Assessing the Functionality of Hand pumps based Rural water Supply: The Case of Kurmuk Woreda, Benishangul Gumuz Regional State.

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Declaration

This thesis is my original work and has not been presented for MSc degree in any other University and that all the sources and materials used for the thesis have been properly acknowledged.

Declared by: **Fikadu Bekele Leta**

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This is to certify that the thesis prepared by Fikadu Bekele Leta, entitled: Assessing the Functionality of Hand pumps based Rural Water Supply: The Case of Kurmuk Woreda and submitted in partial fulfillment of the requirements of the degree of master of sciences (Water Resource Management) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Abbreviation/Acronym

ADF	African Development Fund
AM	Ante Meridiem
CSA	Central Statistical Agency
DDA	Demand-Driven Approach
DWD	Drinking Water Directive
ETB	Ethiopian Birr
FGD	Focus Group Discussion
GOs	Government Organization
HDW	Hand Dug Well
HHs	Households
HPs	Hand pumps
IRC	International water supply & sanitation Reference Center
KII	Key Informant Interview
MASL	Meters above sea level
MDGs	Millennium Development Goals
MoFED	Ministry of Finance and Economic Development
MoWR	Ministry of Water Resource
NGOs	Nongovernmental Organizations
O&M	Operation & Maintenance
OECD	Organisation for Economic Co-operation and Development
PM	Post Meridiem
RSPF	Revolving Spare Parts Fund
RWS	Rural water supply
RWSN	Rural Water supply Network
SDA	Supply-Driven Approach
SPSS	Statistical Package for Social Scientist
SW	Shallow Wells
UAP	Universal Access Program
UNDP	United Nation Development Programme

UNICEF	United Nations Children's Fund
UN-WATER	United Nation- Water
USAID	United States Assistance for International Development
VLOM	Village Level Operated and Maintained
WATSAN	Water and Sanitation
WCs	Water Committees
WHO	World Health Organization
WSP	Water and Sanitation Program
WSSA	Water supply and Sanitation Authority
WWRDO	Woreda Water Resources Development Office

Abstract

Safe, adequate and sustainable supply of water is basic needs, and essential components of socioeconomic development of a given society. In relation to this, in Ethiopia, although considerable efforts have been made to improve and expand access to potable water supply, many rural communities still suffer from lack of safe drinking water. Therefore, a great section of society still remained without access to safe, adequate and sustainable supplies of water.This study was conducted to assessing the functionality of hand pumps based rural water supply in Kurmuk woreda, Benishangul Gumuz Regional state, Ethiopia.To achieve the objective of the study, a total of 105 household heads were randomly selected and interviewed by using a semi structural questionnaire.Both quantitative and qualitative data were collected through questionnaire, focus group discussion participants, key interview informants and field observations. In addition, different documents from secondary sources were reviewed.The collected data were analyzed using a descriptive statistics. The analysis attributed the non-functionality of schemes to different limiting factors like: weak performance of water committee since scheme management training were not provided in most cases and lacks working manuals; weak participation of women during hand pumps development; very limited in number and responsibility share of women in water committees in most cases; community technicians and spare parts supply chain almost don't -existent in the study area. Majority of users do not contribute water fee for operational and maintenance (O&M) regularly; some hand pumps were abandoned because of water quality problem and low yield as result of inappropriate site selection and lack of supervision during construction; limited institutional support mainly from woreda water resource office in terms of human, material and financial resources. Hence the study calls for: adequate scheme management trainings along with support of necessary working manuals and directives for water committees (WCs); legal status of WCs should be ensured; women's decision making roles should be strengthened;WCs, local community technicians should be trained and necessary toolkits to be provided before scheme hand over to community. Simultaneously, to address problem of spare parts, Revolving Spare Parts Fund (RSPF) should be established in woreda center; integrated feasibility study and construction/drilling supervision should be conducted by appropriate professionals; institutional support of Woreda Water Resource Development Office should be strengthened in terms of human, material and financial resources.

Keywords: Handpumps, Potable water supply, sustainability, water scheme, community participation and women participation.

1. INTRODUCTION

1.1. Background to the Study

Water is a common property resource and is a critical factor for sustainable livelihoods. All households' need water for domestic purpose, for drinking, food preparation, washing and cleaning. Access to adequate, clean water greatly contributes to improved health and productivity (Rahmato, 1999). At the global level, the availability of safe water is low. UNICEF and World Health Organization (WHO, 2019) joint report indicated that 844 million people around the world lack basic drinking water services, and 2.3 billion people lack basic sanitation services in 2015. The majority of the world populations, particularly in Africa and Asia live without access to improved water supply and sanitation services. One of the reasons might be non-functionality of improved drinking rural water supply systems and the higher number of hand pumps in Africa are not working at any given time. Nearly a third of all rural water supply schemes across sub-Saharan Africa are considered non-functional at any given time (Foster, 2013).

According to the WHO/UNICEF Joint programme monitoring report on water supply and sanitation (UNICEF/WHO, 2012), worldwide approximately 780 million people use unimproved water sources for drinking. Sub-Saharan Africa is the region with the lowest percentage of people with improved drinking water sources. An average is 61%, but for urban areas it is 83% and for rural areas 49%. The lack of improved water supplies in rural areas of Sub-Saharan Africa has motivated governments, non-governmental organizations, stakeholders and other entities to highly invest in the sector. Deep wells, shallow wells and boreholes fitted with hand pumps are promoted as the most viable option for rural water supply schemes in many developing countries and have become the principal technology (Harvey & Reed, 2004).

After implementation, many hand pumps stop functioning within a few years service. This time in Sub-Saharan Africa, between 30 and 40 percent of all hand pumps are not functioning (RWSN, 2009). In this regard, according to Harvey (2005), the proportion of people without access to safe drinking water is significantly higher in rural areas than urban areas throughout the less developed world. For example, 56% of people living in rural areas of sub-Saharan Africa and 34% of those living in Latin America lack access to safe water, as compared to only 17% and 6% of their respective urban population.

In this regard, water supply and situation in Ethiopia is not different from Sub-Saharan countries. According to MoWR (2006) the overall national water supply coverage is 47.3%. The service (water supply and situation) coverage is considerably high in urban areas than rural, where the coverage is 78.8% and 41.2%, respectively in the same year. Furthermore, 25% of developed water supply schemes found to be non-functional at national level (MoWR, 2006). Access to safe drinking water supplies and sanitation services in Ethiopia are the lowest in Sub-Saharan Africa. Access to safe potable water for urban areas was 91.5%, while the access to potable water in rural Ethiopia is about 68.5% (within 1.5 km) in the year 2010. Systems are however frequently broken and non-functioning with poor arrangements for maintenance and repair.

Hand pumps are installed on hand-dug, shallow and deep wells to lift water from below to the users. A bucket and cord system is the traditional device but requires excessive effort and strength to lift the water, entails frequent replacement, and subject to pollution both from the ground surface and the bucket and rope. A hand pump is composed of a pumping arm, a piston or plunger, valves, pump rods and pump cylinder. The arm is pumped by hand and drives the piston and pump rods up and down within the pump cylinder causing the different valves positioned above and below the piston to open and close depending on whether water is being pulled in or pushed up (Water Aid, 2011). There are several types of hand pumps exist and are used to rural Ethiopia.

This study was conducted in Kurmuk District of Benishangul Gumuz Region state. Kurmuk woreda is one of the vulnerable woreda which has poor management of water system and accessibility of spare parts. Preliminary review of literature made on the same issue tend to indicate poor operation and maintenance, and lack of sufficient water supply as the major challenge in clean water supply to the community. Therefore, this study has addressed the sustainability of water supply system in the region, particularly Kurmuk woreda and pointed out on how to utilize the existing water supply scheme better in the study area.

1.2. Statement of the problem

Safe, adequate and accessible supplies of water combined with proper sanitation were basic needs and essential components of primary healthcare (Hofkes, 1986). Most of developing countries in general and sub-Saharan African countries in particular are suffering from negative social and economic out comes as result of lack of safe and adequate water supply at reasonable distance, where Ethiopia is also one of the sub-Saharan country facing similar problems. In spite of the fact that, there were several challenges appear with the communities of most rural water supplies in sub-Saharan Africa (Harvey & Reed, 2004). Similarly, many findings show that the rural communities of our country with the problem of water supply (Gebrehiwot,2006; Gujo,2009; Addis, 2010; Musa, 2010; Demeke, 2011; Endashaw, 2011).

However, in spite of its importance, the wealth of researches exploring the sustainability of hand pumps based water supply has been quite meager in Ethiopia in general and in the study area in particular. For instance, Addis (2010) conducted his research on "A Comparative Study on the Performance of Rural Water Supply Schemes: The Case of Debatie Woreda, Benishangul Gumuz ". His findings show that poor community participation in the stage of planning, low level of women participation, weak performance of water committee and weak sense of ownership from the community negatively impacted sustainability of hand pump. Additionally, Awoke (2010) studied the achievement and challenges of rural water supply and sanitation strategic plan implementation in Toleana woreda in South West Showa. He found that the water supply and sanitation developments were not satisfactory because of the limited financial, human and material resources capacity; less emphasis given for constructed water supply scheme's management,less follow-up the schemes and scattered settlement pattern of the people. Moreover, Demeke (2011) conducted study on the problems of rural water supply and the roles of community participation in Lemo Woreda, Hadiya Zone. The study found that absence of local technicians responsible for technical aspects of the schemes; absence of availability of spare parts for community and the matter of technology selection for rural water system schemes development as major problems of rural water supply.

Therefore, there exists no systematic and comprehensive study done so far to establish factors affecting sustainability of water supply schemes in generally on hand pumps didn't addressed the functionality of hand pump based rural water supply schemes and its challenges (social,

technical, financial, institutional and environmental factors). Therefore, this problematic situation prompted the researcher to conduct a study on sustainability of hand pumps based rural water supply schemes in Kurmuk Woreda in Benishagul Gumuz regional state with the intension to fill the existing literature gap in this respect.

1.3. Objective of the Study

1.3.1. General objective

The general objective of the study is to assessing the functionality of hand pumps based rural water supply in Kurmuk woreda, Benishangul Gumuz Regional state

1.3.2. Specific objectives

i. To assess the coverage and functionality of hand pumps based water supply service
ii. To investigate the challenges (social, technical, financial, institutional and environmental factors) influencing functionality of hand pumps based rural water supply
iii. To identifying the coping mechanisms of the community in times of water supply shortage

1.4. Research Questions

- What is the status and magnitude of hand pumps based water supply service in the study area?
- What are the challenges and opportunities of sustainable rural water supply in the study area?
- How do the communities mitigate the risks of water supply shortages in the study area?

1.5. Scope of the Study

The research focus on the functionality of hand dug wells, and shallow wells fitted with hand pump, which are the predominant improved sources of potable water supplies in rural parts of Kurmuk Woreda. The functionality of rural water supply mainly affected the supply as compared to urban areas. These is because; in urban area relatively better water supply management and functionality. Therefore, the research considered only rural water supply hand pump schemes among others because of its high non-functionality rate and service unreliability in many rural areas of Ethiopia and other developing countries.

1.6. Limitations of the study

This research provided emphasis on functionality of hand pumps based rural water supply systems. Apart from the others, the popular sustainability of water supply systems is associated directly and indirectly to sustainability complications of service provisions. In this regard, the study focused on assessing functionality of water supply hand pumps managed by the effort of the community like protected springs, hand dug wells and shallow wells, which are the prime improved water supply sources in rural context and settings of Ethiopia, including Kurmuk woreda.

The concentration on protected spring, hand dug well, and shallow well typology of water supply sources and water supply technologies only, could be considered as drawback of this study. Because functionality of hand pumps based water supply systems, which contribute to sustainability complications go beyond such water supply technologies as well. Apart from the limitations associated to the sustainability rural water supply sources typologies and technologies, there were also limitations in relation to finance, time, distance, security problems and logistical facilities to details work in kebeles while performing the data collection process for this research. Moreover, the study focused on hand pumps related to sustainability based rural water supply systems.

1.7. Significances of the study

This study was expected to make a certain contribution for the study area in the following ways: it can contribute by finding out the reasons behind high non-functionality of rural water supply hand pumps in the study area; it is significant since development actors in charge of rural water supply can use the findings & functionality of rural water supply hand pump schemes. Needless to say, the presence of sustainable, accessible and adequate water supply service has got great contribution for socio-economic development of the community. The finding of the study will also help private sector, development partners and the government to inquire a better means to sustain water supply schemes.

1.8. Organization of the thesis

The thesis is divided into five chapters. The first chapter covers the introduction part which includes the background of the study, statement of the problem, objective, research questions,limitations,scope of the study and significance of the study. Chapter two deals with the related literature review on access to water supply and functionalty of water supply schemes, chapter three contains overview of the study area and detail research methodology, chapter four result and discussions while chapter five conclusions and recommendations parts.

2. LITERATURE REVIEW

2.1. Definition of some operational terms

Community: refers to a group of people in one village using/used water from the same developed water supply source (Brikke, 2000).

Community managed water supply: refers to community takes a full responsibility of the management of its water supply schemes (Davis & Brikke, 1995).

Functional: HPs those were giving water supply service for a community during HHs survey.

Handpump: water supply scheme that is operated by hand through protruded handle for pumping purpose.

Maintenance: refers to the activities required to sustain the water supply in a proper working condition (Davis & Brikke, 1995).

Non-functional: HPs those were not giving water supply service for a community during HHs survey.

Operation: refers to actual running of a service i.e., staring or handling of pumps (Brikke, 2000).

Safe water: refer to drinking water that meets the requirement of MoWR's drinking water quality standard.

Sustainability: refers to water supply schemes being maintained in a condition that ensures a reliable and adequate potable water supply over a prolonged period of time (Davis & Brikke, 1995).

Water Committee: refers to a group of people (5-7 individuals), elected by users and those serve for overall management of water supply schemes at community level.

Water supply schemes: refers to safe water points from where beneficiaries of given community collect water.

2.2. Overview on hand pumps

Hand pumps are given a status within the quest to supply potable water to the worlds' burgeoning rural population by leading players in development just like the international Bank for Reconstruction and Development, UNICEF and a plethora of international NGOs. Since the water decade of 1980s, thousands of different types of rural water supply hand pumps were

installed in the developing countries as part of the united nations-led drive to provide safe drinking water and adequate sanitation for all 1990 (Wood ,1994).

This type of hand pumps are vigorously promoted as being the best option by which communities could enjoy a safe and reliable water supply assuming hand pumps are: low cost, affordable, easy to maintain, an appropriate technology, readily available, easy to install, user friendly and efficient. During the 1970s, the planet World Bank/UNDP pioneered the concept of an easy hand pump which might be maintained at the village level in Africa. The Bank financed the development of what became known as the Afridev, based on the belief that hand pumps must be made and maintained locally, by local people. Furthermore, the advent of the Village Level Operated and Maintained (VLOM) hand pumps in the late 1970s to early 1980s did much to further the hand pumps option, particularly in Africa with the Afridev leading the way toward the goal of affordable village-based maintenance to ensure sustainability(Wood, 1994). However, according to Harvey and Reed (2004) despite to the popularity of hand pumps, evidences suggest that it has failed to deliver satisfactory level of water to the community in sustainable basis. With regard to the handpump performance for village level operation & maintenance (VLOM) are considered,both of the scheme types are considered as village level operation and maintenance schemes (Arlosoroff et.al.,1987).

