JIMMA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

JIMMA INSTITUTE OF TECHNOLOGY

FACULTY OF CIVIL AND ENVIRONMENTAL ENGINEERING

HYDRAULIC ENGINEERING MASTERS PROGRAM

ASSESSMENT OF CHALLENGES FOR DESIGN AND CONSTRUCTION OF RURAL WATER SUPPLY- A CASE OF WUCHALE WOREDA, OROMIA REGION, ETHIOPIA

BY: WENDIMAGEGNEHU NIGUSIE

A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF JIMMA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF SCIENCE IN HYDRAULIC ENGINEERING

JANUARY, 2019

JIMMA, ETHIOPIA

JIMMA UNIVERSITY

JIMMA INSTITUTE OF TECHNOLOGY

SCHOOL OF GRADUATE STUDIES

FACULTY OF CIVIL AND ENVIRONMENTAL ENGINEERING

HYDRAULIC ENGINEERING MASTERS PROGRAM

ASSESSMENT OF CHALLENGES FOR DESIGN AND CONSTRUCTION OF RURAL WATER SUPPLY- A CASE OF WUCHALE WOREDA, ETHIOPIA

BY: WENDIMAGEGNEHU NIGUSIE

A FINAL THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF JIMMA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF SCIENCE IN HYDRAULIC ENGINEERING

MAJOR ADVISOR: -PROF., DR.-ING. ESAYAS ALEMAYEHU

CO-ADVISOR: - Mr. MEGERSA KEBEDE

JANUARY, 2019

JIMMA, ETHIOPIA

Declaration

This thesis is my original work and has not been presented for a degree in any other university.

This final thesis entitled "Assessment of Challenges for Design and Construction of Rural Water Supply with case of Wuchale woreda, Oromia Region Ethiopia" has been approved for Thesis work for partial fulfillment of the Degree of Master of Science in Hydraulic Engineering.

Submitted by

Wendimagegn Nigusie ------------------------ -------------------------

Signature Date

Approved by

1. Prof., Dr.- Ing. Esayas Alemayehu (PhD) ------------------------ -------------------------

   Major Advisor Signature Date

2. Mr. Megersa Kebede (MSc) ------------------------ -------------------------

   Co-Advisor Signature Date

3. ______________________ ------------------------ -------------------------

   External Examiner Signature Date

4. ______________________ ------------------------ -------------------------

   Internal Examiner Signature Date

5. ______________________ ------------------------ -------------------------

   Chairperson of Department Signature Date

Graduate Committee

Abstract

Water is fundamental for life and health. It is the basic need for human being welfare. However, sustainability of the water supplies is the current key challenge of developing countries, both in terms of the water sources and service delivery. The problem is worst in sub-Saharan Africa and Ethiopia in particular where getting safe potable water supplies and sanitation services is very low. Recently, while both governmental and non-governmental organizations have been implementing different water supply and sanitation projects in different parts of the country, only a portion of these schemes continue to provide water sustainably. The efforts made to improve and expand access for drinking water still was unable to completely alleviate all in all the rural communities suffer of potable water supply. Thus, the main aim of this study was to assess the challenges in the design and construction of rural water supply projects and to assess the functionality and service level of the water supply systems in the rural areas of Wuchale Woreda of Oromia Region. Both primary and secondary data was collected with structured and approved questioner. A systematic sampling technique was employed as the major methods of sampling for the selection of sample schemes (water points) and kebeles. The most common challenge of the water supply projects in the design of the schemes were, lack of considering appropriate information. Especially constructing the rural water supply points without checking the water yield of the schemes, untimely construction and development of the springs, and most of the experts were not volunteer to select sites with the help of the community rather they made independently. Therefore, a full exchange of information between the action agency and the community during all rural water supply project phases was found to be very important for successful water system development and to feel the real ownership of the schemes.

In general, the findings on assessment of challenges for design and construction of rural water supply projects in the study area reflect a critical situation. Therefore, it is important to establish a design and construction standards (methods) depending on the reality of the Woreda.

***Key words**: - Construction, Design, functionality, potable water, rural water supply, sustainability*

Acknowledgement

I would like to express my gratitude to my advisors Prof., Dr.- Ing. Esayas Alemayehu (PhD) and Mr. Megersa Kebede (MSc) for their support and great advice and support for the completion of this thesis.

My thanks extend to my sponsor the Ministry of Water, Irrigation and Electricity for giving me great chance and I am grateful to the staff member of Wuchale Woreda Water Supply for their cooperation by providing me with desired information and data.

Last but not least I would like to thank to Jimma University institute of technology for creating favorable condition to my study.

Table of Contents

List of Tables

List of Figures

Acronyms

ADB	African Development Bank
ADF	African Development Fund
BOQs	Bill of Quantities
DWAF	Department of Water Affairs and Forestry
HDWs	Hand Dug Wells
MoWIE	Ministry of Water, Irrigation and Electricity
NGOs	Non-Governmental Organizations
NORAD	Norwegian Agency for Development Corporation
ORDA	Organization for Rehabilitation and Development of Oromia
PSNP	Productive Safety Net Program
RWS	Rural Water Supply
UAP	Universal Access Plan
UNICEF	United Nations Children's Fund
USAID	United States Aid for International Development
WADO	Woreda Agricultural Development Office
WATSANCOs	Water and Sanitation committees
WHO	World Health Organization
WWMEO	Woreda Water, Mineral and Energy Office

1. INTRODUCTION

1.1 Background

Water is among the most important resources for developing of all kind of economic and noneconomic activities. The sustainable provisions of adequate and safe drinking water are the most important of all public services. It is a useful natural resource for human and ecosystem needs, as well as economic development. The human right to water is indispensable for leading a healthy life in human dignity. Water is life and especially potable water is essential for life and health. So, access to drinking water, improves overall socio-economic and environmental existence. Sustained growth in human population and economic activity in the world has led to increasing demand for water. In developing countries national and regional governments, local and international NGOs and other concerned organizations invest large sums every year for the implementation of rural water supply projects (Gebrehiwot, 2006).

Worldwide 1.2 billion people are without access to safe water (Klawitter and Qazzaz, 2005). But, according to a report of USAID (2009) more than one billion people do not have access to safe drinking water and over 2.5 billion people have inadequate sanitation. Studies further revealed that one in six and two out of five people worldwide lack access to safe drinking water and sanitation facilities (Dawit, 2007).

In Africa around 300 million people do not have access of safe drinking water and 313 million have no access to sanitation. Breakdown of water infrastructures may affect the coverage as well as the access of potable water supply. It is an alarming fact that, breakdown rates of water supply systems in sub-Saharan African countries exceed 50% (UNICEF, 2007). In global terms, it is estimated that, 30% to 60% of existing water supply systems are inoperative at any given time (Brikke and Bredero, 2003) and the globe is littered with failed water supply and sanitation projects(UNSW- water research center, 2010; Moe and Rheingans 2006). That means Africa has the lowest total water supply coverage of the other continents in the world (ADF, 2005).

Access to safe drinking water supplies and sanitation services in Ethiopia are among the lowest in sub-Sahara Africa. ADF 2005 report shows that about 33% of rural water supply projects in Ethiopia are non-functional (Carter *et al*, 1999).

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 cannot even keep pace with the failure of the old ones in some countries.

The CSIR recommended that in planning for a water supply scheme in an area, the potential sources of water should first be assessed and consideration should be given to the quantity of water available to meet present and future needs in the area as well as the health quality of the water. In order for rural water supply to be sustainable, appropriate technology must be used. Where the technology deployed is remote from the user's capacity to maintain, operate or pay for it, prospects of sustainability of services are equally remote. Therefore, it is experience with a number of projects that can ultimately lead to a better choice of technology (Harnold*et al,* 1999).

Warner & Laugeri (1991) stated that little attention was paid to whether the systems functioned as designed or whether people actually used them. Carter *et al.,* (1999) indicate that few studies have actually quantified consumers' responses to 'improved' water supply technology with few projects measuring actual consumption and time spent on water carrying, pre- and post-construction.

HDWs and developed springs are the most common technology employed for rural water supply projects in the study site. Bosoke Jate and Ilu IguIdoro (2006) state that without the mobilization and participation of people at all levels of society, including women, local communities and the poor, the goal of full coverage is unlikely to be attained.

The quality of construction is crucial for sustainability (Sara and Katz, 1998). Therefore, the construction site should be selected where runoff cannot enter the spring; latrines have not been constructed upstream, and children and livestock are prevented from entering the site (Water Aid, 2011).Furthermore, the construction site should not experience saturation or subject to flooding and eroding processes (Water Aid, 2011).

In general, this study has tried to assess the challenges for design and construction of rural water supply for wuchale woreda.

1.2 Statement of the problem

Sustainability of rural water supply projects and the benefits they deliver is the current overriding concerns of the sector. This is due to the fact that Potable water supply and sanitation services would have a main involvement in the producing our healthy and productive citizens. Every year, thousands to millions of money are invested by national governments and international donor agencies in project implementation despite of increasing attempts to tackle the problems, many still fail to maintain the flow of expected benefits.

Although the effort to increase the potable water supply have been started long period of ago to the existing situation of potable water and sanitation services in urban areas are only better than the rural ones. As of 2004, national water service coverage in Ethiopia was estimated at only 37% (24% rural coverage and 76% urban coverage) (ADF, 2005). This indicates that the consequences of poor water supply coverage in the country are severe. These consequences are more serious in the rural populations that have virtually no sanitation facilities, though only eight percent of the total population has access to sanitation (Zemenu, 2012)

The shortage of water supply threatens food production, increasing demand economic development, sanitation and environmental protection. Problem of water scarcity could be caused by ground water depletion through tapping of groundwater to increase supply without replacement, rapid process of urbanization, consumption and industrialization, expansion of mechanized agriculture and increment of population size.

Proper design and construction of rural water supply schemes are currently not given due attention especially at the woreda levels; and therefore a limiting factor to the improvement of water supply. As Austin et al., (1987) states that a poor choice of technology, manpower, inappropriate construction, and lack of spare parts and supplies for maintaining equipment have led to the deterioration of water facilities. According to Stephenson (1987) the problems can be caused by poor design or the desire to save money, poor construction materials and construction work which were covered up, improper management or maintenance after installation, lack of training of the managers.

