ASSESSMENT OF SUSTAINABILITY OF RURAL WATER SUPPLY SCHEMES:

A CASE STUDY OF DAMOT GALE WOREDA,

WOLAITA ZONE, SOUTHERN ETHIOPIA

M.Sc. THESIS

BY

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A THESIS SUBMITTED TO THE DEPARTMENT OF WATER RESOURCE AND IRRIGATION ENGINEERING

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STATEMENT OF AUTHOR

I, Gelan Gasho Malako declare that, this thesis is my own original work and it has not been presented to any other university for perusing similar degree award. Moreover, all the source of materials used for the thesis is duly acknowledged.

Name: Gelan Gasho Malako

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BIOGRAPHICAL SKETCH

The author was born on February 16, 1980 at Wolaita zone, Damot Gale. He attended his elementary education at Boditi primary school. He followed his secondary education at Boditi Secondary and preparatory School. After completion of the secondary school he joined Jimma University and obtained first degree at chemistry in 2006. He joined Hawassa University to follow his master program in Water Resources Engineering and Management.

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LIST OF ABBREVIATIONS AND ACRONYMS

CSA	Central Statistical Agency
DGWWMEO	Damota Gale Woreda Water Mines and Energy Office
DGWFEDO	Damota Gale Woreda Finanace and Economy Development Office
FGD	Focused Group Discussion
JMP	Joint Monitoring Programme
GTP	Growth and Transformation Plan
HH	Household
KII	Key Informant Interview
Km	Kilometer
lpcd	litres per capita per day
MDGs	Millennium Development Goal
MoWE	Ministry of Water and Energy
MOWRD	Ministry of Water Resource Development
mpcd	Minutes per capita per day
NGO	Non-Governmental Organization
O&M	Operation and Maintenance
RWSS	Rural Water Supply Scheme
SDG	Sustainable Development Goal
SNV	Sanitary Napkin Vendor
SPSS	Statistical Package for Social Science
UN	United Nations
UNICEF	United Nations International Children Fund
WASH	Water Sanitation and Hygeine
WASHcos	Water Sanitation and Hygeine Committes
WHO	World Health Organization

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ABSTRACT

The Sustainability Development Goal targets to reduce the proportion of people without sustainable access to safe drinking water, but huge disparities still exist. The main objective of this study was to assess the main factors affecting the sustainability of rural water schemes in the Damot Gale Woreda. The main factors considered were: water usage, water quality, time spent to collect water, service provision, service interruption, water tariff, willingness to pay, management factors, choice of technology and environmental factors. Data was collected using questionnaires, focused group discussion, field visits and key informant interview. Statistical Package for Social Sciences (SPSS) was used to analyze the data and to calculate sustainability scores for water schemes. The analysis showed that the average daily water usage was below the mean, i.e 20 to 40 liters/ household. About 75.47 % of the beneficiaries spent more time to collect water than the standard (30 minute round trip). About 73.21 % of the beneficiaries were dissatisfied with the absence of operator during water collection. About 57 % of beneficiaries answered there were service interruptions because of system failure rated at 77.74 %. About 50.18% of water users perceived taste and odor problem. About 23.02 % of beneficiaries argued that the newly set tariff was expensive and 34.34 % are not willing to pay. The results indicated that the main factors which made the schemes unsustainable were: long fetching time; service interruption due to scheme failure; new water tariff; willingness to pay and commitment of all members. Water service providers and the community should address the identified affecting sustainability factors in their conception, planning, construction and post construction management activities of rural water supply schemes. Therefore, the findings call for adopting demand responsive approach, strengthening community participation, building community capacity to manage water supply schemes properly, establishing effective user fee collection system, developing trusted and transparent system of funds management, choosing appropriate technology, building local technicians' capacity, minimizing problems related with availability of spare parts, improving construction quality as well as strengthening the capacity of the leading office at Woreda level to support rural communities in managing water supply.

Key words: Damot Gale, Sustainability, Water supply schemes

CHAPTER ONE

1. INTRODUCTION

1.1 Background

Water is a common property resource and is a critical factor for sustainable livelihoods. All households need water for domestic use i.e. for drinking, cooking, washing, cleaning, etc and for productive use. Access to adequate, clean and safe water greatly contributes to improve health and productivity (Rahmato, 1999). Access to clean water and sanitation is declared as a human right by United Nations in 2010 (UN, 2013). Improved water supply and sanitation, and better management of water resources, can boost countries' economic growth and can contribute greatly to poverty reduction (WHO and UNICEF, 2017). It is a pre-requisite for the realization of many human rights, including those relating to people's survival, education and standard of living. To a greater or lesser extent, these rights are denied where people are unable, for whatever reason, to access safe water.

On other hand, insufficient access to water is not only bad for heath, but also contributes to food insecurity and lagging social development. By the end of 2017, globally, an estimated 785 million people lack even a basic drinking-water service, including 144 million people who are dependent on surface water, the majority in developing countries, while 2.2 billion people without safely managed services, the large majority of those living in rural areas (WHO and UNICEF, 2017). 90% of the global population (6.8 billion people) used at least a basic service and 61% in sub-Saharan Africa. In Ethiopia has the lowest safe water coverage in Sub-Saharan Africa and only 41% population gets least a basic service. Regarding to report, 71% of the global population (5.3 billion people) used a safely managed drinking-water service that is, one located on premises, available when needed, and free from contamination. While, at national level about 11% of the Ethiopia population used a safely managed drinking water service and 5% population living in rural area of Ethiopia gets safely managed water supplies. The proportion of people without access to safe drinking water is significantly higher in rural areas than urban areas throughout the less developed world (Harvey, 2005).

In Ethiopia, In order to meet the Millennium Development Goals (MDG) for water and to halve by the year 2015 the proportion of people without sustainable access to safe drinking water, huge international investment and effort is still required. This task was made even harder by the low levels of sustainability prevalent in low-income countries. It is estimated that 35% of improved rural water supplies in Sub-Saharan Africa are out of service at any given time (Harvey, 2005).

With the adoption of the SDGs, governments have committed to achieve universal and equitable access to safe and affordable drinking water for all by 2030. This means closing the urban-rural and equity gap and delivering higher levels of services, in terms of quality, accessibility, and reliability. However, rural water supply systems (RWSS), especially those in developing countries, are characterized by their infrastructure and technology deficit and a lack of knowledge or experience among those operating or managing the systems (Dickson *et al*,.2016). Thus, sustainability of a water supply schemes and its supply service level are multifaceted. There are social, technical, financial, institutional and environmental issues to address (Brikke and Bredero, 2003). To achieve sustainability of water supply schemes, it is vital to have the involvement of all segments of the community, in the form of full participation and control over the schemes operation and maintenance (O&M), overall management, strategic decision making, ownership and cost sharing for O&M), and construction activities (Lockwood, 2004).

Poor sustainability of rural water supplies has been recognized for some time, and a number of management approaches have come and gone with the aim of addressing these problems, (Lockwood and Smits, 2011). Unsustain water points deprive people of intended health and livelihood benefits, (Shaw, 2012). There are a number of research studies which show that the sustainability of rural water supply system is dependent on many factors. The widespread failures in water supplies have been attributed to a complex mix of Policy, legal and institutional factors; Social factors such as demand for water, community participation and community organization; Economic factors such as ability to meet the cost of maintenance and ability to pay for services; Technological factors such as technology choice; availability of spare parts and operation and maintenance; and finally Management factors, (Parry-Johnes, 2001, Harvey and Reed, 2004; Mukherjee and Wijk, 2002; Sugden, 2003; Harvey and Skinner 2002).

In rural area of Damot Gale Woreda attempts has been made towards increasing coverage through national and regional development framework. According to WASH inventory done in 2017 in the Wolaita Zone, the rural water supply coverage at zonal level has 37.65 % and for Woreda has reached 27.01 % within the 1 km radius (DGWWME, 2019). However, this water coverage is far below the Ethiopia rural water coverage 61% at end of 2017. The same report indicated that there are a total of 200 different types of rural water supply schemes in the Woreda. However, the inventory data of the Woreda show that out of the total water supply facilities only 139 are functioning while the rest 71 are either non-functional or fully abandoned. In other words, 35% rural water supply systems are not sustainable in Damota Gale Woreda. This is above the Ethiopia national level schemes non-functionality.

Therefore, the above problems indicate the importance of investigation of the rural water supply systems in the area and finding out the strategies to improve the sustainability of the schemes. Thus, this study assessed the sustainability of the water supply schemes in the rural area of Damot Gale Woreda, Wolaita Zone, Southern Ethiopia.

1.2 Statement of the Problem

According to Lockwood and Smits (2012) water supply schemes in rural areas often appears to be at the expense of the sustainability of services already in place. The problem is that many of rural water supply schemes in the developing world are not working to the optimum level (Montgomery *et al.,* 2009).

There are a number of research studies which show that the sustainability of rural water supply system is dependent on many factors. The widespread failures in water supplies have been attributed to a complex mix of Policy, legal and institutional factors; Social factors such as demand for water, community participation and community organization; Economic factors such as ability to meet the cost of maintenance and ability to pay for services; Technological factors such as technology choice; availability of spare parts and operation and maintenance; and finally Management factors, (Parry-Johnes, 2001, Harvey and Reed, 2004; Mukherjee and Wijk, 2002; Sugden, 2003; Harvey and Skinner 2002).

The interventions were made by governmental and non-governmental organization in the study area particularly to develop new water supply schemes and upgrading traditional spring development. According to the national WASH inventory were done in the Woreda in 2018/2019, 35% of the total water supply schemes are non-functional due to lack of improved scheme management, monitoring systems and other problems are facing a number of factors that influence the sustainability of the schemes. Poor environmental management, uncontrolled liquid and solid waste disposal, which are common in the study Woreda, need to be looked at to maintain water quality.

Therefore, there is no question that sustainable use of water resources needs greater attention throughout Ethiopia. Although other functioning schemes in the woreda, are operating below their capacity and service level are in question. Thus, this study endeavored to answer the underlying causes of poor sustainability of rural water supplies schemes in Woreda and specifically study area. Therefore, this study aimed to assess the water supply scheme sustainability in the Damot Gale Woreda, Wolaita Zone, Southern Ethiopia.

1.3 Objective

1.3.1 General Objective

The general objective of this study was to undertake an assessment of the sustainability of water supply schemes in rural areas of Damot Gale Woreda, Wolaita Zone, Southern Ethiopia.

1.3.2 Specific Objectives

The specific objectives of the study were:

- To assess sustainability of rural water supply schemes (RWSS) in Damot Gale Woreda,
- To investigate the factors that determines sustainability of RWSS in study area,
- To determine the level of functionality of the RWSS in Damot Gale Woreda; and
- To determine the water quality in the schemes.

1.4 Research Questions

- Does water supply schemes in the rural area of the Damot Gale woreda sustainable?
- What are the main factors that affect the sustainability of water supply schemes in the study area?
- What are the level of functionality in the study area?
- How was the water quality in the schemes?

1.5 Significance of the Study

The findings of the study help to improve the understanding of the problems and factors affecting the sustainability of rural water supply systems in the study area. This study investigated important information concerning rural water supply schemes; water supply scheme functionality, level of service and users' satisfaction with the service gained from functioning water supply schemes in the study area. The study also identified different factors that determine water supply schemes sustainability; current interventions done by different rural water supply actors and recommended on further interventions that should be done to ensure safe water supply for the rural dwellers.

It also gives baseline information to solve the problems on sustainability of rural water supply system and for those working in the planning and design works of RWSS projects. The government, NGOs, water resource analysts, managers and water users (water user association) and any concerned persons to know the current situations of the water schemes status of the study area. It is significant since development actors in charge of rural water supply can use the findings and recommendation for planning and implementation of community managed sustainable rural water supply schemes. The provision of safe and adequate water contributes to better health and increase individuals productivity. The result of this study serves as an input to rural water supply actors to intervene and take effective approach to sustain the water schemes and contribute in the rural water supply framework.

In addition, the findings of the study improve policy formulation by the Ministry of Water to improve sustainability of community managed water supplies. The finding assists in the design and formulation of future sector funding programmes by donors and other development partners to enhance sustainability of sector investments.

1.6 Scope of the Study

The focus of this study was only rural water supply systems constructed in the rural part of Damota Gale Wored, concerning the scope of the research, on certain aspects of rural water supply system sustainability and water services level in terms of house hold water use practices. It has a primary focus on community managed rural water schemes, where the beneficiaries themselves are taking full responsibility for operating and maintaining systems. The water management committees which are usually established when water systems are established and handed over to the community was intensely studied besides to the households. So that, the study emphasized on the sustainability issues of rural water supply systems and to assess their sustainability achievement of rural water supply schemes in the study area.

1.7 Limitations of the study

The study was limited to eight kebeles in Damot Gale Woreda because of transportation problem, time and budget restrictions to cover all kebeles.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Concepts of Sustainability of Water Supply Schemes

The concept of sustainability has taken its root from the debate on sustainable development during the early 70s. It becomes a concept that is found out to be more "complex and contested" (Pretty 1995). According to United Nations (1987) document entitled "Our Common Future" "sustainable development is development that meets the needs of the present generations without compromising the ability of future generations to meet their own needs". Sustainability is therefore the responsible management of resource use. Its meaning might include to maintain or to support. In the water sector, sustainability has to do with sustained access to services, sustainable operation and maintenance of water facilities.

The majority of these definitions are similar in nature but, they have slight differences in emphasis. The following three definitions emphasize on issues including; the flow of benefits, relationship between community management organization and external support institutions, efficiency, effectiveness, reliability and equity issues. Sustainability is best defined by Abrams (1998) as "whether or not something continues to work overtime". More specifically, it implies the ability to recover from technical breakdown in the scheme.

On the other hand, Sustainable rural water supply has been defined by Harvey and Reed (2004) as one in which '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 a cost-effective use of resources that can be replicated.' According to Parry-Jones *et.al,* (2001) rural water supply defined as sustainable if the systems:

- Are being used effectively and equitably by users
- Can be managed and financed users with limited external support.
- Will continue to deliver benefits for a long period after project inputs cease.