However, Harvey and Reed (2004) indicated despite the popularity of hand pump, evidence suggests that it has failed to deliver satisfactory levels of sustainability. In 1994, it was estimated that 40 to 50 percent of hand pumps in Sub-Saharan Africa were not working, and according to RWSN (2004) there are currently approximately 250,000 hand pumps in Africa, but half which are operational. This is protected by data from Uganda (DWD, 2002) and South Africa (Hazelton, 2000) indicates similar operational failures rates. An evaluation in Mali in 1997 found 90 percent of hand pumps inoperable one year after installation (World Bank, 1997).

Reynolds (1992) reported that most of hand pumps have a hard life. Many are in continuous to use throughout the daylight hours for as long as they can survive such treatment. They are exposed to the elements, may be a subject to pilferage and vandalism, and can be a convenient scratching post for domestic animals. At least some of users expected to be unsympathetic in the

way they use them, not out of any animosity but simply because they are unaware of the consequences of striking the handle repeatedly.

In this regard, Wood (1994), VLOM hand pumps were developed and installed in rural areas because it was assumed that users themselves would be able to maintain them. In many cases in Africa and other developing countries this has been proved impractical due to a number of social, technical, financial, institutional and environmental problems.

2.3. Conceptual reviews

2.3.1. Concept & definitions of sustainability in rural water supply service

The sustainability issues of rural water supply schemes disregard of their types, is explained by different institutions and academic researchers in different ways. According to IRC, 2003 a water supply service is sustainable when:

- It functions properly and is used;
- It provides the services for which it was planned, including: delivering the required quantity and quality of water; providing easy access to the service; providing service continuity and reliability; providing health & economic benefits.
- It functions over a prolonged period of time, according to the designed lifecycle of the equipment;
- The management of the service involves the community (or the community itself manages the system); adopts a perspective that is sensitive to gender issues; establishes partnership with local authorities; and involves the private sector as required;
- Its operation, maintenance, rehabilitation, replacement and administrative costs are covered at local level through user fees, or through alternative sustainable financial mechanisms;
- It can be operated and maintained at the local level with limited, but feasible, external support (e.g. technical assistance, training and monitoring);
- It has no harmful effects on the environment.

Similarly, Colin and Ball, (1991) described the water supply sustainability as "...a water supply program is it should not only provide good water in sufficient quality but continue to provide it. Where good practice has been identified throughout this account, it had been directed to this end: to ensuring that the water continues to be used for the maximum benefits of the whole community."

Davis and Brikke (1995) pointed out, sustainability in a rural water supply refers to the water consumed is not over-exploited but naturally replenished facilities being maintained in a condition which ensures a reliable and adequate potable water supply and the benefits of water supply are continued to be realized over a prolonged period of time. On the sustainability of rural water supply benefit such as access to greater quantities of water may decline from an initial high level but still continue as an overall benefit compared to a previous supply. It is clear that the benefits of water supplies cannot be sustained without effective O&M and adequate quantity at least for the designed life cycle of the equipment.

2.4. Empirical reviews

2.4.1. Approaches in rural water supply

2.4.1.1. Supply-driven approach to rural water supply

Water is currently perceived by most rural communities as a right to be provided free by the government, rather than a scarce resource which must be managed locally as socio-economic good in order to ensure its effective use. This perception is grown out of the approach that has been adopted before 1980s by actors involved in water supply. This approach was commonly known as supply-driven (Alemu, 2006). This approach is commonly known as top-down approach of project planning. According to MoFED (2006), top-down approach to project planning is applied by central agencies and works outwards from a starting concern with national conditions. According to aforementioned source, top-down approach is the most logical way of thinking about projects and usually the best approach to new endeavors. It guides project planners according to national/regional realities and objectives in a systematic and comprehensive manner.

Musonda (2004) study showed that supply derived approach is the first approach used in providing water in rural communities /societies where those that favored highly centralized system. Regarding this approach, communities were selected for assistance on the basis of an external determination of need, rather than the communities demand for service. Communities were not involved in the decision-making process about the management of water supply facilities. The nature of service provided was also based on an external perception of 'affordability', rather than on the communities' desire or willingness to pay (Musonda, 2004). In rural water supply hand pumps, this approach is dependent and directed by the central governments for managerial, technical and financial support to rural water supply.

The basic needs or supply-driven approach had been adopted for its own merits that were taken to expand water services in the developing nations. The first element is that donors and governments provide the minimum level of improved water service such as hand pumps, to as many people as possible with available funds. The second one was to build up the capacity of government agencies so as to enable them appraise, implement, and manage schemes. And the third one was providing subsides to rural water supply (Kleemeir, 1995).

Generally supply-driven approach (SDA) is proved to be ineffective in most developing countries. Because of aforementioned serious shortcomings, there appears a general recognition that a transformation from supply-driven approach, that pays little attention to the actual practice and/or preferences of the end users to a demand-driven approach, where users get services they want and to which they are willing to pay and responsive to schemes' up keeping is required. This is because the supply-driven approach makes the rural community to develop the mentality that water is a social right to be provided free by the government rather than as scarce resource which should be managed locally as a socio-economic good in order to ensure its effective use (Musonda, 2006).

2.4.1.2. Demand-driven approach to rural water supply

Starting from the later part of 1970s, developing countries experience very poor growth and huge balance of payments deficits. To restore growth, there appears a paradigm shift from micro level-basic needs focused growth and equity approach to macro level structural adjustment policies with central measures such as restraining public expenditures, removing subsidies, and letting the

private sector and market forces take over many functions from government agencies (Kleemeier, 1995)

This approach is also commonly known as bottom-up or demand-responsive approach of water supply development. By the early 1990s, World Bank had officially adopted the new approach to water supply. This approach, according to the writers, was adopted in order to correct shortcomings of the basic needs/supply-driven approach, i.e., in sufficient coverage, high cost, and poor utilization (Alemu, 2006).

MoFED (2006) reported that demand-driven approach is applied by the people at grassroots community level. It is people centered approach which is used to plan projects from grassroots level as bottom line. The approach demands series grassroots community level participation in determining and implementing local plans and projects that suits local needs and priorities. Bottom-up approach of project planning builds confidence and ownership of peoples at grassroots community level, because community needs and priorities will be taken into account by the project to be implemented.

Demand-driven approach primarily proposes the necessity of transferring roles from public sector to the beneficiaries and private entrepreneurs. According to DDA, effective demand of consumers i.e., their willingness and ability to pay, will determine who gets what level of services. The central theme of DDA is that communities should receive, via the private sector, safe beverage, that they're willing and ready to pay (Kleemeier, 1995). Moreover, the approach gives each community and various groups in that community an informed choice of services and service management systems. This means all locally relevant groups, or stakeholders, get information on all relevant aspects& implications of the various water supply options (Smet and Van Wijk, 2002). The information may include in this approach: the amount and quality of water provided; the purpose for which this water will be adequate; potential implication for health and socioeconomic development; investment and recurrent costs involved; approximate walking distances; requirements and possibilities for sharing service and costs (e.g. through group connections or by forming users groups); prospects for service regularity& reliability; and differences in ease of maintenance (e.g. spare parts& technical skills required) and administration. The expected role of the community in DDA differs considerably between urban

and rural areas. In urban areas, private companies and cooperatives are thought to handle the management, whereas in rural areas community organizations would generally have to assume all management responsibilities. Government officials are still to take the responsibility of motivating and organizing communities (Briscoe and de Ferranti, 1998).

As far as effectiveness of DDA at ground is concerned, some empirical works have proved its practicality. In this regard, Whittington et al., (2008) on their research findings suggested that the demand-driven community management model, coupled with access to spare parts & some technical expertise, has come a long way toward unraveling the puzzle of how to best design and implement sustainable rural water supply programs in developing countries.

2.4.1.3. Sustainability of rural water supply in Ethiopia

The water supply and sanitation sector in Ethiopia is one of the least developed and is mostly characterized by service deficiency of physical infrastructure as well as by inadequate management capacity to handle policy and regulatory issue and to plan, operate, and maintain the service (Rahmato, 1999). The national safe water supply coverage has reached 42.2% (MoWR, 2007). The Ethiopian government (subsequently the regional governments) adopted the National Water Resources Management Policy in 1999 (MoWR, 1999) so on to increase and sustain water system services in both rural and urban areas. The overall goal of the policy is to reinforce and promote 'efficient, equitable and optimum utilization of water resources' for sustainable socioeconomic development. The policy follows the principle that the water supply sector has to ensure that every Ethiopian citizen has access to safe water of acceptable quality to satisfy their basic human needs.

The government later adopted the Universal Access Program (UAP) to scale up the water supply and sanitation coverage of the country and achieve 100% water supply coverage in most of the rural regions by 2012 (MoWR, 2006). To attain this target, the UAP assumes that, to form water system schemes sustainable, hand pumps need to be made locally and repaired by local technicians and, generally, pumps and generators need to be standardized in reference to village-level operation and maintenance for sustainable service (MoWR,2006). It has been estimated that 33% of rural water system schemes in Ethiopia are non-functional at any time, due to lack of funds for operation and maintenance, inadequate community mobilization and commitment and a

scarcity of spare parts (MoWR, 2007). With reference to this issue, the UAP aims to rehabilitate and maintain existing water system schemes within first two years of its seven-year plan, so on to develop a maintenance culture and increase the sustainability of both the newly constructed and therefore the existing water system schemes. Like any other sector, water system needs institutions (organizations) which are liable for the supply of water system and sanitation: Planning, financing, monitoring, and maintenance of water system and sanitation activities. In this water sector is characterized by complex institutional arrangements, variety of channels and sources of funds are used to finance the sector (OECD, 2003).

Based on this , decentralization principle, the government of Ethiopia established the Ministry of Water Resource (MoWR) in 1995 at the federal level. The Water Supply and Sanitation Authority (WSSA) reduced to a modest department level within the Ministry's functional structure. The management of water resources at the national level is carried out by the Ministry of Water Resources. Ministry of water resources is responsible for formulating policies for the water sectors at national level, for long term planning strategies, the setting of generic standards for the coordination of projects and funding alongside foreign donor agencies (MoWR, 2006). It is also liable for legislation with reference to utilization and protection of water resources also because the allocation of water between regional governments. It also provides technical assistance and advice upon request to the regional governments of the country.

2.4.1.4. Water supply schemes functionality status in Ethiopia

Scheme functionality status is one of important indicator of water scheme sustainability. However, considerable numbers of developed water supply schemes are not functional in the country because of multifaceted factors. The scheme non-functionality is contributing for already existing low water supply coverage.

According to MoWR Annual Report (2007), number of non-functional schemes in the country is 25% in average. However, the rate varies from 30% in B/Gumuz, 17%, SNNPR to 30% in many regions (Afar, Somali, Harar, Gambela, and Diredawa). Furthermore, it is possible to that regions with low water supply coverage have got high scheme non-functionality rate.

2.5. Factors affecting functionality of hand pumps based rural water supply systems

According to Brikke and Bredero, (2003) and Smet and Van Wijk , (2002), sustainability of hand pumps based rural water supply schemes relies mainly on five interrelated factors: social, technical, financial, institutional and environmental factors. As one can understand, each factor is very broad and constitutes different important elements. Therefore, some important elements of each factor in relation to rural water supply hand pumps are discusses as follows.

2.5.1. Social factors

The social factors which are likely to impact sustainability of hand pump based rural water supply (RWS) are: the availability of demand or perceived need for an improved service; Community participation in all project phases, including planning, designing, constructing and managing the services and the operation and maintenance (O&M) of the services. Demand for water supply improvement and desired service level (men and women, including marginalized groups).

2.5.1.1. Demand for an improved service

Demand for an improved service by the communities is a pre-requisite for sustainability. It is an expression of their commitment, and a way to make communities responsible for their choices and future tasks. However, demand should be promoted because communities must be made aware of the different technology options available, and of their financial consequences. Demand can be manifested in the form of an initial contribution in cash or in kind to capital costs, or in the form of a written solicitation from organized community group to the competent authority/responsible organization (Brikke, 2000).

2.5.1.2. Community participation

In order to increase the chances of the water supply system to meet the needs of users, community participation should begin as early as possible in the project development. In fact, community participation should begin as soon as a community has requested water supply facility. Therefore, community members should be directly involved in planning the new scheme and deciding how it can be run, and by so doing, the prospects of its success so improved (Musonda, 2004). The way of participation is concerned; some water supply agencies reduce community participation to the provision of labor and locally available materials. In order to

ensure ownership and sustainability, however, communities should participate in making major decisions concerning the projects. The community should also participate in carrying out baseline surveys conducted at beginning of the project, in order to ensure that they continue to participate throughout the project life (Musonda, 2004).

However, the way of community participation in Ethiopia especially during rural water supply hand pumps development is restricted to: access road preparation, local material provision (stone in most cases), and fencing around water scheme by the time scheme is developed. After a year or so, however, is impossible to see even the fence around the scheme because of lack of continual motivation of community to participate in the scheme management and consequently community members expect the provider of the water supply system operate and maintain it for them.

2.5.1.3. Women participation

Community participation should also be looked at from the gender perspective, because women have the responsibility of fetching water and yet they are usually not involved in the decision making processes. It should be borne in mind that women are the prime collectors of water and are also the primary beneficiaries of any improvement and should therefore be involved in any attempt to improve their water supply facilities (Musonda, 2004).

2.5.1.4. Community management

Community participation could only be sustained when there is a system for organizing the community (Musonda, 2006). Community organization, therefore, entails that a community has the institutional capacity to manage the development and operation of the water supply schemes, if it is to be sustainable. Hence, responsibility to manage water supply schemes should not be transferred onto the community structure that does not have the capacity to operate and maintain it (Musonda, 2004). The tasks of a water committee (WC) represents the community in contacts with support agencies; coordinate with other community institutions and decision-making bodies; ensures efficient and effective overall management of systems-takes up assigned roles and tasks, ensure equity, organize contributions, organize effective O&M, ensures accurate financial management, use of the facilities, holds regular committee meetings, ensures good communication of all levels, provide information and feedback, and collects information.

Generally, WC is composed of a chairperson, secretary and representatives of the users, with a balance between posts occupied by men by women. In a case whereby the community is directly responsible to technical O&M of the system, the committee also includes the operator and or care taker (Brikke, 2000). According to the same source and researcher experience, the WC does not have legal status.

2.5.2. Technical factors

According to Brikke (2000) the technical factors which are likely to influence sustainability of hand pumps based rural water supply schemes are: technology selection; technical skills needed to operate and maintain systems; availability, accessibility and costs of spare parts; and construction quality of the schemes. Technical standards and complexity of O&M procedures, with a preference for technologies that can be operated and maintained at community level (Smet and van Wijk, 2002).

