same water source (Mengesha *et al*., 2002). This will ultimately lead to household water insecurity (less water available than is needed for drinking, cooking, and sanitation) in rural areas, especially for those households for which the demand is higher due to large family size (Collick, 2008). Because of these conditions, personal hygiene and

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[2] Improved water sources are water sources including protected springs and manual pumps formally developed for domestic water uses of rural households.

sanitation are poor within many households, since priority for water use is given to drinking and cooking purposes. In extreme cases, rural communities are forced to use nearby alternative water sources[3] such as rivers, unprotected springs, and hand-dug wells for washing clothes and even for cooking and drinking purposes.

Development of rural water supply schemes remains too costly for poor countries relative to their available resources (Lockwood, 2002; Biswas, 2005). The failure of many water sources developed through large scale projects or investments is the worst case scenario (Kleemeier, 2000). Kleemeier (2005) further indicated that as many as one out of four rural water facilities are broken down or poorly functioning in developing countries and the construction of new systems can not even keep pace with the failure of the old ones in some countries. One of the major challenges in the rural water supply efforts in developing countries is to ensure that the systems are adequate for community water use, and that communities manage their water sources in a sustainable manner.

If communities are to be considered as the managers of their water supply sources, then we should know what attitudes and potentials they have, and how they should be organized and supported. Since adequate protection and routine maintenance enhance the sustainability of water supply systems, and improve the quality of the water from the sources (Ainsworth and Jehn, 2005), an important question to be addressed in the community is, what factors prevent households from achieving this? Whereas criticism over the policy of requiring capital cost contributions for water from poor communities is

[3] Alternative water sources are possible sources of water for rural community in an area such as rivers which are different from those constructed or improved to serve for household purposes.

emerging (Schouten and Moriarty, 2003), it is crucial to know whether this initial participation has any positive or negative implications on future outcomes (i.e., sustainability of the water supply infrastructures).

In past years, the focus often has been on technological and institutional aspects of water supply systems. User communities in developing countries have rarely been a focus of research to understand how they benefit from such development programs. Despite stated intentions of social inclusion, it has become clear that many participatory development initiatives do not deal well with the complexity of community differences, including age, income, education level, and other social issues (Godfrey and Obika, 2004; Schouten and Moriarty, 2003).

The purpose of this study is to assess household water use practices, household-level determinants of water use, communities' attitudes towards water safety, and the benefits of safe local water supply, the status of selected rural water supply structures, institutional approaches followed to enhance the sustainability of water facilities, and community contributions for water source protection and maintenance, and its determinants. Understanding these aspects of rural water supply systems and generating useful knowledge base can give an insight into developing a useful strategy that can potentially address large scale non-sustainability of newly installed water facilities in developing countries, including Ethiopia. The study was carried out in Amhara region in Ethiopia, where Organization for Rehabilitation and Development in Amhara (ORDA), funded by Water Aid Ethiopia (WAE), is implementing a joint pilot project of Water Supply, Hygiene and Sanitation (WASH) and Integrated Water Resource Management (IWRM). Surveys were carried out in 14 villages concerning household water use practices and community members' current roles and willingness to protect and maintain their water sources in an attempt to capture the determinants of demand for sustainable water services in the area.

CHAPTER TWO
MATERIALS AND METHODS

2.1. The Study Area

The Democratic Republic of Ethiopia is a land-locked nation located in the Horn of Africa covering an area of 1.1 million km^2. It is one of the poorest countries in the world with a population of 83 million in 2008 being the second most populous in Africa. The nation's economy is mainly dependent on rain-fed agriculture, which accounts for half the GDP, 60% of exports and 80% of employment (WAE, 2008). It has nine National Regional States and two Special City Administrations: Addis Ababa and Dire Dawa. Achefer with an area of 2,500 km^2 is situated 560 km north of Ethiopia's capital city, Addis Ababa in Amhara National Regional State, and the study area within Achefer has geographical boundaries between 11^o 00' 40" to 11^o 38' 00" North and 36^o 48' 00" to 37^o 01' 35" East. It is part of the West Gojam Zone which is bordered (shown in Figure 1) on the south by Agew Awi, on the west by North Gondar, on the north by Lake Tana, on the north-east by Bahir Dar Zuria and on the south-east by Merawi. The Gilgel Abay River defines the area's eastern boundary. According to the Central Statistical Agency (2005), Achefer has an estimated total population of 326,000, including 161,000 males and 165,000 females, and an estimated population density of 130 people per square kilometer. Only 25,000 of its population (7.7%) are urban dwellers. Over the past few years, the Organization for Rehabilitation and Development in Amhara (ORDA) has been constructing a number of rural water supply sources in this area through a community-based approach with a goal of improving the health status and the livelihood of rural communities. Even doing so, the water supply coverage remains only 6.6% in the rural areas.

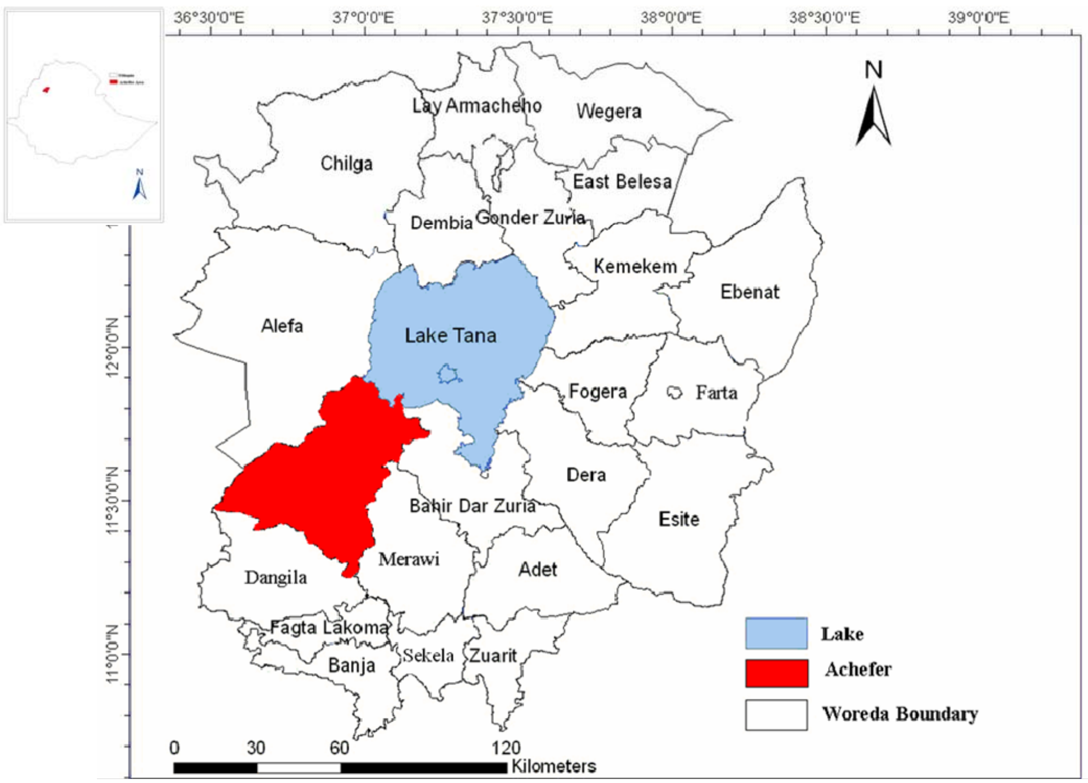

Figure 1: Map of the study area and adjacent Woredas of the Lake Tana sub-basin

2.2. Research Methods

2.2.1. Data Collection

From July to November, 2008, a cross-sectional descriptive research design complemented by interviews of households and observation surveys of water sources was conducted in communities where water sources exist. A total of 75 water sources exist in the Achefer, which constituted the sampling frame from which 16 water sources were selected randomly. The villages in closest proximity to improved water sources were identified, and 10 household respondents who reside in each village were randomly selected for the survey. The main criteria for the selection of the villages was simply the existence of a water source developed by ORDA, and the main criteria for selection of sample respondents was that they were residents of these villages. Respondents were randomly selected from the list of residents from each village obtained from ORDA project implementation office at Ismalah. The total sample size was 160. The household was considered as a unit of analysis because water supply issues were concerns of the entire household. Secondary data, such as project approaches to enhance sustainability of water sources and number of beneficiary households were obtained from the project office of ORDA. In order to achieve the objectives of the study, a pre-tested semi-structured questionnaire was administered to the sample households. The survey questions were carefully translated in to the local language (Amharic) prior to the pre-testing process. This helped to convey the questions effectively to the rural interviewees. The questionnaire (see Appendix A) had six major parts:

1) Part 1 covered detailed information on household’s access to education about water supply issues.
2) Part 2 evaluated elements viewed as perceived barriers, which were hypothesized to hinder households from protecting water sources. There were also several other questions in this category included in different sections of the questionnaire to maintain the logical flow of the questions.
3) Part 3 covered household water use practices.
4) Part 4 collected data about the household’s attitude towards water safety, which was compared with the technical quality of the water from the sources as analyzed by a laboratory.

5) Part 5 requested information concerning cash and labor contributions households willingly made during the previous three months for water source protection and maintenance.
6) Part 6 focused on demographic and socio-economic characteristics of the respondents. The head of the household was responsible for responding on all parts of the survey, except the third part, which was the responsibility of the head female of the household.