As a result, many researchers conducted relating to water supply services have produced definitions concerning sustainability in the context of water supply schemes. Most of these definitions capitalize on financing of regular operation and maintenance costs by users, minimal external support in the long term, and continued flow of benefits over a long period (Parry-Jones, *et al.*, 2001). Additionally, water supply sustainability definition of has been adapted by Abrams (2013): as "Sustainability is about whether or not water and sanitation services and good hygiene practices continue to work over-time". According to this definition, the achievement of sustainability involves the realization of enduring "beneficial" changes in rural water services. In this case, the issue of sustainability is considered further than limiting itself on technical functionality debate; the expression "beneficial" highlights the outcome on the lives of people and it indicates to services other than technology (Jansz, 2014). Most of the definitions of sustainability from the water and sanitation sector in rural areas have in common the ability of the system to provide benefits over time, such as improved lifestyle and human health (Barnes and Ashbolt, 2010), and enhanced quantity, quality, convenience, and continuity of water supply (Brikke and Rojas, 2001).

Over years, a number of conceptual frameworks have been developed to understand the principle of rural water supply sustainability. Among those developed conceptualization frameworks, the one that has been shared by many researchers has five key dimensions (Parry-Jones, 2001): institutional (organizational), social, environmental, technical, and financial. It is well identified that the success of lasting sustainable water supply services is dependent on the interaction of a combination of factors that give due emphasis for community participation, external collaboration and technical support in order to ensure operation and maintenance of the system (Parry-Jones, 2001).

2.2 Sustainability and Functionality of Rural Water Supply Schemes

Sustainability and functionality of rural water supply system are interrelated but different performance indicators of service delivery. Functionality is a simple pictorial view of whether or not water supply systems are working at the time of inspection. It cannot on its own tell us anything about the reasons for the particular state that the water point is in, or why it may be providing an adequate service, intermittent service or no service at all. Functionality data are of

limited value, but they are best indications of inadequacies in sustainable service provision (Carter *et al*, 2010).

However, rural water supply scheme sustainability is whether or not schemes provide the designed level of service (water quantity and quality) continues over the designed time period (Abrams, 2013). Sustainability of water supply schemes is whether benefits from the service continue satisfactorily until the end of the design life. As Mebrahtu (2012), Benefits include health benefits through providing improved quality of water from protected source, water delivery to reduce time spent and convenience.

Sustainable rural water supply is defined as one in which the water sources are not over-exploited but naturally replenished, facilities are maintained in a functional state which also ensures a reliable and adequate water supply and also benefits of the supply continue to be realized by all users over a prolonged period of time. Enabling rural water supply scheme to remain operational over the design period requires a number of complex and interrelated technical, social, environmental, financial and managerial issues upon which failure in meeting any of these can lead to failure of scheme (Abrams, 2013). The same source pointed out that "if the water flows, then all of the many elements which are required for sustainability must have been in place. There must have been money for recurring expenses and for the occasional repair, there must have been acceptance from the consumers of the service, the source supplying the service must have been adequate, the design must have been properly done, and there must have been sound construction."

According to Carter *et al.* (2010) described that sustainability is about the interrelationship of natural resources, physical assets and the services they provide; the people and organizations which use and manage them; and the rules and financial systems which facilitate effective management. According to similar authors, Functionality is about whether (and where degrees of service are possible, to what extent) a service is operating at a particular point in time. The partial functionality or non-functionality of a service may provide a trigger for more detailed investigations of sustainability.

2.3 Rural Water Supply Scheme Sustainability

Monitoring the sustainability of WASH service is complex and multi-dimensional as the term sustainability is linked with number of hardware and software factors (Mebit, 2013). In line for to this complexity, assessment of sustainability needs deep analysis and interpretation of those multi-dimensional indicators and possible sub-indicators. The key indicators for sustainable rural water supplies include reliability, adequacy, accessibility, water fetching time, establishment of operation and maintenance (O&M) fund, ownership, user committee existence and functioning (Panthi and Bhattarai, 2008). According to Len Abrams (2013) sustainability can be determined from technical, social, environmental, financial, and managerial principles. However, definitions of sub-indicators are not well consolidated and are more reliant on the researcher's objective and insight (Sharma, 2012, Muhumed, 2013 and Mebrahtu, 2012).

To attain the desired benefits through the provision of sustainable WASH service, there must be well structured and consolidated WASH service sustainability assessment tool. This tool will support to track and better understand the underlying causes of poor sustainability. Sustainability of WASH interventions using a range of both quantitative and qualitative indicators. It is designed to assess the extent to which crucial sustainability criteria are being met across a range of indicators grouped under five main areas or factors: institutional, management, financial, technical and environmental (Lockwood, 2013). Factors listed here are interdependent, interactive and crucial for achieving sustainable water services with a corresponding behavior changes over time (Carter *et al.,* 2010).

According to Lockwood (2013) the tool expands the level of inquiry beyond only the physical condition of the water supply, sanitation or hygiene infrastructure to include district and national level aspects which can have a bearing on the continuity of services. The indicators in the tool are based on global best practice and the tool pilot testing experiences, but are also meant to be 'contextualized' to the country or region in question (Lockwood, 2013). The tool provides a step by step process guide for carrying out an assessment, including the modification of indicator questions to fit the reality of whichever country context is being investigated, as well as how to approach sampling of communities and households, preparing field teams and analyzing the data (Lockwood, 2013). The tool produces sustainability scores for the different factors and can also present the information by type of intervention.

2.4 Determinants of Sustainability of Rural Water Supply Schemes

A number of studies have identified many determinants of sustainability of rural water supply system. However, some of the most common determinant factors are: Factors have been identified by (Awoke 2012; Harvey and Reed, 2004) as critical to achieving sustainability of rural water supplies, these are: Institutional arrangements; Financial and Economic issue; Community and Social aspects; Technology and Environment; Spare parts supply; Maintenance systems; and Monitoring. On the other hand, based on literature review, desk review of rural water supply project documents and field work, Lockwood *et.al* (2004) identified two broad sets of issues which can lead to problems for community-managed Rural Water Supply System after projects have been implemented: Those limitations within the community: community dynamics, political or social conflict, lack of cohesion, lack of capacity (technical, managerial etc), lack of financial resources; and those constraints which are external to the community: lack of space parts supply, lack of supportive policies and legislation or the lack of long term support to help communities through major repairs, conflicts and other problems with extension and upgrading. The following factors are tried to be discussed in detail in relation to the role they played in promoting the sustainability of community managed rural water facilities.

2.4.1 Institutional Support

According to Harvey and Reed (2003), there are many different institutional issues that influence rural water supply sustainability. The institutional type of sustainability relates to external support being available to communities from NGOs, national and local government institutions, as well as the private sector. According to them traditionally the water supply sector in sub-Saharan Africa has been heavily dependent on external support from international and bilateral donors. But, authors point outed that, national and local government institutions are generally the most important stakeholders if services are to be sustainable. In order to promise the sustainability of Rural Water Supply systems and the associated benefits, it is necessary to provide support and guidance that addresses a range of issues. Support activities identified by Whittington *et.al*. (2008) included assistance with maintenance and repairs, accounting and tariffs, technical training, free repairs, manuals and other materials, as well as access to spare parts. But, these authors found no evidence that free repairs or technical assistance were

positively associated with sustainability; the most promising support activities identified were those relating to administrative management and system operation.

Moreover, Lockwood (2004) noted that, there are four main functions provide by such support mechanisms above and beyond technical support for the Operation & Maintenance (O&M) of physical infrastructure. These are technical assistance, coordination and facilitation, monitoring and information collection and training. According to Chaka *et al.* (2011) the study made in Ethiopia on Rural Water Supply sustainability indicates that overall the external support in post construction is very limited and ad hoc.

Sustainable service of rural water supplies schemes is achieved when external supports agents have a package of sustainable community management of the systems during implementation and after hand over of the systems developed. Once the water committee is formed, the provision of technical training for effective maintenance, operation and management of the scheme need external support in addition to community participation (Tadesse *et al., 2013).* According to Lockwood (2002) and Schouten *et al.* (2003) both identified external support as a key determinant factor for sustainability of RWSS. They pointed out that external support should focus on technical assistance, training, monitoring and information collection, coordination, and facilitation.

2.4.2 Financial Factors

A water supply service is sustainable if its operation, maintenance, rehabilitation, replacement and administrative costs are covered at local level through user fees or through alternative sustainable financial mechanisms (Brikke, 2002). To explore the causes of no functionality of distribution points, a purposive survey was undertaken covering 38 villages, in six different districts by Water Aid Tanzania (2009), and the finding indicated that poor financial management was the primary correlate of non-functionality. Similarly, Baumann (2006) stated the inability of communities to collect sufficient revenue for repairs could reduce the life expectancy of installed water supplies.

The financial sub-category of sustainability includes issues of community financing and the cost of operation, maintenance and repairs (Harvey and Reed, 2004). According to Harvey and Reed, if systems are to remain operational indefinitely, sustainable financing mechanisms need to

consider Operation & Maintenance and longer-term rehabilitation needs. In other words emphasis must be shifted from paying for maintenance of a facility to paying for the provision of safe, adequate and accessible water. While securing finance for operation and maintenance is a major part of the maintenance task, Shaw (2012) states that community members are usually reluctant to pay when everything appears to be working. Ideally, water tariffs should satisfy for future system upgrade, rehabilitation and expansion costs as well as ongoing O&M costs, and currently, this occurs very rarely, (Harvey and Reed, 2004).

According to Nedjoh *et al.* (2003), a lack of knowledge regarding maintenance costs, inadequate tariffs and high of defaulting combined with ineffective collections and poor financial management undermines the ability of communities to establish such financing mechanisms. According to Harvey and Reed (2004), one of the main constraints to this is the need for a transparent, secure and sustainable method of storing and investing money for future use. Community managed financing mechanisms are rarely able to fulfill these requirements, (Harvey and Reed, 2004). Besides, the success of cost recovery efforts, as a key post-project determinant of sustainability, will be influenced by the extent to which individuals and committees are supported, re-trained, and guided in relation to tariff structures and broader financial management (Gebrehiwot, 2006). If such (external) guidance is absent, then it is likely that the success of cost recovery efforts will slowly diminish over time, ibid according to Musunda (2004), in order for the community to meet the cost of maintenance; community members must be willing to pay the service.

2.4.3 Technical Factors

Under this sub-section technology choice, operation and maintenance and availability of spare parts and how they determine sustainability. Technology options which are low-cost, easy to understand and easy to maintain and repair are likely to be more sustainable than those that require specialist skills or equipment (Harvey and Reed 2004). According to Katz and Sara (1997) stated that sustainability was higher in communities where informed choices about technology type and level of service were made.

According to Katz and Sara (1997) also stated that construction quality had a major impact on sustainability; poor quality lowered the chances that systems would be sustained. Ease of

operation and maintenance, user acceptability and cost must be considered jointly (Harvey and Reed, 2004). When breakdowns occur, access to a supply of spare parts is essential for repairs to be made. According to Hocking (1994), the availability of spare parts is a critical factor to keep the system infrastructure working properly. An adequate supply of spare parts and maintenance tools is obviously of primary importance to long-term sustainability. Supply chains are now recognized as one of the key determinants of sustainability, especially where the technology provided is imported, which has often been the case with large-scale hand pump programs in Africa (Harvey, 2009).

2.4.4 Community and Social Factors

Braimah and Fielmua, (2011) in their study indicated that Demand–responsiveness (meaning that demand is expressed directly by householders, rather than through traditional leaders) at the household level is a determinant of overall sustainability primarily due to its role in increasing consumer satisfaction and willingness to sustain the system. According to them consumers are more likely to be satisfied with results such as quantity of water, color and test of water, distance and waiting time to fetch water when they initiate the project, are involved in decision-making, and are informed about their responsibilities in terms of costs and Operation & Maintenance. It is expected that under such circumstances users express a higher sense of ownership, greater confidence in their ability to maintain the water system, a better understanding of how the tariff is used, and a willingness to pay for improvements.

Furthermore, there is ample evidence to indicate that a more active involvement of women can optimize the results and impacts of Rural Water Supply projects (Misgana, 2006). The central role that women pay in the collection, management and use of water, as well as with the general sanitation of the household is well documented (Fong *et.al*, 2003). Therefore, it is not surprising that the continued involvement of women, after project implementation has been complete, is identified as one important determinant of sustainability. Similarly, an adequate degree of social cohesion within a community is now considered as a fundamental factor in sustainability, Braimah and Fielmua, (2011).

2.4.5 Management Factors

Three main management approaches in rural water supply are identified by professionals in the water sector (Musunda, 2004) each with its pros and cons. These are; the centralized Management approach, the Community-based Management approach, and the Partnership Approach. On the other hand, according to (Lockwood & Smits, 2011) a number of formally recognized management options were found across countries, with a clear predominance of the Community based Management approach. Other options have also been recognized, according to the authors, including public sector management (through municipal utilities or local government providers) and the growing involvement of small private operator arrangement. Finally, there is self-supply which is understood as the investment in and management of household facilities by the same households.

Community-based management refers to a service provision option whereby communities control management of their water supplies, (Lockwood and Smits, 2012). The community management model is the most widely adopted approach to managing rural water supplies in Africa (Harvey and Reed, 2004). However, as identified by Carter (2009), communities are not always motivated to manage water points effectively. Consequently, many communities experience a gradual decline of the service prior to a major breakdown, which is resolved only through an external rehabilitation program, (Shaw, 2012). Harvey and Reed (2004) indicated that with the coming of community ownership and Management there is a widespread idea that ownership of facilities will lead to responsibility for their management; though in reality, just because a community owns a facility does not necessarily mean that it will acquire a sense of responsibility for its management, nor does it guarantee a willingness to manage or pay for its O&M.

Furthermore, Lockwood *et.al* (2010) reported that in many cases this approach still leaves the community, and especially the water committee, isolated once the infrastructure is in place and the program implementers disappear. By and large this approach has failed to achieve the ultimate goal of reliable and sustainable water supply at scale. Similarly, Tamm (1991) argues that community management is more ideological than operational and as much guided by beliefs than by practical consideration. On the other hand, however, Whittington *et.al* (2008) discussed that Community management has undoubtedly brought many benefits and it says recent studies

indicate that this approach has indeed improved the performance of water supply systems. Much effort has been put in to better understanding the reasons for the success and failure of communities, such as supply chains, gender, participation and financial contributions of communities and low-cost technologies.

In this regard, Lockwood and Smits (2011) advise that where community-based management is the mainstay Service Delivery Model it should be strengthened through legal recognition of committees and formalizing their relationships with local government. Community management is the main service delivery model implemented in the rural water sector in Ethiopia, and thus after construction and the handover of schemes, operation and minor repairs are handled by the WASH committees (WASHCOs) representing the community (Chaka *et.al*, 2011). However, the absence and /or lack of legal recognition for WASHCOs also compound their problems and effective performance.