1.3 Objectives

1.3.1 General objective

The main aim of this research was to assess challenges for the design and construction of Wuchale Woreda rural water supply.

1.3.2 Specific objectives

The specific objective of the study or activity of the study was the following:

- To assess the role of community participation and their support in the development of rural water supply system in Wuchale woreda.
- To oversee the impact of institutional support given to local communities for water projects.
- To investigate major challenges at the time of design and construction stage of rural water supply projects.
- To assess the functionality and service level of the water supply schemes in the study area.

1.4 Research questions

1. What were the roles of local communities in the development process of rural potable waters supply?
2. What are the level of institutional supports to the community and the responsibilities of the community in the rural potable water supply systems?
3. What are the major challenges at the time of design and construction stage of rural water supply projects?
4. What is the functionality and service status of the existing water supply schemes?

1.5 Significance of the study

The main purpose of this study is to look at what are the challenges in the design and construction of rural water supply projects and to assess the functionality and service level of the water supply systems in the rural areas of Wuchale Woreda of Oromia Region. Therefore, the result of this study will serve as source of information and can also serve as an input for planning and designing for the same project.

1.6 Scope of the Study

The design of the study is to assess the major challenges of rural water supply projects. It has a primary focus on design and construction stage of the water supply projects constructed in the rural part of Wuchale Woreda.

2. LITREATURE REVIEW

2.1 Introduction

Rural water supply (RWS) systems are commonly defined as those water supply systems that operate independently of other formal services (Schouten and Moriarty 2003). These systems maybe rural or otherwise independent of a municipal supply network or, simply, a RWS may be a water system established where the regional water management agency does not have authority or the ability to extend infrastructure (Deverill*et al*. 2004; Swartz and Ralo, 2004).

RWS systems are also defined by a type of management and governance, which is often community based and derived from social rules and socially agreed upon modes of operation (Brooks 2002). RWS projects differ from municipal water development, large-scale irrigation works, or hydropower development in that a RWS project is focused primarily on the management of land and water resources for human consumption in rural areas, through the utilization of local institutions (Cairncross 1992; Narayan 1995; Paudel and Gopal 2004; Swartz and Ralo 2004).Moreover, a RWS improvement project is generally an action, by a community and any collaborators to materially improve the access individuals have to a clean and reliable water source(Lammerink 1998; MacDonald, 2005).

Pearson *et al* (2002) has reported that approximately 75 % of the fresh water on earth is fixed as ice, mainly in the polar ice caps. Out of the remaining 25%, 24% is ground water, and the remaining 1% is surface and atmospheric water. Thus, groundwater is the largest source of fresh water in storage on our planet, and these points to the vital importance of groundwater as a resource for fresh water supplies. However, its distribution in many parts of the world varies greatly with the distribution of suitable underground water-bearing rocks.

2.2 Sources of water supply

According to Turneaure and Russel (1974) water sources are divided into the following classes according to the general sources.

1. Surface water sources
    - Water from springs and seeps.
    - Ponds and lakes
    - Streams and rivers.

- Rain water harvesting from roofs.

2. Ground water sources
    - Water from shallow wells.
    - Water from deep and artesian wells.
    - Water from infiltration galleries.

2.3 Surface water sources

Water that does not infiltrate the ground is called surface water. Surface water appears as direct runoff over impermeable or saturated surfaces and then collecting in large reservoirs and streams or as water flowing from the ground to the surface openings (Water for the world, 2005)

2.3.1 Springs and seeps

Rural communities often collect water from existing sources close to their homes. Many rural areas use a spring. A spring or seep is water that reaches the surface from some underground water system, appearing as small water holes or wet spots on hill sides or along river banks (Water for the world, 2005)The intake structure is located at the source of the spring (called the eye, or the point with in the spring where the spring flow is concentrated and flows a stable channel), and collects the water for transfer to the collection tank (Water for the world, 2005).According to Anderew Tayong the quantity of water a spring produces is known as yield. Yield is studied in terms of flow rate and consistency. Variation in the yield of a spring during the dry season and the rainy season is an important criterion to determine whether the spring is a suitable source. If the ratio between the highest yield in the rainy season and the yield in the dry season is below 20, then the spring has an acceptable consistency and can be regarded as a reliable source in both wet and dry seasons. Christian and Kart (2001) states that springs intended to feed a water supply must be measured for at least a period of one year to estimate the minimum yield.

2.3.2 Development of springs into drinking water sources

Shaw (1999) states that the main objective of spring development and protection is to provide improved water quantity and quality for water supply. Spring development activities include the construction of an intake structures, collection tank, tap stand, and retaining wall and the provision of drainage, fencing and grassed surrounding.

Pearson *et al* (2002) recommended that a typical spring box should have a back wall built with an un-mortared open stone wall to facilitate inflow of the water and should lie between the water table and the impervious rock. The foundation box should be at least 50 cm into the impervious rock below the aquifer, and the top of the box should be higher than the position of high water table.

When springs are used for multiple purposes such as domestic use, livestock watering, irrigation and tanker supply, care should be taken to prevent contamination of water used for human consumption (Muthusi et.al. 2007). Relative to hand dug wells natural or developed springs is easily contaminated by different contaminant agents.

2.3.3 Types of springs

Pearson *et al* (2002) have divided springs into three categories namely: -

- Gravity springs
- Artesian springs
- Karst springs

A. **Gravity springs**: -Gravity springs occur where groundwater emerges at the surface because an impervious layer prevents it seeping downwards. This type usually occurs on sloping ground, although it can be found in areas that seem flat to the eye.
B. **Artesian springs**: - Artesian springs occur when water is trapped between impervious layers and is under pressure. The yield from artesian springs is uniform and the flow is very nearly constant in spite of seasonal variation in rainfall and evapotranspiration over the catchment.
C. **Karst springs**: - these occur where a surface stream disappears into a sinkhole and flows underground along channels, caves and other cavities produced by the chemical and mechanical actions of water on leachable or soluble rocks such as dolomite and lime stone. The water finally emerges a spring at a lower altitude elsewhere. These types of springs also offer a good source of water supply.

2.4. Ground water sources

Ground water is particularly important source of fresh water supply and many communities can only be served from ground water resources. Harvey and Reid (2004) have attributed this to the fact that in most cases the respective population is low to justify the costs of construction, operation and maintenance of dams and treatment works, which are often required in surface water sources. It may also be that there are no suitable dam sites nearby. In such cases, the communities often have to rely on ground water.

2.4.1 Locating potential groundwater sources

Ground water is stored underground in porous layers called aquifers. These aquifers are water saturated geologic zones which have connected pores or fractures that will yield water to springs and wells, and may be visualized as underground storages reservoirs (pearson etal,2002).

2.4.2 Hand dug wells

Hand dug wells are water points that source water from shallow water tables and are excavated in unconsolidated and weathered rock formations such as clay, sands, gravels and mixed soils by the use of picks and shovels or hand hold excavation machinery like jack hammers. Soils can be excavated out with a bucket and rope. A properly constructed dug well penetrating a permeable aquifer can yield 2500 to 7500 m^3/day, although most dug wells field less than 500 m^3/day (tood,1980). Depths of hand dug wells range up to 20 m deep. Wells with depths of over 30 m are sometimes constructed to exploit a known aquifer (Watt and Wood, 1985).The provision of wells as a method of rural water supply is considered carefully at the design stage to ensure a suitable water supply. Harvey and Read (2004) have recommended that the important factors to ensure should be:

- Correct design
- Correct construction
- Correct development/completion.

The main objectives of a good well design should be to ensure the following for water supply boreholes (BOSOKO JATE AND ILU IGU IDORO, 2006):

- The highest suitable water yield with proper protection from contamination

- Water that remains sediment free to protect pumps and to prevent the silting up of boreholes
- A borehole that has a long life
- Optimum operating costs in the short and long term

The materials considered in design include: well head, casing and screen, filter pack, annular seal and grout (USAACE, 1999). The well head should be built on an earthen mound 15 to 20 cm above the ground level so that water will drain away from the well. The casing consists of the solid casing and the perforated portion (BOSOKO JATE AND ILU IGU IDORO, 2006) and the screen is a perforated section of the casing to serve as the intake portion of the casing in a well. Gravel pack is necessary when pumping of water from a borehole may bring fine material such as sand out of the formation in to the borehole and therefore cause problems in the hydraulic performance of the borehole as well as abrasion in pumps. As stated by Todd (1980) wells should be grouted and sealed in the annular space surrounding the casing to prevent the entrance of water of unsatisfactory quality, to protect the casing from corrosion, and to stabilize caving rock formation.

The addition of a lining to the HDWs decreases the likelihood of a well collapsing and excessive loss from seepage. From the Technology Notes published by Water Aid (2011), four different linings have been suggested: pre-cast concrete caissons (cylinders), reinforced concrete, brick, and galvanized iron. When using caissons, the initial concrete cylinder is pressed into the excavation site and the soil extracted from within the cylinder, and as the depth of the well increases, concrete caissons are added as the depth increases (Water Aid, 2011).

2.5 Feasibility study of rural water supply projects

The project feasibility study phase involves the making of a project feasibility study that comprises an evaluation and analysis of the potential of a proposed project and is based on extensive investigation and research to support the process of decision-making.

Munns and Bjeirmi (1996) state that “the project definition and early decision making is critical to overall success and suggest that the broader decisions in selecting a suitable project in the first place are more likely to influence the overall success of the project.” The project feasibility phases the second phase in the lifecycle of a project but the first one is the conceptualization phase(Kerzner, 2006). According to Kerzner (2006) the conceptualization phase involves two critical factors: (1) Identify and define the problem, and (2) identify and define the potential solutions.

Kerzner (2006) gives the following explanation of the feasibility study phase: “The feasibility study phase considers the technical aspects of the conceptual alternatives and provides a firmer basis on which to decide whether to undertake the project.”