Because all parts other than part 3 were mainly incorporated to understand the determinants of household contributions, which involved household’s decisions; and given that household heads often make the majority decisions pertaining their household issues in the study area, it was reasonable and appropriate that the household heads were involved in responding these parts. It was also reasonable that part 3, which was concerned about household water use practices, was covered by the head women since women are more involved in household water management issues in the study villages.

In order to achieve the proper characterization of selected water supply structures, careful observation was conducted using structured checklists (Appendix B) to record the type, status, functionality, level of protection and neatness of water sources.

Water quality testing including conductivity, and levels of pH, nitrate, nitrite, fluoride and total coliform count was performed for eight (four pumps and four protected springs) randomly selected sample water supply sources. This process helped to examine the technical safety of water from the sample sources and to compare it with households’ perceptions about the safety of water from these sources.

2.2.2. Model Specification and Analysis

Analysis of community participation and its determinants in water source protection and maintenance is one of the major objectives of this study. The contributions of cash (CASHCONT) and contributions of labor (LABORCONT), which were willingly provided by the users during the last three months for the protection and maintenance of water sources can be taken as major dependent variables to understand the role of users in the protection and maintenance of their water sources and the socio-economic and other determinants of this role.

Independent variables were identified based on published literature and the actual conditions in the area useful to explain the variations in the dependent variables across households. An increase in the household socio-economic and demographic variables, such as age of the household head (HEADAGE) and his or her educational level (HEADEDLVL), household income (INCOME), household head gender (HEADGENDER): female=1, 0 otherwise, and household size (HHSIZE) were hypothesized to affect the dependent variables positively. Other exogenous factors, like sense of responsibility to protect and maintain water source (SENORES), number of alternative water sources existing in close proximity (NOALWS), convenience of location of the water source to the household (CONOL), and incidence of waterborne diseases in the household during the last year (INOWBDs), were included to evaluate the impact of increasing or decreasing the participation by the households towards the protection and maintenance of their water supply sources. Furthermore, the frequency of using water from the source for generating some income to the household, such as for vegetable production (UOWFSGI), the level of advocacy provided by local health promoters

(ADVOCACY), and the degree of household participation during the project implementation (DPARDPIMP) should influence the dependent variables positively. In contrast, the perceived safety of water from the source (PSOWS) and household daily water satisfaction (WASATS) were expected to affect the dependent variables negatively.

The relationship between the dependent and independent variables in this case could be best represented by censored linear regression. A linear model was selected because it allowed analysis of the link between participation in water source protection and maintenance (i.e., contributions) and the corresponding factors, which could affect these outcomes. This assumed that the values of contributions were continuous dependent variables. The dependent variables could also be censored, because there was a lower limit of zero applicable when households did not actually contribute anything within the previous three months. Quite often, rural people perceive water as a free of cost commodity and consider it a luxury. For example, low-income households may not spend any money for water source protection and maintenance. This situation where the distributions of observations becomes censored as the observed values are close or equal to zero can be analyzed using the Tobit model (named after Tobin who proposed it in 1958; Greene, 2002; Marin-Galiano and Kunert, 2005). Formally, the Tobit model can be represented as follows:

$$y_i^* = \beta x'_i + e_i \quad (1)$$

where y_i^* is the latent variable which fulfills the characteristics of the linear model, β is the unknown vector parameter to be estimated, x_i are a vector of independent variables, and the e_i are continuous random variables, which are assumed to be independently and normally distributed about the mean zero and a common unknown variance of σ^2. If the observed dependent variable is denoted by y_i, then a Tobit model, for observations y_i, $i=1, 2\ldots n$ can be represented by one of the following.

$$y_i = 0 \qquad \text{if } y_i^* \leq 0 \qquad (2a)$$

$$y_i = \beta x'_i + e_i \qquad \text{if } y_i^* > 0 \qquad (2b)$$

Based on the above specifications, the unknown parameters can be estimated by maximizing the corresponding likelihood function.

$$L(\beta, \sigma^2) = \prod_{y_i=0}\left(1 - \Phi\left(\frac{\beta x'_i}{\sigma}\right)\right) \cdot \prod_{y_i>0}\frac{1}{\sigma}\phi\left(\frac{y_i - \beta x'_i}{\sigma}\right) \qquad (3)$$

Where Φ and Φ are the standard normal density function and distribution function, respectively.

The values of coefficients of a Tobit model do not directly correspond to the changes on the dependent variable as a result of a unit change of the independent variables. Rather, the model estimates a vector of normalized coefficients which can be transformed into the vector of first derivatives. The marginal effect of the explanatory variables on the observed values of the dependent variable given the above specifications represents the expected value of y_i conditional on y_i being greater than zero. The marginal effect of a standard case, censoring at zero and normally distributed disturbances, estimated at the means of the independent variables is represented as the following:

$$\partial E\left[\frac{y_i \mid x_i}{\partial x_i}\right] = \beta \cdot \Phi\left(\frac{\beta' x_i}{\sigma}\right) \qquad (4)$$

where Φ represents the cumulative standard normal distribution.

Because the results of this study are of interest for policy recommendations, the marginal effect on the observed values of the dependent variables due to a 1% change given on the independent variables is a valuable result of the Tobit analysis.

Analysis of household-level determinants of water use is another objective of this work. To achieve this, the total household water use per day at household level and per capita water use per day at an individual level were taken as dependent variables. It was obvious that a household with one or more individuals would inevitably be using some amount of water per day for various household purposes. Hence, total household water use per day at household level and the per capita water use per day at an individual level were all different from zero. However, they varied across households. The variations were hypothesized to occur due to other factors such as household size (HHSIZE), average waiting time at the source (WAITINGTIME), and Convenience of location of the water source with relative to households (i. e., the distance of the water source from individual households, its geographical location and physical accessibility) (CONOL) or alternatively, the average estimated distance of the water source from a household (DISTANCE). Thus, this relationship between the dependent and the independent variables in this case could be best represented by linear regression model.

The survey data were recorded and organized in a Microsoft Excel spreadsheet. The data encoding procedure was carried out strictly based on the survey questionnaire. A combination of double-entry and print-and-verify methods of data entry checking was performed to avoid errors in the recording process. Data consistency checking was also performed by considering the frequency distribution of household age, educational and gender parameters evaluated against the recent national comparative socio-economic indicators. The minimum and maximum limits of contributions, income and livestock holding values were also examined. In addition, the total time spent at the sources by the households per day and water uses versus household size were also checked, if they were reasonably reported by respondents. The results confirmed that the majority of information provided by the respondents was consistent.

Qualitative analysis was employed to characterize water supply structures, to compile household water use practices, and to summarize socio-economic information. STATA/SE 10.0 for Windows (StataCorp LP, College Station, Texas USA) software was used for data processing.

CHAPTER THREE

RESULTS AND DISCUSSION

3.1. Household Socio-economic Characteristics

Table 1 summarizes some basic descriptive statistics of gender, age and educational characteristics of the households surveyed. Children account for 65% the household members. The table also shows that 51% of the household members are below 15 years of age. Females constitute 51% of the total household members, but they only constitute 9% among the total household heads.

Table 1: Household gender, age and educational characteristics

Characteristics	Obs.	Percent
Household Member type[4]		
Household head	160	18
Spouse of the household head	146	17
Child	575	65
Total	881	100
Household Member Gender		
Male	432	49
Female	449	51
Total	881	100
Household Member age		
1-15 years	451	51
16-30 years	231	26
31-45 years	120	14
46 years and above	79	9
Total	881	100
Household Member Educational level		
Illiterate	557	63
Read and write	251	29
Elementary complete	37	4
Junior complete	27	3
High school complete and above	9	1
Total	881	100

[4] Demographic data about household members other than specified in the table, such as relatives and laborers in a household were not collected by the survey in this study.

Educational levels are low across households. Around 63% of the household members are illiterate and only 1% have attained formal education up to high school and above. Over 64 % of the household heads can not read and write. These characteristics are consistent with the report by the Federal Democratic Republic of Ethiopia Population Census Commission (CSA, 2008).

The mean household size is about six persons. Nearly all of the households make a living out of subsistence agriculture and animal farming. The mean non-agricultural income of households and the average value of total crops harvested by households are 154 ETB per year and 14,047 ETB per year, respectively (see Table 2). Thus, households have gained an average annual value of cash and non-cash total income of 14,200 ETB per year, or per capita income, 2,705 ETB per year. The total value of livestock holdings range from 0 ETB to 26,400 ETB across households, with a mean and standard deviation of 8,406 ETB and 5,650 ETB, respectively.

Table 2: Income and livestock holding of households

	Obs	Minimum	Maximum	Mean	Std. Deviation
Total annual non-agricultural income, ETB per year	160	0.0	10,000.0	153.6	839.1
Total value of crop harvested, ETB per year	160	900.0	45,340.0	14,046.7	8,102.7
Total income, ETB per year	160	900.0	45,340.0	14,200.3	8,043.1
Total value of livestock holding, ETB	160	0.0	26,400.0	8,406.3	5,649.9

3.2. Household Water Use Practices

Over 66% of the surveyed households depend entirely on the improved sources developed by ORDA to provide water for household purposes, stating that they do not have alternative sources in their proximity. Less than 30% report that they have one or two additional alternatives in their vicinity. The considerable labor involved in water collection is almost exclusively done by women and children. Only 6 % of the husbands are responsible for collecting water. This clearly shows that gender plays a significant role in domestic water management. Households report that individuals responsible for fetching water, mostly women, travel to the water sources on average three times a day to collect water. ADF (2005) indicated that women in rural areas often travel long distances to collect water, accounting for two to six hours per day. The report further states that this exposes women to "all sorts of hazards". As the amount of time spent on water collection increases, women's involvement in other economically beneficial activities significantly decreases. For the majority of the villages, rules are enforced by the WUCs that limit the quantity of water allocated for each household per day based on the household size. All the households use jerry cans to collect water; these cans typically hold 20 liters. Children also use smaller jerry cans, up to 10 liters. The customary use of clay-pots to collect water have gradually been replaced by jerry cans as a result of intensive educational efforts by health extension workers and ORDA staff with the intention of reducing the occurrence of water contamination from point-of-collection to storage and household-use. The magnitude and impact of this kind of water contamination is unknown in the area, and calls for further investigation to be better understood.