2.4.6 Environmental Factors

The sustainability of water supplies is intrinsically linked to the water source that they use, (Harvey and Reed, 2004). A water supply will only be sustained if the extraction rate does not exceed the replenishment rate of the resource over the lifetime of the system. Similarly, Lockwood *et.al* (2004) stated that deterioration of source water quantity will be of major concern in areas of low rainfall, or poor groundwater re-charge, where there is greater sensitivity to over-extraction. But even in relatively water abundant regions of the world, the source can fail to satisfy demand, either due to population expansion or abuse of the supply for non-domestic purposes. An assessment of borehole reliability by Harvey and Reed (2004) demonstrated the importance of drilling wells at specific times of the year; well depth in relation to dynamic water level; and the depth of the pump cylinder below the dynamic water level when installing reliable boreholes.

2.5 Assessment of Functionality and Water Supply Service Levels

2.5.1 Assessment of Functionality

Although the factors that rural water supply scheme functionality is headache for sector actors and researches confirmed this, accurate and widely accepted indicators were not set so far. In most cases functionality of water supply facilities are roughly defined based on its status at the

time of inspection without deep analysis of the level of service it can deliver. Sharma (2012), the water supply system should be sufficient to meet the basic demands of communities in the project areas and water is consistently acceptable.

There are four indicators of functioning of water supply facilities to manage the increased necessity of water use which are quality, quantity, reliability of water supply and convenience. According to SNV (2013), rural water supply schemes are defined as non-functional if they fail to meet the basic level of service based on national standards. Where the levels of service are determined using quantity, quality, reliability and accessibility as indicators and the worst score of these indicators define the service level.

2.5.2 Water Supply Service Levels

2.5.2.1 Water Service

Water services emphasis on the delivery of water to people. It can be defined as the quantity of water of a given quality accessible by users (service) and the system used to deliver water. In practice, the two (service and system) are often closely related. According to Moriarty *et al* (2011) there is critical difference between service and system. For instance, a borehole and hand pump operated at the village level provides one type of service while a professionally managed network of household taps another. However, engineers and planners focus on systems and lose the objectives to be achieved by providing new water supply infrastructure. Coverage is often calculated by counting the number of systems implemented without considering whether they are in fact providing the planned level of service (Moriarty *et al*, 2011).

According to Moriarty *et al* (2011), a water service is assessed based on qualitative methods of data gathering. Some questions asked include:

- Do the systems provide the designed amount of water?
- Do they do so every day?
- Does everyone in the community have access to them?
- Do they meet national norms for quality?

The water service accessed by an individual can only be said to meet a certain standard or level when the answers to all these questions are considered together and meet normative standards

(Moriarty *et al,* 2011). A water service therefore refers to the provision of access to water in a way that meets a set of key indicators (or norms). Taken together these key indicators define the service.

2.5.2.2 Water Service level

Service level defines and differentiates between qualities of service. Service level is a collection of different indicators some dependent and some independent of the other. Its definition varies across countries. It may be set through a combination of engineering factors (what is easy/ possible) and social and political factors (what is politically acceptable, the cost, the desire and capacity of a community to press for improvements, and historical norms) (Moriarty *et al*, 2011). For case, a rural community may live with a level of service, in terms of distance travelled and quality of water that would be considered as unacceptable in a town. In an ideal world, the level of service would perhaps be set through agreements made between the providers and the users (Moriarty *et al,* 2011).

The most common indicators against which the quality of water services can be assessed include: quantity, measured in litres per capita per day (lpcd); quality, typically composed of one or more separate indicators looking at chemical and biological quality; and distance, from a household or the center of a community to a water point (Moriarty *et al*, 2011). In addition, countries may also use other national or international norms, such as the number of people sharing a point source, and the reliability of the service, typically defined as the proportion of the time that it functions to its prescribed level.

According to Lloyd and Bartram's (1991), identifies five key indicators for assessing access to water services, namely: coverage, continuity, quantity, cost and quality (analytical plus sanitary inspection). Subsequently the service level concept was further endorsed by the World Health Organization (WHO) in 1997 and 2003. In spite of this, the approach has been slow to be adopted at scale, probably falling victim to the broader problem of poor monitoring of access to rural water supplies. Actually, it is telling that beyond endorsing it in its publications, WHO itself has limited its Joint Monitoring Programme (JMP) of global water coverage primarily to the type of technology used. However, this may change in the future with more recent discussions on post-MDG monitoring.

2.5.2.3 Service ladder

Service ladder is incremental progression between service levels of different quality starting from bottom rung and climbing to the top (Moriarty *et al*, 2011). They are highly technology driven, in that each rung of the ladder is related to specific technical choices and while sometimes they can be completely new systems. Some rungs of the ladder can be climbed by individual household or through the community's effort, while others heavily rely on substantial funding, engineering capacity and professional management. Moriarty *et al* (2011) discussed the concept of service level ladder is about service levels, not infrastructure, though some service levels, in some situations, can never be achieved without substantial infrastructure development and associated running costs.

In Ethiopia, the basic service level for rural communities is defined as the access to safe water supply of 15 liters per capita per day within 1.5 km radius (MoWE, 2011). Regarding the number of households accessing a water point it was determined to be 50 households and 60 to 70 households per water point for hand pump and spring development respectively (OWNP, 2013).

Table 2. 1 Water supply service level ladder and indicators (Moriarty et al, 2011)

Service level	Water quantity (lpcd)	Quality	Water fetching travel time (minutes)	Reliability	Status (JMP 2010)
High	≥60	Good	<10	Very reliable	Improved
Intermediate	>40	Acceptable	<30	Reliable/secure	
Basic service	>20				
Below standard	>5	Problematic	<60	Problematic	Unimproved
No service	<5	Unacceptable	>60	Unreliable/insecure	

Note: JMP= Joint Monitoring Program

There is also a service level ladder used by SNV (2013), which include measurable reliability indicator in terms of the number of months that the water supply scheme provide service in a year. SNV's service level ladder also provides better utilization of other indicators. It looks simple and can be applicable.

Generally, to ensure the basic water supply service level, users should access basic capita per day of potable water, within 1km of collection distance or 30 minutes time for round trip per capita

per day. And this service should be reliable (serve at least 7 -8 months per year). Besides, the quality of drinking water should be in a good or acceptable custom by the beneficiaries.

CHAPTER THREE

3. MATERIALS AND METHODS

3.1 Description of the Study Area

Damot Gale Woreda is located at 364 km away from Addis Ababa and 140 km from Hawassa, on the highway to Arbaminch crosses the Woreda. It is geographically located 6º 57`20`` N Latitude and 37º 46`31``E Longitudes and it has sub-divided in to 27 rural Kebeles (DGWFEDO, 2021). It is bounded by Hadiya Zone, Badawacho Woreda in the North, Sodo Zuria Woreda in the South, Damot Woyde Woreda in the east and Boloso Sore and Damot Pullasa Woreda in the West. Damot Gale Woreda is located on the west edge of the Ethiopian Rift Valley. The population of the Woreda has 162,025 (DGWFEDO, 2021).

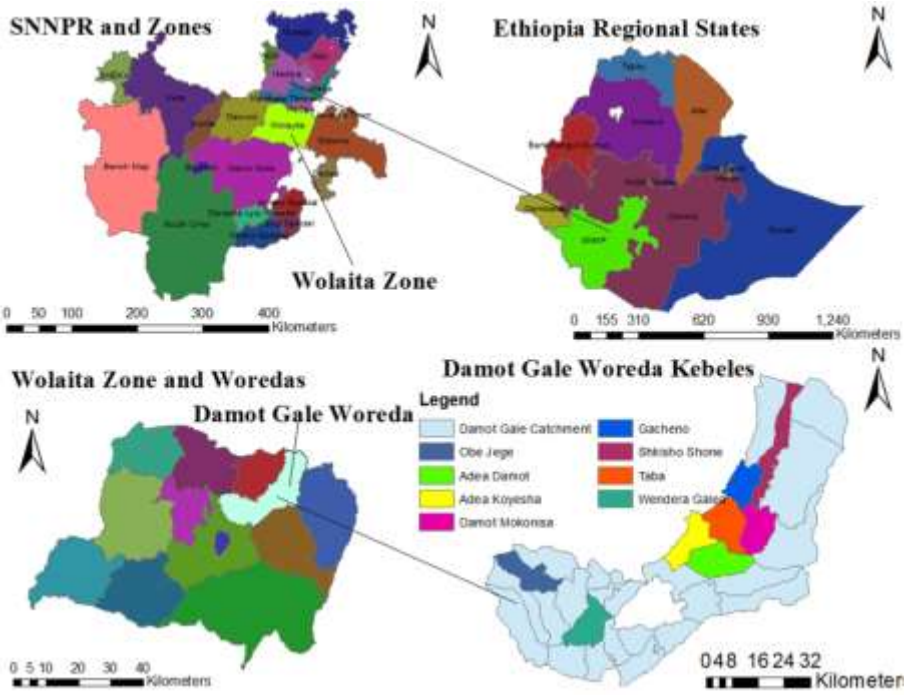

Figure 3. 1 Map of the study areas

The study area has more than 200 rural water supply schemes, of which 25 are shallow wells and 6 deep well (boreholes). 4 Hand dug well, 29 on springs equipped with a gravity system, 13 spring with distribution and rest are water points. About 27.15 % of the rural populations have access to tap water (DGWFEDO, 2021).

3.2 Data Collection

The study was used combination of both quantitative and qualitative research methods. In order to achieve the stated objectives of the study both primary and secondary data sources were collected.

3.2.1 Primary Data

The primary data was collected by using household survey, structural questionnaire (include both close-ended, and open ended questionnaires), interviews, focus group discussion, personal observations and key informant interview. Also, it was collected from field observation, laboratory results, checklists and structured questionnaires administered to the households.

3.2.2 Secondary Data

All the secondary data were gathered from the Woreda water, irrigation and energy office and health office. The secondary data was collected from existing documents, books, different available data sources such as census (CSA) and annual reports, journals, other published and unpublished documents, some other relevant standards or documents and concerned bureaus inside and outside the woreda.

3.3 Methods of Data Collection

In the study, data was collected using interview schedule, sampled respondents, key informant interviews and focus group discussions. The qualitative data was also collected through house hold interviews, focus group discussions and key informant interviews using checklists.

3.3.1 Household questionnaire

A total of 397 households were sampled from the eight kebeles (Table 3.1) using statistical technique and samples from each kebele as presented in section 3.4.3. The household questionnaire was divided into sections, which was collected information on socio-economic characteristics, related to the technical, social, economic, financial, institutional performance of the water schemes which are determinants that affects sustainability that was considered under each factor several variables in frame work figure 3.2. And users water satisfaction, water

access, and service delivery of water schemes (The sample questionnaire was shown in Appendix).

3.3.2 Questionnaires

Two types of questionnaires were used to collect data for the study. One questionnaire was administered to households while the other one was administered to water supply scheme committees after it translated in to local language. Both questionnaires were closed and open-ended questions. The uses of closed-ended questions were enable the researcher to collect data quantitatively with pre-selected options, while an open-ended question was provided an opportunity for the respondents to respond and express their opinions. Results from open-ended questions were coded for analysis.

3.3.3 Key Informant Interviews

Questionnaires were provided broader information on the research question, thus for depth and to answer questions on why things happen KIIs and FGDs was used. A total of 48 interviews were conducted, 6 at kebele level. In addition, key informant interview were conducted with woreda water supply experts, technical operator and woreda WASH team leader. The main contents the interview was include factors that affect the scheme sustainability on social, technical, financial, environmental, choice of technology, availability of technical operators/technical, water accessibility, coverage and major constraints and challenges of water supply schemes in general.

3.3.4 Focus Group Discussions

Focus group discussions were conducted with water committee members, woreda water staff, community leaders and Kebele leaders to collect qualitative data using a semi- structured questionnaire guide and note taking.

3.3.5 Transact walk

Observation is a way of gathering data by watching behavior, events or noting physical characteristics in their natural setting. Observations were done to check the physical status of the water points and their surroundings. A field observation using a structured checklist was done in selected water points focusing on physical condition of the scheme, functionality, level of

protection, construction quality and protection mechanisms, operation maintenance and management status of the facilities.

3.4 Research Design and Procedures

3.4.1 Kebele Selection

Firstly, stratification of rural Kebele's based on presence and absence of water supply scheme was done in consultation with the woreda water mine and energy office to select Kebeles to conduct the study. Due to resources limitation, Kebeles having 6 and above water points were purposively selected. Thus, eight Kebeles were selected out of a total of 27 Kebeles in Woreda. Since the focus of the study was to assess sustainability of water supply schemes, the selected kebeles have the highest number of water supply schemes. The selection also based on the types of water schemes, where the Kebeles with all types of water supply schemes used in the Kebele was preferred. This increased the probability of assessing different technology types and visiting more water points per day.

3.4.2 Selection of Water Points

Selection of samples is decisive to arrive at reliable conclusions and to provide workable recommendations. The purpose of this study was to assess rural water supply schemes sustainability. To provide valid conclusions all community managed water supply schemes were selected as representative sampling for sustainability Analysis. About 68 water supply schemes were selected in the eight Kebeles.

3.4.3 Sampling Technique and Sample Size

After the selection of the schemes, the beneficiaries of the water supply schemes were identified and their lists were secured from the documents of water committees. Then the samples of respondents were drawn from the beneficiary household using simple random sampling method to give equal chance for all water users.

The population size for the study was the water users of respective water supply scheme in the selected kebeles. Lists of households in each selected kebeles were obtained from the WASHCos in the study Kebeles. Then, sample HHs were taken proportionally from each Kebele from the total populations. It is to mean that a sample size (n) in each Kebele was picked on the basis of

its proportion to a sampling frame (N). To select sample HHs simple random sampling method was applied.

To determine sample size (n) the mathematical formula of Taro Yamane (1967) was used. Assuming a 95 % confidence level, (e) specifies the desired level of precision between (5-10) percent.

$$n = \frac{N}{1+N(e^2)} \quad \text{----------(3.1)}$$

Where: n = Sample size; N= Total number of population/households in the selected Kebeles;

e = precision level or sampling of error 5% (0.05);

$$n = \frac{54303}{1+54303(0.05^2)} = 397$$

Based on the above sample size determination calculation, 397 sample households were obtained. Totally, 397 households were selected from the total selected water points (Table 3.1).