In other words, the feasibility study includes an analysis of the project´s viability and focuses on helping answer the essential question of “should we proceed with the proposed project idea?” The end result of a feasibility study is therefore the go/no-go decision. Kerzner (2006) gives a more detailed purpose of the feasibility phase:

- Plan the project development and implementation activities
- Estimate the probable elapsed time, staffing, and equipment requirements
- Identify the probable costs and consequences of investing in the new project

Feasibility studies are typically carried out before the project initiation in support of the proposed business case and provide an accurate assessment of the factors that might affect the project. A feasibility study enables a realistic evaluation of a project, incorporating both the positive and negative aspects of the opportunity (Gardiner, 2005).

2.6 Environmental aspects of rural water supply projects

Harvey and Reed (2003) take the environmental aspect into account in their definition: ‘The water sources are not over-exploited but naturally replenished, facilities are maintained in a condition which ensures a reliable and adequate water supply, the benefits of the supply continue to be realized by all users over a prolonged period of time, and the service delivery process demonstrates cost-effective use of resources that can be replicated’ (Harvey and Reed, 2003). This definition takes the environmental aspect of the source into account, but it gives just a narrow vision on this aspect. Not only might the source be over-exploited; the environment might also be effected negatively by site-effects like wastewater or erosion.

2.7 Water consumption

Gleick (2006) stated that the international acceptable standards for water requirements for basic needs, commonly referred to as basic water requirement (BWR). BWR is defined as water requirement in terms of quantity and quality for the four basic needs of drinking water, human hygiene, sanitation service and modest household needs. This standard is defined by WHO guide line as 20 liters per capita per day (Admassu et. al, 2002). For example, according to Water Aid (2011), a flow of 0.1 liters per second (Lps) would result in a daily flow of about 3,000 liters which would supply a community of 150 people with their water requirements (20L per person per day).However, an addition of a spring collection box or tank would allow even lower flows (< 0.1lps)to be considered for water supply.

The human body's basic water requirement depends on climate, work load and environmental factors. If the work load is high and the season is dry the family use large amount of water per day, whereas the family size increases the amount of water consumed by one person per day decreases relative to the one that small number of family sizes. However, Gleick (2006) defined the minimum requirement for human body and found that it is between 3 and 10 liters per day. The amount of water needed for other purposes, including cooking or hygiene, is more variable and depends on cultural habits, socio economic factors and types of water supply in terms of quantity, quality and availability.

2.8 Selection of appropriate technology for rural water supply systems

It is assumed that whether a technology is appropriate depends on the quality of design and construction. The first sub-indicator is 'guidelines'. Guidelines can be an appropriate measure to ensure the technology only factor determining sustainability, but that it can have a significant impact. The technology choice should not only be made based on the cheapest solution, but also on the availability of spare parts and the costs of operation and maintenance. If local solutions and/or local materials are available, they are preferable since it will eliminate the problems with spare.

2.9 Institutional support

Studies indicated that lack of backing of local community management body is an important reason for the failure of improved water supply schemes (European Commission, 1898). According to Getachew (2002), lack of finance, skilled manpower, inadequate stakeholder participation, lack of coordination among stakeholders, lack of well institutionalized setup and appropriate regulatory framework, and poor infrastructure are considered to be the major causes for low coverage of rural water supply service in the country. Inputs of experienced expertise of hydrology, geophysics, engineering, development planning and sociology are vital in the course of water resource potential assessment, well site selection, and depth to ground water and to hoose the right hand pump option. If assessments such as, groundwater resource and depth to ground water is not well identified, the result mostly would be drywells and thereby unsustainable schemes (Sebsibe Alemneh, 2002).

2.10 Community education or Training

The project approach towards training is for both committee and household level indicated by the training done and by the effectiveness of the training. The effectiveness at household level will be indicated by attendance and awareness. At committee level it is determined by attendance and received topics. The effectiveness is not easy to indicate, but depending on the knowledge people show during interviews and the attendance lists it is possible to indicate whether it is good or bad.

Participation requires training on household and committee level. At committee level the training should provide the needed competences to keep the system operational. Brikké and Rojas (2001) mentioned that an assessment of the management capacity before a project starts is crucial. If capacity building activities appear to be too complex, it might prove necessary to choose for another technology. This also indicates the needed training to run the service efficiently. Training should provide committees with technical information about how to prevent major problems, to operate the water system and repair parts. Further the committee should receive the needed financial and managerial training, especially those skills related to budgets, organizing bills, collection, recording expenses and revenue, monitoring, and applying sanction (Brikké and Rojas,2001). With regard to financial training of the committee Netshiswinzhe (2000) mentions problem. Financial training of the water management committee has mainly focused on basic bookkeeping. The result is that committees don't have the capacity to do financial planning, for example, to recalculate tariffs and deal with non-payment. Training should broaden the local level of financial management capacities instead of focusing on the individual. At household level the main purpose of training is awareness to create user commitment. The first kind of awareness is on the linkage between hygiene and health. Ntengwe (2004) argues that this health and hygiene education should focus on single behaviors, which once they have changed have a positive impact on the community. The education should not be prefabricated, generalized messages, but depending on the situation inside a community. The second awareness is 'what it takes to produce water and have it delivered at the tap near or in households'. This contains the provision of information about cost of pumping, maintenance of lines, treatment, supply and their relation to the water tariff. Research proved that this kind of awareness has a positive effect on the willingness to pay, which will prevent financial problems during the operation and maintenance phase(Ntwengwe, 2004).

2.11 The concept of community participation in rural water supply projects

Community participation is one of the most important factors contributing to water supply service effectiveness (Narayan, 1994 cited in Haysom 2006). The importance of community participation in rural water supply sustainability through prioritization and vocalization of community needs, selection of appropriate facilities, technology and location, financial contribution to capital costs, provision of labor for construction of systems and facilities, management of operation and maintenance, setting and collecting water tariffs, and physical maintenance and repair activities (Harvey and Reed, 2004).

White (1981) considers that the 'depth of participation' is the extent to which *all* members of the community are involved in *all* aspects of a project. To get a better idea from the extent of participation Arnstein introduced the ladder of participation in 1969, which describes the manner in which the community is involved in a project. This ladder shows that the highest form of participation is the one in which the community feels in control in all stages of the project. Netshiswinzhe (2000) argues that almost everybody agrees about the need for participatory development instead of a top-down approach, but still the reality remains that most development work is external driven or top-down. The kind of participation that works is the one in which 'all role-players actually believe that people, regardless of age, sex, educational background, socioeconomic status and history, can actually solve their own problems.' (Breslin and Netshiswinze, 1999 In: Netshiswinzhe, 2000) In summary implementing a project in a truly participatory way implies that the community members feel in control during all project phases and that the beneficiaries become owners, partners and managers.

Participation is about the extent to which *all* community members are in control during *all* phases of the project. This is in decision-making, execution, costs and benefits. The involvement of households during initiation will be indicated by the use of a demand-driven approach. The indicator participation will indicate other aspects of participation, like the empowerment through a community-based organization, the presence of participatory activities, gender-sensitivity, efficiency and transparency of the participation process. The attribution of scores towards all these sub-indicators will be done based on the degree to which the community is allowed and felt to be in control.

Musch (2001) describes three dimensions of participation in water projects: decision making; execution; costs and benefits. Full participation consists not only of a contribution in cash and kind, but also of participation in the decision-making and the benefits. To facilitate all these dimensions of participation there are a lot of participatory methods available. Another aspect of participation is the involvement of *all* community members. Gross *et al* (2001) concluded that the gender and poverty sensitivity pays off substantially in sustainability. It appears from research that the more men, women, rich and poor are in control in all phases of a project, the more satisfied they are and the better the service will be sustained. Sara and Katz (2003) argue that participation at household level is necessary, since community representatives the institution of a community based organization to manage the project during and after implementation is also a form of participation. Sara and Katz (1998) prove that a designate community organization, which manage and oversee the system's operation, is a necessary component of success.' Netshiswinzhe (2000) argues that the more decentralized the system is operated, the better it is. She argues for the decentralization of maintenance and collection. Contribution of the community in cash and kind during all project phases is assumed as to enhance a sense of ownership. Sara and Katz (1998) however found out that it is often seen as a tax and that people don't see the link between their contribution and their choice for a water supply.

3. MATERIALS AND METHODOLOGY

3.1 Description of Study Area

The study was conducted at WuchaleWoreda which is located in Northern Oromia Regional State having an elevation of 2581m above sea level and 80km far away from Addis Ababa. The surrounding of rural villages is accessible through either all weather road or dry weather road networks.