About 79 % of the respondents indicate that they are 'satisfied' or 'highly satisfied' by the water which is available to their household, in spite of the relatively large distances and long waiting times reported. The mean estimated distance to the water sources is reported to be 433 meters far from the households (Table 3). The result also shows that households use an average of 62.4 liters a day for household chores (drinking, cooking, and washing hands and dishes). The average water consumption per person per day is thus 12 liters.

Table 3: Daily water consumption, estimated distance of the sources from households and estimated average waiting time at the sources

	Obs	Min.	Max.	Mean	Std. Dev.
Frequency of water collection, travels/day	160	1.0	10.0	3.1	1.5
Amount of water collected by households, liters/day	160	20.0	200.0	62.4	28.5
Per capita daily water consumption, liters	160	2.5	50.0	12.1	6.3
Estimated distance of the sources from households, meters	160	25.0	2,000.0	432.8	381.7
Estimated average waiting time at the sources, minutes	160	0.0	120.0	24.7	23.1

This figure is significantly lower than the WHO guidelines, which state that the per capita water consumption should be at least 20 liters per day (Mengesha *et al*., 2002; Minten *et al*., 2002; and Collick, 2008). The waiting time at the sources varies from 0 to 120 minutes, with a mean duration of 25 minutes and standard deviation of 23 minutes. The majority of the respondents explain that waiting time is higher for hand-pumps than the protected springs, due to the single get-valve and the requirement of labor and time to pump water. They also state that the time required increases significantly during the dry season. Many of the improved water sources dry up between December and May, forcing women and children to travel longer distances in search of water from unprotected sources.

A regression was run to examine the household-level determinants of water use such as, convenience of location, family size and waiting time at the water source (see Table 4).The result suggests that wealthier families use more water per day and the amount of water collected by households is positively correlated to family size, and waiting time at the water source has a negative impact on water use. It also shows that that convenience of location of the water source is also a significant determinant of water use at household level. This means that those households located nearer to the water source are likely to use water more than others located farther away.

Table 4: Determinants of total household water use per day at household level

Determinants	Unit	Coef.	Std. Err.	t	P>t
HHSIZE	Numbers	5.43*	1.17	4.64	**0.00**
INCOME	1000 ETB per year	1.00	0.49	2.03	**0.04**
CONOL	Index: 1 to 5	6.05*	1.78	3.40	**0.00**
WAITINGTIME	Minutes	-0.17	0.09	-1.94	**0.05**
Constant		8.85	8.64	1.02	0.31
Number of obs.	160				
R^2	0.31				
Adj. R^2	0.29				
Root MSE	24.01				

*Significant at 0.01 level

A second regression was run for per capita water use (Table 5) and it shows that if a household has one member, and is located at zero distance from the source and there is no waiting time at the water source, then the per capita water consumption will be about 21.6 liters per day, which is above the

WHO limit. If a household has the six family members, is located 0.43 kilometers away from the water source, and the waiting time at source is 25 minutes (note that this figures are the average values in the area), then the per capita water consumption is reduced to about 11.6 liters per day. It is clearly observed that the per capita water use is negatively and significantly determined by the distance of water source from household (i.e., keeping other factors constant, as the distance of a water source from the household increases by a kilometer, the per capita water use significantly decreases by 6.2 liters). This implies that water facilities should be as accessible as possible to all segments of the population to better satisfy daily water requirements of individual residents. This also reduces children's and women's burden of work and saves time spent for collecting water. The time saved may allow children to properly attend school, and women to be engaged in other productive activities that lead to better living standards of households (ADF, 2005).

A further investigation of the data shows that as the household size increases, the amount of water used per person per day significantly decreases (Table 5). This suggests that, although larger households increase the frequency of travel per day to the water sources as (see Figure 2), they still are not able to increase the available water at the household enough to satisfy the daily requirements of their individual household members. It also means that some household water use is relatively fixed with household size. The significant decrease in the per capita daily water use because of additional household members might be explained by the fact that the available water at a household level is limited by factors, such as distance and waiting time at the water source. Thus, additional members share this limited amount, clearly reducing the per capita water use.

Table 5: Determinants of daily per capita water use

Determinants	Units	Coef.	Std. Err.	t	P>t
HHSIZE	Numbers	-1.40*	0.24	-5.89	**0.00**
WAITINGTIME	Minutes	-0.02	0.02	-1.09	0.277
DISTANCE	Kilometers	-6.21*	0.1.13	-5.47	**0.00**
Constant		23.03	1.48	15.58	0.00
Number of obs.	160				
R^2	0.32				
Adj. R^2	0.30				
Root MSE	5.25				

*Significant at 0.01 level

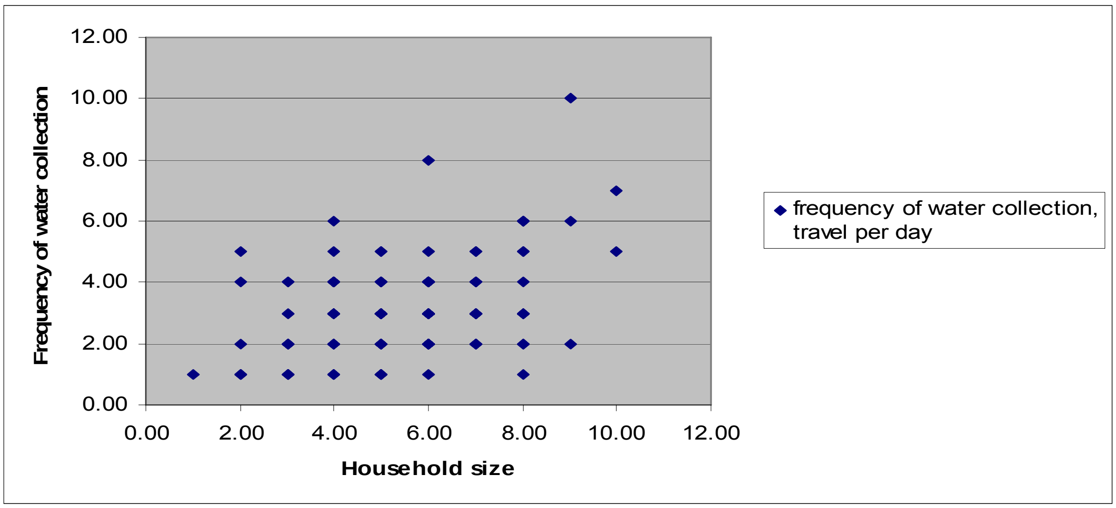

Figure 2: Frequency of water collection vs. household size

3.3. Use of Water from the Sources for Livestock Watering and Micro-scale Irrigation

While the fundamental priority of water use from the improved water sources is for human consumption, at many of the protected springs, the taps are used not only for domestic water needs. Cattle troughs are constructed as well for animal watering. The best example is Gudri, a water source designed considering the needs for the rural livelihoods in addition to the domestic water demands by the households. The natural water sources in the area, such as rivers, are seasonal and livestock do not have adequate water access during the dry season. Hence, households use the cattle troughs at water sources to water their livestock.

Very recently, attempts have also been made to link water supply to income-generating activities such as in horticultural development. This effort is observed only at one water source named Luhudi located in Kuala Baka village. This water source supplies adequate drinking water to 40 households. In addition, it provides ~ $0.04 m^3 sec^{-1}$ water for micro-scale irrigation to a number of households in the near by village. These households benefit from the additional water by growing fruits and vegetables. The WUCs in the village have enforced regulations that require households using water for irrigation to safeguard the water source by turns. Thus, that the additional benefits involve additional responsibility, which address the equity of water access, as a number of other households do not have water access for irrigation. In addition, the WUCs had set strict regulations of water collection timing and water use turns for irrigation. For instance, the water source is closed from 8:00 AM in the morning to 5:00 PM in the afternoon so that no one is allowed to collect water during this period every day. The water running out of the full storage-tank through the release valve is directed by gravity to an irrigation channel which is about 350 meters long and runs towards the village located downhill.

Literature on rural water supply shows that water supplies can potentially be built to provide a range of services beyond the domestic supply as noted above. These are usually termed as "multiple-use water supply systems". Multiple-use water supply services are intended to meet the domestic and productive demands of the poor in more comprehensive manner. If appropriately planned, designed and managed, they have a much greater potential to reduce poverty, to lesson health hazards and to circumvent livelihood vulnerability of rural households. They can also facilitate gender equity, cost recovery, and hence sustainability of the water facilities (Fontein, 2007).

Clearly, efforts are underway in the villages to promote integrated water resource management that focuses on sustainable water resource development and efficient use of water on an equitable basis. This underscores an increasing recognition of water as economic and social good, which, in part, is behind the current moves toward more proficient use through integrated management between competing demands and livelihoods. Because these efforts are carried out at different levels in the observed water facilities, water for multiple-uses seems to depend on the capacity (quantity) of water supply and geographical location of the water sources.