The study was carried out by considering the homogeneity characteristics of sample households. The total sample size was distributed to each stratum and sample kebeles proportional to their total number of households using the Dawson (2003) formula:

$$ni = n * Ni/N \quad or\ ni = n * pi \quad \text{----------(3.2)}$$

Where: ni is the sample size of stratum I, n is the total sample size of the study, Ni is the total households of the stratum i, N is the total households of the woreda (of kebele i), & pi is the proportion of households of stratum I from the total households of the woreda (of kebele i). For example, Wandara Gale: n = 397, N_i = 6601 and N = 54,303, then

n_i = 397x6601/54,303 = 48

Table 3. 1 Selected kebeles, water supply schemes and sample size distribution

	Kebeles	Water supply schemes per kebeles	Population of Kebele	Sample size of stratum
1	Wandara Gale	12	6,601	48
2	Gacheno	11	7,854	57
3	Shakesho shone	9	7,917	58
4	D/Mokonesa	8	5,686	42
5	Ade Damot	8	6,573	48
6	Obejage	8	7,954	58
7	Ade Koysha	6	5,408	40
8	Taba	6	6,310	46
	Total	68	54,303	397

(Source: Damot Gale Woreda water mine and energy office, 2021).

3.5 Assessment of the Sustainability of Rural Water Supply Systems

To assess sustainability of water supply schemes, a pre-tested structured questionnaire was used for the quantitative survey. The questionnaire included information on demographic and socio-economical characteristics of the respondents, level of consumer satisfaction for the service provided, scheme functionality and non-functionality or physical condition of the water supply points under study, water supply service delivery level and participation in water supply facilities, willingness of the beneficiaries to sustain the system, and repair and maintenance issues for the water supply services. Field observations using structured checklists were administered.

3.6 Assessment of Main Factors that Affects the Sustainability of Rural Water Supply Systems

Assessment of main factors that affects the sustainability of rural water supply schemes were conducted through collection of data which were used in this study to fulfill the requirements of the mixed research design are questionnaires, key informant interviews, focus group discussions, document analysis and observations. Considering the main factors and independent variable which is listed below figure 3.2, was used to assess sustainability of rural water supply schemes. Therefore, assessment was employed through following data collection methods.

3.6.1 Assessment of Scheme Functionality of Water supply

The functionality of rural water supplies was assessed by questionnaires, focus groups discussions and field observations. The questionnaire was used to evaluate the degree and type of participation, and to evaluate the institutional support during design, construction and maintenance phases. The questionnaire was included questions about community contribution (capital, labor and material), female participation, technical factors (design of construction), financial factors, environmental factors (the sustainability of the water source), health factors and the like (Appendix A).

3.6.2 Water supply service level

In this study, the water supply service levels of rural water supply schemes were evaluated using the following indicators in accordance with national targets of quantity, quality, accessibility and reliability of water supply system.

The following are the main international water supply service delivery performance indicators.

- Water supply access indicators: Water supply access coverage with improved water supply schemes (%), Water supply access coverage (%)
- Service levels and service delivery performance indicators: water quality, water quantity delivered and distance from the water delivery point to residence (in km or in round trip travel time minute).

In addition, user satisfaction was assessed as part of the baseline study. User satisfaction questions were designed to measure whether the user felt very unsatisfied, unsatisfied, neutral, satisfied or very satisfied with different characteristics of water services (reliability, quality, quantity, accessibility). Regarding the standards on the quantity of water needed to be supplied and the distance for water fetching; the following is internationally accepted service level ladder.

3.6.3 Quantity of Water Delivered

Amount of water beneficiaries were collected from improved sources is one of the factors to achieve targeted health benefits through provision of improved water supply sources. Daily water collection of sampled households in each day of a week was collected and summed up then

average daily water collection per household calculated as total water collected in a week divided by number of days per week.

Then, computation was done to see the per capita water usage from improved water supply sources. The average daily per capita water usage was calculated as the average daily water collection per household divided by number of individuals in a household.

$$\text{Average daily collection per a HH } (Q_{Av}) = \frac{\text{water collection in week(liter)}}{\text{number of days per week(days)}} \quad (3.3)$$

$$\text{Average per capita water usage(lpcd)} = \frac{\text{Average daily collection per a HH } (Q_{Av})}{\text{family size}} \quad (3.4)$$

3.6.4 Water Quality

In order to assess the safety of water sources with regard to drinking quality, from selected water points the water samples was collected and chemical analysis were performed following the standard procedures outlined in America Public Health Association as given in APHA (1998). Sampled water from sampling points for physicochemical and microbiological analysis were collected in polyethylene bottles and transported to the laboratory in ice box containing ice freezer packs.

Bacteriological analyses of total coliforms are detectable by practical techniques such as membrane filtration using agar solution (Jesuis and Terry 1987; Hyland *et al*. 2003). Chemical water quality was determined by spectrophotometer (DR 2800). Transmission spectrophotometers project light through the sample, and detectors measure the wavelength and quantity of light that pass through. Electrical conductivity of water samples were measured in situ by using digital portable conductivity WAGTECH (WGPH 1102). Turbidity of water samples were measured by Micro-processor Turbidity Meter (HANNA HI 93703). The pH and temperature of water samples were measured by using a Digital P^H Meter (WAGTECH 661729).

Physical, chemical and biological water qualities were analyzed by using SPSS 20.0. The inferential statistics ANOVA and LSD were employed for water quality analysis to see the statistical significances and association of the temporal and spatial variations of samples. The results were compared as per Ethiopian and WHO Water Quality Standards drinking water quality parameters.

3.6.5 Service Accessibility

Ensuring improved sources of water supply within a reasonable radius of collection from the time spent to collect water and residence area result reduction and allow females to participate in productive activities including education. In addition the amount of water used by household is affected by accessibility (WHO, 2011)

- Time spent to collect water per capita per day
- Number of households per water points
- Average number of households per water point was found
- Availability of service operator and users satisfaction

3.6.6 Service Reliability

Water supply service reliability deals with the service provision in which beneficiary communities receive the designed service level without impairing of each indicator. According to SNV (2013), service reliability was calculated as the number of months in a year the system serves the designed service level. In this study, service reliability was measured using service interruption, water supply shortage, Water tariff and community perception, and other proxies related with O&M.

3.7 Data Analysis and Presentation

The both quantitative and qualitative data were collected by the structured questionnaires and analyzed using quantitative methods that involve descriptive statistics analysis. The qualitative data was generated through sample households interviews, focus group discussion, key informant interview and observations made were used to triangulate the findings of the quantitative survey of water points and beneficiary households. Then data were coded and processed using SPSS version 20, MS Excel and Word were used to analyze the qualitative data.

Descriptive statistics (frequencies, percentages and means) were produced for the quantitative data depending on the nature of data collected about the water points and beneficiary households. Finally, all the related information obtained from literature review and data analysis were managed and present the result using descriptive statistical tools such as tables, figures, percentage, graphs and etc.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1 Assessment of the Sustainability of Rural Water Supply Systems

The objective of this study was to assess the rural water scheme sustainability situation in Damota Gale Woreda, in order to investigate the main factors that affect the sustainability of rural water supply systems, the functionality and supply service level of existing water supply schemes in the study area. Here, the results of the water supply schemes problems in the Woreda were discussed. Based on the findings of the survey, remedial measures are proposed to improve the water supply problems in the study area.

4.1.1 Demographic and Socio-Economic Situation

Understanding the socio-economic and demographic background information about sample population is very important to know their characteristics.

Head of sampled households in each water point were used to answer the questions that assess different aspects of their water point (Table 4.1). As female are more responsible and aware of water collection and usage of a family female household heads are preferred as possible.

Table 4. 1 Sex, family size and source of income of the respondents

Variables	Option	No of respondents	Percentage (%)
Sex of respondent (household head)	Male	267	67.17
	Female	130	32.83
	Total	397	100
Family size	1 to 4	104	26.04
	5 to 7	181	45.66
	8 and above	112	28.30
	Total	397	100
Source of income	Farming	343	86.41
	Government employee	20	4.91
	Daily labour	34	8.68
	Total	397	100

As the sample taken i.e. 397 people from the users or beneficiary, 397 questionnaires were filled and returned from the total samples. 267 (67.17%) are males and 130 (32.83 %) females (Table 4.2). Out of these 86.41% are farmers, 8.68% daily labor and 4.91% government employee.

Table 4. 2 Educational status of the respondent

Educational status	Frequency	Percent
Illiterate	165	41.51
First cycle (1-4 grade)	85	21.51
second cycle (5-8 grade)	94	23.77
High school complete	35	8.68
Diploma and above	18	4.53
Total	397	100

The sample population which represents 41.51 % (165) of the total respondents is illiterate. Those who can read and write constitute 21.51 %. Respondents with elementary education represent 45.28 % of the total respondents. Others with junior education status constitute 23.77 %, while 8.68 % of the respondents are with high school educational status.

Educational Level of the Respondents

Education is an instrument for socio-economic development of a nation. It is a basic parameter for any development activity particularly water supply programs. This is because literate citizen can't be better participants and involve in projects targeted to water supply and management. Knowledge and technology transfer are also easier in a community that constitutes educated peoples. Educated individuals demand for better services and toward improvement of their living condition.

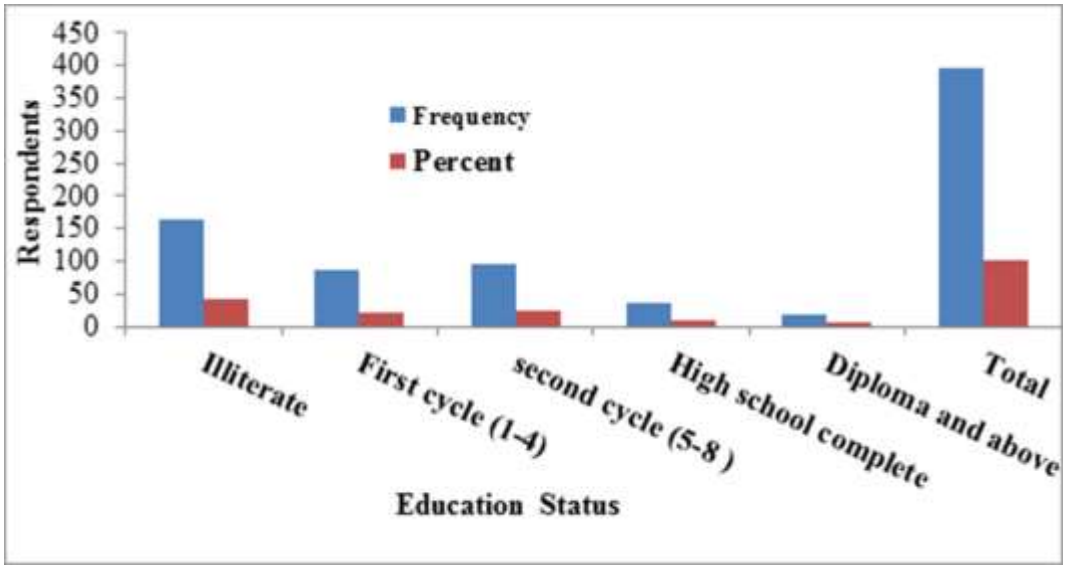

Figure 4. 1 Educational levels of the respondents

The survey results in figure 4.1 about 41.51 % of the respondents are illiterate meaning that they did not attended formal education. Out of this group, 21.51% of the households can read and write by attending informal education program. The remaining 45.28 % have obtained their knowledge from formal primary education, 8.68% attended school high school level and 4.53 % attended diploma level. Based on the findings, conclude that the literacy level in the rural setting to the Woreda is very low.

4.2 Assessment of Main Factors that Affect the Sustainability of Rural Water Supply Schemes

4.2.1 Management Factors

Sustainability of water supply has recently been acknowledged as a crucial issue in supply schemes projects. 31 % of the supply schemes are closer to washing and bathing, 4 % of water points have stagnant water near them, and 41% of the water points are not fenced at all, which could have prevented animals from reaching the water points and might reduce the possibility of contamination of the water points by animals. Besides, none of the water points had guards. In addition, only one of the on-spot springs that the spring box dose not covered well.

Water supply schemes management factors affecting sustainability are presented in Table 4.3. The water supply schemes have established rules and regulations. However, the rules and

regulations were not properly implemented. 68.30% of the respondents answered the presence of established management system and 31.7 % said no management system.

Table 4.3. Established management system, managing body and their responsibility

Issues	Response	Respondents	Percent
Established management system	Yes	271	68.3
	No	126	31.7
Who manage the schemes	Water committee	228	57.36
	Government	148	37.36
	NGO	21	5.28
Performance of duties & responsibilities of managing body	Yes	286	72.08
	No	111	27.92

Based on the beneficiaries' responses, the water supply schemes have weak follow-up and monitoring. Besides, the responsibility of all community involvement is poor and regular follow up and monitoring, strengthening the water committee, and capacity building have to be implemented to sustain the water supply schemes. The result is in line with similar study by Desta (2009), the institutional capacity of the leading office is limited and the external support service given to the community from implementing agencies to effectively manage their water systems is found to be inadequate.

4.2.1.1 Community participation

Community participation is the major factor determining the sustainability of water supply points. As indicated in Table 4.4 below, the community participation was low at inception and planning stage. About 7.17 % and 12.08 % of the respondents participated in the inception and planning, respectively. A 41.13% and 39.62 % of the respondents participated in the scheme construction and scheme management, respectively. These imply that communities are more active in labour requiring activities and decision making than those activities requiring technical skills. Riswan (2021) and Muhabaw (2020) confirmed that community participation is broadly recognized as a basic element of rural drinking water supply systems in developing countries such as Kenya, Tanzania, Ethiopia, India and Sri Lanka.

Table 4. 4. Community participation from project inception to scheme management

Community participation	Number of respondents	Percentage (%)
Inception	29	7.17
Planning	48	12.08
Construction	162	41.13
Post construction management	158	39.62
Total	397	100

4.2.1.2 Community Contribution

Contribution of local communities in kind or in cash for the construction of water supply schemes is necessarily important to create sense of ownership in the community. Local material and labour are cheap resources for rural community living in Damot Gale woreda (Table 4.5). About 58.49 % of the respondents contributed in labour and local materials for the construction of water points around their locality. This is due to the approach followed by service providers to mobilize the community. However, the contribution of the community in-cash was relatively nothing. While it was 29.06 % for local material supply. User communities were contributing inadequate O & M funds resulting in long downtimes in Chipinge District of Zimbabwe (Kativhu *et al*. 2022), upheld this result.

Table 4. 5 Community contribution at Woreda.