2.5.2.1. Technology choice

Musonda (2004) underlined that technology selection is crucial to sustainability of hand pump based rural water supply schemes.Community is to manage a water supply schemes, the technology used needs to be of a type that community caretakers can maintain with little outside assistance. Also, technology must suit the existing locally available skills or skills that can be acquired by community members. Technologies are considered suitable if it is socially acceptable, economically viable, technically effective, and environmentally sound. Communities should have a say in technology option. The technology option should not be too technical and beyond the comprehension of community members and socio-economic viability, social acceptability and appropriateness of technology influence the ability and willingness to manage the improved water supply systems. The use of appropriate technologies, which are low, cost, easy to maintain, simple to use, and readily available is one response to challenge of sustainability.

The VLOM concept includes the development of hand pumps specifically designed to be maintained by village care takers, but also extends into the institutional arrangements needed to ensure that skills, tools and spare parts are available when needed. Community participation in

the selection of technology type in general and the mark of technology depending on their easiness for O&M in particular should be considered. In this regard, study in Mirab Abaya has shown that WCs have never been participated in technology selection activities (Israel & Habtamu, 2008).

2.5.2.2. The availability, accessibility and costs of spare parts

Hand pump installation is the most widespread solution for supplying water to millions of people in Africa's rural areas. However, at any given moment, average 30 percent of all potentially functional hand pumps in Africa are not working. In some areas, 50 percent or more are non-functional, partly due to difficulties in obtaining spare parts (WSP, 2006). The problem of spare parts for sustainability rural water supply hand pumps primarily attributed to lack of formal supply chain mechanism. Hence, Lack of spare parts has been a major constraint in sustainability of water supplies and has been a recurring problem. In some cases, it has led to the complete abandonment of the water supply system (Brikkke *et al*., 1995). If sustainability is to be achieved, it should be ensured that after appropriate technology is chosen, spare parts for that type of technology are made readily available (Musonda, 2004).

2.5.2.3. Availability of toolkits and technical skills needed for O&M

For village level operation and maintenance(VLOM) hand pumps, there should be trained care takers those can undertake maintenance work when needed. The care takers should be capable of doing preventive maintenance work, replacement of worn out parts, and maintain breakage. Therefore, in order to discharge those responsibilities, the care takers should have necessary trainings from the very beginning of scheme installation.

2.5.2.4. Construction quality of hand pumps

From experience, it is not uncommon for the failure of water supply hand pumps because of construction quality problems. Common construction quality problems that result in scheme dis-functionality are: improper site selection due to poor and/or lack of feasibility study, partial penetration of an aquifer, poor casing arrangements, and poor gravel packing and poor estimation of well yield. Such kind of well completion problems eventually results in well dry up and as a result hand pumps will be abandoned (Harvey & Reed, 2004).

2.5.3. Financial factors

Smet and van Wijk (2002) provided important financial factors that are likely to be considered for the sustainability of hand pump based rural water supply schemes are: financial ability to meet the cost of maintenance. For example, tariff structure covering O&M and replacement costs; willingness & ability to pay; and financial management system.

2.5.3.1. Financial ability to meet the cost of O&M

Failure to adequately cover costs of improved water supply services in developing countries has been identified as major constraints to achieving the goal of safe water supply for all on a sustainable basis. In recent years, increased community financing through user payment for services has been strongly promoted as a solution (Evans, 1992). In this regard, Getachew (2002) mentioned that even small water supply systems require investments, operation and maintenance. These are often costly and thought to be beyond the financial capacity of community, however, experience shows that communities are willing to shoulder portions of the investment costs and to pay for full O&M provided that they are in need of the service and appropriate community promotion exercise is being carried out. Although there are undoubtedly some areas in some countries where poverty is extreme, the review of global situation reveals that most rural communities can afford to pay for improved water supply services provided that appropriate technology choice to used. The reason for this argument is that people in rural areas are already spending large amount of time and energy in water collection (Musonda, 2004).

As far as payment for water supply service is concerned, Ethiopian Water Resources Management Policy (1999) promotes that for rural water supply schemes partial cost recovery principle to be applied i.e. user communities should cover O&M costs. Such kind of payment was proposed to be effected through different tariff structures. The tariff fees that is adopted for rural water supply schemes that provide communal services like hand pumps and public stand posts is flat rate tariff, in which all beneficiaries are expected to contribute equal amount either in cash or kind in fixed time interval(for instance, on monthly basis for tariff fees).

2.5.3.2. Willingness and ability to pay for services

Providing services which people can afford is a pre-condition for cost recovery (partial cost-recovery in rural water supply case in Ethiopia). Being able to pay for something and being

willing to do so, however, do not always go hand in hand. From an economist's point of view demand is only real (or "effective") when it is accompanied by willingness to pay, in cash or kind, for goods or services offered. From this view willingness to pay & demand essentially mean the same thing (Evans, 1992). In order to the communities meet the cost of O&M, community members must be willing to pay for the service. However, not every community member is willing to pay for the services. Willingness to pay for the services are influenced by number of factors. For example, a community with a river near-by is prepared to pay much less for a hand pump than a community with similar income who has to walk kilometers to fetch water.

2.5.3.3. Financial management system

In order to cover O&M costs and other important replacement costs, the collected money from user community should be managed properly and used for the intended purposes. Especially, training should be given for water committee for prudent financial management. Or else, there should exist transparent working & accountability mechanism in order to avoid misutilization and embezzlement of collected money (Davis &Brikke, 1995).

2.5.4. Institutional factors

According to Brikke and Bredero, (2003) and Smet and Van Wijk, (2002), institutional factors that are likely impact sustainability of hand pumps based rural water supply schemes are: institutional support; availability of technical assistance to communities (from government and NGOs); and train local technician to deal with community development and knowledge of participatory approaches.

2.5.4.1. Institutional support

Brikke (2000) emptied that institutional support is a critical factor in the water supply sector and influenced particularly by the organizational framework and the quality of staff. The organizational framework should encompass all the components of the sector from planning and design to O&M, with support for programs of health education and community participation. There should be clear lines of authority and responsibility, and when several government agencies are involved, coordinating mechanisms are essential. Unless aforementioned technical, material and financial capacity of the responsible institution is fulfilled, the institution cannot

discharge its responsibility properly and as result sustainability of the schemes will be compromised. Furthermore, Misigina (2006) study found that one way of enhancing sustainability of rural water supply schemes is the provision of institutional support to community management bodies. Problems that are beyond community level need to be addressed by supporting agencies like government staffs and NGOs. Studies indicate that lack of assistance to local community management body is one of important failures of improved water supply systems.

Similarly, Kebede (2003) reported that legal recognition of the user groups, as one institutional support, assures the realization of their full capacity as self-help associations. It also facilitates the resource recovery of the system through direct and legal partnership with external support agencies and acquisition of loan whenever need arises. Sustainable community management requires partnership all owing scope for shared responsibilities among community level water management structures, local government units and government offices for water development.

2.5.5. Environmental factors

According to Brikke and Bredero, (2003) and Smet and van Wijk, (2002), the most important environmental factors that affect sustainability of hand pumps based rural water supply are: the quality, quantity of water source and continuity of supply. It need for water treatment, water resource management and seasonal variations.

However, even in areas where there is sufficient availability of water supply, the source can fail to satisfy demand, either due to population expansion or use of the water supply for other purposes apart from domestic use purposes. Climate change also affects water availability, especially in rural arid or semiarid climatic condition areas. Hence, ground water table level depletion will be the major adverse effects of climate change.

2.5.5.1. The quality of water source

The quality of water source determines whether the water needs to be treated or not. It also influences the technology choice. Therefore, domestic water should be available in acceptable quality water to satisfy minimum requirements for drinking, cooking, and food preparation as a priority in addition to water for washing clothes, bathing and personal hygiene and for watering

small plots and/or small number of livestock. Therefore, water source to be developed should fulfill a minimum set of quality standards (Dereje, 2007).

2.5.5.2. The quantity of water and continuity of supply

In selecting site & appropriate method of developing and providing water for domestic uses, attention should be given to potential future demands on the system. The system should be designed with a view of possible future expansion in population or other condition requires it. In addition to this, knowing and calculating the different uses of water is important. Therefore, understanding the hydrology is the key in the process of identifying how the water sites will behave under stress and also the long- term sustainability of water sources under the impact of drought and climate change. Well planned community supplies, which take into account the nature of water resources, will be more sustainable. It is thus vital that for the sound development of water resources, the integrated strategies should be adopted (Dereje, 2007).

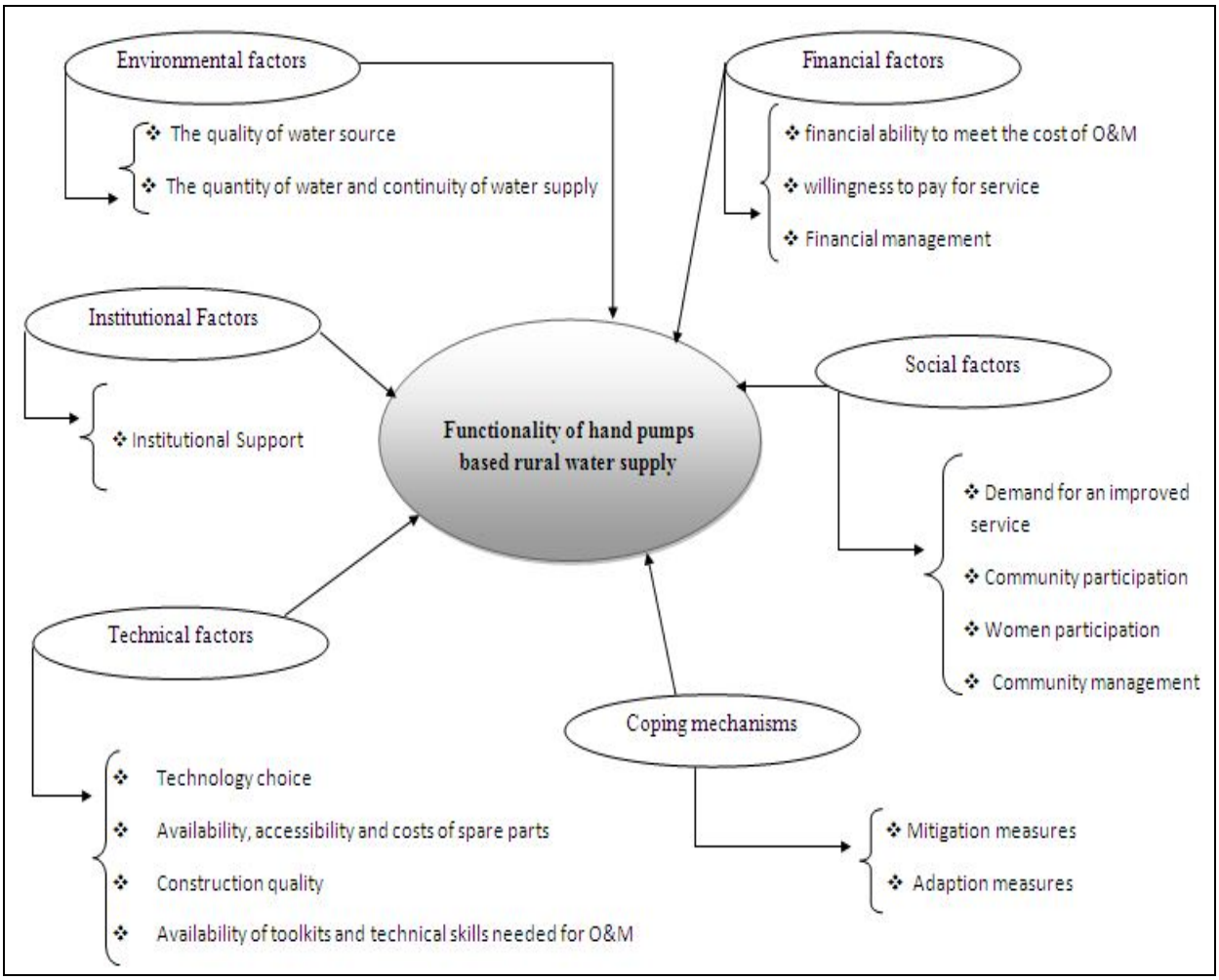
2.6. Conceptual /Theoretical framework

Sustainability is a complex and dynamic concept which is made up many interrelated components. As can be seen from the literature section of this paper, sustainability of hand pumps based rural water supply depends on social, technical, financial, institutional and environmental factors. Furthermore, each factor comprises of important elements that have to be considered to ensure sustainability of water supply hand pumps. As far as social factors were concerned, there should be a demand from community for improved water supply hand pumps before development of the schemes. Community participation in general and women participation in particular should be ensured starting from planning to final management stage of the scheme development. Overall management of implemented hand pumps should be undertaken by locally organized and recognized water committees. Furthermore, staffing of water committees should be gender sensitive to include women as decision making body for hand pumps management.

As technical factors, water supply projects should consider village level operated and maintained (VLOM) hand pump for ease of community management. Also, adequately trained and skilled technicians those can undertake minor maintenance of pumps should be created within user communities. Besides, important toolkits those are required to undertake maintenance works

should be availed. Furthermore, spare parts supply system should be established in a way that the communities can access and afford them if needed for maintenance. Also, construction quality of hand pumps during well excavation/drilling and top works construction should be supervised by relevant professionals to avoid construction quality problem.

Concerning financial factors, user communities should make regular contribution for O&M of hand pumps. However, in order to maintain the existence of regular contribution for O&M the amount of contribution should be based on users' ability and willingness to pay taking into account minimum requirement for covering all O&M cost of the pumps. Also, practice of saving users contribution in local financial institutions should be there so that the maintenance of emergency breaks and cost of spare parts can be financed with little down time period of hand pumps. With regard to environmental factors, in order to avoid pump disuse and service unreliability due to water quality problem and inadequacy of well yield, integrated feasibility study should be there before commencement of well drilling for hand pumps. Also, potential future users' number and impact of climatic variation on water level need to be considered during planning of pumps to avoid the water source inadequacy and to ensure continuity of supply.Regarding institutional factors, should be exists institutional support under which water supply schemes are developed and managed. Also, there should exists a room for involvement of private sector. Furthermore, capacitated local public institution responsible for monitoring and management is required. Also, the external support rendered for community management should have some form of continuity with defined and clear phase out strategy. So, this study employs the following conceptual framework to assess the sustainability problem of rural water supply hand pumps by examining the existence or absence of factors those contribute for water supply schemes sustainability (See fig.1)



Source: adopted from Smet and Van (2002), Brikke and Bredero (2003), Musonda, (2004)

Figure 1: Conceptual and theoretical framework of the research

3. RESEARCH MATERIALS AND METHODS

3.1. Description of the study area

3.1.1. Location and demography

Kurmuk woreda is one of the 8 woredas of Assosa zone of Benishangul gumuz regionals states (fig. 2). This woreda is administratively divided into 19 rural kebeles and one urban town. It is bordered by Assosa woreda on the South, Homosha on the east, and Mengie on the North east, Sherkole on the North and Sudan country on the North West. Its geographically the woreda is located between 34°19'04" Longitudes and 10° 33'13" Latitude covering an area of 1434 square kilometers with average elevation of 645 meters above sea level (m.a.s.l.). The highest and lowest elevating are 1337 m.a.s.l. and 750 m.a.s.l. respectively that situated in the Southern and Northern portion of the study area.