3.4. Households' Attitude towards Water Quality

Households' perceptions about water quality indicate that knowledge about quality is somewhat limited. About 38% of the participants mention that 'clean water' is water free from harmful pathogens and chemical toxicity, whereas 41% of the respondents report that 'clarity to the eyes' is the sole indicator of safety. Twelve percent and 8%, respectively, explain that 'test and odor' and 'being piped' are indicators of water quality. Accordingly, 59% of the respondents believe that the water from their source is 'safe' or 'highly safe' for them for all household purposes. Respondents who believe that the water from their source is not safe mention that the cause is flood waters entering into the tank (31%), which suggests that environmental mitigation such as flood protection, drainage canals and catchments rehabilitation are underlying concerns of the households. About 8% believe that the cause of poor quality is livestock contamination, indicating that well-built fencing and full-time caretaking are required. About 16% report that there have been one or two incidences of waterborne diseases during the last 12 months within their individual household. A significant number of respondents believe that the incidence of illness has significantly decreased after the construction of the water sources.

To compare the safety perceptions of the households towards water from their sources to its scientific quality, and to examine the technical quality of water from the sources, a laboratory testing was carried out on selected drinking water quality parameters. The results depict that important elements for chemical quality of water from all the sample sources are under the World Health Organization (WHO) guideline values. However, the bacteriological results show that four sources have 4, 5, 6 and 8 total coliform colonies per 100 milliliters (see Table 6) exceeding the WHO standards, which do not allow any fecal or total colonies in drinking water. The results indicate that rural households in the study area have fair knowledge, judgment and water quality perceptions of improved water supply sources.

The majority of respondents store collected water in a big jar made of clay which is washed and smoked beforehand. Only 3% of the households boil water as a treatment. A significant percentage of households believe that adequate protection of the water sources improves the quality of the water from the sources.

Table 6: Chemical and bacteriological quality of water from sample water sources

	pH	Conductivity, µs/cm	Nitrate, mg/l	Nitrite, mg/l	Fluoride, mg/l	Total coliforms, colonies/100 ml
WHO guideline value	6.5 to 8.5	<4000	50 (as NO_3)	3 (as NO_2)	1.5	0
Water sources						
Gist-2	6.89	314	0.25	0.007	0.2	0
Aba Adera	6.78	292	1.2	0.009	0.25	6*
Biret Minch	6.73	216	0.2	0.006	0.25	8*
Addis Alem	7.14	300	0.21	0.082	0.3	5*
Gudri	6.12*	153	0.6	0.004	0.2	0
Buakbuakit	6.98	359	0.2	0.009	0.3	0
Shulet-1	5.56*	93.4	0.2	0.001	0.1	0
Aba Kulkual	7.53	293	0.27	0.009	0.5	4*

*Beyond WHO threshold

3.5. Water Supply Sources, Characterization and their Current Status Quo

Table 7 presents characteristics of the sample water sources observed. The oldest water source was constructed in 2004, whereas the rest have been developed since that time. The minimum number of user households from a single water source is 35 while the maximum is 450, with an average of 85 households per water source. Villagers contributed an average of 1,073.4 ETB per water source or 12.4 ETB per household, before installation, which is still deposited in Amhara Credit and Saving Institution (ACSI), as part of the community contributions to the capital investment cost. Half of the water sources observed are protected springs, while the rest are hand-dug wells (with hand-pumps). About 44% of the water sources are found to be functioning with 'some breakage problems', while 56% are 'well-functioning' with out any disrepair. Complete non-functionality is not observed in any of the observed water sources. Among those functioning with some technical breakdowns, 86% exhibit disrepairs of the faucets and valves, letting water run continuously from the taps. Hand pumps with some technical disrepair have mostly shown mechanical problems. The pumping rates of some of the hand-pumps were measured. For instance, Sunduda and Gist-2 draw about 9.5 liters of water per minute and 11.5 liters of water per minute, respectively. Both figures are lower than the WHO's established acceptable limit, which is 13 liters of water per minute for rural water sources (Gleitsmann, 2005). Among the water sources studied, 75% of them are 'somewhat protected', whereas the rest have been 'well-protected'. The neatness of the areas surrounding the sources was also carefully observed because it may have an impact on the quality of the water.

The result shows that 75% of the water sources are 'not neat at all', as demonstrated by poor drainage and water stagnation, bad smell, and in some of the sources by the presence of livestock waste. Three-fourths of the water sources have functional guards. Catchments rehabilitation with the aim of increasing ground water recharge is done around the surroundings of 44% of the water sources. Additionally, 38% have animal troughs, 50% have clothes washing stands and 38% have communal shower rooms constructed along the water supply facilities in an attempt to make the most of community services.

Table 7: Type, functionality, level of protection and surrounding neatness of observed water sources

Name of village	Name of water source	Type of water source	Year of construction	Households' contribution to capital investment cost, ETB	Number of beneficiary households	Functionality of water source	Main disrepairs	Level of protection	Neatness of the surrounding
Adamna	Biret Minch	Protected spring	2007	450	45	Well functioning	No disrepairs	Fairly protected	Not neat at all
Mezemir	Buakbuakit	Hand-dug well	2008	500	45	Well functioning	No disrepairs	Fairly protected	Not neat at all
Skut	Shillanga	Protected spring	2006	1000	112	Functioning with some breakage problems	Disrepairs of the faucets and valves	Well protected	Not neat at all
Shulet	Shulet-1	Hand-dug well	2004	230	81	Well functioning	No disrepairs	Well protected	Very neat
Mehal Ambeshen	Addis Alem	Hand-dug well	2008	300	70	Well functioning	No disrepairs	Fairly protected	Somewhat neat
Mehal Gist	Gist-2	Hand-dug well	2006	550	82	Well functioning	No disrepairs	Fairly protected	Somewhat neat
Kuala Baka	Luhudi	Protected spring	2007	1000	40	Well functioning	No disrepairs	Well protected	Not neat at all
Degbassa	Aba Kulkual	Protected spring	2007	1000	175	Functioning with some breakage problems	Disrepairs of the faucets and valves	Fairly protected	Not neat at all
Markie	Aba Adera	Protected spring	2008	360	58	Functioning with some breakage problems	Disrepairs of the faucets	Fairly protected	Not neat at all
Geberie Mender	Barka Awzi	Hand-dug well	2006	600	95	Well functioning	No disrepairs	Well protected	Somewhat neat
Shulet	Shulet-2	Hand-dug well	2006	3500	110	Well functioning	No disrepairs	Fairly protected	Not neat at all
Sunduda	Sunduda	Hand-dug well	2006	3000	120	Functioning with some breakage problems	Unknown	Well protected	Not neat at all
Gudri	Gudri	Protected spring	2006	3000	120	Functioning with some breakage problems	Disrepairs of the faucets and valves	Fairly protected	Not neat at all
Adamna	Adamna-1	Protected spring	2005	85	85	Functioning with some breakage problems	Disrepairs of the faucets and valves	Fairly protected	Not neat at all
Jugdana	Mukti	Protected spring	2007	1000	89	Functioning with some breakage problems	Disrepairs of the faucets and valves	Fairly protected	Not neat at all
Azanoch	Minchit	Hand-dug well	2008	600	35	Well functioning	No disrepairs	Fairly protected	Not neat at all

As indicated above, the majority of the protected springs have additional facilities, whereas none of the hand-pumps observed have any of these services. Because of this, and also partly due to low level of system reliability and frequent pump failure, many households complain about hand-pumps and seem unwilling to manage them properly. This suggests that technological preferences are likely to have effects on the sustainability of water facilities. Apart from this, strong complaints by the landowners around the water supply sources occur because their crops are destroyed by individuals walking over the cropped land while collecting water and by those households whose source is shared by two or more separate villages. Households living in the villages where the source is located in it feel that the water source belongs to them, and others do not have the right to collect from it. These conditions have frequently created disputes and a lack of integration resulting in obstacles to effectively participate in the management activities (such as meetings) called by WUCs. This confirms that some of the water sources are placed according to hydrological criteria than the social dimension of the beneficiaries.

3.6. Description of Institutional Approaches Followed to Enhance Sustainability of Water Services

Many organizations working in the water supply sector have come to recognize that the sustainability of the water service is equally important as ensuring the initial access itself. This holds true for ORDA. ORDA is working in Achefer to provide clean water to communities who have previously gotten their water from traditional sources such as boreholes, home-made wells, unprotected springs and rivers, through a partnership of WAE that provides funding to the project. ORDA follows the core approaches of WAE to supply clean water to rural communities and to ensure the sustainability of the services. These approaches which include targeting poverty and vulnerability, incorporating gender sensitivity, ensuring genuine participation of community members and concerned stakeholders in all the project cycles and addressing advocacy issues are designed based on the demand responsive approach (DRA). DRA has been described as an approach that “allows communities to make informed choices about the types and levels of services to be provided, taking into consideration of their affordability” (ADF, 2005). The sustainability approach includes development of project exist strategies and facilitates handing over to the beneficiary communities, applying user-friendly technologies, training WUCs, strengthening community management efforts, and establishing community by-laws.