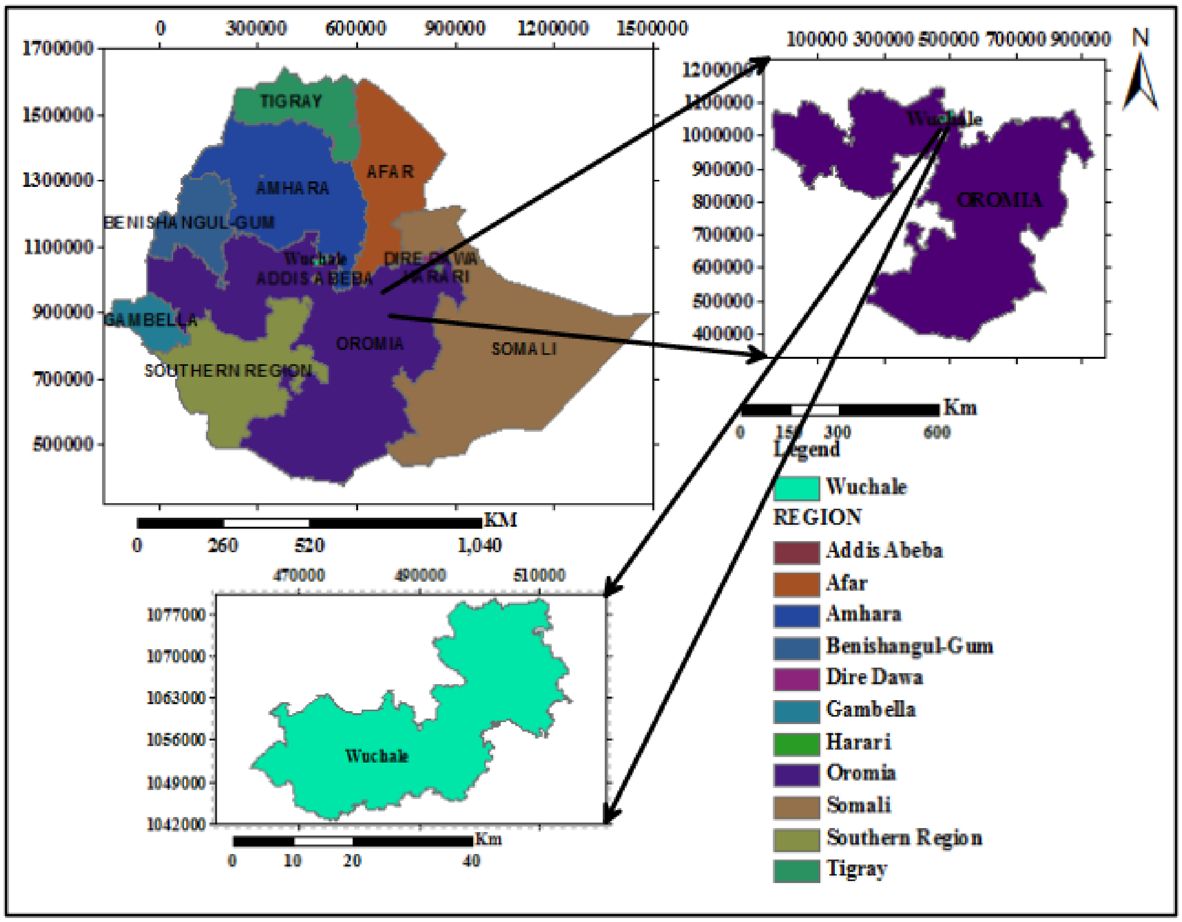


Figure 3.1 Map of Wuchale Woreda

3.2 Study design

The study has involved both qualitative and quantitative research methods to assess the challenges for design and construction of rural water supply projects. The study has emphasized on characteristics features of selected water supply schemes and appropriate investigative analysis of observed incidents. The villages and water points of the study area were selected in close consultation with woreda water experts.

3.3 Data collection methods

Before starting detailed data collection, some general information pertaining to the socio-economic and demographic characteristics, of the communities under study were gathered. This information has been used as a base for planning the field data collection instruments (questionnaires') were prepared and checked through consulting with experts and conducting initial interviews to obtain feedbacks for pre-testing. The feedbacks were analyzed and the necessary adjustment and corrections has been effected on the questioners, interviews and field observation. This improved data collection instruments were used to conduct the actual data collection.

Data were generated through a combination of primary and secondary sources. In this research primarily two types of data collection have been conducted.

Primary data: - the necessary data is collected through a prepared set of questionnaires for household survey, key informants interview (with woreda experts and artisans), personal observation or direct field observation.

Secondary data collection: - collecting all other data which could not be found through questionnaires, interviews and personal observation from official statistics and reports available in the project implementing agencies' offices.

Structured questionnaires have been conducted with the households, artesian (local contractors), woreda water experts and in the study area. The questionnaires are used to assess the challenges of rural water supply projects during design and construction phase as well as to assess the functionality and service level of the schemes in the study area.

Direct field observations were conducted to know the real condition (physical) of the rural water supply schemes. This helped the researcher to identify the appropriateness of construction practice and design methodology, types of water supply schemes and the activities done by the communities, artisans and experts.

3.4 Sampling design

In Ethiopia, rural water supply projects are constructed by local and regional governmental officials, non-governmental organizations and other concerned organizations. In Wuchale woreda the responsible organization for the construction of rural water projects are Organization for Rehabilitation and Development in Oromia (ORDO), UNICEF, Woreda Water Resource Development Office (WWRDO), zonal and Regional Water, Mineral & Energy Bureau. The most commonly constructed systems are developed springs and HDWs.

A systematic sampling technique is employed as the major methods of sampling for the selection of sample schemes (water points) and kebeles. The selection of the schemes was depending on the data from reconnaissance results. During the reconnaissance visit, the researcher have had discussion with the woreda water resource experts, technicians, water users and water committee and responsible body with reference to each scheme visited.

The sample size for each community was extracted from list of beneficiaries who can access the water supply points both within the range of 1.5 km radius and out of this radius based on the list of water supply schemes inventory of Wuchale woreda. As a result 386 households were selected randomly from 30 water points. These 386 households were used as source of primary data for this study. On the other hand, to establish a base line and acceptable scope (i.e. sampling frame) for the analysis and to ensure maximum comparability among sample communities, formal discussion(interview) with local contractors (artesian) was held to get another primary data source. Sample size for respondents was summarized by the following equation.

$$SS = \frac{Z^2 x(P) x(1-P)}{C^2} ------------------------ 3.1$$

Where: SS = Sample Size

Z= Z-value for 95 percent confidence level is 1.96.

P = Percentage of population picking a choice, expressed as decimal

C = Confidence interval, expressed as decimal (0.0499)

$$SS = \frac{(1.96^2) x(0.5) x(1-0.5)}{(0.0499^2)} = 385.7 \approx 386$$

3.5 Materials

GPS, ArcGIS and Woreda Map with Scheme location in the woreda were used. At present, although some Woredas in developing countries are introduced GIS based information system, many countries are still applying conventional methods for collecting, storing, processing and retrieval of information system, but the good news is that GIS have the ability to use previously collected and stored digital data makes introducing GIS easy and not costly.

3.6 Methods of analysis

This is a process of data clearing; refining and transformation to analyze the collected data. On the other hand, the data gathered was analyzed in terms of the study objectives already designed and the existing situation of the water supply schemes. Depending on the nature of the survey different data analysis techniques were used among these descriptive statistics based on percentages to analyze findings. Finding analysis was held through computer software like SPSS, Excel, Word, etc. Finally, data collected during water point mappings was analyzed using graphs and charts to present the information visually.

4. RESULT AND DISCUSSION

4.1 Socio-economic characteristics of the respondents

The study was carried out in Wuchale woreda. From the total respondents 28.57% are female and 71.43% are male. The majority of the respondents are in the age of 20-40 accounting for 71.43%. The age of the respondents above 40 is 28.57%.64.29% of the respondents are farmers involved in crop cultivation (both irrigation and rain fed) and cattle production. Agriculture is the basis of the economy of the woreda. The economic activities of most people in the area are centralized around rain-fed subsistence agriculture. Petty trading is another important economic activity in the district. Accordingly,14.29% of respondents were involved in petty trade. The remaining 21.43% of the community are engaged in government work as teacher and nurses. The educational level of the majority of the respondents are above secondary with 35.71% and 7.14% of the respondents are illiterate, where as 42.86% have reached only primary to secondary. As most of the respondents were farmers, they need their children to help them with farming, livestock grazing and household activities. As the result children's are forced to stop education either at primary school or secondary school (9th to 10th). Only few students who have support from educated relatives living in urban area were able to finish high school and join a university. 64.28% of the respondents are married.

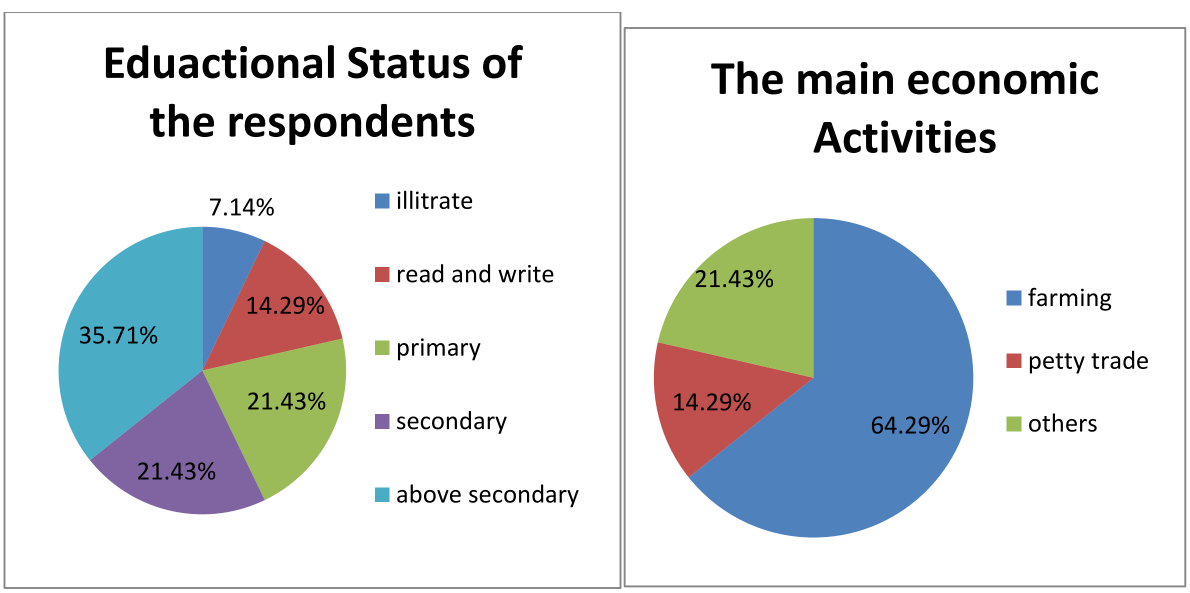


Figure 4.1 Socio economic characteristics of the respondents

4.2 Design of rural water supply projects

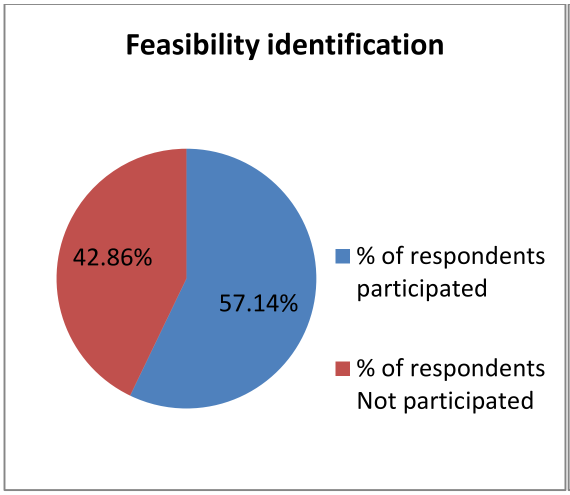
4.2.1 Community participation in the selection of water supply projects

The feasibility study of a rural water supply system aims to investigate the quality and quantity of water from the source. As communities especially Local people are the primary sources of implementation in project identification process, they should be involved in decisions about the feasibility of developing any particular water supply system.