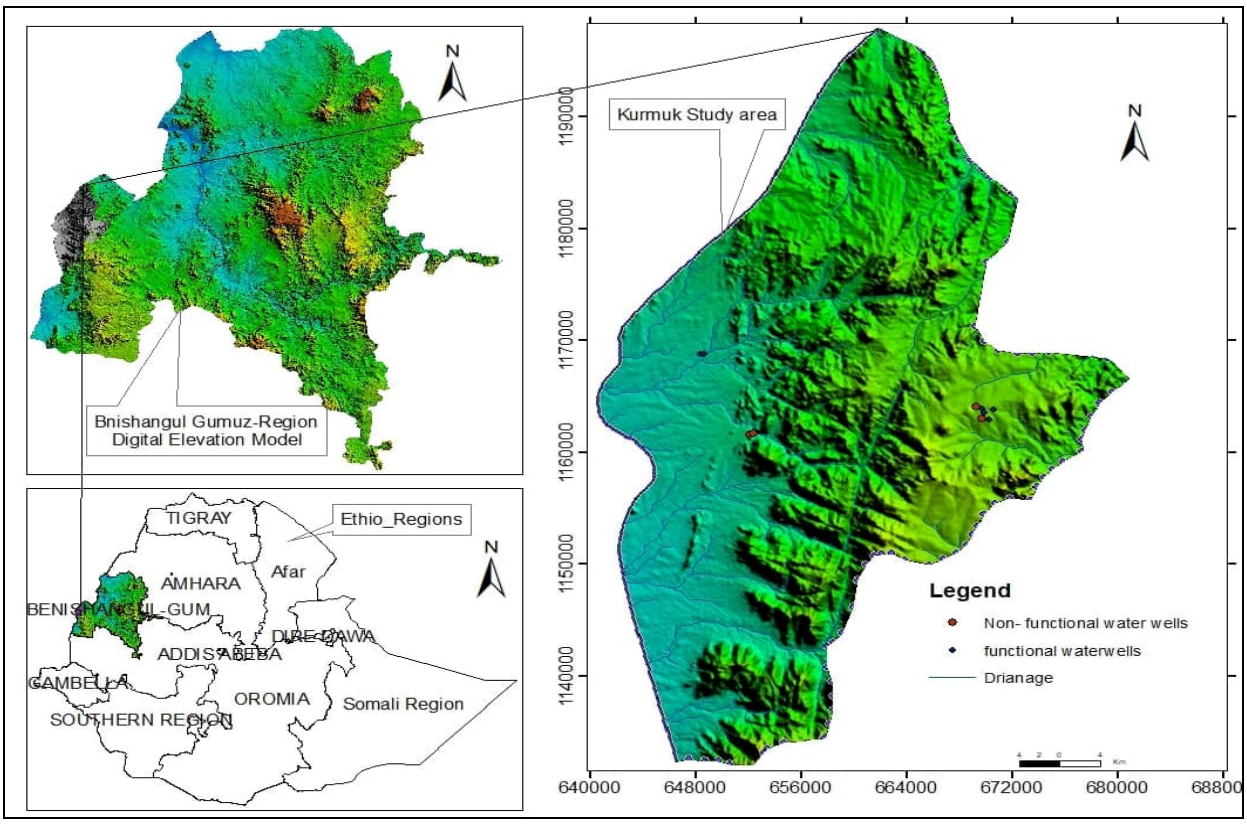


Figure 2: Location map of Kurmuk woreda

The current population of the Kurmuk district is 26,692 from this 12,666 are male and 14,026 are females living in 2515 households (kurmuk woreda report, 2021). Agriculture and traditional gold mining is the primary economic source in the Woreda's. Nearly 80% of the people directly or indirectly support their livelihood income generated from traditional gold mining. The major crops cultivated in Kurmuk Woreda's include: sorghum, and maize.

3.1.2. Status of water supply in Kurmuk woreda

As per the information obtained from Kurmuk woreda water resource development office, the woreda average and rural water coverage in 2020 was 47.8% and 50.3%, respectively. In the woreda there are 99 water supply schemes serving the community, out of which 91 are shallow wells having depths ranging from 32- 50m, 8 hand dug wells with average depths of 12m. In fact one new deep borehole with 92m depth constructed in Dul hodie kebele in 2021 and do not started service provision.

The aforementioned water supply access coverage is calculated only relying on the number of the water supply facilities constructed so far and does not base on tangible current functionality levels of the constructed water supply systems. This is attributed to budget limitations, lack of logistics facilities and unavailability of technical supporting staffs to perform regular water supply functioning inventory across the rural kebeles of the woreda. Table 3.1 summarizes the distribution of different types of rural water supply systems and their status in Kurmuk woreda.

Table 3. 1: Overview of potable rural water supply schemes in Kurmuk woreda

No	Type of potable (clean) water supply schemes	Total number of water supply schemes	Functionality status	
			Functional	Non functional
1	Shallow wells	91	76	15
2	Hand dug wells	8	0	8
	Total	99	76	23

Source: Kumuruk Woreda Water Resource Development Office (WWRDO, 2021)

Majority of the water supply schemes installed by government and local/international Non-governmental organizations (NGOs) through ONE WASH program that mainly base on ground water supply sources because limited perennial surface water sources in the woreda. During the

critical and extended drought seasons, the water supply sources (shallow and hand dug wells) don't provide water owing to depletion of the ground water table below the pumping levels. The principal reason for the drowning of the water level is the insufficiency of recharges coming into the water sources. The ground water table variability is associated with the repeated occurrence of extended dry seasons and erratic rainfall. From this, it can be deduced that impact of climate change has been worsening the life of the rural population and are also the prime contributor of such prevalence's (WWRDO,2020). Hence, this is one indication that multidimensional and multispectral collaborations worth imperative at international, national, regional, and local level to lessen the adverse impacts of climate change on the life of the rural population. According to the Woreda water office Annual report in 2020, from the total number of rural water supply schemes at the end of 2020 were 99 schemes are developed in rural setting.

3.2. Research Methods

3.2.1. Research design

Methodology is one of the underlying beliefs and assumption concerned with how a research approaches in conducting empirical research in search of knowing the phenomena (Guba and Lincolin, 2005). Accordingly, the research design employed in this research applied mixed-method approach. Creswell (2009) treated mixed research as an approach to inquiry combining both the quantitative and qualitative forms of research. Its central premise is that the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone. Therefore, by considering time and other logistic constraints in to account, this study applied household survey for quantitative and also used qualitative approaches of data collection and analysis to get in depth insight of the issue under investigation.

3.2.2. Household survey sample size and sampling techniques

In relation to sample size for household survey, it is necessary to determine the minimum sample size which is representative of the wider population (Barlett et al., 2001). Therefore, the research employed probability and non-probability sampling techniques to select the study area and the

sample populations, respectively. Accordingly, Kurmuk district is purposively selected grounding the researcher's frequent observations and real-life experience.

According to official sources, Kurmuk woreda has 19 *kebeles* with a total household size of 2,515 where each *kebele* possess hand pump water supply scheme and sanitation intervention (Kurmuk *Woreda* Administration office, 2020). Considering the limited time and available facilities in to account, involving all of the *kebeles* in to the study is hardly possible. Therefore, four sample *kebeles* were randomly selected, the sampled kebeles were Horazabi (250 households), Abadi (175 households), Hushiri Guma *kebele* (100 households) and Dul Hodie (147 households) altogether making a total of 672 households. Then sample size of 105 households is statistically determined using Kothari (2004) formula as follows.

$$n = \frac{Z^2 pqN}{e^2(N-1) + Z^2 pq}$$

Where:

n = Sample size

Z = Values of standard variant at 95% confidence interval (Z = 1.96).

N= the total number of households in the four *kebeles* (672)

P= proportion of sampled population (0.03)

e = 0.03 (since the estimate should be within 3% of the true value).

q=1- P

$$n=\frac{(1.96)2*0.03(1-0.03)672}{(0.03)2(672-1)+(1.96)2*0.03(1-0.03)} = 105$$

Having determined the sample size, the sample population were proportionally drown on the ground of each sample *kebele* population size through simple random (lottery method) sampling technique. Generally, the sample population accounts for about 16% of the total households in the study *kebeles* as detailed in Table 3.2 below.

Table3. 1: Sample size and proportions

Name of selected Kebeles	Total household heads	Sample proportion	Percent (proportion)
Horazabi	250	39	37.1
Abadi	175	27	25.7
Hushiri Guma	100	16	15.2
Dul Hodie	147	23	21.9
Total	672	105	100

Source: Own calculation, 2020

3.3. Method of data collection

The research used various data gathering instruments composed of both primary data sources. The primary data collection methods include household survey, focus group discussions, key informant interviews and field observations and secondary data from published and unpublished documents as detailed hereunder.

3.3.1. Household survey

Household survey is one of the key sources of quantitative data on social phenomena as it is the most flexible method of data collection. Questionnaires were used as a primary instrument to collect data from the sample households. A pre-tested questionnaire composed of both open and close ended questions were administered from the sample respondents. By this instrument, 105 of the sample households were considered. The survey question was designed to elicit adequate information related to the sustainability of water supply schemes, its challenges and opportunities and coping mechanisms. The questionnaire was prepared in English and translated into the local language (Berta) to avoid communication barrier.

3.3.2. Focus group discussion

Focus group discussion (FGDs) was one of the methods that the research employed to collect a variety of qualitative information. Key informant interviews and focus groups discussions help to generate different information, reflecting public versus private views (Morgan, 1998). Regarding the focus group discussion, water scheme committees and women, who are believed to be knowledgeable about the water supply issues were identified and included in the discussion.

Separate sessions of discussion were arranged for woman participants from women development army so that the groups able to speak out their feelings freely and more comfortably. Given the limited time and logistic constraints, Horazabi and Abadi *kebeles* were purposively selected for the focus group discussions grounding on relative size of the households. Accordingly, four focus group discussions (one FGD from water scheme committee and one from women groups in the two selected *kebeles*) were conducted where each focus group comprised six to eight individuals so as to compile with COVID-19 protocol otherwise size of FGD participants range between 8 and 12.

3.3.3. Key Informant Interview

The researchers also employed key informant interview (KII) as another qualitative primary data gathering tool for the research. As far as key informant's interview is concerned, Grover (2008), suggested that, the respondent approached should be the most informed and knowledgeable person about the issue of interest. Accordingly, key informants of the study were purposively selected that include community representatives and sector officials from relevant offices. Taking in to account the limited time and available facilities, the research purposively included twelve key informants, specifically eight community representatives, i.e. two from each kebele and four stakeholders from relevant office.

3.3.4. Observation

Personal observation as another important means of obtaining primary data was used as part of the field research. The researched conducted critical observation concerning functionality of the hand pump based water schemes and also conducted informal oral questions with villagers met during walks about the sustainability and challenges of the water supply service. Moreover, during field observation, field notes taken and issues raised during focus group discussion and key informant's interview were used to further drill water scheme users.

3.3.5. Secondary data sources

Review of secondary data sources were done as additional data gathering instrument to supplement the primary data collected through above various tools. Accordingly, secondary data gathered by referring documents, reports of relevant offices and online materials. The results used to cross check and triangulate with the data gathered using primary sources and obtain further information in the process of reaching on better findings and defensible conclusions.

3.4. Method of Data Analysis

Regarding the analysis, information generated through various methods of data gathering tools were approached through quantitative and qualitative analytical techniques. Accordingly, the survey data were analyzed using descriptive statistics with the help of statistical software (latest version of SPSS. 20). The portions of data readily quantifiable (information from the structured questionnaire) were organized in tabular form and discussed using percentages, frequency distributions, graphs and cross tabulations. Moreover, qualitative data obtained from focus group discussions, key informants' interview and personal observations were transcribed, systematically organized and discussed in the triangulation of evidence.

4. RESULTS AND DISCUSSIONS

This section of the research is devoted to presenting the results of the data obtained through various data gathering instruments. The data obtained through questionnaire is organized in table form and analyzed using descriptive statistics. In addition, the data acquired through key informant interview, focus group discussions and personal observations were systematically triangulated and discussed alongside with the results of household survey and interpretations are made accordingly.

4.1. Survey household characteristics

4.1.1. Sex and age of survey households

Survey households sex and age structure are given in table 4.3. The analysis showed that 12.1% respondents were male and 86% were female. It is well known that water fetching in most rural households in developing countries in general and Ethiopia in particular primarily regarded as responsibility of women. According to African Development Fund (ADF) (2005) indicated that women living in rural areas often travel long distances to collect water, accounting for two to six hours per day. The interviews (household survey respondents) were conducted with women although most of households were male headed. The survey analysis revealed the majority (86.8 %) of the respondents were in the age category of 18 to 49 and the remaining, 11.2% were between 50 and 64 years age category. Thus household heads in active working age (18 to 49) group are expected to actively participating in process of rural water supply development (like hand pump) and management particularly in planning, construction and management so as to ensure sustainability of the schemes. The availability of economically active work force is particularly important in areas where capital is scarce and labor-intensive development activities, like small-scale water supply schemes development need to be encouraged in all rural areas. Thus, based on the result of the survey households, it was safe to say that the community participation in the study area can share labor and local materials involve in development schemes and management of water supply projects.

4.1.2. Marital status and family size of respondents

Out of 105 respondents, 84.1% were married, while 9.3% and 4.7% were separated and single, respectively. With regard to the household family size, the minimum size is 1 and the maximum sizes are 10. Household's family size is important in order to determine the water consumption and number of households a particular schems to serve. Accordingly, analysis of household survey showed that study area community on average households that has 5.3 family size, which is slightly larger than the rural national (4.9%) average (Hoddinott and Mekasha, 2020). In depth analysis revealed that most (86%) households have 3 to 8 family size and considerable portion (6.5%) have over 9 family size while only 11.2% have 1 to 2 members (table 4.3). This show that water need (consumption) of study community is relatively larger volume compared to the national average of most rural households of Ethiopia. From this the mean of the family size is 4.9 which is slightly greater than the family size of 4.7 persons in Ethiopia (CSA, 2007).