As one of the core approaches mentioned above, ORDA requires active community members’ participation from the commencement of the project through implementation. The greatest emphasis is given to the involvement of the households at reasonable levels, such as through the contributions of cash, labor, local resources and time for source development. This is considered as expression of demand for improved water services. For instance, among the total households surveyed, about 92% had provided labor useful for site clearing and construction, 75% had provided cash in response to the notification by ORDA that 10 to 12% the project cost would be covered by the community, 81% had provided local materials such as wood for the construction of the water sources and fencing, and only 11% had been involved in active decision making processes such as in site selection, financial and project management issues. It is widely thought that payment for source construction induces a sense of ownership and management responsibility (Schouten and Moriarty, 2003; Steve and Khan, 2004). Hence, among the surveyed households, over 87% report that more than 25% of the maintenance and protection responsibility should be assumed by the user households. This shows that many of the households have a generally optimistic view towards water source protection and maintenance. The other 13% of households believe that they should not be responsible at all. Households who claimed not to be responsible were requested to justify their reasons. About 35% of them state that 'the water source is extremely far from their household'. Another 35% believe that 'water should be a commodity free of charge' and 20% believe that, 'the sources are owned by the government'. Of those households believing that they are not responsible, 10% reasoned that 'if the source is well-functioning, it does not require maintenance and protection'. A small number of households not assuming responsibility also state that 'management of the water sources is the responsibility of the WUCs'.

The survey had questions aimed at understanding whether efficient, transparent, and well-functioning management committees exist in the villages to coordinate the operation, protection, and maintenance of the water sources. The results show that all of the villages have democratically elected WUCs, many of them comprised of widely popular volunteers from the villages. However, they are less organized than expected and have unclear responsibilities and authority. The majorities set monthly cash donations, and call for communal labor contributions. Some have imposed monetary fines on those who violate the management rules. However, many of the interviewed households do not seem to be concerned about the fines (penalties) as the fines are meager, and the WUCs have limited power to enforce them and are inconsistent in their application. If households pay some cash on a regular basis or contribute labor when required, it is supposed to be based on their willingness, based on their desire to maintain the quality of the water services over time. In spite of the training and capacity building efforts provided by the project implementing organization, the role of the WUCs in water source management in the study villages is limited. About 11% of the households believe that WUCs lack transparency and accountability in their managerial decisions, and 9% report that WUCs lack the educational knowledge to maintain accurate financial records. However, about 75% of respondents are optimistic that the money collected monthly can be used for its intended purpose, i.e. for water source protection and maintenance.

ORDA also promotes innovative methods to sensitize and mobilize the community with an objective of awareness creation. One well-known approach in the villages is the “let’s drink coffee” (“buna enteta”) promotion program. It is a coffee drinking ceremony that involves gathering the village members together for discussions on hygiene, sanitation and water issues. About 40% of households report that ‘relatively intensive teaching is provided by local health promotion workers’ and 30% of households think that ‘extremely intensive advocacy is provided by the water use committees, health extension promoters and ORDA staff on water quality and sustainability issues’.

In addition to the above strategies adopted by the pilot project, the surveyed households were asked to provide recommendations to make the water sources more sustainable. In response, 73% offered their opinions. Among them, 33% recommend ‘increasing the number of water supply sources, preferably at convenient places’; 28% suggest ‘regular maintenance'; 21% suggest 'improving the level of users' participation'; 17% recommend 'building additional facilities such as shower rooms, cloth washing structures, and cattle troughs along with the drinking water infrastructure'; 9% recommend 'hiring efficient guards'; and, 4% suggest that 'improving the technical efficiency of WUCs by training' can enhance the sustained services from the water sources.

Sustainability of water sources is, indeed, a key concern in the water supply sector, as it probably affects the long-term livelihood of rural communities. Achieving the goal of sustainability requires the generation of efficient and participatory strategies targeting adequate water source management that circumvents the interruption and deterioration of both the quality and quantity of water supply over time. This requires understanding the socio-economic and attitudinal characteristics of households, water use practices, supply and access situations and institutional setups linked to the water sources, and recognizing factors that require special attention that contribute to successful community management interventions. This procedure saves resources and helps in achieving sustainability objectives more effectively by avoiding costly decisions. The next section will examine the cash payments and labor contributions by the households for water source protection and maintenance to guarantee functional sustainability, and quantitatively justify their determinants based on the background information presented in this and the preceding parts.

3.7. Household Contributions of Cash and Labor for the Protection and Maintenance of Water Sources and Its Determinants

Although safe water coverage in rural areas (of developing countries) is very limited, the cost of investment in water projects and their operation and maintenance is getting sufficiently high that governments, donors and implementing organizations can no longer afford them all (Kleemeier, 2000; Biswas, 2005). One of the daunting challenges in the water supply sector is securing resources to manage and maintain frequently breaking water facilities and keeping the water sources operating in a sustainable manner. In part as a solution to this phenomenon, and for two other additional reasons, project-implementing organizations require at least operation and maintenance costs to be covered by user households. The first justification is often stated as “management at the lowest appropriate level”, which assumes management by the beneficiaries is easier and logical, and the other perspective treats water as “economic good” for which people should be willing and able to pay. In contrast, other international water policies and water management strategies conceptualize water as a renewable resource that is a free gift of nature to all human beings (Bhandari *et al*., 2007). However, its utilization entails cost in terms of access, storage and management. Approaches that endorse management of rural water supply sources by user communities are generally known as “community management” (Schouten and Moriarty, 2003; Steve and Khan, 2004). Community management is a management theory that advocates DRA based on the principle that demand for improved and sustained water services induces the involvement of beneficiaries, and this in turn reduces entailed cost in terms of initial capital outlay as well as costs of operation and maintenance. These approaches also better target the real needs of communities by incorporating indigenous knowledge at the grassroots level. They also aim at building local capacity in extending and replicating the existing services (Kleemeier, 2000). Steve and Khan (2004) stated that “the theory behind community management as such aims to empower and equip communities to take control of their own development”. But are rural households really willing to pay (contribute) for communal water services? Will they assume management of communal water sources as their responsibility? If the answers of these questions are dependent on other factors, what are these determinants? These questions remain poorly answered, and require detailed investigations to be conducted.

If households are supposed to shoulder management responsibilities, effective participatory methods and support mechanisms must be formulated and implemented. This requires, among other factors understanding the role of households in the protection and maintenance of the water sources and distinguishing the basic determinants of their contributions, which is one of the major objectives of this study. To achieve this, the contributions of cash and labor intended for water source protection and maintenance by individual households during the previous three months were recorded and examined.

As noted in section 3.6, the village WUCs had mainly determined and set monthly contributions of both cash and labor for the protection and maintenance of the water sources with minimum or no consultation of households. Accordingly, households contributed an average total of 2.5 ETB for three months with a standard deviation of 1.6 ETB, and they also provided total average labor of 1.3 days with a standard deviation of 1.1 days (without including monetary fines or labor done as a penalty) during the stated period of time (see Table 7). It is useful to note that these payments are referred to as "contributions" rather than fees for water to show that they are voluntary donations. A relevant question is whether the amount that households are currently contributing on average can cover the cost of operation and maintenance of the water sources. For a water source with 85 users on average paying 2.5 ETB every three months, the total annual contribution would be about 850 ETB per year. With the current cost of spare-parts, and if caretaker is additionally employed, this amount would not likely be sufficient to support the protection and maintenance requirements of the water source. The cash amount required to sufficiently manage a water source (including salary for a full-time caretaker of about 250 ETB per month and allowance for maintenance, about 1,500 ETB per year) is estimated at 4,500 ETB per year. Thus, current user contributions provide only about 19% of the estimated cost, indicating that either contributions would need to be markedly increased or outside support provided for adequate protection and maintenance.

The contributions also varied significantly across households. Cash payments for instance, ranged from 0 to 6 ETB. This was due to the different tariff levels imposed by the respective WUCs of different villages, delayed and partial payments, or complete refusal to pay or to contribute, and in some cases, additional contributions of cash over the determined tariffs by interested households. A number of socio-economic and exogenous factors were hypothesized to affect this variation of households' decisions about regular and timely participation. These variables and the results of the descriptive statistics and their description and measurement are summarized by Table 8.

Table 8: Variables, their description, measurement, expected sign and descriptive statistics of the results

Variables	Description and measurement	Exp. Sign	Obs.	Min	Max	Mean	Std. Dev.
Dependent Variables							
CASHCONT	Actual cash contributed during the last 3 months, ETB		160	0	6	2.48	1.58
LABORCONT	Actual labor contributed during the last 3 months, Days		160	0	5	1.291	1.08
Explanatory Variables							
HEADGENDER	Household head gender, dummy (1=female and 0 other wise)	+	160	0	1	0.09	0.28
HEADAGE	Age, 1 to 4; 1=1-15 years, 2=16-30 years, 3= 31-45 years, 4=46 years and above	+	160	2	4	3.12	0.77
HEADEDLVL	Educational level, 0 to 4; 0=Illiterate, 1=Read and write, 2=Elementary complete, 3=Junior complete 4= High school complete and above	+	160	0	2	0.37	0.5
HHSIZE	Household size, numbers	+	160	1	10	5.51	1.75
INCOME	Total income , ETB/year	+	160	900	45340	14200	8043
ADVOCACY	Advocacy and promotion about water supply, index 1 to 4; 1=No teaching at all, … 4=Extremely intensive advocacy	+	160	1	4	2.83	1.04
NOALWS	Number of alternative water sources, numbers	-	160	0	4	0.5	0.83
TOWUCs	Trust on water use committees, index 1 to 5; 1=No trust at all,… 5=Full trust	+	160	1	5	4.12	1.19

Table 8 (Continued)