Community contribution	Number of respondents	Frequency (%)
Labour and local materials	232	58.49
Money (in cash)	-	-
Supplying local materials	115	29.06
Other	50	12.45
Average	397	100

4.2.1.3 Functionality of Water Supply Schemes

Though water supply schemes identified as functional during 2022 inventory of Damot Gale Woreda with were considered for the study 36.78 % of total water points visited were found as

non-functional (Table 4.6). Besides, focused group discussions with WASHCOs, these water points were not providing service for the two to three months on average.

Table 4. 6 Functionality of water points visited

Status	No of water points	Percentage (%)
Functioning	43	63.24
Not functioning	25	36.76
Total	68	100

Out of 43 functional water points, 17 are indicated in the Figure 4.2 and water samples were collected for bacteriological and physico-chemical analysis for the Regional and Zonal laboratories.

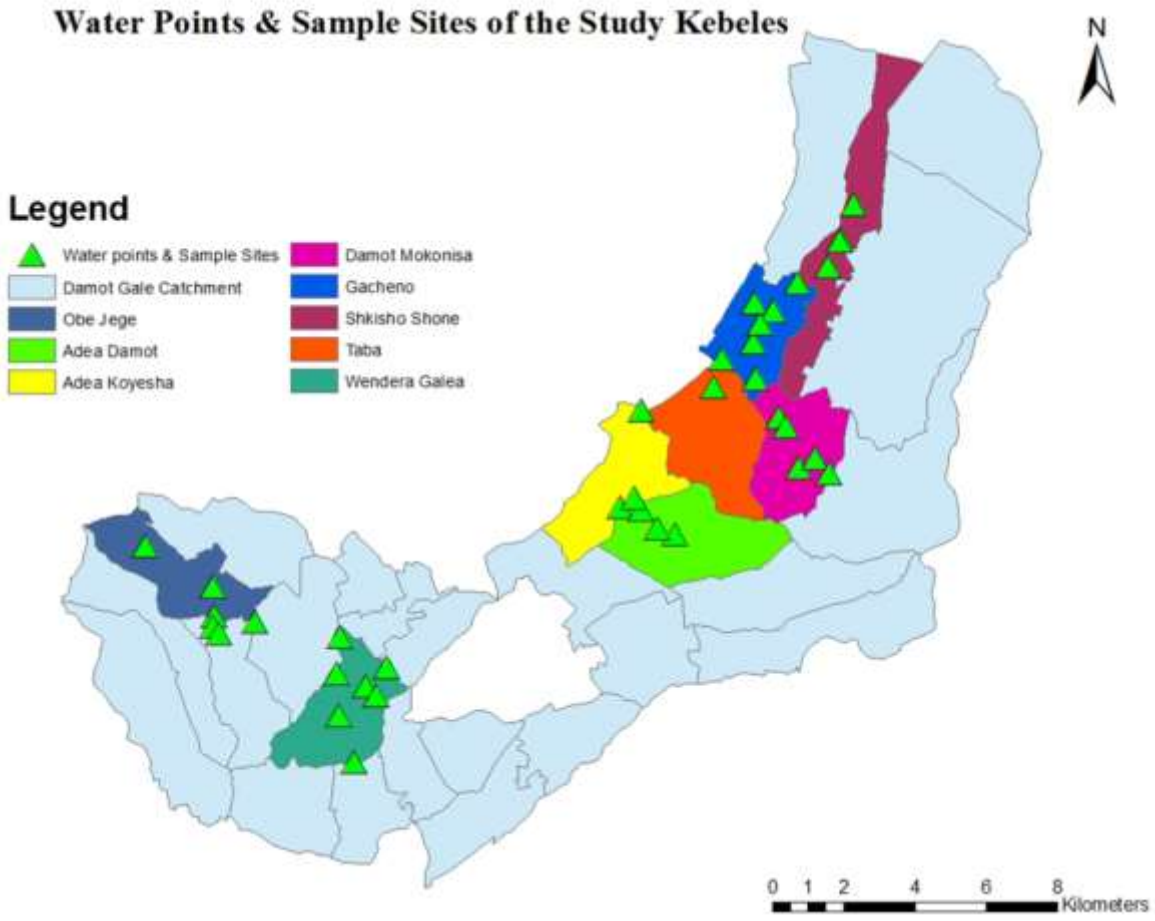

Figure 4. 2 Water points & samples site map

4.2.2 Environmental Factors

Among many environmental factors temperature may have stress on water supply. The hotness and dryness are factors to cause the sustainability of water supply schemes. In the dry periods the water tables fall and in the wet weather the water tables rise. In Damot Gale woreda, the water supply schemes development periods were assessed and the results were indicated in Table 4.7.

Table 4. 7 Water supply scheme development period, source sufficiency

Issues		Respondents	Percentage (%)
Scheme developed	Wet	61	15.47
	Dry	236	84.53
Sufficiency of water source/point	Yes	219	55.09
	Not	178	44.91

About 15% of the schemes were developed in wet season and 45% of the water points were not sufficiently providing the water to the community. This shows the supply and demand have gaps, or may be water source limitations. This shows the inconsistency of the sustainability of the schemes. To alleviate the problem the concerned bodies have to perform O & M activities. Aquifers at shallow depths, however, are likely to be very thin with a limited storage capacity for groundwater, and one may start pumping the water during the rainy season, after the aquifer has been replenished, and find a dry well after a few months (Brouwer *et al.* 1992; HEHM 2022).

4.2.3 Technical Factors

4.2.3.1 Choice of Technology

The choice of technology essential for efficient distribution, it is required that water should reach end user with required flow rate with needed pressure in the piping system. Piped water is powered by electrical pumping, gravity and manual flow in Damot Gale Woreda. The water facilities including shallow well, bore hole and protected springs are common in the Woreda. Type of water supply facilities are indicate in Table 4.8

Table 4. 8 Water supply schemes facilities of Damot Gale Woreda

		Respondents	Percentage (%)
Power source	Electricity	117	29.41
	Manual flow	169	42.65
	Diesel power	18	4.41
	Gravity flow	93	23.53
Appropriateness of technology	Yes	217	54.72
	Not	180	45.28
Functionality	Yes	282	70.94
	Not	115	29.06
Reason of non-functionality	Breakdown of equipment	262	66.04
	Electricity problem	51	12.83
	No fuel	8	1.88
	No operator	36	9.06
	Others	41	10.19

45.28% of the beneficiaries responded that the technology is not appropriate. This was attributed to breakdown of equipment, electricity problem, fuel shortage, absence of operator and/or may be shortage of spare parts and others. Olela and Wanyonyi (2018) recommended selection of appropriate technologies such as solar powered systems in place of generators to reduce costs of regular maintenance due to lack of trained technicians, Training of service team and water committees technical and management of water supply projects and advocacy for local entrepreneurs to become stockiest of spare parts required for existing systems. A study was done by Desta (2009), similar observations and reported that failure to consult beneficiaries in technology choice, lack of community skill required to operate and maintain the schemes properly because of absence of trained local technicians, unavailability of tools and spare parts either at woreda or community level and poor construction quality are found to be major technological threats to sustainability of RWS in the Basso Liben Woreda, Amhara Region.

4.2.3.2 Service Interruption

As indicated in the Table 4.9 below, nearly 57 percent of sampled beneficiaries answered there were service interruptions because of system failure (77.74 %), drying of source (10.94 %) or other reasons (11.32%). Based on interviews with different beneficiaries the apex of pump handles are important for artificial silver jewelry. Besides the problem with pump handle, water

service was interrupted due to lack of community cohesion. Some members of beneficiary households are willing to keep the water point during the night in rotation/shift and need to receive the service but part of beneficiary households do not agree. Water supply schemes components failure a major issue interrupts the supply services. According to Bondank *et al.* (2018) reported that component failures are projected to have a percent increase of 10–101% in scenario which creates the conditions for service outages to have a percent increase of 7–91%.

Table 4. 9 Water supply service interruption

		Frequency	Percentage (%)
Service Interruption	Yes	228	57.36
	No	169	42.64
Service Interruption due to	System failure	309	77.74
	Drying of source	43	10.94
	Others	45	11.32

4.2.3.3 Availability of Service/Scheme Operator and Users Satisfaction

More than 55.85 % of beneficiaries informed they have a person responsible for provision of water at the water point and open the water point two times a day (morning and afternoon) (Table 4.10). However, 32.83 % beneficiaries responded that the service operator not responsible to provide the services. A study done by Bhandari & Grant (2007) emphasized that users in rural villages place high priority on good operation of water supply schemes in Nepal ought to consider when designing and planning rural water-supply programs.

Table 4. 10 Availability of service operator and users satisfaction

Variables	Options	Respondents	Percentage (%)
Availability of service operator responsible for water provision from the water point	Yes	267	67.17
	No	130	32.83
Daily frequency that service operator open the water point for the user	Once	106	26.79
	Two times	222	55.85
	Open/ springs	69	17.36
Average duration of time that users can collect water once the water point is opened (morning or afternoon)	30 minutes	10	2.52
	One hour	21	5.28
	One hour and half	79	20.00
	Two hours	150	37.74
	Two hours and half	60	15.09
	Three hours	11	2.77
	Twenty four hours(spring users)	55	16.61
users satisfaction on the service operator	Strongly not satisfied	11	2.77
	Not satisfied	52	13.21
	Fair	228	57.36
	Satisfied	94	23.77
	Strongly satisfied	12	3.02

Some water points do not have an operator because the water point is abandoned or yield of water point is low. In addition water points having higher yield (that exceed the household demand) mostly SPDs have not a service operator because beneficiaries feel there is no problem in getting enough water. Hence beneficiaries can collect water for 24 hours. From the total sampled beneficiaries of visited water points having the service operator (67.17 %) more than 57.36 % are satisfied. Depending on the crowding, the type of water point and the season, beneficiaries can collect water from the water supply scheme from 1 hour to 24 hours a day. 72% of total surveyed populations collect water for 2 to 4 hours in a day (Table 4.10).

4.2.3.4 Operation and Maintenance

Operation and maintenance are key elements under technical factors influencing sustainability of water supply schemes. Operation of water supply schemes requires the performance of system operator or technician. In Damot Gale Woreda the condition of water supply schemes operator,

training and affordability of spare parts are presented in Table 4.11. Based on the respondents some schemes have no operator (18.49%) to maintain the system. Besides, the operators have skill gaps (58.11%) and the spare parts are not accessible (92.83%) at the community level to sustain the schemes. Generally, the Damot Gale Woreda water supply schemes have operation and maintenance problems to have sustainable schemes.

Table 4. 11 Conditions of operator, skills and spare parts

Issues		Respondents	Percentage (%)
Is there system operator/technician	Yes	324	81.51
	No	73	18.49
Basic training given to technician	Yes	231	58.11
	No	166	41.89
Spare parts affordable & accessible at community level	Yes	28	7.17
	No	369	92.83

4.2.4 Community and Social Factors

4.2.4.1 Water Use

Amount of water beneficiaries can collect from improved sources is one of the factors to achieve targeted health benefits through provision of improved water supply sources. Daily water collection of sampled households in each day of a week was collected and summed up then average daily water collection per household was calculated as total water collected in a week divided by number of days per week. Table 4.12 shows the percentage distribution of beneficiary households with average amount of water collected per household per day.

Based on the household survey the mean average daily water collection from the water point per household is found to be 20 to 40 liters or 27.93 %, while the daily average maximum and minimum is 80 and 10 liters, respectively. The statistical analysis showed that 34.34 % of households have average daily water usage below the mean (20 to 40 liters/household). Considering national estimate of only 12.07 of households met the national target of greater or equal to 60 liters per household.

Table 4. 12 Average household water collected per day

Amount of water (liters)	Respondents	Percentage (%)
10-20 lits	136	34.34
20-40 lits	111	27.93
40-60 lits	102	25.66
60-80 lits	48	12.07
Total	397	100

The universal access plan (UAP 2011) targets to reach 15 lpcd of safe water supply for rural communities within 1.5 kilometer radius. The minimum and maximum per capital water collection on average was found 4 and 6 lpcd not including additional water collection for animal watering and gardening. The Universal Access Plan (UAP) had not achieved in the study area.

The households have been using water from the water point for additional purposes mostly cloth washing, animal in house watering and gardening. From Table 4.13 below, as indicated that, communities need water for other purposes beyond domestic water requirement like animal watering 28.3 %, cloth washing 62.64 % and gardening 9.06 %.

Table 4. 13 Additional usage of water from the water point

Water use	Number of respondents	Percentage (%)
Cloth washing	249	62.64
Animal watering	112	28.30
Gardening	36	9.06
Total	397	100

Therefore, during the designing water required for other purposes particularly animals must be considered unless alternative accessible sources are available. Though implementers inform users to apply the service level they need at the project inception (all key informant interviews) it did not become effective so far. The researcher experienced during his stay in the field that communities are not able to identify basic components of water requirement.

4.2.4.2 Water Quality

Factors affecting water quality at source of contaminating sources such as pit latrines close to water points has been an important indicator in indicating the possible source of bacterial contamination of groundwater. In most case, it is advisable to construct latrine at a minimum

radius of 30m down-slope. The mentioned factors are responsible for water quality problems. As beneficiaries responded that 11 % of water points were found in less than 30 m radius to laterins may be risk of fecal contamination.

In the study, 32.83 % of users reported that the taste and odour may be affected after heavy rain indicating easy infiltration of runoff to the groundwater and increased risk of groundwater contamination (Table 4.14). Users (17.35%) of the respondents complained that the water had taste and odor problems.

Table 4. 14 water users' perception on water quality

Respondents	**water quality**	
	Frequency	**Percentage (%)**
Strongly satisfied	42	10.57
Satisfied	156	39.25
Fairly	130	32.83
Not satisfied	69	17.35
Total	397	1000

The bacteriological water quality analysis of samples from 17 water points (Figure 4.2) were performed based on facial coliform counts per 100 milliliter and turbidity of drinking water and the results were shown in Table 4.15. The bacteriological analysis was carried out at the laboratory of SNNPR Wolaita Zone Irrigation and Mine Development Department, Wolaita Sodo.