Table 4. 2: Background of the survey households

Variables	Categories	Frequency(N)	Percentage (%)
Sex	Male	13	12.1
	Female	92	86.0
	Total	105	100.0
Age	18-24	18	16.8
	25-34	39	36.4
	35-49	36	33.6
	50-64	12	11.2
	Total	105	100.0
Marital status	Married	90	84.1
	Separated	10	9.3
	Single	5	4.7
	Total	105	100.0
Family(HHs) size	1-2	12	11.2
	3-4	25	23.4
	4-6	37	34.6
	7-8	24	22.4
	Above 9	7	6.5
	Total	105	100.0
Educational level	Illiterate	51	47.7
	Informal education	5	4.7
	First cycle(1-4)	21	19.6
	Second cycle(5-8)	9	8.4
	High school(9-12)	9	8.4

	College level	10	9.3
	Total	105	100.0

Source: Own survey, March 2021

4.1.3. Educational level of respondents

Regarding the education level of the survey respondents, nearly half (47.7%) of the respondents were illiterate (unable to read and write), which is followed by those attended first cycle (grade 1 to 4) school that account for 19.6% and the remaining educated at different level (Table 4.3). Few (4.7%) respondents have reading and writing ability by attending informal education like religious and adult education. Respondents attended first cycle (grade 5-8), high school and college level accounts 8.4%, 8.4% and 9.3%, respectively. Educational status of household heads (husband and wife) is very important to adopt improved technologies and service. In this regard, nearly half of survey households (women) at least able to read and write, thus they are expected to uses potable water than open sources at any cost (labor, time and money). The health extension services provided in each *kebele* in rural Ethiopia also focuses on hygiene and sanitation including uses of potable water is another opportunity to enhance household's preference to use potable water. The health extension education modality tacking women at the center using different structural arrangement starting from neighborhood to *kebele* level, 1:5, 1:30 and *kebele* women development army that help easy communication and diffusion of required extension idea. This was turn could be one main reason for little follow up and poor management of rural water supply schemes. With regard to domestic water quality improvements, education was one major factor which will help them in how to use water resource in a better way.

4.1.4. Survey household's livelihood and annual income sources

All of the respondents' occupations were traditional gold mining and few households have additional income from crop production, casual labor work, both crop and animal production, employment(salary based) and business/trade.

As shown in table 4.4, the major income sources of survey household's traditional gold mining. The survey revealed that the average the annual income for 79.05%, households from traditional gold mining was estimated about 25,000 Ethiopian birr (ETB) and followed by from crop production for about, which 7.6% households who earn an average 15,000 ETB, 3.8% earn

15,000 ETB from casual labor work, 4.8% were government works and earn an average birr 8,000 ETB. There are also other income sources for few households, i.e., 2.8%, 0.9% and 0.9% respondents on average get 15,000 ETB, 10,000 ETB and 5,000 ETB from business/trade, both crop and animal production and other income sources at annual base, respectively. As clearly seen from table 4.4, the households participate in both farm and off-farm activities earning an average annual income of 22,428.57ETB.This result shows that the primary income source of the survey households in the study area is traditional gold mining.

Table 4. 3:Main income sources of survey households and the average annual income

No	The major income sources (livelihood means) for the households	HHs who reported the major income sources from the list		Average annual income (Birr)
		Number	Percent (%)	
1	Crop production	8	7.6%	15,000.00
2	Both crop and animal production	1	0.95%	10,000.00
3	Business/ trade	3	2.85%	15,000.00
4	Traditional gold mining	83	79.05%	25,000.00
5	Casual labor work	4	3.8%	15,000.00
6	Employment (salary based)	5	4.8%	8,000.00
7	Other	1	0.95%	5000.00
	Total	105	100.0	22,428.57

Source: Own survey, March 2021

4.1.5. Water supply coverage the study woreda

According to the current inventory result of water supply service of the survey households, there are 99 different types of water supply hand pumps in the woreda. The pumps are found within 19 rural kebeles.Secondary data obtained from the woreda water resource development office (WWRDO,2020), showed that the woreda population in 19 rural kebeles of study woreda depend on different water sources for household uses (table 4.5). The water sources include: shallow wells, hand dug wells and unprotected sources (mainly traditional wells, springs and rivers). From the lists majority (86.7%) of the population depending on shallow wells and the remaining 7.6% and 5.7% depending on hand dug wells and open sources respectively. From this,8 hand dug wells (HDWs) and 91 shallow wells (SWs) were constructed and fitted which hand pumps between 2002 and 2018, i.e., biggest (33.3%) numbers of water supply schemes were built in

2012 and the remaining 23.8%, 23.8%, and 19% were constructed in 2013, 2018 and 2002, respectively. The HDWs are manually hand dug wells with average depth of 12m while SWs are machine drilled and the average depth is 40m in the study area. As far as the distribution of the wells concerned, 8.1% are HDWs and 91.9% are machine drilled shallow wells fitted with AFRIDEV hand pumps technology. The WWRDO prefer Afridev pumps types due to its suitability for village level operation and maintenance (VLOM).

Woreda and village (kebele) level KIIs, FGDs and record of WWRDO revealed that construction of shallow and hand dug wells and fitting of the wells with pumps. The schemes were constructed by government and non-governmental organizations in collaboration with community. Of the different water supply schemes 48.6% were constructed by government, 6.5% by community, 42.1% by collaborative effort of government, community and NGO the remaining 0.9% by NGOs. The government office engaged in rural water supply development is the regional water works. In addition, particularly in recent two years, NGOs have been involving in potable water supply activity in the study woreda through one wash program (ONE WASH). This figure shows that, even though NGOs have contributed a lot for provision in potable water supply in the study area, greater share of water points/schemes were constructed by government.

Regarding, functionality of water supply schemes the survey households suggested that the water supply scheme are not adequate to meet the needs of the majority of the community. Therefore, the responsible institutions in collaboration with the community shall invest more to provide the society with adequate potable water.

Table 4. 4:Water supply schemes of the survey households

Characteristics	Categories	Frequency(N)	Percentage (%)
Types of water supply system	Shallow wells	91	86.67
	Hand dug wells	8	7.62
	Unprotected spring	6	5.71
	Total	105	100.0
Year the water supply schemes constructed	2012	35	33.33
	2013	25	23.81
	2018	25	23.81
	2002	20	19.05
	Total	105	100.0
Bodies constructed the water supply scheme	Government	52	48.6
	Community	7	6.5
	NGO	1	0.9
	Gov't, community and NGO	45	42.1
	Total	105	100%

Source: Own survey, March 2021

4.1.6. Water supply systems in the area and their functionality

The focus group discussions (FGDs) with community, kebele and woreda level key informant interviews (KIIs) and field observation showed that the studied four kebeles have 12 water supply schemes, from those schemes 8(66.7%) are functional and 4(33.3%) are non-functional at the time of the study. Of the functional schemes, all are shallow well fitted with hand pump. The information obtained from the respective schemes water committee and woreda water resource development office shows that beneficiary people have been using functional schemes for longer time. The schemes were constructed at average distance of 0.5km from residence areas. The service life of the schemes ranges from 12 to 15 years.

Table 4. 5:Status of water supply schemes and their functionality of the selected kebeles

Kebeles	Site name Got/village	Well types	Status of HP	Year of installed (G.C)	Year of non-functional (G.C)	Service years (G.C)
Dul hodie	Got 02	Shallow well	Non-functional	2013	2019	
	Got 03	Shallow well	functional	2014	-	7
	Got 01	Shallow well	Non-functional	2015	2018	
Horazab	Got 02	Shallow well	functional	2014	-	7
	Got 03	Shallow well	functional	2014	-	7
	Got 01	Shallow well	functional	2014	-	7
Abedi	Got 03	Shallow well	functional	2019	-	2
	Got 03	Shallow well	Non-functional	2018	2020	
	Got 02	Shallow well	functional	2016	-	5
Husher	Got 01	Shallow well	Non-functional	2003	2009	
	Got 02	Shallow well	functional	2009	-	12
	Got 01	Shallow well	functional	2019	-	2

Source: WWRDO data, March 2021

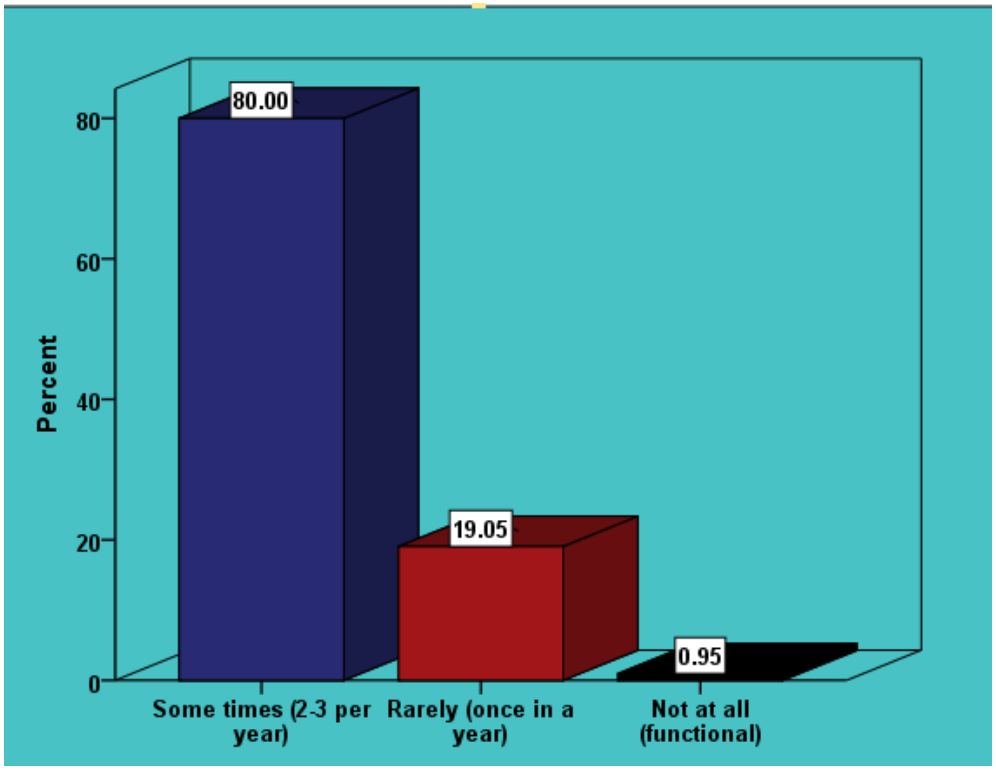
As far as functionality rate of observed hand pumps were those fitted with Afridev technologies. As shown in table 4.7, the surveyed households indicated that 76.2% of the water supply systems were functional while the remaining 23.8% were non-functional by the time of survey. Majority of functional hand pumps were providing service with problems, i.e., they have low yields and frequent interruptions as learned from household's beneficiaries. As a result, considerable numbers of beneficiaries have run out of potable water supply or else have shifted their water fetching place to other villages that are relatively far from their leaving place.

The field survey indicates that about half (55.2%) reported that the schemes sometimes (in 2 to 3 years interval) get non-functional (broken) but 24.8%, 19.0% and 1.0% respondents indicated that schemes encounter failure to render the service frequently (at least once in a year), rarely (in more than 3 years interval) and not happened so far (1%), respectively (fig.3). The interview results also further uncovered that unless beneficiaries report system failures, the *woreda* level stakeholders would not know the status of the water schemes. FGD participates indicated that unless beneficiaries report system failures, the woreda don't know the status of the water supply schemes. This indicates weak monitoring, follow-up and supervision activity at the woreda level.

Table 4. 6:Functionality status of water supply hand pump of the survey households

Characteristics	Categories	Frequency(N)	Percentage (%)
Does the hand pump is currently functional?	No	25	23.8
	Yes	80	76.2
	Total	105	100.0
When was it become non-functional, _____years?	2018	2	1.9
	2017	8	7.6
	2019	9	8.6
	2009	9	8.6
	2020	4	3.8
	I don't remember	73	69.5
	Total	105	100.0

Source: Own survey, March 2021



Source: Own survey, March 2021

Figure 3:Frequency of non-functionality status of water supply hand pump

Moreover,the major problems of the non-functionality hand dug wells were seasonal drying of the wells, related with site selection for scheme development and construction quality problems. Apart from this, if the top of the water sources is not sealed properly (firmly with concrete) there is possibility of being contaminated due to leakage of organisms facilitated by human activities and animal wastes. In relation with water shortage and quality concern from hand dug and shallow wells, applied technologies, schemes functionalities and management remain the main matters for sustainable service delivery of the water supply schemes(Gujo,2009).According to Addisu (2010) reported that rural water supply schemes are functional when they provide the service delivery to the beneficiaries but if not, non-functional.As far as type of handpump schemes with respect to scheme functionality concerned. World Bank(2009) reported that the current cities are faced with many urgent challenges which have necessitated the implementation of new intelligent service delivery systems to tackle those problems. Functionality is one of the important contributors to sustainability of water supply schemes in study areas. In other words, non-functionality has negative impact on sustainability of the schemes and it can't be immediately maintained because of this the community used unprotected water source for consumption(Mathewos,2016).

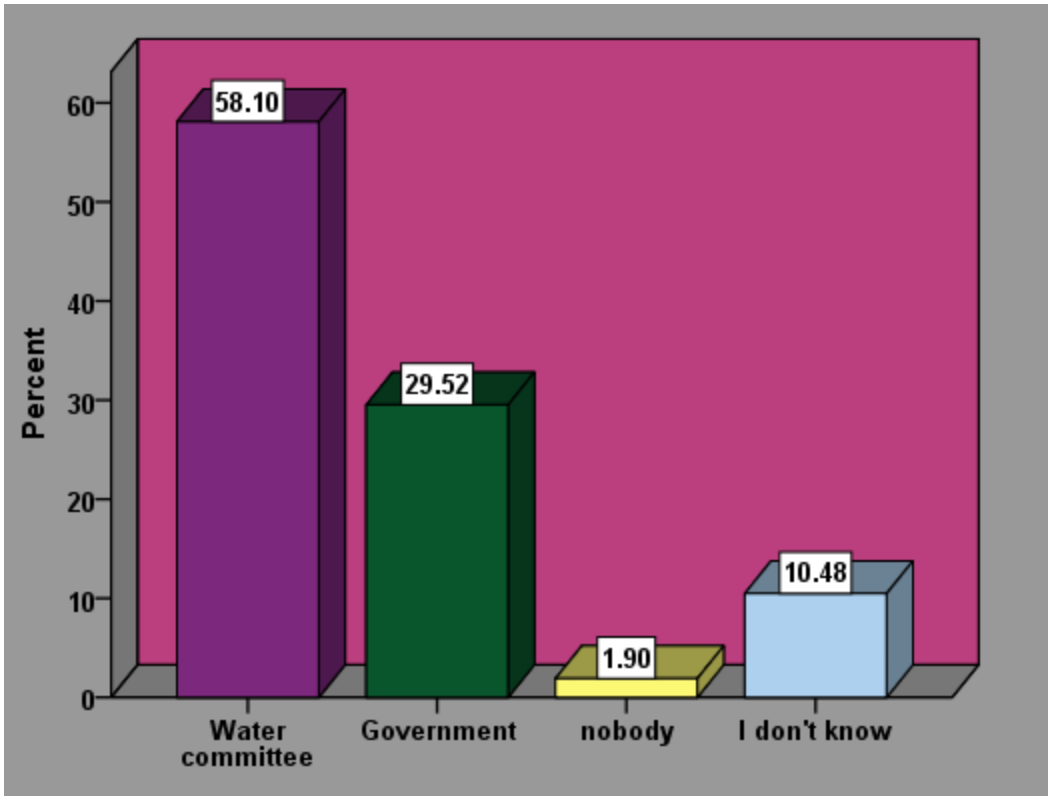
4.1.7. Management of hand pumps of the survey households

Out of 105 respondents, 89.5% reported that there water supply schemes fitted with hand pump have water management system (table 4.8). Thus, the 58.1% survey households indicated that water supply schemes fitted with hand pump schemes were managed by water committee, while 29.5% respondents pointed that the schemes are managed government and the remaining reported replied that the schemes do not have managing body (2%) and don't know (10.5%) see fig.4.