With respect to the community participation, 42.86% of the respondents were not participated in the identification of feasibility of these water supply schemes where as 57.14% of the respondents were participated. Even though more than half of the respondents were participated in the feasibility study of the projects, their contribution at the planning stage of the project is very limited. From the 57.14%, only 35.71% were participated in the planning stages.64.29% of the respondents have no any contribution in the planning stage of the water supply schemes. This shows that the number of participants at the time of site selection were better than those which were participated during the planning stages.

Table 4.1 Respondents participation in the feasibility of projects and during planning stages of the projects

Respondents participation	% of respondents	
	Participated (%)	Not participated(%)
Feasibility identification	57.14	42.86
Contribution in planning stages	35.71	64.29



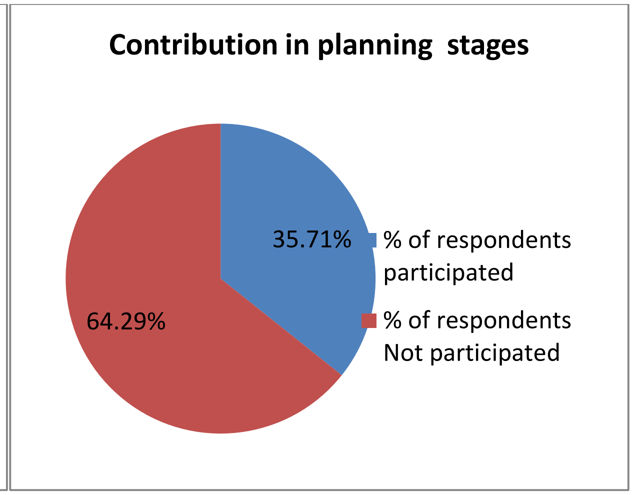


Figure 4.2 Community Participation

The information from the community was both direct and indirect information. The problem in the variation of the information is based on the level of knowledge they have towards a water supply project. As a result selections of feasible projects were not knowledge based as most of the rural communities are illiterate and lack of technical supports. Even though, they are not technical they are a good observer about the characteristics of the sources in their daily activities. So, they can observe the seasonal changes of their surroundings. Generally, community members are expected to be actively involved in the process of interventions through planning, implementation, and evaluation. Furthermore, they are expected to acquire skills and knowledge that would later enable them to take over the project or program.

From the 35.71% of the respondents involved in the planning stage of the projects, 80% of them have contributed an idea (base information) during the development of the project. 20% of the respondents among the participated community were directly involved in identification of the feasible projects.

The responses of the respondents involved in the planning stages regarding the challenges of identifying feasible project indicated adequate water yield (40%), access road (40%) and visibility (40%) as the major ones. The other challenge was rejection of the respondents view and comment. The study found that, 20% of the respondents comment and idea is not taken into account while the project was being developed. This was found to be the main challenge for sustainability of the schemes.

When the participation of the community is valued with the status of schemes, the sites selected by the participation of the community is more functional than those which have less community participation. This means that community participation is lower in the non-functional schemes. However, the numbers of participants were lower in functional schemes. This means that the number of participants at the time of site selection were very low for functional schemes and those which were not participated are higher in numbers.

Besides the community participation, the other main challenges of the non-functioning schemes are due to the failure of fully accepting without any complain by the community. One reason for this is considering the time and distance of fetching water.

4.2.2 Challenges of rural water supply projects during design and construction stage

According to the information from the respondents most of the nonfunctional schemes were due to untimely construction of the projects. This is due to the fact that the level of groundwater will fluctuate between the rainy season and dry season. If the scheme is constructed during the wet season, the level of water will decline during the dry season where the schemes will get problem.

The non-functionality was due to lack of technical supports such as large flow rate of springs located in hilly area and swampy area for HDWs. This indicates that the non-functionality rate will became low if there was cooperation between experts and communities during selection of feasible sites. However, most of the experts were not volunteer to select sites with the help of the community rather they made independently.

Therefore, a full exchange of information between the action agency and the community during all rural water supply project phases is very important for successful water system development and to feel the real ownership of the schemes. Generally, in the feasibility stage of rural water supply projects discussion with community members such as water beneficiaries and water and sanitation committee was the most important issue to continue the whole project healthy and effective. This implies that community participation is the most critical issue in development and selection of feasible sites for rural water supply projects.

For any type of rural water supply projects preparing of design documents and detail estimation of project cost for each water points should be on the hand of woreda water office. It can minimize the conflict between the artesian and the office at the time of the construction period and payment. From the study observation there was no water point having a detail design document except a similar rough estimation of labor cost for the purpose of bid document preparation. Because of this most of the water projects end later than the estimated period. There was no a guide how and in what way they construct the total project activity.

All local contractors perform the whole project without any design documents. This led to conflict between the contractor and the office and difficult to supervise the work activity. For example, fencing of water schemes was one of the activities that conflicts arise between the two parties. According to the local contractor it was the responsibility of the community but they have paid. According to the office members fencing of the scheme is one of the activities done by the contractor. So that at the time of payment always there was conflict.

In general, the common challenge of the water supply projects in the design of the schemes were, lack of considering appropriate and relevant information. Especially constructing the rural water supply points without checking the water yield of the schemes is the big problem. Untimely construction and development of the springs were some of the other challenges. Decline of the water level and drying of the springs were also among the anxieties.

4.3 Institutional support of the communities for rural water supply projects

Out of the total respondents, 64.29% were a member of water committee where as 35.71% were not a member of water committee. According to the respondents result 71.43% of the community including the water committee members have got training for their contribution in the construction of the water supply projects. The time of training for those who were trained was before the construction 30%, at the time of construction30% and during both i.e before the construction and during the construction 40%. From the trained respondents 60% were trained by the woreda experts, 30% by local contractors and 10% by NGO.

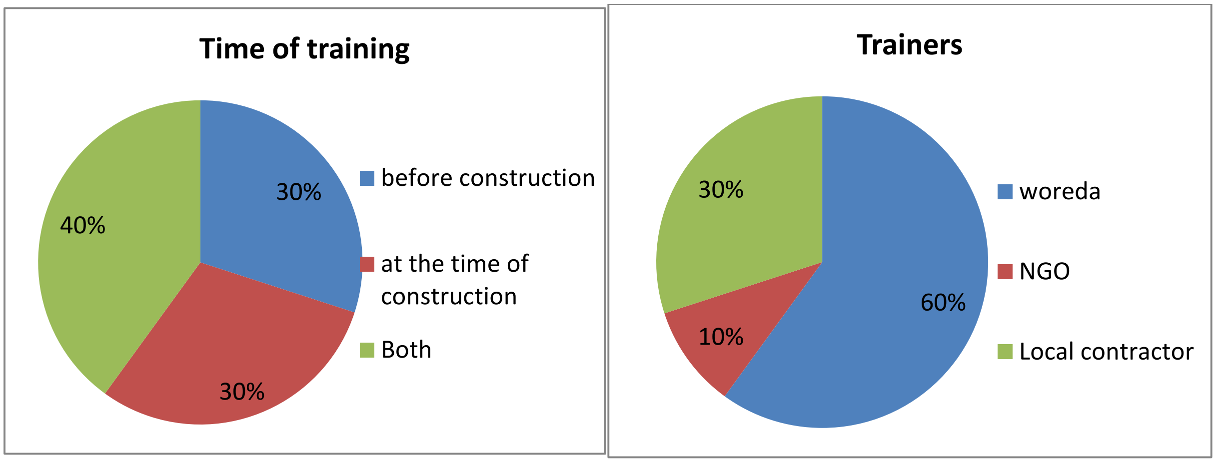


Figure 4.3 Organizational support of the community for rural water supply projects

According to the respondents 53.85% of the trained communities have got technical support during the constructions in addition to the training they have taken and 46.15% have not got any technical support.

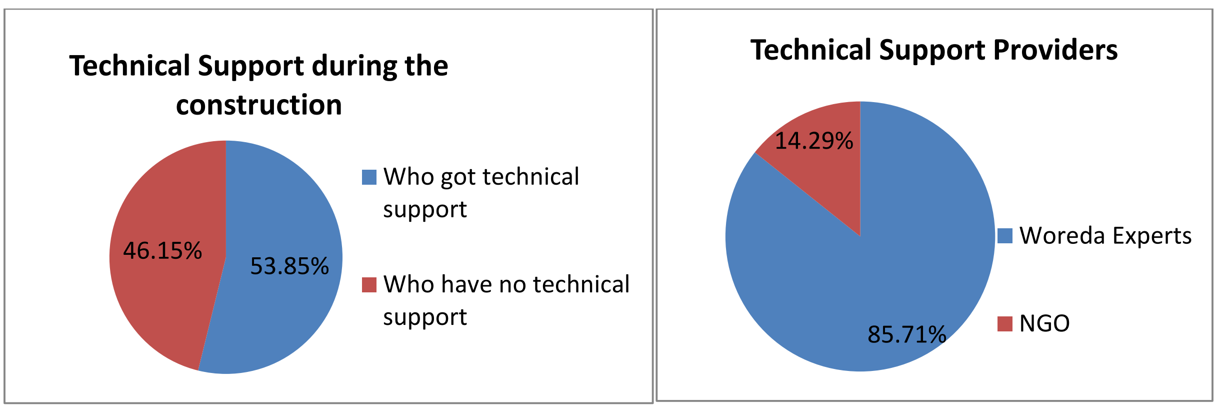


Figure 4.4 Technical supports of the community and the providers

The rural communities and the water and sanitation committee by themselves select feasible schemes and report to the Woreda Water Resource Development Office (WWRDO) for detail design and construction. However, due to the lack of support the respondents were select feasible project without any scientific baseline about the type of the water supply system. In those water supply schemes where there was support the performance of the schemes was good. However, in those schemes where there was no technical support the performance of the schemes was not good.