Table 4. 15 Bacteriological water quality

S.No	Kebele	Sample site	Turbidity (NTU)	Fecal counted (100ml)
1	Gacheno	04/03	1.79	1*
2	Gacheno	Wodeba	93*	1*
3	Ade Koysha	Lo'o Aysuwa	37.6*	1*
4	Wandara Gale	Ketena-6	24.4*	3*
5	Wandara Gale	Ketena-3	22.8*	1*
6	Ade Koysha	Shoya	10*	1*
7	Ade Damota	Shakisho	4.5	0
8	Wandara Gale	Chilo chariya	21.9*	2*
9	Wandara Gale	Woshiraso (spring)	20.7*	3*
10	Gacheno	Ketena-2	1.6	0
11	Gacheno	Koka02	32.1*	1*
12	Shakishshone	Ketena-03	0.01	3*
13	Damotmokonisa	Woyira K-3	0.01	0
14	Ade Damota	Ketena-5	0.47	0
15	Taba	Ketena-3	10.9*	3*
16	Ade Koysha	Tida	56*	2*
17	Ade damota	Lola K-3	38.7*	1*

Note: * = values that exceed WHO standard/guideline (Turbidity = 5NTU & Facial coliform = 0)

Among 17 water samples from water points analyzed, 13 water points have facial coliforms counts exceeding the WHO standard. Therefore, water treatment has to be required before supplying to the community and the result is in line with the beneficiaries perceptions with respect to taste and odour problems.

One Way Analysis of Variance (ANOVA) test showed that significance differences ($P<0.05$) for samples taken from 17 water points. Turbidity of samples has significant differences between and within groups and at significant level of ($p < 0.05$). Samples for coliform from water points have significance differences within and between groups at significance level of ($p < 0.05$) [$Refer\ Annex\ II\ \&IV$].

Physico-chemical water quality analysis for 17 water-points were performed based on 32 parameters, such as turbidity, total chlorine (Cl_2), total hardness, dissolved ammonia (NH_3), magnesium (Mg^{2+}), iron (Fe^{2+}), copper Cu^{2+}), manganese (Mn^{2+}), chromium (Cr^{6+}), chloride (Cl^-), fluoride (F^-), bromine (Br_2) and others. The samples were analyzed in milligrams per liter (mg/L). The physic-chemical analysis was carried out at laboratory of SNNPR state water irrigation and mine development bureau, water resource study and management directorate,

Hawassa. The results were compared with the WHO standards and those parameters exceeding the standared are indicated in Table 4.16.

Table 4. 16 Physico-chemical water quality.

S.No	Kebele	Sample site	
1	Gacheno	04/03	Turbidity* 10, [5]; Mg^{2+*} 48.6, [30]; F^{-*} 1.68, [1.5]; Cl^{-}<10, [250]
2	Gacheno	01/Wodeba	Turbidity* 155, [5]; Fe^{2+*} 3.75, [0.3]; Cr^{6+} <0.01[0.05]; Cl^{-}<10, [250]; SO_4^{2-} <2, [250]
3	Ade Koysha	Lo'o Aysuwa	Turbidity* 56, [5]; Fe^{2+*} 2.0, [0.3]; Cl_2 <0.02,[5]; Br_2<0.05
4	Wandara Gale	Ketena-9	Turbidity* 24, [5]; Fe^{2+*} 4.0, [0.3]; Cl^{-}<10, [250]; SO_4^{2-} <2, [250]
5	Wandara Gale	Ketena-3	Turbidity* 20, [5]; Fe^{2+*} 0.88, [0.3]; Cl_2 <0.02,[5]; Br_2<0.05;Cu^{2+}<0.04, [2]; $NO2^{-}$ <0.01,[3]
6	Ade Koysha	Shoya	Turbidity* 21, [5]; Fe^{2+*} 4.71, [0.3]; Cr^{6+} <0.01[0.05]; Cl^{-}<10, [250]; SO_4^{2-} <2, [250]
7	Ade Damota	Shakisho	Cu^{2+} <0.04, [250]; Cr^{6+} <0.01[0.05]; Cl_2 <0.02,[5]; Br_2<0.05; SO_4^{2-} <2, [250]
8	Wandara Gale	Chilo chariya	Turbidity* 23, [5]; Fe^{2+*} 0.56, [0.3]; Cl_2 <0.02,[5]; Br_2<0.05; Cl^{-}<10, [250]; $NO2^{-}$ <0.01,[3]
9	Wandara Gale	Woshiraso (spring)	Turbidity* 18, [5]; Fe^{2+*} 0.60, [0.3]; Cr^{6+} <0.01[0.05]; Cl^{-}<10, [250]
10	Gacheno	Ketena-2	$NO2^{-}$ <0.01,[3]; SO_4^{2-} <2, [250]; Cl^{-}<10, [250]
11	Gacheno	Koka 02	Fe^{2+*} 0.73, [0.3]; F^{-*} 1.6, [1.5]; Cl_2 <0.03,[5]; Cl^{-}<10, [250]; Br_2<0,05
12	Shakishshone	Ketena-03	F^{-*} 3.20, [1.5]; Cl^{-}<10, [250]
13	Damotmokonisa	Woyira K-2	F^{-*} 1.73, [1.5]; Cl^{-}<10, [250]; Cu^{2+} <0.02, [2]
14	Ade Damota	Ketena-15	Turbidity* 7, [5]; Fe^{2+*} 0.63, [0.3]; Mn^{2+} *<0.1,[0.5];Cl^{-}<10,[250]; $NO2^{-}$ <0.01,[3]
15	Taba	Ketena-3	Turbidity* 589, [5]; Fe^{2+*} 3.0, [0.3]; Mn^{2+}*1.5,[0.5]; F^{-*} 1.54, [1.5]; $NO2^{-}$ <0.01,[3]; SO_4^{2-} <2, [250]
16	Ade Koysha	Tida	Turbidity* 37, [5]; Fe^{2+*} 0.73, [0.3]; Cl^{-}<10, [250]; SO_4^{2-} <2, [250]
17	Ade damota	Lola K-3	NH_3, 1.56*[1.5]; Fe^{2+}, 1.4*,[0.3]; Cl^{-}<10,[250]

Note: * = exceeding WHO standard, [ ] = WHO standard.

All 17 water samples from water points analyzed for physic-chemical, some parameters exceeding and below the WHO (2011) standards. Therefore, water treatment has to be required

before supplying to the community and the result is in line with the beneficiaries perceptions with respect to taste and odour problems.

4.2.4.3 Time spent to collect water

Ensuring improved sources of water supply within a reasonable radius of collection from residence area result reduction of the time spent to collect water and allow females to participate in productive activities including education. In addition the amount of water used by household is affected by accessibility (WHO 2011).

As UAP targets 30 minutes round trip time to collect water from improved source for rural dwellers (WIF 2011). According to analysis users spent an average of 2.26 % or less than 10 minutes per capita per day (mpcd) for round trip including time of train; well below than the national target for rural water supply (Figure 4.2). Maximum and minimum time spent was 49.43% mpcd and 2.26 % mpcd, respectively. Almost 24.53 % of households meet the target set for time spent to collect water (30 minute round trip). However, 75.47 % was below the set target. As the field observation the increased in time spent to collect water is more related with time of travel due to water shortage. The times spent to collect water for additional use beyond domestic purpose also have significant effect on average time spent mpcd. This result below with Obosi (2020), who reported that 26.8% of the population have access to a basic minimum level of service in Ethiopia, while 64.2% have access in Kenya and 84.5% have access in South Africa. Besides, Peter and Nkambule (2012) reported that long fetching time is a main factor which made the schemes unsustainable.

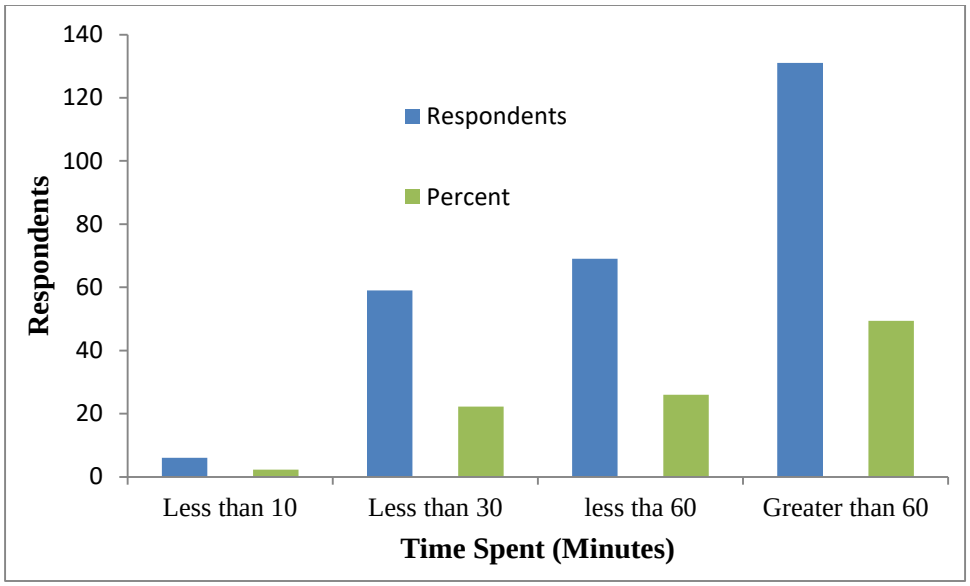

Figure 4. 3 Percentage distribution of average time spent to collect water per capita per day (round trip)

4.2.5 Financial Factors

Finance is a decisive factor which can sustain water supply schemes. In Damot Gale Woreda there is weak financing system (Table 4.17). As the result shows that 33.21% and 66.79 % of respondents confirmed that the government and NGOs respectively financed the water supply schemes. The community financed none and their contribution is almost zero. Financing gap in the Water supply is perhaps the largest obstacle to achieving sustainability of the supply schemes, for example in Tanzania one-in-five newly constructed water schemes breakdown within the first few years (Welsien and Lwakabare 2020).

Table 4. 17 Financing of water supply schemes

		Frequency	Percentage (%)
Who financed the schemes?	Community	-	-
	Government	132	33.21
	NGOs	265	66.79
	All in collaboration	-	-

4.2.5.1 Water tariff and community perception

Water supply schemes are easier to construct than maintain. To ensure a water supply scheme provides the appropriate service quality in a sustainable way, appropriate financial resources that support ongoing operation and maintenance activity must be set. All beneficiaries participated for the survey agreed that increase in tariff level/ setting water tariff was increased the service quality they get from the water supply scheme and are willing to pay for the water tariff (Table 4.18).

The water supply schemes of Damot Gale woreda, the tariff was set in two ways: one for shallow wells and boreholes. Water fetched from shallow wells the payment is per month, i.e. 10 birr per month, while for the boreholes the payment is fetch, i.e. 20 liters costs 1 birr.

Table 4. 18 Water tariff and community perception on the tariff level

Variables	Options	Respondents	Percentage (%)
Water tariff set	Yes	363	91.32
	No	34	8.68
User perception on the service quality as the tariff	Increased	286	72.08
	Not increased	111	27.92
User perception on the tariff	Very cheap	62	15.47
	Cheap	46	11.70
	Fair	198	49.81
	Expensive	70	17.74
	Very expensive	21	5.28

Based on the household survey result (Table 4.16) 79 percent of beneficiaries answered the water tariff is set and they are paying accordingly. From focused group discussion with WASHCOs even the water tariff collected is not totally meant for operation and maintenance but half of it is for the water guard (service provider) and the collection system is very weak. This result supports a study by Hysom (2006) reported that the revenue collection was weak in the majority of villages.

4.2.5.2 Willingness to Pay

The users' perception on service quality on increased tariff and their willingness to pay rated at 72.08 and 65.66 %, respectively (Table 4.19).

Table 4. 19 Payment system, tariff and willingness to pay

Variables	Options	Respondents	Percentage (%)
User pay for the water as per the tariff	Yes	315	79.25
	No	82	20.75
Payment system	Reactive	4	1.13
	Monthly	156	39.25
	As you fetch	171	43.02
	No	66	16.60
Willingness to pay for the set tariff	Yes	261	65.66
	No	136	34.34

Of the total beneficiaries 20.75 % did not pay regularly. This poor water tariff collection is related with multi-dimensional factors. A study by Desta (2009) support this study, communities are able and willing to pay for the WS service.

4.3 Focus group discussions and interviews

Eight focus group discussions and 15 key informant interviews were performed to find out the major factors that affect the sustainability of rural water supply schemes. Focused group discussion with WASHCO members, indicated that some communities are not willing to pay for the water they fetched. This implies WASHCO members are not able to force the community to pay for the water as it will affect their social relationship. Lack of community involvement, poor management system, insufficient water quality, lack of adequate training and follow up, low women's involvement at any stage, water committee are not capable to manage the system properly, community have weak sense of ownership to develop water supply facilities, mis-use of collected funds, lack of proper bookkeeping and saving, failure to consult beneficiaries in choice of technology, absence of working manuals, lack of finance at community level, lack of community skill to O & M schemes properly were the major problems pointed out during focus group discussion and interviews.

4.4 Overall Satisfaction in Service Delivery

The sustainability of water supply system was assessed based on the level of consumer satisfaction and service delivery, the functionality of the scheme, the participation in water supply facilities, the willingness to sustain the supply system, the repair and maintenance issues. Besides, field observation using structured checklist was administered during the study.

Service delivery is the combination of infrastructure and management arrangements required to ensure affordable, safe and reliable water for users. The most common service delivery model is community-managed wells, springs and hand pumps in Damot Gale. The level of service provided under different delivery models varies widely, even within one service delivery model, depending on the type of access point. For example, the level of service provided through public taps. The unit cost of water service provision and the amount users pay to access services also varies depending on the service delivery model. Thus, prioritization and implementation of certain service delivery models matters and impacts the level of service and associated costs of sustainable water access. Based on these factors, the result from the obtained data showed overall service delivery satisfaction is indicated in Table 4.20.

Table 4. 20 Overall satisfactions

Issue	Respondents	Percentage (%)
Strongly satisfied	21	5.28
satisfied	114	28.68
Fairly satisfied	163	41.13
Not satisfied	79	20.00
Strongly not satisfied	20	4.91

The consumers' behavior is important for sustainability of rural water supply system. The finding from the obtained data showed an overall customer satisfaction rated at 33.96%. The customers living in Damot Gale rural district are recorded less customer satisfaction rate and are less satisfied with the service quality delivered by Damot Gale Woreda Mine & Energy office. Ojo (2011) reported that 73.4% of customer satisfaction index as a good indicator for the sustainability of the water supply system.