Variables	Description and measurement	Exp. Sign	Obs.	Min	Max	Mean	Std. Dev.
Explanatory Variables							
CONOL	Convenience of location, index 1 to 5; 1= Very inconvenient; 5=Very convenient	+	160	1	5	3.31	1.17
SENORES	Perceived sense of responsibility, index 1 to 5; 1=Not responsible at all=0%,… 5=Highly responsible=100%	+	160	1	5	4.02	1.26
INOWBDs	Incidence of water born diseases, numbers	+	160	0	4	0.24	0.61
UOWFSGI	Use of the water from the source for income generating activities, index 1 to 4; 1= Not at all,… 4=Very often	+	160	1	4	1.33	0.71
WASATS	Household daily water satisfaction, index 1 to 5; 1= Not satisfied at all,… 5=Highly satisfied	-	160	1	5	3.81	0.77
PSOWS	Perceived safety of the water from the source, index 1 to 5; 1= Not safe at all,… 5=Highly safe	-	160	1	5	3.58	0.93
DPARDPIMP	Degree of participation during the project implementation, index 1 to 5; 1=None at all,… 5=Excellent	+	160	1	5	3.98	1.24

Econometric results from the Tobit model (Table 9) support the validity of using such a simple approach to analyze the determinants of households' decisions towards participation in water management agendas. The analysis further confirms that most of the coefficients are consistent with the hypothesized relationships and some are statistically significant. These help identify important characteristics explaining the decisions for regular and on time contributions (cash and/or labor) by the households for water source protection and maintenance, and this also indicates that some of the factors are necessary for consideration in the formulation of rural water source management strategies. A number of variables appeared to be insignificant; this might more likely be due to the relatively small sample size involved. Due to high collinearity between sense of responsibility (SENORES) and degree of household participation during project implementation (DPARDPIMP), sense of responsibility (SENORES) was dropped from the regression. Additionally, the coefficient and standard error values for sigma indicate that there is statistically significant censoring in the samples for both dependent variables in the model.

The household head gender (HEADGENDER) has a negative relationship with both cash payments and labor contributions but is not significant based on the conventional statistics. This is different from the initial proposition that women would participate more in water source management through cash and labor contributions. However, the descriptive data show that female-headed households are among the poorest of the surveyed households.

Table 9: Tobit estimates of the determinants of cash and labor contributions by households for water source protection and maintenance

		Cash contribution, ETB/month				Labor contribution, days/month			
Determinants	**Unit**	**Coef.**	**Std. Err.**	**t**	**P>t**	**Coef.**	**Std. Err.**	**t**	**P>t**
HEADGENDER	1=female and 0, other wise	-0.63	0.45	-1.42	0.16	-0.24	0.32	-0.76	0.45
HEADAGE	1 to 4	-0.19	0.16	-1.19	0.24	-0.11	0.11	-0.94	0.35
HEADEDLVL	0 to 4	0.30	0.26	1.14	0.26	-0.29	0.18	-1.61	0.11
HHSIZE	Numbers	-0.03	0.08	-0.41	0.68	0.03	0.05	0.64	0.53
INCOME	1000 ETB per year	0.03*	0.02	1.84	**0.07**	0.04***	0.01	2.95	**0.00**
ADVOCACY	1 to 4	0.12	0.13	0.89	0.38	0.32***	0.09	3.53	**0.00**
NOALWS	Numbers	-0.28*	0.15	-1.85	**0.07**	0.25**	0.10	2.49	**0.01**
TOWUCs	Index:1 to 5	0.19*	0.11	1.74	**0.08**	-0.05	0.08	-0.60	0.55
CONOL	Index:1 to 5	0.03	0.12	0.28	0.78	0.07	0.08	0.84	0.40
INOWBDs	Numbers	0.06	0.23	0.27	0.79	0.16	0.15	1.02	0.31
UOWFGI	Index:1 to 4	-0.35*	0.18	-1.88	**0.06**	0.33***	0.12	2.67	**0.01**
WASATS	Index:1 to 5	0.07	0.17	0.43	0.67	0.02	0.11	0.19	0.85
PSOWS	Index:1 to 5	0.05	0.14	0.39	0.70	0.06	0.10	0.65	0.52
DPARDPIMP	Index:1 to 5	0.45***	0.13	3.61	**0.00**	0.18**	0.09	2.09	**0.04**
Constant		-0.31	1.01	-0.30	0.76	-1.64	0.69	-2.38	0.02
Sigma		1.40	0.09			0.96	0.06		
Uncensored obs.		140				135			
X^2		72.03				76.22			
Pseudo R^2		0.12				0.15			
Log-likelihood		-266.68				-208.86			

***, **,* indicate significance at 0.01, 0.05 and 0.1 levels, respectively.

It is more likely that they have other priorities than paying or working for water source management, which seeks their voluntary participation (although this effect should be at least somewhat controlled by the income variable). Likewise, the age of household head (HEADAGE) appears to have an insignificant and negative relationship with both cash and labor contributions. Household head educational level (HEADEDLVL) is insignificantly associated with cash payments, and labor contributions, contrary to the initial assumptions. Furthermore, household size (HHSIZE) has a negative impact on cash payments but a positive with the labor contributions. This seems reasonable, as households with large family size are concentrated more within low-resource categories (ADF, 2005). However, the reason for the latter case could be that bigger households can easily afford labor for water source management as they have enough for farming and other productive activities.

Total household income (INCOME) also influences the payment of cash and provision of labor, both with positive signs, as expected. This result is consistent with basic economic theory, which states that individual's demand for most commodities or services depends on income (Mbata, 2006). This also implies that poor households may not make payment for water a priority, as they may have to make choices to spend their limited financial resources for subsistence needs. The parameter value for advocacy provided (ADVOCACY) was also a significant factor for the labor contributions with the positive sign as expected, but not on cash contributions. This suggests that advocacy to create awareness about the opportunities in promoting protection and maintenance of water sources is an important component of the support framework as it positively affects the households' motivation to provide labor for water source management. The number of alternative water sources in close proximity

(NOALWS) also influenced the payment of cash by the households at high significance level, and has the expected negative sign. This suggests that the existence of alternative water sources such as rivers, undeveloped springs and home-made wells decreases households' willingness to make cash payments for sustained water services. However, at the same time, it significantly and positively increases the labor contributions. This implies that an increasing presence of alternative water sources in a village decreases cash and increases labor which would be available for water source protection and maintenance, and hence one offsets the other. Thus, further and detailed research is required to clearly determine the effect of alternative water sources in water source sustainability.

The households' level of trust in water use committees (TOWUCs) influences significantly the cash payments with a positive sign, as expected. This tells us that households with high level of trust in water use committees that the money raised would be used for the intended purpose contributes more. Convenience of location of the water sources (CONOL) is found to have a positive but insignificant impact on both cash and labor contributions. The regression results also indicate that incidence of water born diseases (INOWBDs) has a positive but insignificant relationship with both contributions. This finding supports the view that households do not link the quality of water from improved sources with the incidence of water-borne diseases. Thus, more educational efforts may be required to better utilize the effect of this parameter on the sustainability issues.

The negative coefficient sign for use of water from the source for generating income (UOWFSGI) in explaining cash payments negates the initial assumption that it is supposed to increase participation. However, this result is probably attributable the small proportion of households in the study villages (3%) have been using water ‘most frequently’ to generate some income such as in vegetable production. Thus, the resolution of the analysis is not sufficient to detect the hypothesized effect. In addition, the majority of such use involved the Luhudi water source, where the water use committees had set rules that required water users (for micro-scale irrigation) guarding the source by turns. Because they are caretakers of the source on weekly basis, they may have been less interested in providing cash. This implies that this parameter did not influence the majority of households’ decisions of cash payment in water source management in the study area at least during the study period. However, the labor contributions are influenced by this parameter positively and significantly showing that those households who use water for vegetable production participated more by providing labor for water source management than by contributing cash (due at least in part to rules specified by the water use committees).

Daily water satisfaction (WASATS) and Perceived safety of water from the sources (PSOWS) have positive but insignificant effects on both contributions, contrary to what was initially hypothesized. Although these variables are insignificant, this likely reflects the households’ limited awareness of the inherent health and economic benefits of increased water quality. Thus, additional education about these relationships might have the effect of enhancing the sustainability of water sources. The level of household participation during the service establishment phase (DPARDPIMP) is significantly associated with the variations of both the cash payments and the labor contributions across households. The coefficients demonstrate the expected positive signs. This finding suggests that incorporation of households in early phases of the project cycle will have a positive implication for future sustainability outcomes.

Given that the significance estimates of Household head gender (HEADGENDER) on cash contributions, and household head educational level (HEADEDLVL) on labor contributions are somewhat close to statistical "significance" threshold, these variables might be important in other samples.

The marginal effect estimates reveal that degree of household participation during the project implementation (DPARDPIMP) is the first and most important variable (for a unit change in its value)[5], which exerts the greatest effect on both contributions (see
Table 10). An increase of the degree of participation during project implementation phase by one unit significantly increases the cash contributions by 0.37 ETB per month and the labor contributions by 0.13 days per month. Thus, it could be very useful for project-implementing organizations to increase the participation of households during water source installation as much as possible to achieve increased participation in water source protection and maintenance through increased cash and labor contributions.

Advocacy provided on water issues (ADVOCACY) is the other factor which exerts a larger effect on labor contributions. The analysis shows that a unit increase of the level of advocacy provided significantly increases the labor contributions by 0.22 days per month whereas it insignificantly increases the cash contributions.

[5] Note that an alternative approach is to calculate a response elasticity, which would evaluate the percentage change in response (cash or labor contributed) given a percentage change in the independent variable (with all other variables evaluated at the mean). This is omitted here for simplicity.