Table 4. 7:Survey household's response on management of hand pumps

Characteristics	Category	Frequency (N)	Percentage (%)
Is there established management system for the developed water supply hand pump?	No	11	10.5
	Yes	94	89.5
	Total	105	100.0
Who manages the hand pump?	Water committee	61	58.1
	Government	31	29.5
	Nobody	2	1.9
	I don't know	11	10.5
	Total	105	100.0

Source: Own survey, March 2021



Source: Own survey, March 2021

Figure 4:Managing body of water supply hand pumps

4.1.8. Survey households source of water and scheme functionality issues

The assessment captured sources of water of the survey households and it revealed that 96.2% respondents indicated that they have been fetching water from potable water sources, i.e., 94.3%

from shallow wells and 1.9% from hand dug well where both are fitted with hand pumps. In converse 3.8% fetch water for household uses (cooking, drinking and hygiene and sanitation) from open sources mainly from river (1%), unprotected spring (1%) and traditional hand dug wells (1.9%). Out of the total 105 HHs, 72.4% were fetching water from their hand pumps (i.e., from schemes belonging to the village), while the remaining 27.6% were not getting water supply service from hand pumps belonging to their village because of hand pumps non-functionality (table 4.9).

Table 4. 8:Potable water sources and daily water need of survey households

Characteristics	Water sources	Frequency (N)	Percentage (%)
From which source do your households currently fetch water for the household use?	River	1	1.0
	Unprotected spring	1	1.0
	Hand dug well fitted with hand pump	2	1.9
	Traditional hand dug well	2	1.9
	Shallow well fitted with hand pump	99	94.3
	Total	105	100.0
Amount of water your HH obtain from the developed scheme per day (in liters)?	< 100 litters/day	96	91.4
	> 100 litters/day	9	8.6
	Total	105	100.0
Amount of water your HH need in a day (liters/day)	< 50 liters/day	30	28.0
	> 50 liters/day	63	60.0
	vary	12	11.4
	Total	105	100.0

Source: Own survey, March 2021

This finding shows that people were very aware of the benefits of using potable water from developed (clean water for drinking and cooking) source. Majority of them were fetching water from developed water sources by traveling long distance in cases of the scheme near their village get non-functioning. According to respondents, community KIIs and FGDs with water committee and selected women groups in ***Hushur Guma and Horazab rural town*** said that women and children obliged to travel long distance to fetch water far from community, whenever their water scheme broken. In such cases the queuing time is other problem because of

additional users. In this regard interviewed woman indicated the severity of problem whenever their scheme gets non-functional as follows:

> *´´Currently, my child is student in this community travel long distance to fetch water from our or neighboring schemes (whenever our water supply scheme gets non-functional) than fetching unprotected source at nearby distance to our home. For example, most of the time, I myself have to travel long distance to fetch water from safe source. We know what will happen if we drink from unprotected source like river as it is bad for our health. Therefore, I must travel where safe water found into far distance in the community. Sometimes, I send my children to fetch water off school times. When they come back with water they feel tired. Sometimes, they complain because of the load they fill illness, hence I prefer to fetch than sending children. This created additional work burden and sharing time of home activities and I cannot prepare food on time for my children coming from school and timely send them to school, and also this share time for income generation from gold mining. Besides, community of other water scheme fill uncomfortable whenever we go to their scheme to fetch water as our scheme get broken. They disgrace us as if we broke our hand pump knowingly, thus the formal users (owners) of that community do not respect turn. Hence, we obliged to say long time and beg them to fetch. In addition carrying water long distance on back under blazing sun particularly during day time, thus to avoid this we have to travel early in morning to fetch water, consequently our children got to school without breakfast or delay from school time. Therefore, we are punished much because of our hand pump failure´´ (KIIs participant women in Hushur Guma community Got 02).*

The survey also showed that very few (3.8%) households still fetching water from unsafe sources such as rivers, traditional wells and unprotected springs mainly due to failure hand pump near their village. Although the proportion of households who compromise health than traveling longer distance to fetch water from neighboring schemes the health implication of unsafe water source can be considerable. As per FGDs and KIIs, the major causes water supply hand pumps non-functionality include: pump failure, inadequate/low water yield of wells compared to the demeaned and delayed pump maintenance.

The FGD participant indicated that community fetch water from developed schemes two times a day. Mostly water fetching time is from 6:30 AM to 10:00 AM in the morning and from 4:00 PM to 7:00 PM in the afternoon. However, there is some variation on the timing the service from the developed water supply schemes depending available water. Conclusively, the findings provide clear evidence of the fact that the actual water demand of the households was found to be higher than the supply provided by the schemes. In relation to this finding, Abrams (1998) on the adequacy of the water supply resources, recommends that both quantity and quality of water should be reliably available, regardless of the length of time since its commission.

The majority (91.4%) of the survey households reported that they consume less than 100 liters of water per day (table 4.9). Hence, majority (60%) of survey households consume between 50 and 100 liters per day and 28% HHs consume less than 50 liters of water in a day and 11% of the respondents don't know the exact consumption. Household water consumption can be calculated based on the average household size, as per WHO standard the minimum per capita water requirement is 20 liters per day. Considering average family size (5 members per HHs) the water need should be 100 liters per day. However, the actual potable water use of survey households is much below the minimum standard. This might have serious implication on health as HHs are not using required amount for drinking, cooking, hygiene and sanitation purpose. In most rural community, HHs uses potable water for drinking and cooking ignoring the importance of potable water for hygiene and sanitation purpose, which in turn compromise health (Zemenu, 2012).

As shown in table 4.10 nearly 45% spends less than a half an hour to fetch water from developed water point in their village, and 55% HHs need between half and one hour. The average time required to fetch water from developed water points of the survey households is 35 minutes for single trip & queuing , which is significantly greater than the WHO (1997) guideline (i.e. 15 minutes.

Table 4. 9: Distances to water sources by survey households

Characteristics	Time in minute	Frequency (N)	Percentage (%)
How long (minutes) do you take to fetch water for round trip and queuing?	10	2	1.9
	20	14	13.3
	25	7	6.7
	30	24	22.9
	35	3	2.9
	40	21	20.0
	45	9	8.6
	50	10	9.5
	55	1	1.0
	60	14	13.3
Total		105	100.0

Source: Own survey, March 2021

4.2. Factors influencing functionality of hand pumps-based rural water supply schemes

The factors which play significant influencing on sustainability of hand pumps based rural water supply schemes as per this study include: social, technical, financial, institutional and environmental factors. The survey findings of those factors are discussed in the following sections.

4.2.1. Social factors

The current analysis revealed two major social factors inflaming sustainability of hand pumps based rural water supply schemes, namely i) demand for improved water and ii) Community participation in the development & sense of ownership as detailed hereunder.

4.2.1.1. Demand for an improved service

As indicated above, the household survey, FGDs and KIIs revealed that study communities have strong demand to fetch water from potable sources.Nearly 96% of survey HHs fetch from protected sources (shallow and hand dug wells fitted with pump), therefore no problem related with demand related social factor of hand pumps based rural water supply schemes sustainability. In relation to this, Brikke (2000), presence of demand for an improved water supply service by the communities is a pre-requisite for sustainability of hand pumps. This could be taken as an expression of their commitment and way to make communities responsible for

their choices and future tasks. Furthermore, the presence of development hand pumps for improved water supply service can be manifested in the form of initial contribution pay in cash or in kind to capital costs for water supply schemes development.

4.2.1.2. Community participation in the development & sense of ownership

The conventional way of community participation in rural water supply project is by provision of labor and locally available construction materials such as stone, sand and wood. But in some cases every input of the projects comes from the implementing agency and end users contributions in terms of ideas while material and labor provision are neglected. Having this in mind, sample respondents were interviewed whether they have participated in development of their water supply hand pumps, the phase in which they participated, their contribution and their sense of ownership towards the water points (Gujo,2009). The issue of participation influence project planning, management structures and maintenance provisions. Participation refers to many channels for voicing and exchanging opinion- in voting, articulating preferences, providing advice and counsel, and channeling feedback from the public to the decision makers. In its largest sense, participation represents a fundamental link between project beneficiaries and project suppliers (Campbell et al,. 1993). The finding of the study similar to the study results of Getnet (2009) who was reported that there was weak sense of ownership of beneficiaries for the improved water supply.In connection to this as shown in table 4.11 community participated in the processes, which revealed that 87.9% respondents indicated that they participated in the development of the water supply scheme. Among households participated in the potable water supply schemes development in their respective village 38.1% reported that they had participated in all phases (during planning, construction and post-construction), 21.0% respondents participated during construction, 3.3% participated post-construction, 4.8% respondents involved in the planning process only and the rest 2.9% involved in different phases (table 4.11).

In this regard, the study community contribution during potable water supply development included labor, local material and cash. As the table 4.11 shows, among the total respondents who had participated during development of their water supply hand pumps, 3.8% contributed labor, 27.6% contributed both labor and local material, 5.7% contributed money, 15.2% contributed various local material (e.g. stone, sand and wood) and about half (47.6%) contributed

in all forms (money, labor and local materials, meal to skilled laborers). Moreover, considerable proportion (42.9%) survey households indicated that the community together with government and NGO technicians involved in technical aspects through providing important information during the planning and site selection processes. In fact community participation in site selection still remaining behind as confirmed by the survey as 49.5% respondents said that only government experts selected the site for scheme construction.

Table 4. 10: Community participation in development of water supply schemes and sense of ownership

Community participation systems	Category	Frequency (N)	Percentage (%)
Have you participated in the development of the water supply hand pump?	No	11	10.5
	Yes	94	89.5
	Total	105	100.0
Phase to community participation in developed based handpumps	During planning	5	4.8
	During construction	22	21.0
	Post-construction	35	33.3
	In all phase	40	38.1
	Other	3	2.9
	Total	105	100.0
What was your contribution in development of hand pump?	Labor	4	3.8
	Local material(e.g., stone, sand, wood)	16	15.2
	Both labor &local material	29	27.6
	Money	6	5.7
	all(money,labor,local materials)	50	47.6
	Total	105	100.0
Who selected the site for development of hand pump?	Community	7	6.7
	Government	52	49.5
	NGO	1	1.0
	All in collaboration	45	42.9
	Total	105	100.0

Source: Own survey, March 2021

As long as community participation in water supply scheme development and management is concerned, it would be important to assess participation of women in the development of water supply hand pumps.Women are the prime water collectors, key beneficiaries of improved water

supply. Hence women should be involved in any attempt to improve potable water supply services (Misgina,2012).

Similarly, Misgina (2012) reported that the burden of water source inaccessibility and its consequences largely affect females. Women travel and spend more time to fetch water from the source. Participation of women in both development and management of water service is crucial for sustainability and functionality. This issue, according to the survey result, has not been given the necessary focus especially in project design and preparation phase. Involving of women participation in all water planning and implementation activities is one way to guarantee the sustainability of the system (Habtamu, 2013). In relation to this, the study assessed the level of women participation in water supply schemes development of the study area. As can be seen from table (4.12), out of total 105 respondents, 72.4% respondents replied that women had participated in the development of water supply schemes, however 27.6% respondents indicated that women's did not participate. As per the survey households, the reason for non-participation of women in the processes 43.8% reported no solid the reason, 35.2% indicated burden women due to home activities, 12.4% indicated that women do not have interest and the remaining 6.7% due to social reasons like religions cultural reason and prohibited by husband. From this finding, it can be deduce that there should be more effort to improve women participation in potable water schemes development and management. In fact,might not be fear to engage women in labor work during construction as they are busy at home activity, but it is vital to maximize women participation during planning and management aspect.

Furthermore, the ultimate goal to promote development of hand pumps schemes improved water supply service & women's participation in particular is to enhance sense of ownership of the user community and as a result, ensure water schemes sustainability (Wood, 1994). Therefore, in this regard 88.6% of respondents said that they have strong sense of ownership for their water supply scheme hand pump while the remaining 11.4% don’t have such feeling. This clearly shows that the majority of beneficiary’s strong sense of ownership as the developed scheme belongs to them. Therefore, community participation in the development and sense of ownership related factor for sustainability of water supply scheme is satisfied.

Table 4. 11: Women's participation and sense of owneship in water supply schemes development

Women participation variables	Response	Frequency(N)	Percentage (%)
Do women participate during water scheme development?	No	29	27.6
	Yes	76	72.4
	Total	105	100.0
What do you think the reason behind non-participation of women?	Burden of home activities	37	35.2
	Religions reason	1	1.0
	Cultural reason	1	1.0
	Non-permitting husband	7	6.7
	Not interested	13	12.4
	Other	46	43.8
	Total	105	100.0
Do you feel that the developed water supply schemes (hand pump) belong to you too (sense of ownerships)?	No	12	11.4
	Yes	93	88.6
	Total	105	100.0

Source: Own survey, March 2021

Furthermore, the results of key informants and focus group discussions uncovered that communities have strong demand to use potable water from protected sources like water supply schemes as they are safe to prevent waterborne diseases and other health problems. The communities also further asserted that they are ready to share and contribute costs required for the development, maintenance and management of hand pump based water supply schemes including their labor and necessary local materials. Consistent with this finding, Brikke (2000) argued that the presence of demand for an improved water supply service by the communities is a pre-requisite for sustainability of hand pumps. This could be taken as an expression of their commitment and way to make communities responsible for their choices and future tasks. Therefore, the study found no problem related with demand related social factor of hand pumps based rural water supply schemes sustainability.

4.2.2. Technical factors

An investigation of the technical factors that potentially affect sustainability of potable water supply schemes mainly focused on technology choice, construction quality, and technical skills

of community (WATSAN committee) for operation and maintenance and spare parts (availability, accessibility and costs) of the hand pumps.

4.2.2.1. Technology choice

In the response to question delivered to know who selected their water supply technology choices(table 4.13), 57.1% respondents replied that the water supply hand pumps technology was selected by government, 9.5% reported the technology was selected by NGO in collaboration with governmental office, 28.6% respondents reported the hand pumps types were selected by governmental office, community & NGOs and 4.8% respondents didn't know the issue. In addition, feasibility study (site and pump technology selection) of the water supply schemes was assessed. With regard to preliminary study conducted before selection of hand pump scheme (5.6%) replied as their water supply hand pump feasibility study is not conducted before scheme selection, (55.2%) replied that preliminary study was conducted before site selection while the remaining (39%) respondents said that they didn't know the issue.They indicated that site selection took place during the construction. This finding clearly signifies that considerable number of the communities did not know about scheme selection and the necessary precondition.