CHAPTER FIVE

5. SUMMARY AND CONCLUSION

5.1 Summary

A number of factors were employed to evaluate the sustainability of rural water schemes in the study woreda. Community participation from inception to management varies at different stages. The participation of the respondents in scheme inception (7.17 %) and planning (12.08 %) was low. Interviews, focus group discussions and field visits confirmed that 37 % water supply schemes are functional and the remaining 63 % are non-functional. The mean average daily water collection from the water point per household is found to be 20 to 40 liters, while the daily average maximum and minimum is 80 and 10 liters, respectively. The analysis showed that 34.34 % of households have average daily water usage below the mean, i.e 20 to 40 liters/ household. About 50.18% of water users perceived taste and odor problem. The pit latrines, absence of fence, stagnant water, turbidity, close bathing and washing and test and odor to water points has been an important indicator in indicating the possible source of bacterial contamination.

Accessibility was measured in terms of time spent to collect water, availability of operator to serve the community and service interruption. About 75.47 % of the beneficiaries were below the target set for time spent to collect water (30 minute round trip). The users' satisfaction on the service operator during water collection was rated 73.21 % in which the beneficiaries were dissatisfied. 57 % of sampled beneficiaries answered there were service interruptions because of system failure rated at 77.74 %. User perception on the newly set tariff was analyzed and about 23.02 % of beneficiaries argued that the tariff was expensive. The users' perception on increased tariff and their willingness to pay was rated at 65.66 % and 34.34 % not willing to pay.

Lack of cooperation between local leaders and users community, lack of spare parts and tool kits, weak institutional support, weak women's participation during scheme management and decision making, users contribution on O & M is not regular, weak performance of water committee, schemes non-functionality due to water faulty problems, lack of willingness to raise funds, lack of adequate training and follow up, lack of funds for O & M, absence of working manuals, community have weak sense of ownership to the developed water supply facilities, absence of

water users committee, and failure to consult beneficiaries in choice of technology were major problems.

5.2 Conclusion

In order to improve the sustainability of Damot Gale Woreda water supply schemes the concerned bodies have to work with the user community members. Cooperation between local leaders, committee and users community must be improved. Fund has to be raised, consumers must pay for the tariff, and adequate training and follow up must be performed. The WASHCO members have to educate the community to make all users must pay in order to sustain water supply schemes. Focus group discussions and key informant interviews recommended to alleviate the existing problems by providing awareness to the community, budget allocation (for maintenance and operation), taking environmental/sanitation management measures to develop groundwater and its quality issues.

5.3 Recommendations

The following recommendations may be helpful in achieving sustainable water supply schemes in Damot Gale Woreda.

- To strengthen the sustainability of water supply schemes the government and stakeholders commit and work together with community, women's participations should be improved, improve lines of communication b/n stalk holders, choosing appropriate technology, building local technicians capacity and carry out monitoring and evaluation measures.
- Since non-functionality of schemes are ever existing, funds raising and fee collections must be continuous and thus all ensuring reliable water facilities and improving sustainability of water supply schemes.
- Since the per capita per day water consumption is low, water supply enterprise of the Damot Gale Woreda and other concerned bodies have to maintain and develop schemes for people who have low water supply to meet the millennium development goal which sets water supply access for all.

- Measures are required to improve the quality of water in the schemes. This can be achieved by disinfection process such as chlorination or at the individual level water quality can be improved through boiling to decrease the level of pathogens.

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APPENDICES

Annex I: Questionnaire for Household Survey (users of water point)

General Objectives and Confidentiality:

The purpose of the study is to generate relevant information on assessment of rural water supply schmes sustainablity. The research is conducted for partial fulfillment

MSc. Degree in Water Resource Engineering and Management, Hawassa University, Institute of Technology, Water resource and Irrigation Engineering Department. It is expected that different rural water supply sectors, governmental and non-governmental organizations, policy makers and other responsible bodies will make the finding of this study as background information to improve the conditions of the rural community with regard to safe, suitable and sustainable rural water supply schemes. The study is conducted only for academic purpose and be sure that the information you provide will only be used for this research. Your full support and willingness to respond to questions is very important for the success of the study. Therefore you are kindly requested to answer all questions and give reliable and complete information on the issues.

Identifications:

1. Name of interviewer_____
2. Date of interview_____
3. Name of kebele _____Village _____
4. Questionnaire identification number_____

Demographic and socioeconomic characteristic of respondenet:

1. Sex of the respondent: ☐ Male ☐ Female
2. Educational level: ☐ Illiterate ☐ First cycle (1-4 grade) ☐ second cycle (5-8 grade ☐ High school complete ☐ Diploma and above
3. What is your major occupation? ☐ Farming ☐ Government employee ☐ daily labour

Specify, if other_____.

4. Any source of income additional to your major income_____

5. How many family members you have in your house including you_____.

6. What is your main source of water supply? ☐ Hand dug ☐ well protected Springs

7. What is your average income range per month?

A/ Less than 260 B/ 260-450 C/ 450-850 D/ 850-1100 E/ More than 1100

Water service level/quality, users' satisfaction

1. Have you participated in the development of the water supply scheme? Yes ☐ NO ☐

2. If your answer for 'Q1' is 'Yes'

2.1 At which development stage you have participated? ☐

Inception ☐ Project inception ☐ Planning ☐ Construction ☐

Post construction/scheme management ☐

2.2 What was your contribution for the provision of water supply scheme?

Labour ☐ Money (in-cash) ☐ Local material ☐

Specify, if other_____.

3. If your answer for 'Q1' is 'No', what is your reason for not participating?

Not asked ☐ Lack of awareness ☐ Not lived here before ☐ Everything done by implementing agency ☐

Specify, if other_____.

4. How much water do you or your family collect on average each day in a week from the water point? Amount and time

Day	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

Material used for water collection								
Pots								
Jericans in liters	5							
	10							
	15							
	20							
	30							
	40							
Total								

5. For what purpose do you use the water from the water supply scheme in addition to domestic uses? Washing cloth ☐ Animal watering ☐ Gardening Small scale irrigation ☐ Specify, if other_____.

6. Was there any shortage of water from the water point you are collecting? Yes ☐ No ☐

7. If your answer for 'Q 6' is 'Yes',

7.1. In which season was the shortage of water of the scheme mostly occur? ____

7.2. What problem was occurred due to shortage of water from the water point? ___

7.3. Where do you collect water for domestic consumption? _____

7.4. How long the alternative supply sources take? _____.

8. How far is the water point from your house?

Below 500m ☐ 500 to 1000m ☐ 1000 to 1500m ☐ Beyond 1500m ☐

9. Time you take for the round trip to collect water from the water point? minute____.

10. Average time you wait to get water from the water point? minute_____.

11. Is there a person responsible for service provision? Yes ☐ No ☐

12. If your answer for 'Q11'is 'Yes',

12.1.1. How many times a day the water point open for beneficiaries? _____.

12.1.2. For How many hours beneficiaries collect once it is opened? _____.

12.1.3. What is your satisfaction about the responsiveness of service operator?

Strongly not satisfied ☐ not satisfied ☐ not satisfied ☐ fair satisfied ☐ strongly satisfied ☐

13. Do you think the water you are getting from the water point has quality problem?

Yes ☐ No ☐

14. If your answer for 'Q13' is 'Yes',

14.1. What type of water quality problem you observed or tasted? _____.

14.2. When was the problem started? _____.

14.3. Have you told the problem to the WASHCOs? Yes ☐ No ☐

14.4. What do you think the reason for the problem? _____. ☐

15. Has there been any service interruption from the water point? Yes ☐ No ☐

16. If your answer for 'Q15' is 'Yes',

16.1. How many days a year was the service interrupted? _____.

16.2. What was the main reason for the service interruption? scheme failure ☐

drying of the source ☐ Specify, if other_____.

17. Was tariff set for the water you collect from the water point? Yes ☐ No ☐

18. If your answer for 'Q17' is 'Yes', do you pay for water you collect from the water supply point as per the tariff? Yes ☐ No ☐

19. If your answer for 'Q18' is 'Yes',

19.1. How do you pay for it? Reactive ☐ monthly tariff ☐ pay as you fetch ☐

19.2. If your answer is ‘monthly tariff’ or ‘pay as you fetch’, how much do you pay per month on average or per container you use to fetch?_____.

19.3. What is your perception on the tariff level? Very cheap ☐ Cheap ☐ Fair ☐

Expensive ☐ Very expensive ☐

19.4 Do you think increase in the tariff level or set water tariff, will increase the service level you gain from the water point? Yes ☐ No ☐

19.5. If your answer for ‘Q19.4’ is ‘Yes’, are you willing to pay if the tariff increased or set?

Yes ☐ No ☐

19.5.1. If ‘Yes’ how much can you afford to pay_____?

19.5.2. If ‘No’, why_____?

19.6. If your answer for ‘19.4’ is ‘No’, why_____?

20. If your answer for ‘Q17’ is ‘No’, why don’t you pay? I can’t afford ☐ Betray by WASHCOS ☐ No one responsible for collection ☐

21. Do you have regular meeting with water committee? Yes ☐ No ☐

22. Do WASHCOs report an audit report on financial usage of the money collected from user fee and other activities accomplished? Yes No

23. Do you perceive that WASHCOs are discharging their duties appropriately? Yes No

24. If your answer for ‘Q23’ is ‘No’, what do you think is the reason they fail to fulfill their duties? _____.

25. Is there any incentive given for WASHCOs to compensate for their time spent as a water committee? If yes what is it_____?

Annex B: Women’s Participation

1. Did women participate during water school development? Yes ☐ No ☐

2. If your response to Q 1 ``yes`` in what form?--------

   Planning and management ☐ Implementation ☐ Utilization ☐

   others, specify----------

3. If your response to Q 1 ``No`` what do you think the reason behind their non-participation?

   Burden of home activities ☐ Religions reason ☐ Cultural reason ☐ Non-permitting husband ☐ Not interested ☐

   Others, specify----------

4. What is the average distance from your home to your previous source of water?

5. Does the present source of water help you reduce the amount of time required to fetch water? If so, how much time?

6. Are you member of the water committee? Yes ☐ No ☐ No committee ☐

7. Do you think presentation of more women in the water committee is good for the society? Why? or why not?

8. Have you been given special encouragement to participate in the water committee? Yes ☐

   No ☐

Annex C: Community Participation

1. Do you think the community participated in the dev't processes planning and implementation of the water supply scheme?

   A/ To a very great extent ☐

   B/ To a very good extent ☐

   C/ To as one extent ☐

D/ To a low extent ☐

E/ Not involved ☐

2. What type of participation did you have during the water supply scheme?

A/ Cash ☐

B/ Idea ☐

C/ Labor contribution ☐

D/ Local material contribution ☐

E/ Others, specify----------

3. Do you think community participation is important for sustainability of your water supply scheme? A/ Yes B/ No

4. If yes, to what extent ?

A/ To very great extent ☐ C/ To Some extent ☐

B/ To very good extent ☐ D/ To low extent ☐ E/ Not important ☐

5. If No, please explain----------

6. Suggest what can be done on community participation to enhance sustainability of your water facility?

7. Who do you think should be involved in the community?

A/ WASH committee ☐

B/ Women Groups ☐

C/ Community leaders ☐

D/ All community members ☐

E/ Other's specify----------

3.7 Who makes the decisions about water in community?

A/ Men B/ Women C/ Both

Annex D : Economic and Financial Issues

1. Who financed the developed water supply scheme?

   A/ Community B/ Government C/ NGO

   D/ All in collaboration E/ If others specify ----------

2. Do you pay for the developed water supply service/

   A/ Yes B/ No

3. If your response to Q2 is ``yes``, in what form you pay? How much do you pay per household/month? And if not, why?

4. Do you support the idea of paying water tariff /user fee?

   A/ Yes B/ No

5. If your response to Q 4.4 is ``yes`` what is your reason for supporting water payment?

   A/ To undertake scheme maintenance

   B/ To pay water caretaker & technicians

   C/ Science the service is better

   D/ Potable water should cost money

   G/ If other, specify----------

6. If your response to Q 4.5 is ``No``, why not?----------

   A/ Lack of weakness about its importance

   B/Dissatisfaction with the service.

C/ Water is natural gift, so no need of payment.

D/ I don't have confidence on water committee

E/ If Other, specify----------

7. Do you think the payment is affordable?

A/ Yes B/ No

8. How much money are you willing and able to pay for the service per month?-------

9. Do you /your family/ regularly pay for the water supply service?

A/ Yes B/ No

10. If ``No``, why do you not pay regularly? ----------

11. Who set the price of the water fees?

A/ Community B/ Gov't C/ NGC D/ All in collaboration

E/ If other, specify----------

12. Do you think the water fees collected from the beneficiaries is adequate to cover all O & M costs of the water supply scheme?

A/ Yes B/ No

13. If your response to Q 12 is ``No``, why?

14. What costs of the water supply schemes are covered by fees collected from users?

A/Costs of minor repairs.

B/Costs of major repairs.

C/ Salary of care takers

D/Costs of community technicians.

E/Costs of spare parts.

F/ If other, specify----------

15. Who manages the water fees collected from the users?

A/ Water committee

B/ Gov't

C/ NGO

D/ All in collaboration

F/ If other, specify----------

16. Do you think the scheme managers have the capacity and honesty to manage, the money collected?

A/ Yes B/ No

17. If your response to Q15 is ``No``, what do you suggest to be done to resolve the problem?----------

18. What is your perception on tariff level?

A/ Expensive B/ Fair C/ Cheap D/ I don't know

19. Do you have problems in paying tariff?

A/ Yes B/ No C/ Sometimes

20. Does community had financial capacity to sustain the service?

A/ Yes B/ No C/ I don't know

Annex E: Technical Factions

1. Are spare parts are affordable and accessible at community level when needed?

A/ Yes B/ No

2. From where does the community get spare parts to carry out maintenance?

A/ purchase on market

B/ Given by regional /zonal/Woreda water office/

C/ Donated by NGOs

D/ If other, specify----------

3. Are there community technicians that have taken basic training to carry out schemes encounter problem or non functionality? A/ Yes B/ No

3.1 If your response to Q3 is ``yes``, are any of them are females? A/ Yes B/ No

3.2 Are they equipped with necessary tools to carryout repairs when needed?

3.3 If your response to Q3 is ``No``, who carryout repairs and maintenance when needed?

4. How many times in a year does your water source need repair?

A/ Once in a year

B/ Twice a year

C/ Three times a year

D/ More than three times a year

E/ No need

5. Currently does the water system need repair

A/ Yes B/ No

6. How often does facility breakdown?

A/ Once every two weeks

B/ Once a month

C/ Once every three months

D/ If other, specify ----------

Annex F: Choice of Technology

1. Are you happy with the technology for operating your water facility?

A/ Yes B/ No C/ If ``No``, why?