Table 10: Marginal effects of determinants on cash and labor contributions

		Cash contribution, ETB/month				Labor contribution, days/month			
Determinants	**Unit**	**dy/dx**	**Std. Err.**	**Z**	**P>z**	**dy/dx**	**Std. Err.**	**z**	**P>z**
HEADGENDER	1=female and 0 otherwise	-0.49	0.32	-1.52	0.13	-0.16	0.20	-0.80	0.43
HEADAGE	1 to 4	-0.16	0.13	-1.19	0.24	-0.07	0.08	-0.94	0.35
HEADEDLVL	0 to 4	0.24	0.21	1.14	0.26	-0.20	0.13	-1.60	0.11
HHSIZE	Numbers	-0.03	0.06	-0.41	0.68	0.02	0.04	0.64	0.53
INCOME	1000 ETB per year	**0.03**	0.01	1.84	**0.07**	**0.03**	0.01	2.94	**0.00**
ADVOCACY	1 to 4	0.10	0.11	0.89	**0.37**	**0.22**	0.06	3.50	**0.00**
NOALWS	Numbers	**-0.23**	0.12	-1.85	**0.07**	**0.18**	0.07	2.48	**0.01**
TOWUCs	Index:1 to 5	0.16	0.09	1.74	0.08	-0.03	0.05	-0.60	0.55
CONOL	Index:1 to 5	0.03	0.10	0.28	0.78	0.05	0.06	0.84	0.40
INOWBDs	Numbers	0.05	0.19	0.27	0.79	0.11	0.11	1.02	0.31
UOWFGI	Index:1 to 4	**-0.28**	0.15	-1.87	**0.06**	0.23	0.09	2.66	**0.01**
WASATS	Index:1 to 5	0.06	0.14	0.43	0.67	0.02	0.08	0.19	0.85
PSOWS	Index:1 to 5	0.04	0.11	0.39	0.70	0.04	0.07	0.65	0.52
DPARDPIMP	Index:1 to 5	**0.37**	0.10	3.59	**0.00**	**0.13**	0.06	2.08	**0.04**
Scale Factor for Effects	2.51					1.39			

Note: Marginal effects reported here are for the mean values of the independent variables.

The significance of the variables along with the magnitude of the marginal effect suggests that, project-implementing organizations should advocate and create awareness on the importance of water source management as much as reasonably possible[6] to achieve better participation of households through labor contributions. This is empirical evidence that supports beliefs commonly held by water development organizations.

Household total income (INCOME) has come to be the third most useful variable which slightly affects the labor and cash contributions. An increase of a household income by 1000 ETB significantly increases the cash contributions by 0.03 ETB per month and the labor contributions by 0.03 days per month. These effects are very small compared to costs of water projects, although projects that increase income may become somewhat more sustaining.

[6] A more complete analysis of this would include the costs of advocacy and additional awareness.

CHAPTER FOUR
CONCLUSIONS AND RECOMMENDATIONS

This study has been undertaken to help further understanding of the complex nature of rural water supply issues such as water use practices, attitudes towards drinking water quality, the technical quality of water from improved water sources, the status of improved water facilities, and institutional approaches followed to enhance the sustainability of these facilities. Further, it has tried to identify the leading determinants of household participation in managing their water supply sources and recommend possible solutions to the large-scale breakdown of water supply sources in Ethiopia. To achieve this, a total of 16 water sources were selected and observed. The villages in closer proximity of the water sources were identified, and 10 household respondents in each village (a total of 160 households) were randomly selected and surveyed. Water quality analysis from sample sources was also carried out. The results brought forth the following major findings.

Gender plays significant role in household water management. Water use at the household level is positively and significantly determined by household size and convenience of location. The observed outcomes also suggest that wealthier families use more water per day, and water use has a negative relationship with waiting time at the water source (i.e., higher water use means less waiting time at the source). These results suggest that water sources need to be located within a reasonable distance to all beneficiaries and additional facilities may also be constructed to reduce the waiting time at the sources to better satisfy daily domestic water requirements. Decreasing the waiting time at the water sources will provide more time for women to be engaged in other (productive) activities.

Household perceptions about water quality were found to be somewhat informed. Nearly 38% mentioned that ‘clean water’ is water free from harmful pathogens and chemical toxicity, and 41 % report that clarity to the eyes is the sole indicator of safety. Following this, about three-fifths of the respondents believe that the water from their source is ‘safe’ or ‘highly safe’ for all household purposes. To test this belief of the households, a laboratory water quality analysis was carried out on selected and important drinking water quality parameters. The chemical and bacteriological quality analysis of sample water sources depict that the chemical quality of all the water from all sample sources, and the bacteriological quality of water from the half are under WHO standard values. This result suggests that rural communities in the study area have somewhat accurate knowledge, judgment, and water quality perceptions of improved water supply sources. Increasing efforts on community water education enhances households’ awareness about water quality issues. Teaching them to differentiate the ‘actual’ from the ‘perceived’ quality of water and helping them to realize the benefits of improved water management can ensure better participation in water source management initiatives. Considering the fact that some the sources have some total coliform colonies, it is apparent that efforts are necessary to improve the safety of water from the sources. This can be made through the use of source disinfection mechanisms such as chlorination or point-of-use disinfection mechanisms such as boiling to decrease the bacteriological health hazards.

Complete non-functionality and non-protection of water sources were not observed in any of the sample water sources. Among those functioning with some breakdowns, the majority had exhibited disrepairs of the faucets and valves, which can easily be repaired. Additionally, three-fourths of the surroundings of water sources were characterized as ‘not neat at all’. This clearly reduces the safety of the water and increases health hazards when this can easily be remedied through adequate water source protection and management. Catchments rehabilitation was done around the surroundings of less than half of the water sources. Although there was a fairly good level of functionality, it does not seem likely that the existing efforts are up to the required level to enhance the sustainability of improved water services for the community. Thus, more concerted strategies must be formulated to achieve long-term participation of households to ensure satisfactory water services of adequate quantity and acceptable quality.

To understand the role of households in the protection and maintenance of the water sources and their determinants, the actual contributions of cash and labor by individual households during the previous three months were collected and analyzed. The estimated annual contributions indicate that the amounts currently provided on average by the households are not likely to be sufficient for adequate management of the water sources. Additionally, the empirical analyses conducted using a Tobit model shows that households’ degree of participation during the project implementation, advocacy provided, and household income are the leading determinant factors. Many of the other factors hypothesized to be important were not statistically significant, suggesting that a larger sample size may be appropriate in future work. These results suggest that the sustainability of newly installed water systems can be influenced by household-specific factors within the community that increase willingness-to-pay cash and willingness-to-contribute labor useful for water source protection and maintenance.

This study has shown that the degree of households' participation during the service establishment stage has significantly influenced the willingness-to-pay cash and the willingness-to-contribute labor for source protection and maintenance. The marginal effect estimates from the Tobit model have also clearly shown that holding other parameters fixed, a unit increment of the degree of participation during project implementation phase significantly increases the cash and labor contributions (0.37 ETB per month 0.13 days per month, respectively). The literature on community development suggests that several hierarchies of participation are identified based on the intensities of 'participants' involvement in a particular development project. These usually include; requesting 'participants' to contribute their resources such as cash, labor and time at lower levels; to leaving all decisions to be made by the 'participants' with a minimum external support at the upper levels (Prokopy, 2005; Steve and Khan, 2004). From the finding of this study, it is possible to conclude that more organized participation of households at higher levels during the project implementation enhances the levels of households' participation in water source management and hence, boosts water source sustainability. This also underpins the foundation of the Ethiopian Water Resources Management Policy that puts more emphasis on promotion of participatory approaches as guiding principles of ensuring the economic and social benefits of water on a sustainable manner (ADF, 2005; Haileslassie *et al*., 2008).

The level of advocacy about water supply management and its consequences, such as enhanced sustainability, and improved water quality is revealed to be a determining factor of households' participation in water source management by this study. The marginal effect of a unit increment in the level of advocacy provided by local promotion agents focusing on the benefits of water source management issues significantly increases the labor contributions (0.22 days per month), but has no statistically significant effect on cash contributions. This suggests that awareness must be created through appropriate institutional support to increase the quality and sustainability of water services over time.

Income is shown to affect the decision of households to participate in water source protection and maintenance. This shows the importance to recognize that an increase in the annual household income increases the tendency of paying monthly tariffs and contributing labor for water source management partly due to the ability-to-afford; a fact that one intuitively can accept. Given a number of households with lower level of economic status in the study villages, it may be useful to formulate mechanisms that can address poverty to maintain continued contributions. This might be achieved through working to develop strategies that specifically target the poor as a benchmark of service delivery, and that support uses of water beyond basic livelihoods, such as micro-scale irrigation, and horticultural development initiatives. Subsidies and other support mechanisms may also be designed, which specifically target poor households.

Importantly, however, the marginal effect of increasing total income of a household by 1000 ETB per year is only an increment in the cash contributions by 0.03 ETB per month and the labor contributions by 0.03 days per month. Hence, compared to the cost of protection and maintenance of the water sources, this does not seem a practically and economically sound measure; although if possibly achieved, can potentially enhance sustainability of water sources.

This study concludes that promoting participatory approaches which fully involve beneficiaries according to their willingness and potentials supported by the right advocacy and promotion efforts can significantly contribute to sustainability of rural water sources in developing counties. More generally, water supply projects should not only focus at increasing coverage targets simply looking at the hydrological, financial, and technological possibilities, but also on the sustainability of the systems to help contribute to long-term and comprehensive development objectives. This requires emphasizing on a pivotal role of households among others in development agendas. This research generally suggests that understanding households and their socio-economic, geographical and institutional settings, and matching with the appropriate policy framework is fundamental for sustainable water management. Thus, a high degree of flexibility in project approaches, which considers the inherent socio-economic differences among households, is also important.