Furthermore, as the same table (4.13) shows, in the response to question delivered to respondents to know difficulties related to fitted shallow well pump technology their water supply hand pumps, the following results has been obtained. Grounding on this finding, one can deduce that friendliness and technical easiness of the hand pump technologies were found not to consider the community's technical skill and knowhow.Accordingly, 48.6% respondents mentioned that the pumps have very hard handle to move, 24.8% indicated that it have easily wearing and tearing parts and 26.7% reported that the pump has both problem (hard handle to move and has easily wearing and tearing parts).

Table 4. 12: Regarding HPs technology choice

Technology choice variable	Responses	Frequency (N)	Percentage (%)
Who selected the type of the existing scheme (technology choice)?	Governmental office, NGO & Response	60	57.1
	Governmental office in collaboration	10	9.5
	Governmental office, Community &NGOs	30	28.6
	I don't know	5	4.8
	Total	105	100.0
Did the preliminary (feasibility) study conducted before scheme selection to develop?	Yes	58	55.2
	No	6	5.7
	I don't know	41	39.0
	Total	105	100.0
What do you think are the difficulties related to the fitted with shallow well pump technology?	Hard to move the handle	51	48.6
	Easily wearing breaking parts	26	24.8
	Both (1&2)	28	26.7
	Total	105	100.0

Source: Own survey, March 2021

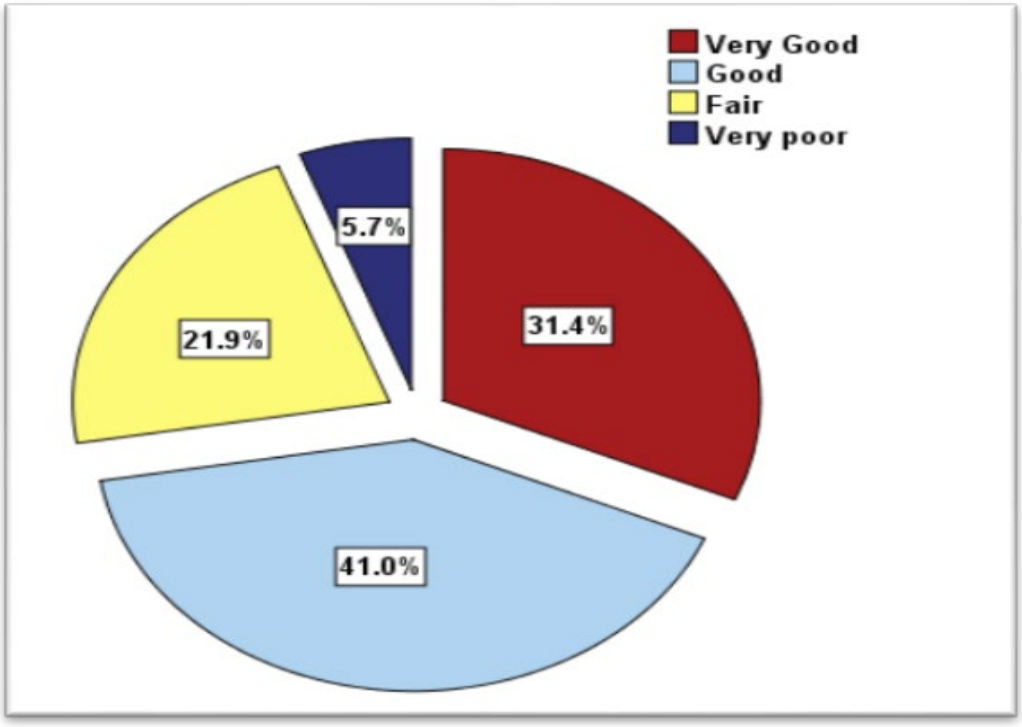
Components of the technical factors category include technology choice and community acceptance, construction quality and spare part availability. In line with this finding,as part of a demand-driven approach to enhance community ownership of installed water services, Whittington et. al., (2008) argued the need to involve households in the choice of technology thus ensuring engineering design was responsive to local needs. From above result, it can be learned that technology choice related factor of sustainability is not achieved. In addition, Sara and Katz (1997) emphasized the use of appropriate technologies which low cost, easy to maintain, operate, simple to use and readily available as key factors determining sustainability of hand pumps based rural water supply schemes. Appropriate technology choices were the concept of village level operation and maintenance. In this regard, the study community said that the technology choice has some problem for operation, maintenance and management by the communities and water committees.Harold et.al.,(2003) reported that technology type, operating and maintenance, capacity and acceptance of rural people and spare part accessibility issues are important for sustainability. The study also showed limited community involvement in the choice of technology that might contributed to higher rate of non-functionality of schemes and challenged water supply schemes sustainability. Use of appropriate technologies in water supply

includes selection of low cost, easy to maintain, simple to use and readily available is one of the factor affect the sustainability of water supply schemes(Tigabu,2019).

4.2.2.2. Construction quality of schemes

Study area communities were asked to evaluate the construction quality of the water supply schemes. With regard to the construction quality of the water supply scheme (see fig. 5), 31.8% replied very good, 41.0%, 21.9% and 5.7% respondents rated the construction quality of the water supply schemes as good, fair and poor, respectively. This finding was further supplemented by the result of focus group discussions. For instance, the communities in **Dul hodie and Hushur Guma *kebeles*** complained about the depth excavated in that it was very shallow and hence adequate ground water was not taped particularly during dry season. In addition, community level FGD and KII participants complained that the head work have construction quality problem hence the structure crack easily and result water contamination. From observation during survey study, it was seen that some hand pumps are located/drilled very close to sand area and as result abandoned without giving any service for communities because of water quality problem (see fig 6). This clearly shows that inappropriate site selection led to non-sustainability of hand pumps in the study area. Therefore, it's apparently clear from the finding that water supply scheme constructed in study areas partly failed to attain required construction quality to ensure sustainability. Quality of construction is one of the technical elements which challenges of sustainability of hand pumps based rural water supply services. As one can imagine, these issues are technical and beyond the capacity of community to assess their quality of construction hand pumps. Furthermore, well completion reports are required in order to evaluate the work is done at good or not. Unfortunately, most of hand pump fitted wells did not have well completion report. For this reason, in this study, respondents were asked how they evaluate construction quality of their hand pumps from what they have observed so far (Gujo,2009). A study by Sara and Katz (1997) found that sustainability was higher in communities where informed choices about technology type and level of service were made. Sara and Katz (1997) reported that construction quality had a major impact on sustainability; poor quality lowered the chances that systems would be sustained. Such kind of well completion problems eventually results in well dry up and as a result handpumps will be abandoned (Harvey

& Reed, 2004). Therefore, water supply scheme constructed in study areas partly failed to attain required construction quality to ensure sustainability.



Source: Own survey, March 2021

Figure 5:Construction quality of hand pump

Source: photo taken during survey, March 2021

Figure 6: Hand pump without fence in both water points and top work crack

4.2.2.3. Technical skills for operation and maintenance

To enhance the sustainability of hand pumps based rural water supply schemes, creating trained and skilled local technicians and water committee at the scheme level is important. Not only training for community technicians, but also provision of necessary toolkits to undertake the minor maintenance work is important (Gujo,2009).According to Addisu (2010) found also further looked at whether local technician have been actually maintaining the technical failures of the schemes and maintain any failure of water supply schemes. The checklist used for village level maintenance trainees included information on the trainees experience in maintaining the scheme, belief of the trainees on their ability to maintain a system, constraints of village level maintenance and their perspective in sustaining water supply service **(** Mathewos,2016**)**.In this regard, respondents were asked whether there exist skilled/ trained local technicians with in their community. During the field data collection, researcher checked and verified presences of trained technicians in all (12) sampled water supply schemes.

ONE WASH program emphasized that water technicians should get training on operation and maintenance by the implementing agency. Accordingly, 53.3% survey households reported that training given on water supply schemes (pumps) operation & maintenance to water technician

and committee members. However, the interview made with one of the technicians revealed that they have not undertaken any maintenance activities and hence can't do maintenance if pump failure occurs. As per FGD result, the community that has got water technicians, they are given some training by the implementing agency (E.g. ONE WASH) though not adequate enough to conduct maintenance.

Table 4. 13 Availability of skill and training on operation and maintenance

Characteristics	Responses	Frequency (N)	Percentage (%)
Is the training on the shallow well pump scheme operation & maintenance given to the technician or the water committee?	Yes	56	53.3
	No	49	46.7
	Total	105	100.0

Source: Own survey, March 2021

4.2.2.4. The spare parts related (availability, accessibility and costs)

The other challenge related to sustainability is price of spare parts; in this regard 78.1% that the price of spare parts is affordable, while 21.9% reported as spare parts price is unaffordable (table 4.15). Concerning availability and sources of spare parts, the survey households had different understand about sources of hand pump spare parts. The survey respondent reported that sources of spare parts for hand pumps to carry out maintenance included provided/supplied by regional/zonal/woreda water offices (28.6%), supplied by water committee (32.4%), purchased from market (20%), denoted by NGOs (1%) and don't know (18.1%).

Since hand pump parts are needed to move in order pump water, they are subjected to wear and tear specially, seals and rods frequently wear out and break due to improper mechanical pumping. So the availability, accessibility and affordability of spare parts are very important factors and in order to which major technical problems have you encountered to make the water supply systems in the properly function and sustain the service to the community. In relation to this, survey households indicated different problems affecting sustainability of hand pump fitted water supply schemes among these problems which include: 54.3% respondent reported lack of adequate spare parts and tools, 22.9% mentioned inappropriate technology/hand pump type selection, 14.3% pointed lack of technical skill to carry out operation and maintenance and the remaining 8.6% reported poor construction quality problems. In this regard WSP (2006) indicated that more than 50% hand pumps in Africa due difficulties in obtaining spare parts.

The study has investigated the availability and accessibility as well as the affordability of the spare parts by communities when needed for operation and maintenance of the hand pumps. As shown in table 4.15, 35.2% respondent's spare parts are not available and easily accessible at community level when needed. Therefore, the analysis showed that spare part related factor for hand pump based water supply schemes sustainability is not fulfilled.

Table 4. 14 Potential technologies to be installed at community level

Characteristics	Responses	Frequency (N)	Percentage (%)
Is the price of spare parts affordable at community level when needed?	No	23	21.9
	Yes	82	78.1
	Total	105	100.0
From where does the community get spare parts to carry out maintenance?	Purchase on market	21	20.0
	Regional/zonal/woreda	30	28.6
	Donated by NGOs	1	1.0
	I don't know	19	18.1
	Water committee	34	32.4
	Total	105	100.0
Which major technical problems have you encountered to make the water supply scheme properly function and sustain the service to the community?	Lack of adequate spare parts & tools	57	54.3
	In appropriate technology/pump type selection	24	22.9
	Lack of the technical skill to carry out operation & maintenance	15	14.3
	Poor construction quality	9	8.6
	Total	105	100.0
Are spare parts are available and easily accessible at community level when needed?	No	37	35.2
	Yes	68	64.8
	Total	105	100.0
Have you been informed of the advantage, costs and disadvantages of the potential technologies or schemes type to be installed?	No	28	26.7
	Yes	77	73.3
	Total	105	100.0

Source: Own survey, March 2021

4.2.3. Financial factors

The major financial factors related with sustainability of hand pump fitted water supply schemes are financial management of the developed water supply schemes, willingness and ability of users' to pay for the service and adequacy water users payments for O&M as detailed in the following subsections.

4.2.3.1. Adequacy of water user payments for O&M

Before talking about adequacy of payment it is important to know whether the respondents are paying for services they get. The study has investigated the actual practice on ground and users position towards the existence of users payment and its adequacy for O&M of their water points. Accordingly, in the response to question delivered for respondents to know whether they pay for developed water supply service.As shown in table 4.16, 71.4% respondents replied that they pay cash (money) for water they fetch from developed water supply schemes, while 28.6% respondents replied that they did not pay cash (money) for the water supply service they got. Among households who reported that they pay for the water they fetch, 94.3% respondents reported that they regularly pay and remaining 5.7% do not pay regularly. In line with this, FGD participants indicated that few users did not pay regularly because monthly contribution practice was not realized in their respective communities, specifically four communities like Dul hodie, Abadi, Hushur Guma and Horazab didn't start water fee collection. During the survey time, the former two (Dul hodie and abadi kebeles) hand pumps are not functioning, thus theses users were not paying water fee in regular bases even during functioning of the hand pumps. This shows that some communities of the study area don't have well established regular finance source to cover O&M cost of the development hand pumps.

This finding shows that regular finance source is not established for O&M cost of the development hand pumps in some communities in the study area.In relation to this, Harvey & Reed (2004) indicated that water user's payment and the adequacy of that payment for O&M are important to ensure sustainability of hand pumps based rural water supplies. The authors emphasized that financial factor is of the other factor of sustainability that includes issues of community financing and the required cost of operation and maintenance and repairs.

During the field research it was observed that in some kebeles there was a strong feeling that water should be free. A need exists to ensure communities understand that for operate, maintaining and repairing hand pumps will cost money. Therefore, 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 fee is used, and a willingness to pay for improvements (Zemenu, 2012).

Paying for water service does not necessarily mean that the users support the idea water fee payment/contribution. As observed during field work, community members who do not regularly (monthly) contribute water fee denied water uses as penalty. For example, great majority 94.3% of survey households replied that they support the idea of paying water fee while the remaining 5.7% respondents do not support the idea. Out of households who supported importance paying water fee, most understood reason for the contribution which include to pay scheme maintenance (51.9%), to pay water attendant and guard salary (10.6%) and to construct other scheme if this get ruined/completely damaged (37.5%). In fact, there're might understanding problem for those gave the last replay.The study finding shows that majority of the respondents support the idea of water fee for water supply service. Therefore the attitude of respondents can be regarded as positive ground to establish regular user fee mechanism within beneficiaries to ensure sustainability of hand pump based water supply schemes in study area.

Users perception on the adequacy of water fee to cover operation and maintenance costs for hand pump based water supply schemes was assessed and 25.7% respondents reported that the payment inadequate while 74.3% respondents replied as the payment is adequate to cover all operation, maintenance and management costs.

Table 4. 15 : Water fee contribution for operation,maintenance and management of hand pump based water supply schemes

Characteristics	Responses	Frequency (N)	Percentage (%)
Do you pay cash (money) for the developed water supply service	No	30	28.6
	Yes	75	71.4
	Total	105	100.0
Do you/your family/regularly pay for the water supply service?	No	6	5.7
	Yes	99	94.3
	Total	105	100.0
Do you support the idea of paying water fee?	No	6	5.7
	Yes	99	94.3
	Total	105	100.0
What is your reason for supporting water payment?	For scheme maintenance	54	51.9
	To pay for water attendant & guard salary	11	10.6
	To construct other scheme if this get ruined/completely damaged	39	37.5
	Total	105	100.0
Do you think the water fees collected from the beneficiaries is adequate to cover all operation & maintenance costs of the hand pump?	No	27	25.7
	Yes	78	74.3
	Total	105	100.0

Source: Own survey, March 2021

4.2.3.2. Willingness and ability to pay for users' service

As discussed in the preceding section, about 90% of respondents were supported the idea of water fee for service they obtained. This shows that larger proportions of beneficiary community are favoring the payment. Therefore, beneficiaries who supported user fee is positive step forward to establish regular finance source to cover O&M costs, but care has to taken as it is not the only thing required to ensure schemes sustainability. In this regard Davis and Brikee (1995) underlined that beneficiary community support of user fee shows only their willing to pay for O&M cost. Ability to pay is purely a financial phenomenon that is derived from income information of households and helps in determining the optimal tariff structure of a service. Ability to pay is primarily a function of income and cost of living, which in turn is a function of employment(Brikke et al., 2003).