This indicates that organizational support whether it is from governmental or NGOs can play a great role in rural water supply projects at the initial stage (feasibility) of the project. However, the experts (water engineer, geologist and technicians) of the WWRDO are small in number, especially water engineer and geologist, relative to the number of water supply systems existed in the woreda and area coverage.

Unfortunately, there is no a geologist or hydro geologist to undertake the task of hydro geological nature of the water supply schemes. Due to (absence) small number of water experts the institutional support is very low. There is one water engineer and five technicians for the selection of feasible water project of the total water supply systems in the woreda without geologist support.

4.3.1 Technical supports of woreda water experts for water committee

The major roles and responsibilities of the WWMEO, according to the WWMEO experts and office Head, include: construction of new schemes; maintenance and rehabilitation of existing water supply schemes; promotion of hygiene and sanitation; and follow-up on the quality of NGO water works construction. Despite the fact that the WWMEO has been given a number of responsibilities, performance regarding the annual and strategic plan is very poor. The WWMEO has no permanent head fully engaged in and performing the office's day-to-day activities. The office head is not a water expert by profession, although he has received a number of trainings related to water supply and sanitation and has rich experience in the sector.

Workloads and due to the lack of commitment of some office experts, the office does not coordinate with other actors and sector offices to help the WATSANCos and everyone is busy with their daily work. Generally, the WWMEO does not provide the necessary support to the WATSANCos owing to a lack of the necessary human, finance and logistical resources in the office. Some NGOs has only very few human resources with the necessary qualifications and experience, who take care of all the organization's activities. Compared with other actors, the NGO has a good profile in terms of bringing different stakeholders together through a steering committee composed of the important actors in the sector. In the NGO, there is no detailed and centralized system to provide information on previous activities, which seriously affects the NGO's regular activities. This owes partly to the high turnover of individuals assigned to management positions.

In the WWMEO strategic and annual plan, there was no direct support for the WATSANCos expressed in terms of budget or human resources. According to the office experts, there was no direct support except help in the case of minor breakdowns or mismanagement. The WWMEO also has limited human and logistical resources to undertake its activities. The resource mapping showed that the number of positions in the office and the number of human resources present are not comparable with regard to structural linkages with the WATSANCos; the WWMEO experts had different perspectives. Some said that there is a legal structure between the office and WATSANCos and the office has been providing technical support to WATSANCos, with the WATSANCos responsible to the office. Other experts argued that there is no legal structure, and this is manifested by the absence of a reporting system to the office. The second group said that the WATSANCos are responsible to the kebele leaders. Despite the absence of a common understanding among the experts, WATSANCos have not been reporting financial or other activities to the office. The WATSANCos report to the office only when a scheme breakdown occurs. All the WATSANCos affirmed that they do not report their activities to the office except in the case of breakdowns.

4.4 Constructions of rural water supply schemes

4.4.1 Communities role in the construction of rural water supply projects

If the community involvement is higher, it has an impact on the ownership feeling of beneficiaries. In the construction of water projects communities’ contribution has different forms. According to the respondent’s information 92.86% of them have participated in the construction of water supply projects. Even though majority of the community have good participation in the construction of the project, their level and forms of contribution was different. The most common role of the community is informing of cash, labor, local materials supply and idea or food provision. From the respondents’ analysis, 38.46% of them contribute by labor, 30.77% contribute cash and 23.08% provide local materials. In the other kind of contribution (idea sharing) almost 7.69% of respondents are categorized in this type of contribution. Figure 4.5shows the percentage of the types of contribution by the participated community in construction of the water supply projects.

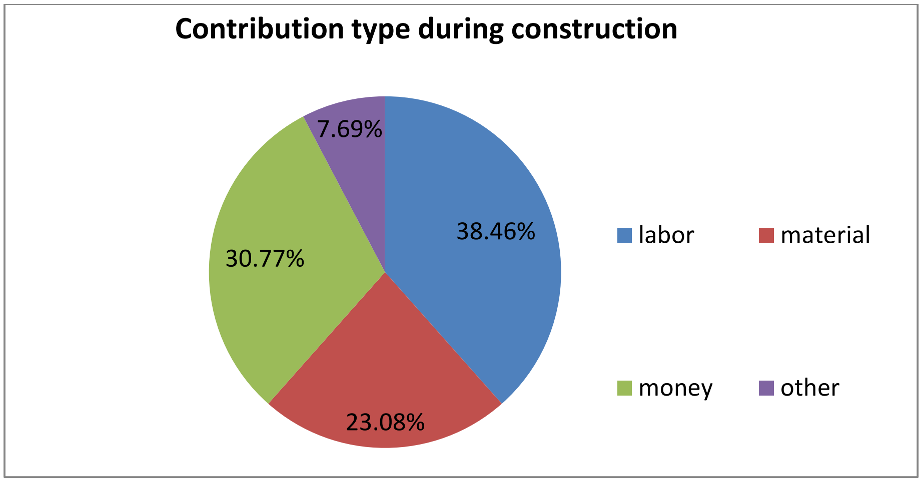


Figure 4.5 Community contributions in construction of the projects

It is known that around most of the population is living in the rural area and they lead their life in agriculture by hand to mouth life style. But In almost all water points the communities contributed money for operation and maintenance before the installation of the project and the contributed money was kept by the water committee treasurer together with WATSANCos accountant or a person selected by the community members. This kind of contribution (in cash) started from the pre-feasibility stage of the project up to the end of the construction period. Labor and local materials are the most predominant contributions of the communities in the study area.

4.4.2 Water committee's contribution

A water committee is an often voluntary body, selected by the community to represent it in discussions and decision making on all aspects of local water management. If a committee is going to function smoothly and meet the needs of the community, it should represent all segments of the community, better off and poor, male and female, groups living in different areas (Bolt and Fonseca, 2001). The most of the users said that the water committees were elected through the active participation of the community. The water committees of these schemes affirmed that there was public participation during their elections. The other users of water schemes, however, said that the water committees were elected by the kebele Council and woreda water experts or technicians without the participation of the community. According to the woreda water experts, the election of the water committee might take place with community participation or the individuals might be selected by the kebele chairperson and the list sent to the office.

All the WATSANCos reported that the WWMEO does not carry out regular follow-up and support supervision unless asked by the committees. According to the WWMEO experts, every year there is a plan to follow up on and supervise schemes and the performance of the WATSANCos, but achievement of this is below 10% because of financial, logistical and human resource constraints. During the field investigation, it was observed that the WWMEO has no checklists for follow-up and supervision, and no field reports of the professionals were seen in the office.

Generally, in the Woreda, there are no clear rules and regulations addressing the accountability of the WATSANCos. No written rules and regulations are in place to facilitate decision making and regulate the user community and committee members. No WATSANCo has prepared a water constitution. According to WWMEO experts, lack of budget, human resources and logistics makes it impossible for the office to coordinate the committees and prepare such constitutions.

The WATSANCos played a great role in coordinating of the community to participate actively by registering who was present or absent. They communicate with the woreda water office experts or technicians about their daily activity. On the other hand, they supervised the local contractors to finish the project with a good quality. The selection of the water committee was considering their educational back ground as well as their knowhow about their surroundings. They contribute more in idea sharing in addition to coordinating the community.

4.5 Functionality and service level of water points

4.5.1 Functionality of water points

Functionality refers to a condition whereby the system provides water to the users. Therefore, the scheme is said to be fully functional when the quantity and quality of the water point is sufficient that the people can fetch water from it. Though it is controversial, shortage of water or less discharge of the well can’t fully satisfy the criteria of a functional and non-functional water scheme.

According to rural water supply universal access plan fully lined hand dug well with raised platform fitted with hand pump designed to serve the community for minimum of 5 years and Capped springs designed to serve the community for at least a minimum of 10 years.

According to the respondents 84.62% said that water points are functional where as 15.38% responded that the water points were not functional. On the contrary, the adequacy of waters supply for the community is getting low currently. Only 23.08% of the respondents have indicated they will get sufficient water for their day to day activities, 53.85%have answered as they are not getting sufficient water. The other remaining 23.08% have answered that the water is sometimes sufficient. The main reason for the inadequacy was high rate of population increment and inefficient yield of the water resources followed by the decline of the schemes.

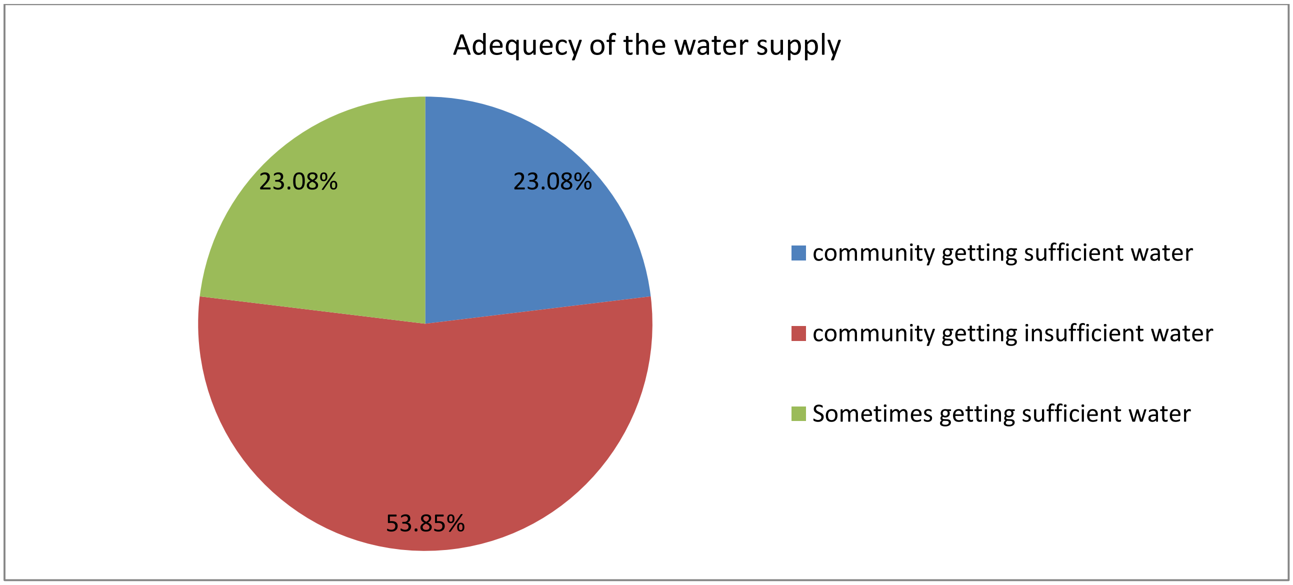


Figure 4.6 Adequacy of the water supply projects

According to the idea of the respondents when scheme breakdowns occur, the speed of maintenance is slow. Maintenance for minor breakdowns is performed within two weeks, whereas major breakdowns take a minimum of one month, with an average of three months.