Besides, any water supply project should illustrate the clear picture and scope of a sustained and improved water service along with its benefits to the beneficiaries from the commencement (Schouten and Moriarty, 2003). This requires demand assessment after visibly advocating the benefits of the project in the earliest planning stages. In the implementation phase, households must also be aware that the project is being managed by them, and outsiders and implementing organizations are only there to support them in their technical and financial limitations. Given that management requirements of the observed water sources (maintenance and protection costs, labor and local materials such as wood) are relatively affordable by the households, it seems acceptable that users would cover it. However, it should be promoted continuously from the beginning that it is going to be shouldered by them. This does not mean that households must be left alone, but appropriate “management capacity” must be created to achieve meaningful sustainability with the right support framework (Schouten and Moriarty, 2003). At the beginning of this paper, sustainability of water sources was defined as the capacity of providing continued and satisfactory water services over a natural life span of the system itself. This implies that, if meaningful sustainability is to be achieved, rehabilitating (renewing) or replacing the system when it gets old and become unable to provide adequate services, is also important. Thus, appropriate, and sustainable financing strategies are required not only for day-to-day management practices, but also for “cost recovery” to replicate the system (Nyarko *et al*., 2006; Harvey, 2007, and Mbata, 2006). Besides, Biswas (2005) stated that: *“*There is no question that if water management is to be efficient and if an adequate amount of water of appropriate quality is to be made available for various purposes in the future; water pricing will have to be an important policy instrument for efficient water management”.

Finally, albeit this research has rigorously focused on community level factors, the importance of further research is indisputable to explore the hydro-geological aspect of the water supply sources and its impacts on sustainability water services in the area.

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APPENDIX A

HOUSEHOLD SOCIO-ECONOMIC, WATER USE PRACTICES AND PARTICIPATION IN WATER SOURCE MANAGEMENT: SURVEY QUESTIONNAIRE

Dear respondent,

This questionnaire is prepared to gather information about your water use practices, socio-economic conditions and your cash and labor contributions useful for the protection and maintenance of your water source. The data is intended to develop a mechanism to help improve the sustainability of the water sources based on your suggested solutions. In answering my questions, please remember that there are no correct or wrong answers. I am just after your honest opinion. This information will be delivered to those who are extremely confidential and who really want to see your socio-economic development. Thank you for your time and cooperation!

Household ID NO ____
Name of Respondent _____________________________________
Name of Village ____
Name of Water Source ____________________________________
PART I

1. Community Water Education (Awareness Creation about Safe Water Supply and Advocacy to Promote User Engagement)

1.1. Did you have some teaching about water supply issues and what was the nature of the advocacy?
- 1=No teaching at all
- 2=Simple awareness creation made by the water use committees
- 3=Relatively intensive teaching provided by local health promotion workers
- 4=Extremely intensive advocacy provided by the water use committees, health extension promoters and Organization for Rehabilitation and Development in Amhara (ORDA) staff

Part II

2. Perceived Barriers[7] (there are also several others in different sections of this questionnaire which fall in this category)

2.1. How many 'alternative sources' (like rivers, home-made wells or undeveloped springs) do you have?

____

2.2. Would you rank the degree of responsibility you assume to protect and maintain the water source?

[7] Perceived barriers are those perceived factors by the users which are hypothesized to hinder them from providing the required level of care for their water supply sources

1=Not responsible at all=0% → (2.2.1) 2=Somewhat responsible= 25%
3=Partially responsible=50% 4=Responsible=75%
5=Highly responsible=100%

2.2.1. If not responsible, could you describe your reasons?

____
____
____

2.2.2. If you described your reasons above, who do you think is then responsible to protect it?

______________________________ Why? ________________________
______________________________ Why? ________________________

PART III

3. Household Water Use Practices

3.1. Who is most frequently responsible for collecting water for household use?

1=Wife
2=Children
3=Husband

3.2. How many times does this person travel to the water source to collect water within a day? ______________________

3.3. How far is the water source from your household (estimated distance)? __________________ meters

3.3.1. How do you view the location of the water source with respect your household?

1=Very inconvenient 2=Inconvenient
3=Convenient 4=More convenient
5=Very convenient

3.3.2. How long is the average waiting time at the water source? _______________minutes

3.4. What is (are) the container(s) you use most frequently for collecting water? (Indicate one or more)

1=Jerry can: How much water can it hold? ___________________Liters
2=Clay pot: How much water can it hold? ___________________ Liters
3=Others (please specify)
________________: How much water can it hold? _____________ Liters
________________: How much water can it hold? _____________ Liters

3.5. How do you handle it at home (storing and treatment measures)?

____
____
____

3.6. How much water did you collect yesterday for the household use? __________________Liters

3.6.1. Are you satisfied with this amount water available to your household daily for drinking, cooking and sanitation?

1= Not satisfied at all 2=Somewhat dissatisfied 3=Partially satisfied 4=Satisfied 5=Highly satisfied

3.7. During the past year, how frequently have you used the water from the source for generating income (an example might be for vegetable production)?

1=Not at all 2=Sometimes 3=Often 4=Very often

3.8. How would you rate the degree of your participation during the project implementation process (in the time of the construction of the water source)?

1=None at all 2=Low 3=Fair 4=Very good 5=Excellent

3.9. If you have participated, in what aspect was your contribution? (Indicate one or more based on your contribution)

1=Providing labor
2=Providing cash
3=Providing local materials such as wood
4=In management and as a member of committees (decision making), Others (please specify) ___________________________________

PART IV

4. Attitudes towards Safety of Local Water

4.1. What do you think are the characteristics (qualities) of safe (clean) water?____
____
____

4.1.1. How do you view the current safety of water from your local source?

1= Not safe at all 2=Somewhat unsafe 3=Partially safe 4=Safe 5=Highly safe

4.1.2. Which of the following affects the safety of your water source? (Indicate one or more)

1=Turbidity due to flooding
2=Algae development
3=Livestock contamination
4=Bird and wild life contamination

4.1.3. How many times one or more of your family member(s) experienced water-borne disease incidences during the last year? _______________

PART V

5. Cash and Labor Contributions for Water Source Protection and Maintenance

5.1. During the last three months, how much have you willingly paid to the water use committee which is useful for the protection and maintenance of the water supply source (with out including fines, if any)?__________ETB

5.2. To how much extent is your trust on water use committees that all the contributed money will be used efficiently for the intended purpose?

1=No trust at all 2=Little trust 3=Partial trust 4=Better trust 5=Full trust

5.3. What do you think are the problems of water use committees?
____
____
____

5.4. During the last three months, how many days of labor have you willingly provided for the protection of the water source and catchments rehabilitation (with out including fines, if any)? ___________________days

5.5. Do you have any recommendations to make the water sources more sustainable?____
____
____

PART VI

6. Household Demographic and Socio-Economic Information

6.1. Household educational, age and gender characteristics
(Complete the following table according to the given specifications)

- household member type: 1=household head 2=Spouse of household head 3=Child 4=Other (specify)
- Gender: 0=Male 1=Female
- Educational level:
  0=Illiterate
  1=Read and write (1-6 grade including priests)
  2=Elementary complete (6-8 grade)
  3=Junior complete (9-10 grade)
  4=High school complete and above (grade 11 and above)
- Age range: 1=1-15 years 2=16-30 years 3=31-45 years 4=46 years and above

No	Household Member	Household Member type	Household Member Gender	Household Member age	Household Member Educational level
1					
2					
3					
4					
5					

6.2. Household size_______________________________

6.3. Income from non-agricultural activities for the household (if any)

No	List of off-farm and on-farm not agriculture related activities	Annual non-agricultural income, ETB/year
1		
2		
3		
4		
Total		

6.4. Household annual crop production (last year's planting and harvest) and its current market value.

No	Crop Cultivated	Annual Yield, Quintals	Local price of the crop, ETB/Quintal	Value of the crop harvested, ETB/year
1				
2				
3				
4				
5				
6				
7				
Total				

6.5. Livestock holdings and their market value (the value at which the owner is willing to sell)

No	Livestock	Number	Average local price per head	Value of livestock, ETB
1	Ox			
2	Cow			
3	Sheep			
4	Goat			
5	Horse			
6	Donkey			
7	Mule			
8				
Total				

6.6. Total income

Total income, ETB/year = Total value of annual non-agricultural income, ETB/year + Total value crops produced during last year's harvest, ETB/year	

APPENDIX B
CHARACTERIZATION OF WATER SOURCE STRUCTURES, THEIR FUNCTIONALITY, LEVEL OF PROTECTION AND NEATNESS: OBSERVATION CHECK LIST

Name of Village____________________________________
Name of Water Supply Source________________________
Location: Lat._____________**Long.**___________________
Year of Construction_______________________________

1. Type of water source: 1=protected spring 2=Pump
3=Others______________________________

1.1. Functionality of water source
1=Non-functioning at all
2=Functioning with some breakage problems
3=Well functioning with out any disrepair

1.1.1. If the observed functionality is '2', the main disrepairs are:
____
____

1.2. Level of protection:
1=Unprotected at all
2=Somewhat protected
3=Well protected

1.3. Presence of guards: 0=Absent 1=Present

1.4. Additional facilities:
0=No additional facilities at all
1=Animal troughs 2=Washing stand
3=Shower room 4=Guard house
Others____

2. Is catchments rehabilitation done?
0=No 1=Yes

3. Neatness of the surrounding of the water supply source:
1= Not neat at all
2= Somewhat neat
3=Very neat