2. What do you recommend about the technology to better enable sustainability of your water facility?

1.2 Type of water facility

a. Shallow well
b. Bore hole
c. Protected spring
d. Other's, specify----------

1.3 Power source for the water facility

a. Electricity
b. Manual
c. Diesel powered generator
d. Solar

E/ Others, specify----------

1.4 When was the facility developed?

a. Three years ago
b. Four years ago
c. Five years ago
d. Six years ago
e. Others, specify ----------

2. Is the water facility functional? A/ Yes B/ No

3.1 If ``No``, for how long?

A/ One week C/ Three weeks

B/ Two weeks D/ One month

E/ Others, please specify----------

3. What was the reason for water facility not functional?

A/ broken down equipment D/ No operator

B/ Electricity problems E/ Others, please specify

C/ No fuel

4. Do you think your water facility is sustainable? A/ Yes B/ No

5.1 If ``yes``, to what extent?

A/ A very great extent B/ A great extent C/ Sometimes D/ To a low extent

E/ To a very low extent

5.2 If ``No``, explain the reasons,-------

5. Was the technology choice appropriate for the water facility? A/ Yes B/No

6.1 If ``Yes``, for what extent

6.2 If ``No``, please explain, ----------

7. Was the community involved in deciding the choice of technology used in your water facility? A/ Yes B/ No

7.1 If ``yes``, to what extent?

A/ To a very great extent B/ To a great extent C/ To so the extent D/ To a low extent E/ Not involved

7.2 If ``No`` please explain it

8. What do you think should be done to the current technology to enhance sustainability of the water facility?

Annex F: Management Factors

1. Is there established management system for the developed water supply scheme?

A/ Yes B/ No

1.1 If Q1 is ``yes``, who manages the scheme?

A/ Water committee

B/Government

C/ NGO

D/ Others, specify----------

2. Does the management body adequately perform their duties and responsibilities?

A/ Yes B/ No

2.1 If Q2 is ``No``, what do you think the reason? ----------

2.2 If Q2.1 is ``No``, what do you suggest to be done the management body perform their duties and responsibilities adequately? ----------

Annex G: Environmental Factors

1. Do you remember in which reason the water supply scheme was developed?

A/ During the wet B/ During dry C/ If other, specify ----------

2. Do you think the existing water supply source is adequate to the beneficiaries? A/ Yes B/ No

2.1 If Q2 is ``No```, what do you think the reason for in adequacy?

2.2 What is your suggestion to tackle the problem?----------

3. Do you think the water supply source now you are using has water quality problem? A/ Yes B/ No

    3.1 If Q 3 is ``yes`` what kind of water quality problem you observed?

4. What do you recommend to alleviate the problem that the water supply scheme is experiencing and to make the scheme proper functional to make the scheme proper functional for long period of time?----------

Annex II: Checklist for Focus Group Discussion

Checklists for points of discussion with water hygiene and sanitation committee's

Date of discussion----------

Kebele----------Village----------

Status of the scheme----------

1. When did the committee established? (Before /after during after construction)
2. By whom the water committee members selected? How many members the committee has? What is the gender disaggregation of committee with individual responsibilities? Are all members are working now? If not how many are not working and what are their reasons?
3. Does the water committee equipped with necessary manuals and working guide lines? (Is there any by- low)?
4. Does the water committee have legal recognition?
5. Are there activities the committee does regularly?
6. Did the beneficiaries pay user fees regularly?
7. How the water committee does manage their financial resources? Do you have bank account of financial record?

8. What are the types of expenses do you have? Is money collected from user fees covers you expenses ?

9. Are there care takers with necessary tools and skills those can carry out maintenance during scheme breakdown within community or committee?

10. How and from where the spare parts are obtained when needed?

11. How does the committee evaluate community participation in general and women's participation in particular at all phases of the scheme Implementation?

12. What supports have been given to the community or committee from external (government & NGO) to sustain the water supply service?

13. What are the major problems encountered in relation with your supply scheme and service delivery?

14. What solutions do you recommend suggest to be done for the water supply scheme to be functional sustainably in your community and Woreda?

Annex III: Checklits for points of discussion with selected women group.

Date of discussion----------

Kebele----------

Village ----------

Status of the scheme----------

1. Who is responsible to fetch water for domestic purpose?
2. Did the women participated before, during and after implementation of the water supply scheme?
    2.1 If ``Yes``, what are the role /contribution on of women in each phase
    2.2 If ``No`` what is the reason for not participating the women?
3. Does the management of the scheme involved women in water committee?

4. How do you evaluate overall performance of the water supply scheme?
5. Have you faced the problem with the water supply scheme non functionality?

   What do you think the regain for the problem?
6. What are the major problems encountered in relations with your water supply scheme and service delivery?
7. What solutions do you recommend to be done for water supply scheme to be functional sustainably in your community and Woreda?

Annex II; Checklists for key informant interview (KII)

IV/ Checklists for Interviewing key informant for government officials (Woreda water ,mine and energy office)

Date of interview----------

Name of the organization ----------

Represented

Position of the respondent ----------

1) Who is the water supply project initiative?
2) Do you make a baseline survey before the project and what situation do you examine?
3) Did the community participate in the project?
4) Did the community participated in choosing place of construction of the water supply system development?
5) Did women participated in the process involved?
6) Had your organization huge the community in organization water committee in the community?
7) Did you make contractor supervision?

8) Do you think that your staff technician are enough for the Woreda water supply system and also capable enough?

9) What problems do you see in the processes of implementing rural water supply system.

10) Did the government institutions adequately prepared the community to manage and sustain their water supply system? Yes/No, if No, what are the reasons?

11) What types of institution supports your office is providing to the lower government community in sustaining the functionality of the water supply system? How refulgent are the supports?

12) Are spare parts and tool kits readily available, affordable at Woreda /community level/ Yes/No, if No, where do you get it?

13) What problems are faced by your organization to make the rural water supply system sustainable?

14) How do you see the coordination of your organization with the lower governments and stakeholders to support the scheme service.

15) How does your office undertake major repairs that are beyond the financial & the technical capacity of the community /Woreda water office?

16) What are the major causes for rural water supply schemes failure in the Woreda?

17) What are the major problems associated with the provision and management of the rural water supply schemes in general?

18) What strategy do you recommended to alleviate existing problems in the water supply sector and to enhance sustainability of rural water supply schemes in general?

II/ Checklists for Interviewing key Informants from Community members (Local Leaders)

Date of Interview----------

Name of the village ----------

1. When was water supply & done developed?
2. What was water source before construction of the scheme?
3. What was the role of community in general and women's in particular before and during implementation of the water supply scheme?
4. Who manages the scheme?
5. What will be done if water committee mismanages the scheme?
6. Is scheme is functional now /Yes/No
   - 6.1 If ``Yes`` , is it giving proper service to community now? (Yes/No)
   - 6.2 If ``No``, what major problems are there in connection with service delivery and when it became nonfunctional? What solutions do you recommend to avoid such failure of the scheme?
7. How do you participate personally in scheme management?
8. How do you see the performance of the water committee in scheme management?
9. What do you think should be done to tackle the challenges facing water committee in scheme management?
10. What complaints are there about the use of the water supply scheme?
11. How do you explain the community demand for water in relation to its population?
12. Capacity building training given to the water committee members?
13. Presence of following and monitoring mechanism regarding the water supply scheme.
14. Community members make timely payments of water, fee and its sufficient for operation and maintenance cost?
15. What do you recommend to be done by user committee and government to make water supply scheme serve community for long period without a problem?

Table 1: Descriptive

Descriptive

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Ga Ketena 03	1	1	1.00	.	.	.	.	1	1
	39	1	2.00	.	.	.	.	2	2
	Total	2	1.50	.707	.500	-4.85	7.85	1	2
Ga Wodeba	1	1	1.00	.	.	.	.	1	1
	39	1	93.00	.	.	.	.	93	93
	Total	2	47.00	65.054	46.000	-537.49	631.49	1	93
Lo Aysuwa	1	1	1.00	.	.	.	.	1	1
	39	1	38.00	.	.	.	.	38	38
	Total	2	19.50	26.163	18.500	-215.56	254.56	1	38
Ketena 6	1	1	3.00	.	.	.	.	3	3
	39	1	24.00	.	.	.	.	24	24
	Total	2	13.50	14.849	10.500	-119.92	146.92	3	24
Ketena 3	1	1	1.00	.	.	.	.	1	1
	39	1	23.00	.	.	.	.	23	23
	Total	2	12.00	15.556	11.000	-127.77	151.77	1	23
Shoya	1	1	1.00	.	.	.	.	1	1
	39	1	10.00	.	.	.	.	10	10
	Total	2	5.50	6.364	4.500	-51.68	62.68	1	10
Shakisho	1	1	.00	.	.	.	.	0	0
	39	1	4.00	.	.	.	.	4	4
	Total	2	2.00	2.828	2.000	-23.41	27.41	0	4
Chilo Chariya	1	1	2.00	.	.	.	.	2	2
	39	1	22.00	.	.	.	.	22	22
	Total	2	12.00	14.142	10.000	-115.06	139.06	2	22
Woshirasho	1	1	3.00	.	.	.	.	3	3
	39	1	21.00	.	.	.	.	21	21
	Total	2	12.00	12.728	9.000	-102.36	126.36	3	21
Ketena 2	1	1	.00	.	.	.	.	0	0
	39	1	2.00	.	.	.	.	2	2
	Total	2	1.00	1.414	1.000	-11.71	13.71	0	2
Koka 2	1	1	1.00	.	.	.	.	1	1
	39	1	32.00	.	.	.	.	32	32

	Total	2	16.50	21.920	15.500	-180.45	213.45	1	32
Ketena 3	1	1	3.00	.	.	.	.	3	3
	39	1	.00	.	.	.	.	0	0
	Total	2	1.50	2.121	1.500	-17.56	20.56	0	3
Woyira K-3	1	1	.00	.	.	.	.	0	0
	39	1	.00	.	.	.	.	0	0
	Total	2	.00	.000	.000	.00	.00	0	0
Ketena 5	1	1	.00	.	.	.	.	0	0
	39	1	1.00	.	.	.	.	1	1
	Total	2	.50	.707	.500	-5.85	6.85	0	1
Ketena 3	1	1	3.00	.	.	.	.	3	3
	39	1	11.00	.	.	.	.	11	11
	Total	2	7.00	5.657	4.000	-43.82	57.82	3	11
Tida	1	1	2.00	.	.	.	.	2	
	39	1	56.00	.	.	.	.	56	56
	Total	2	29.00	38.184	27.000	-314.07	372.07	2	56

Table 2: ANOVA

ANOVA

				Sum of Squares	df	Mean Square	F	Sig.
Ga Ketena 03	Between Groups	(Combined)		.500	1	.500	.	.
		Linear Term	Contrast	.500	1	.500	.	
	Within Groups			.000	0	.		
	Total			.500	1			
Ga Wodeba	Between Groups	(Combined)		4232.000	1	4232.000	.	.
		Linear Term	Contrast	4232.000	1	4232.000	.	
	Within Groups			.000	0	.		
	Total			4232.000	1			
Lo Aysuwa	Between Groups	(Combined)		684.500	1	684.500	.	.
		Linear Term	Contrast	684.500	1	684.500	.	
	Within Groups			.000	0	.		
	Total			684.500	1			
Ketena 6	Between Groups	(Combined)		220.500	1	220.500	.	.
		Linear Term	Contrast	220.500	1	220.500	.	

	Within Groups			.000	0	.		
	Total			220.500	1			
Ketena 3	Between Groups	(Combined)		242.000	1	242.000	.	.
		Linear Term	Contrast	242.000	1	242.000	.	
	Within Groups			.000	0	.		
	Total			242.000	1			
Shoya	Between Groups	(Combined)		40.500	1	40.500	.	.
		Linear Term	Contrast	40.500	1	40.500	.	
	Within Groups			.000	0	.		
	Total			40.500	1			
Shakisho	Between Groups	(Combined)		8.000	1	8.000	.	.
		Linear Term	Contrast	8.000	1	8.000	.	
	Within Groups			.000	0	.		
	Total			8.000	1			
Chilo Chariya	Between Groups	(Combined)		200.000	1	200.000	.	.
		Linear Term	Contrast	200.000	1	200.000	.	
	Within Groups			.000	0	.		
	Total			200.000	1			
Woshirasho	Between Groups	(Combined)		162.000	1	162.000	.	.
		Linear Term	Contrast	162.000	1	162.000	.	
	Within Groups			.000	0	.		
	Total			162.000	1			
Ketena 2	Between Groups	(Combined)		2.000	1	2.000	.	.
		Linear Term	Contrast	2.000	1	2.000	.	
	Within Groups			.000	0	.		
	Total			2.000	1			
Koka 2	Between Groups	(Combined)		480.500	1	480.500	.	.
		Linear Term	Contrast	480.500	1	480.500	.	
	Within Groups			.000	0	.		
	Total			480.500	1			
Ketena 3	Between Groups	(Combined)		4.500	1	4.500	.	.
		Linear Term	Contrast	4.500	1	4.500	.	
	Within Groups			.000	0	.		
	Total			4.500	1			
Woyira K-3	Between Groups	(Combined)		.000	1	.000	.	.
		Linear Term	Contrast	.000	1	.000	.	
	Within Groups			.000	0	.		

	Total			.000	1			
Ketena 5	Between Groups	(Combined)		.500	1	.500	.	.
		Linear Term	Contrast	.500	1	.500	.	
	Within Groups			.000	0	.		
	Total			.500	1			
Ketena 3	Between Groups	(Combined)		32.000	1	32.000	.	.
		Linear Term	Contrast	32.000	1	32.000	.	
	Within Groups			.000	0	.		
	Total			32.000	1			
Tida	Between Groups	(Combined)		1458.000	1	1458.000	.	.
		Linear Term	Contrast	1458.000	1	1458.000	.	
	Within Groups			.000	0	.		
	Total			1458.000	1			

List of Appendix 2: Figures




... Figure: Focus Group discussion with selected water user's,Washco and community leaders

Figure**:** Non-functional and hygiene problem

Figure**:** Non-functional scheme due to poor management


Figure: shortage of water and long duration to fetch	Figure: shortage of water and long duration to fetch
 Figure: shortage of water and long duration to fetch  Figure: Broken down of spring pipe line	 Figure: shortage of water and long duration to fetch  Figure: Broken down of spring pipe line
 Figure: water sampling from water point	 Figure: water sampling from shallow well
 Figure: water quality testing	 Figure: water quality testing