The followings were identified as the major causes of scheme breakdown:

- Lack of standardized design and construction methods for rural water supply projects in woreda level.
- Lack of regular follow-up and supervision during the design and construction of schemes by woreda experts
- Installation of inappropriate technology and unsuitable site selection; and

- Lack of active community participation during design and construction of the water points

4.5.2 Access to water supply points

In 61.54% of the water points, users reported that there is restriction in water use where the supply is predictable and is available both in the morning and in the afternoon (exact time not known). In the remaining 38.46%, supply water use has no restriction. The water points provide a service for one hour to three hours per day, with an average of eight hours. During the survey, users said that the guard sometimes opens the water points when he/she see queuing around the water point. The time taken to fetch water from the main source ranges from 10 minutes to two hours (round trip), with an average of one hours and 15 minutes. These findings exceed WHO recommendations (WHO, 2006a), set at 30 minutes of walking time for a round trip, equivalent to a distance of about 1km. They also exceed the recommendations in the UAP, which plans to provide improved water to every rural dweller within a 1.5km radius by the year 2012 (MoWR, 2006).

Queuing time varies from season to season. During the dry season the queuing time ranges from 15 minutes to three and half hours, with an average of two hours. In the wet season, the queuing time ranges from 15 minutes to two hours, with an average of one hour and 45 minutes. Therefore, the average round-trip including waiting time is found to be four hours in the dry season and two hours in the wet season.

4.5.3 Satisfaction on water supply service

The study has also tried to address the question of an alternative source of water v when the schemes get failed and when there is shortage of tap water. 46.15% responded that they will fetch water from the river and 53.85% will use un protected springs.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

According to the analysis community participation starting from the design up to the end of the project as well as after construction was essential to feel the real ownership of the total project. However, in the study area the participation of community was very low. Community participation in the functional water schemes were more than the non-functional water points.

The water points provide a service for one and half hours per day on average. Water points often start providing a service when queues begin. In most of the schemes with more than one water point, points are not placed at a reasonable distance to serve the majority of the community. The time spent to collect water is also high.

This study elicited the main reasons why water supply systems have become nonfunctional within a short time after installation in Wuchale Woreda. Field survey, personal interviews, and field observations were done to collect the relevant information about the water supply schemes in the woreda. It is usually assumed by donors that all people can pay and a framework of a sliding payment schedule based on income is established usually. However, there is no true tariff stricture to establish water fees. The community has been paying only at the beginning of the project development. Once they paid their share, they were free to get their service. They believe that the operation and maintenance cost should be covered by the local government and project owners because the salary of the guards and expenses for receipt take greater part of operational costs in the study area. Consequently, the general held belief that community involvement is the most crucial factor in the failure rate of a water supply system does not seem to be an important factor in the wuchaleWoreda because often community participation is not from their own motivation but enforced by the local government. However, there is substantial contribution from local communities during the project implementation phase. The provision of materials, provision of workers and monetary contribution is encouraging. In this regard, contribution of labor by the community is dominant.

It was found that community involvement in site selection and the type of technology was weak. This indicates that water supply projects were developed from the supply side and not based on any particular demand from the community. In such cases, community members often expressed dissatisfaction with the service, possessed a low sense of ownership, and had little willingness to-pay for the maintenance and sustainability of the service.

The establishment of a water committee has a significant effect on sustainability of water supply schemes as a committee is important for producing plans for new water supply systems and maintenance of old ones.

As reported by Rural Water Supply and Environmental Program and in accordance with our findings, the wuchale woreda offices are greatly understaffed and unable to deal appropriately with the many water supply projects that are being installed. Therefore, the woreda personnel cannot provide sufficient supervision of the contractors who are installing the systems, and this lack of supervision can result in poor workmanship. The local leaders can provide this supervision to the local contractor, and these local leaders can make sure that the correct site for the water supply is selected. Thus, the construction quality of the schemes had a major impact on sustainability.

The results from field observations confirmed that there were construction quality problems for many of the studied water supply points, especially the nonfunctional ones. When construction quality was poor, systems had a lower chance of sustainability. Systems built by private contractors were not consistently better or worse than those built by community members. The study found that most of developed water points were not properly protected. Moreover, there was no integrated approach to the conservation practices to be conducted by the community.

However, the study reveals that an extended time is required to fetch water for daily use. Without considering the time of travel, people stay for at least two hours waiting to fetch water at some water points. Furthermore, seasonal shortages of water occur. Despite this, the degree of satisfaction with general services is higher.

One of the most conclusive findings of this study is that both household and water committee training before and after the after project plays an important role in ensuring sustainability. The training approach for water committees is inconsistent since some committees have received trainings multiple times while others have not received a single training.

5.2 Recommendations

The following recommendations have been drawn from observation and from suggestions from users, Water and Sanitation committees, Woreda Water, Mineral and Energy Office and other concerned bodies; in order to avoid challenges during the design and construction of the schemes as a result the service period of the schemes will be increased.

- Daily supervision when the spring eyes are cleared and capped to collect the whole eye of the spring.
- Check the reliability of the well water before installing of the caisson rings.
- Check the water yield of the schemes before and after the completion of schemes.
- Make the daily water demand of the beneficiaries before going to construction of the water.
- Increase the involvement of some NGOs in the rural water supply projects because of their quality work.
- Participation of the community throughout project development phases to create a sense of ownership.
- Technical support to the community, water committees.
- Technical support for the woreda water experts regarding to the design and construction of rural water schemes.
- Legal frame work of the Water and Sanitation committees to solve prevailing management problems.
- Regular follow-up and supervision during the design and implementation of newly constructed schemes to avoid leading to recurrent scheme failure.
- Regular follow-up and supervision of the Water and Sanitation committees and schemes to prevent mismanagement and to check on scheme status during construction.
- Establishment of design standards and construction methods depending on the reality of the Woreda.

REFERENCES

1. ADF (African Development Fund) (2005) Rural Water Supply and Sanitation
2. Admassu, Mengesha, Abera Kumie, Misganaw Fantahun (2002) Sustainability of Drinking Water Supply Projects in Rural of North Gondar, Ethiopia, *Ethiopian J. Health Dev*. 2003; (3):221-229.
3. Austin, John D., and Jordan, James K. (1987). Operation and Maintenance of Water Systems in Developing Countries. *Journal of American Water Works Association*, vol. 79, no. 7, pp. 70-77.
4. Biswas, A. (2005) an Assessment of Future Global Water Issues: *Water Resources Development.*
5. Breslin, N., 1999. Lessons from the Field: Rethinking Community Management for Sustainability. Paper presented at Conference on; Rural and Peri-urban Water Supply and Sanitation in South Africa - Appropriate Practice Conference 14-17 March 1999, East London. Available at: http://www.crosslink. net/~ehp/breslin.htm.
6. Brikke, F. and Bredero, M. (2003). Linking Technology choice with operation and maintenance in the context of community water supply and sanitation, Switzerland; World health organization and IRC water and sanitation center.
7. Brooks DB. (2002). Water: Local-Level Management. International Development Research Centre. Ottawa, Canada.
8. Cairn cross S. (1992). Sanitation and Water Supply: Practical Lessons from the Decade Water and Sanitation Discussion Paper Series, DP No. 9.
9. Carter RC, Tyrrel SF, Howsam P. (1999). Impact and Sustainability of Community Water
10. CSIR, Building and Construction Technology (2000). Guidelines for Human Settlement Planning and Design (the redbook). Chapter 9. Revised 2003.
11. Dawit Kebede, 2007. *Water Supply and Access in Rural Africa*. "Churches for Water in Africa" May 21-25,2007. Botanical Beach Hotel Intebbe, Uganda. Available at: http://www.ian/
12. Deverill P. and Smout I., (2004). Designing to Meet Demand: Putting Users First. EDC,
13. Gardiner, P. D. (2005). *Project management: A strategic planning approach.* Macmillan.

14. Gebrehiwot M. (2006) An Assessment of Challenges of Sustainable Rural Water Supply: The Case of OflaWoreda in Tigray Region. MSc Thesis, Regional and Local Development Study (RLDS). A.A.U. Ethiopia.
15. Getachew Abdi, 2002. Managing Sustainable Rural Water Supply in Ethiopia. Available at: http://www.ilri-org.
16. Harvey P.A. and Reed P.2004.Rural Water Supply in Africa: Building Blocks for Hand pump Sustainability, WEDC, Loughborough University, UK
17. Harvey, A. & Reed, A. (2007) Community-Managed Water Supplies in Africa:Sustainable or Dispensable? Community Development Journal 42: 365–378
18. Harvey, P. and Reed B. (2003). Rural Water Supply in Africa: Building Blocks for Hand pump Sustainability. WEDC, Loughborug University, UK.
19. Jennifer Sara and Travis Katz, *Making Rural Water Supply Sustainable*, Report on the Impact of Project Rules, UNDP-World Bank Water and Sanitation Program, 1998
20. Kerzner, H. (2006). *Project management: A systems approach to planning, schedulingand controlling* (9th ed). Wiley.
21. Kleemeier, E. (2000) the Impact of Participation on Sustainability: An Analysis of the Malawi Rural Piped Scheme Program: *World Development.*
22. Kleemeier, L,1995. From Supply Driven to Demand Driven Provision of Rural Drinking Water. A Tanzanian Case Study of the Arguments for Transition. CDR working Paper.
23. Lockwood, H. (2002): Institutional Support Mechanisms for Community managed Rural Water Supply & Sanitation Systems in Latin America: Environmental Health Project, U.S. Agency for International Development Washington, DC 20523
24. Muthusi F.M., Mahamud G., Abdalle A., Gadain H.M. (2007), Rural Water Supply
25. Narayan D. (1995). 'The Contribution of People's Participation: Evidence from 121 Rural Water Supply Projects', Environmentally Sustainable Development Occasional Paper Series No. 1 World Bank, Washington, D.C
26. Paudel GS, Gopal BT. (2004). Impact of social, institutional, and ecological factors on land management practices in mountain watersheds of Nepal. *Applied Geography* 24, 35 55. Projects in India: Evidence from Rural Water Supply, World Development 33,
27. Sara, Jennifer and Katz, Travis (1998) *Making Rural Water Supply Sustainable: report on the impact of project rules*. UNDP World Bank Water and Sanitation Program.

28. Sebsibe Alemneh (2002): Guidelines on sustainable Community management and financing of rural water Supply and sanitation. COWDO, Addis Ababa, 2002
29. Shaw R. 1999. Running Water International Technical Publication, London.
30. Stephenson, David (1998). *Water Supply Management.* Dordrecht, the Netherlands. Kluwar Academic Publishers.
31. Supply and Sanitation Programs in Developing Countries. Journal of the Chartered Institution of Water and Environmental Management 13. 292 - 296.
32. Swartz CD, Ralo T. (2004). *Guidelines for Planning and Design of Small Water Treatment Plants for Rural Communities, with Specific Emphasis on Sustainability and Community Involvement and Participation.* Water Research Commission, WRC Report No: 1185/1/04. ISBN No: 1-77005-103-1.
33. Turneasure F.E. and Rusel H.L. 1947. Public Water Supplies, Fourth Edition, John Wiley and Sons, Inc. (pp. 32, 39)
34. UNSW water research center (2010). http://water.unsw.edu.au/site/waterunsw/community-outreach-projects/watsan/
35. USAID (2009) Environmental guidelines for small-scale activities in Africa: Chapter 16 water and sanitation.
36. Warner, D., & Laugeri, L. (1991). Health for All: The Legacy of the Water Decade. *Water International*. 16(3), 135-141.
37. WHO (2000): Global Water Supply and Sanitation Assessment 2000 Report World
38. Zemenu Awoke (2012) Assessment of challenges of sustainable rural water supply: Quarit woreda, amhara region

APPENDIX A

Socio-economic and demographic characteristics of the respondents

This questionnaire is part of a research work, which is being conducted to assess the challenges for the design and construction of rural water supply in North Shoa Zone Wuchale woreda.

Are you interested to answer to my questions?

So, you are kindly requested to answer the questionnaire as truly as you can and your answer will be taken in confident. Thank you!!

General Information

Project: ____

Village: ____

Questionnaire number: ____________________________________

<u>Socio-economic and demographic characteristics of the respondents</u>

1. Age _____________
2. Sex _______________
3. Family No. ________________
4. Marital Status
    A. Married
    B. Separated
    C. Unmarried
    D. Widowed
    E. Other
5. Educational Level
    A. literate
    B. read and write
    C. primary(1-8thgrade)
    D. 4.secondary(9-10thgrade)
    E. above secondary
6. What is your families' economic base?
    A. Farming

B. petty trade
C. others, (specify)

APPENDIX B

Design of Rural Water Supply Projects

I. Community participations

1. How many years have you lived in this area?
    A. 40 years
    B. 35 years
    C. 30 years
    D. 30 and Above
2. How many sites were there around your residential area before construction of this new water project?
    A. None
    B. One
    C. Two
    D. Three and above
3. Did you get any chance to participate in the identification of feasibility of these water supply systems?
    A. Yes
    B. No
4. Did you have any contribution at the planning stage of this project?
    A. Yes
    B. No

If answer is no why, ____ If your answer of question is yes answer question no 4- 8

5. What type of contribution did you have during the development of this project?
   A. Planning.
   B. Identification of feasible projects.
   C. Implementation.
   D. Idea.
   E. Other Specify _____________

6. How many sites were selected by you in the project feasibility stage?
   A. All
   B. One
   C. Two
   D. Three
   E. Four and above

7. What are the challenges doing you face during the identification of feasible projects?
   A. Visibility
   B. Access road
   C. Inadequate Water yield
   D. Other specify ______________

8. Do you think that your views and comments were respected and taken into account while the project was being developed?
   A. Yes
   B. No

II. <u>The roles of woreda water experts in the design of feasible rural water supply projects.</u>

1. How do you Identified studying site?
2. How do you Identified the feasibility of site?
3. How did you know the yield of the Hand dug well or the spring?
4. Has your office followed demand driven approach?
5. What type of hand pump do you use for HDW?
6. How much meter is this water project far from public institutions such as schools, health centers etc.?
7. By how much distance is this water point far from the river?
8. How did you measure the water yield of the spring and hand dug well?
9. In which season did you measure the yield?
10. In what ways did you measure the water yield of this scheme? Why?
11. How much liters of water do the community use per day?
12. Do you think that this water project is easily accessible by the users?
13. Does the community use this water project for other purpose (other than domestic purpose)?
14. How did you consider these needs during the designing phase?
15. Did your office prepare design documents and BOQ for each water projects?
16. Did your office give chance to the community in choosing feasible sites?
17. Did you get the necessary information from the community to decide whether the project is feasible or not?
18. In what ways did you approach to get this information?
19. What types of information did you get?
20. Did you think that this project was fully acceptable by the users?
21. How much money did you get per sites?
22. What is the advantage to have this money?
23. How did you communicate with the community to contribute the O and M costs?
24. Did your office make EIA for the whole water projects?

APPENDIX C

The Construction of Rural Water Supply Schemes.

I. Points discussed with the communities or water committees.

1. Do you have any contribution in the construction of this water projects?
   - A. Yes
   - B. No
2. If your answer is yes for question no. 1 what was your contribution?
   - A. Labor
   - B. Material
   - C. Money
   - D. Food
   - E. Other
3. Are you a member of water committee?
   - A. Yes
   - B. No

If your answer of question No. 3 answer question no. 4-12

4. Who select you as a water committee?
   - A. By Kebele Council
   - B. By Woreda water experts or technicians
   - C. By the community
   - D. By Kebele chairperson
   - E. Other specify_____________
5. What was the criteria to be selected as water commite?

A. No criteria
B. Educational l back ground as well as knowing about the surroundings.
C. Ability of coordinating the community
D. B & C
E. Other Specify________________

6. Do you get training?
   A. Yes
   B. No

If your answer is yes for question no.4 is yes answer question no. 6-12

7. When did you get the training?
   A. Before the construction
   B. At the time of construction
   C. Both
   D. Other Specify ____________________________
8. By whom the training was given?
   A. By Woreda experts
   B. By local contractor
   C. By NGO
   D. Other specify
9. How many days did it take to trainee?
   A. 5days
   B. 10days
   C. 15days
   D. Above 15 days
10. Did you follow the construction day to day?
   A. Yes
   B. No
11. If you say yes for question no. 9 how?

A. By in coordinating of the community to participate actively by registering who was present or absent.
B. By communicating with the woreda water office experts or technicians about daily activity.
C. By supervising the local contractors to finish the project with a good quality.
D. By idea sharing
E. All
F. Other specify ________________

12. If your answer is no. for question no. 9 why?
    A. There is no prepared a water constitution
    B. I am not accountable to follow the construction
    C. There are no checklists for follow-up of the construction
    D. Other specify_______________________
13. Did you get any technical support during the construction in addition to the training that you have already achieved?
    A. Yes
    B. No
14. If your answer is yes for question no. 13 By whom?
    A. By woreda experts
    B. By Zonal Experts
    C. By oromia Experts
    D. By NGO Experts
    E. All
    F. Other Specify ___________________________

The roles of woreda water experts in the construction of rural water supply projects.

1. At what time did you start the construction of the Project?
2. Why did you start in that time?
3. Is there any legal structure between your office and communities during the construction period?
4. Did the communities participate in choosing the construction material for the construction of hand dug wells and spring developments?

5. In what ways do you support communities and contractor to accomplish the project?
6. How did you manage the site preparation of a spring development to collect the whole eye of the spring?
7. Did you follow up while the spring eye is tapped (collected)?
8. Did you make contractor supervision during the installation of caisson rings for hand dug wells?
9. How did you prepare caisson rings for hand dug wells?
10. In what ways did you install the caisson rings?
11. Did you construct flood retaining wall or diversion ditches?
12. How many Sites have this structure?
13. How did you arrange the sand filter for both spring development and hand dug wells?
14. What type of sand filter did you use for screen purpose?
15. How many water supply schemes are protected by fence?
16. Which types of systems are more protected by fence?
17. Did you think that the whole scheme was finished on times? And why this is happened?
18. Are there any sites postponed for the next year? And how many are they?

APPENDIX D

Functionality and Service Level of Water Supply Schemes

Points discussed with the water users on the functionality and service level of the schemes.

1. What is your main source of water supply?
   A. Water point
   B. Hand Dug Well
   C. Spring
   D. River
   E. Other, specify________________

2. Is the water point functional?

   A. Yes

   B. No

3. For how long is the water point open every day?

   A. 4hrs

   B. 6hrs

   C. 8hrs

   D. 10hrs and above

4. Do you have a restriction on water use?

   A. Yes

   B. No

5. If your answer of question no. 4 is yes, how many jars of water one household is allowed to take?

   A. Three

   B. Four

   C. Five

   D. Six and above

6. Is the water sufficient for your daily activities?

   A. Yes, it is sufficient

   B. No, it is insufficient

   C. Sometimes it is insufficient

   D. Other, specify________________

7. How long do you take to fetch water from your home?

   A. 5min

   B. 10min

   C. 15min

D. 20min and above

8. Where do you get water from when the scheme fails to work and there is a shortage of tap water?

A. River

B. Pond

C. Unprotected spring

D. Other specify__________________________

9. How many times do you fetch water per day?

A. Once per day

B. Twice per day

C. Three times per day

D. Other specify____________________

10. What means of transportation do you use to transport the water?

A. By labor

B. Horse

C. Donkey

D. Other specify __________________

11. How frequently you travel to fetch water per day?

A. Every other day

B. Once per day

C. Twice per day

D. Three times per day