The respondents were also asked amount of money they able to pay and their willingness to cover O&M costs of water supply service. However, 100% of respondents replied that they can pay 10 Birr per HHs/month, which is current rate the communities are paying currently in the study area. The water committees in all sampled kebeles verified that the current water fee rate in the study area is uniform, i.e., 10 Birr/HHs/month. From theses, it can be learned that the study area community are not ready to pay more than 10 Birr/HH/month although some reported that the contribution is inadequate to cover O&M cost so as to ensure schemes sustainability. Therefore, more awareness creation required to enhance community willingness to pay required water fee amount and bring attitudinal change on the possible challenges to happen if the community unable to cover O&M cost.

4.2.3.3. Financial management of the developed water supply hand pump

In the response to the question delivered to respondents to know who financed the developed water supply hand pumps in the study area and about half 54.3% reported that the constructions were financed by government, 41.9% and 3.8% indicated that the developments were financed by GOs and NGOs in construction and by collaborative effort of community & NGOs, respectively. Regarding water fee, majority 74.3% survey households replied that water committee set the price, while the remaining 2.9%, 11.4% and 11.4% respondents replied that water fee set by community, government and all actors in collaboration set the price respectively for water services. From this it can be learned participation of the users in setting water fee is limited, this might potentially affect willingness to pay.

Table 4. 16: Financial management system of hand pump based water supply schemes

Varaible descriptions	Responses	Frequency (N)	Percentage (%)
Who financed the developed water supply hand pump?	Community	2	1.9
	NGO	2	1.9
	Government	57	54.3
	All in collaboration	44	41.9
	Total	105	100.0
Who set the price of the water fees?	Community	3	2.9
	Government	12	11.4
	Water committee	78	74.3
	All in collaboration	12	11.4
	Total	105	100.0

Source: Own survey, March 2021

The importance of user payment, existing practice of user payment in the study area, user willing and able to pay has been discussed. However, it is needless to say that the money collected should be financed properly and utilized for the purpose of water supply services only. The study has investigated/ assessed the way collected money from users or user fees are being managed.
The same response has been obtained from community KII and FGD with water committees. The water committees those are participated on FGD did not opened the bank account to save the money yet. They mentioned that the money collected from users was small to deposit in formal financial institutions. However, the WWRDO should agree for the reason the WCs draw the money and should write support letter for local financial institution if there is a need to draw the deposited money. Therefore, WCs alone cannot draw the money according to their will. During KII, head of WWRDO mentioned that this mechanism designed to avoid miss utilization of users' money. Generally, the finding shows that there exists unclear direction on management of user's money contributed for O&M which might discourage further contribution of the communities.

4.2.4. Institutional factors

4.2.4.1. Institutional support for community water supply services management

One way of enhancing sustainability of rural water supply schemes is the provision of institutional support to community management bodies by government staffs or NGOs. Also, problems that are beyond community level need to be addressed by supporting agencies. This study has investigated whether institutional support has been rendered so far or no for community management in the study area, since existence of institutional support can contribute for water supply schemes sustainability. Therefore, this study analyzed the role of institutional support factor for sustainability of rural community water scheme management. As shown in table 4.18, some respondents replied that they have received supports from government 42.9% and NGOs 41.9% to enable them effectively manage their water supply hand pumps. However, the rest survey respondent indicated as they did not receive any external support from government 57.1% or NGOs 58.1% so as to enable them effectively manage their water supply hand pump. Those who reported that they get supports from government the support includes scheme maintenance, supervision/follow-up, water treatment (disinfection), technical advice,

spare parts/materials provisions, pumps replacement if broken and providing trainings for local technicians. For example, majority 83.8% of survey households reported that stackholders have been providing follow-up and supervision support to their water supply schemes and committee. In this regard, community level FGD and KIIs participants explained that the supervisions were limited as water supply schemes supervise come based on our request whenever problem happened on our scheme.

The questioner based survey assessed community further support need and it showed that the beneficiary require different support from GOs and NGOs to enhances sustainability of hand pump based rural water supply schemes. Accordingly, the survey households underlined that they require additional support mainly on: spare parts 15.0%, quality hand pumps 9.3%, availing technicians whenever the pump get broken 15.0% and 58.9% HHs claimed all round (spare parts, hand pump and local technician) support to ensure sustainability of their hand pump based rural water supply schemes (table 4.18).

In relation to this, the study of Davis and Brikke (1995) emphasized that governments need to provide strategic level support and enforce standards were for O&M of rural water supply systems. In addition government should establish monitoring management systems to improve quality and quantity of water being supplied, efficient spare parts supply and the appropriate technology choice. In the study area ONE WASH program working in water supply can support for new development water supply for community to given necessary scheme management training to water committee and technical trainings for local technicians, and supported spare parts and toolkits to strengthen the capacity of community management. Similarly, Whittington et al.,(2008) reported that external assistance in maintenance and repairs, spare parts, accounting and tariff setting, technical training, manuals and other materials helped sustainability of rural water supply systems. The authors positively associated free repairs or technical assistance with sustainability. The most promising support activities identified were related with administrative management and system operation. However, in sampled communities very limited support had been provided by Water Aid, NGO partners or the local government.

Table 4. 17:Institutional support for community management of HPs

Issues	Response	Frequency (N)	Percentage (%)
Do the community/water committee receives any external support from government to enable them effectively manage their water supply hand pump?	No	60	57.1
	Yes	45	42.9
	Total	105	100.0
Do your community get supports from NGO in relation to managing the water supply schemes to make properly functional and sustainable?	No	61	58.1
	Yes	44	41.9
	Total	105	100.0
What types of supports are needed by the community to make the water supply hand pump functional for long period of time?	Spare parts	16	15.2
	Quality construction	10	9.5
	Local technician	16	15.2
	In all phase	63	60.0
	Total	105	100.0
Is there follow up and supervision by the stakeholders about the status of the water schemes?	No	17	16.2
	Yes	88	83.8
	Total	105	100.0

Source: Own survey, March 2021

As learned from WWRDO during KIIs, the office could not able to provide regular follow-up and supervision of rural water supply schemes because of resource constraints. But, the WWRDO attempting to respond community request especially for maintenance of hand pump failures not proactively but reactively. However, in order to make community management effective continuous follow up and supervision of management should be done to ensure sustainability and service reliability.

4.2.5. Environmental factors

4.2.5.1. Survey households perception on the quantity of the water supply systems

The yield of the water supply system in relation to the number of beneficiaries is one of important issue to be discussed as far as the sustainability and service reliability of water supply schemes is concerned. As known from inventory result, some of the hand pumps in the study area were abandoned due to low yield. Furthermore, key informant interview with experts shows that seasonal variation, population growth and non-functionality have impact on the adequacy of

the water supply in the community. Consequently, the pressure on the schemes will be increased and the sustainability of the schemes will be threatened. In the relation to this, study has assessed adequacy water obtained from the hand pump based water supply systems. Accordingly, the great majority (89.5%) survey households reported that water yield from their water supply source is adequate to cover their daily need, while remaining 10.5% reported that the wells are not providing sufficient yield. The respondents mentioned that increase in number of beneficiaries, shortage of water in the well during dry season, limited fetching hour, inadequate depth excavation/drilling of the well, and pumps failure as the cause for the inadequacy of their water supply. The users recommended for development of additional hand pumps, timely maintenance during pump failure and the rehabilitation of low yield wells.

Table 4. 18: Survey household's perception on adequacy of water from the water supply schemes

	Category	Frequency (N)	Percentage (%)
Do you think the existing water supply source is adequate to the beneficiaries?	No	11	10.5
	Yes	94	89.5
	Total	105	100.0

Source: Own survey, March 2021

In fact, the current analysis revealed that the average daily water consumption rate (50-100 litter/day/HH) of study community is much below WHO (1997) standard. Hence, survey HHs perception concerning adequacy of water from schemes might undermined by awareness problem in relation to the purposes of potable use. Therefore, households might compromises hygiene and sanitation so as to economically use the available potable water. In most rural areas, whenever the face limitation households uses potable water for cooking and drinking by ignoring hygiene and sanitation activities or uses unsafe water for hygiene and sanitation purpose. In this regard Abrams (1998) pointed that adequacy of the water supply play important environmental role; therefore, planers should pay attention to such consideration. Abrams (1998) stated the same quantity and quality of water should be reliably available, regardless of the length of time since its commission. Water supply schemes implemented to improve access for domestic consumption may not give sufficient consideration to other uses (e.g., environmental hygiene and sanitation) of water within rural communities (RWSN, 2009).

4.2.5.2. Survey households perception on the quality of the water from water supply sources

Water quality problem is a typical environmental factor which affects water schemes sustainability and reliability. In this respect, the households were asked whether their water supply source faced water quality problem or not. Water has quality problems due to high concentration of fluoride and ion are known as chemical water quality problem has impact on users and conveying pipes. But this study focused on common water quality problems that can be identified at household level, which mainly include physical water quality problems such as taste, odor and turbidity. Based on these criteria, majority 72.4% respondents rated that the water from their water supply source has quality problem, while the remaining 27.6% survey households rated that the water don't have quality problem (table 4.20). According to the survey households, the major quality problems include: taste problem, contamination by external leaked organisms, turbidity/gray color and other water quality problems as reported by 41.9%, 22.9%, 14.3% and 21.0% households, respectively. Interview and FGD results further confirmed that the schemes were found to seasonally change their taste and thus, the communities fear such changes to have adverse impact on their health while claiming for urgent intervention by concerned bodies. The researcher also observed in real life that some of the water points were abandoned due to quality problems. The finding clearly shows that the overwhelming majority of the respondents claimed quality problem of the water schemes mainly manifested on taste of the water while still considerable number claimed contamination which urges further lab based investigation to safe the health of the communities.

The survey household's evaluated quality of water from hand pump based water supply schemes as they have different quality ranging from very good to very poor. The majority 75% rated the water quality as very good and good, while 28% respondents rated the quality of water from there schemes have very poor quality. The survey households were also asked whether time of scheme construction has impact on water quality or not. Accordingly, 81.9% respondents indicated that hand pump based water supply schemes developed during the wet season have water quality problem and the remaining 16.2% respondents don't know the effect of construction time on water quality.The result shows that most of the water points were constructed during wet season as responded by the majority of the communities. Moreover

household's perception about the relation of water quality with season of the year was assessed and relatively higher proportion (41.9%) of respondents reported poor quality water in Autumn season and followed by summer (30.5%), all round the year (19.0%), and winter and spring (8.6%) seasons.

Table 4. 19: Survey household's perception on quality of water from the water source

	Category	Frequency (N)	Percentage (%)
Do you think the water supply source now you are using has water quality problem?	No	29	27.6
	Yes	76	72.4
	Total	105	100.0
What kind of water quality problem you observed?	Contamination by external leaked organisms	24	22.9
	Turbidity	15	14.3
	Taste	44	41.9
	Other	22	21.0
	Total	105	100.0
Do you think the water supply source now you are using has water quality problem?	During the dry season	1	1.0
	During the wet	86	81.9
	No season dependent	1	1.0
	I don't remember	17	16.2
	Total	105	100.0
Season of water quality problem Occur	Summer	32	30.5
	Winter	2	1.9
	Spring	1	1.0
	Autumn	44	41.9
	Round the year	20	19.0
	Other	6	5.7
	Total	105	100.0
What is the cause of water quality problem?	Construction/crack	27	25.7
	Disinfection problem	12	11.4
	Drainage problem	65	61.9
	Other	1	1.0
	Total	105	100.0

How do you evaluate water quantity and quality of the water supply schemes you are using?	Very good	30	28.6
	Good	45	42.9
	Poor	2	1.9
	Very poor	28	26.7
	Total	105	100.0

Source: Own survey, March 2021

In a relation to water quality problem the households were asked the cause of water quality problem as shown in table 4.21. Hence, study households mentioned construction problem that result crack of the structure, drainage problem, problem of timely conducting disinfection (chlorination) and other unknown problems as causes of water quality problem reported by 25.7%, 61.9%, 11.4% and 1.0%, survey households, respectively. The finding shows that drainage related problem was mentioned by the overwhelming majority of the sample households as the cause of water quality problem in the study area.

During the field survey, totally abandoned hand pump based water supply scheme (fig.7) because of water quality problem as the well scheme are located in living area and alluvial sand deposited ground. This implies that the environmental factor, especially water quality problem, has also contributed for hand pump based rural water supply schemes sustainability problem in the study area.

Source: Photo taken during own survey, March 2021

Figure 7:Hand pumps located/drilled in near living area & sand deposited ,Hushur and Dul hodie villages

4.3. Coping mechanisms and mitigation measures of shortage of water supply service

Coping strategies should be founded on good understanding of the causes of water scarcity, both nationally and locally. A detailed accounting of water supply and demand should be used as the starting point, and the basis for identifying, adapting and developing coping strategies(UN-Water, 2009). It is therefore, important to base strategies on the best evidence available and not rely purely on hearsay or intuition though these might provide useful insights (UN-Water, 2009).

When water is scarce, particular attention should be paid to the re-use potential of recoverable non-depleting uses at every stage of planning, designing and implementing multipurpose water supply and use schemes (UN-Water, 2009).Hence, in connection to this, the study analyzed the coping mechanism of study community whenever they face shortage. Regarding the adequacy of water from shallow wells for domestic use (drinking, cooking and cleaning) 50.5% respondents said that they get enough amount of water while the remaining 49.5% respondents said that they did not get enough amount of water to accomplish the entire household domestic utility purposes (table 4.21). With regard to the type of coping mechanisms the households use during water shortages, 66.7% replied as that they reduce daily consumption, (19.0%) respondents said that they use open sources and the remaining (10.5%), (2.9%) and (1.0%) respondents replied that rainwater harvesting, buying from water vendors and from other option respectively.

Table 4. 20: Household domestic water supply services of the survey households

	Responses	**Frequency (N)**	**Percentage (%)**
Is water which you get from wells (hand dug and shallow wells) sufficient for your household domestic (drinking, cooking, cleaning)	No	52	49.5
	Yes	53	50.5
	Total	105	100.0
If your use of water from main source does not cover the entire household utility purposes, what type of adaptation strategies do your families use?	Using open sources	20	19.0
	Rain water harvesting	11	10.5
	Buying from water vendors	3	2.9
	Reducing daily consumption	70	66.7
	If other, specify	1	1.0
	Total	105	100.0

Source: Own survey, March 2021

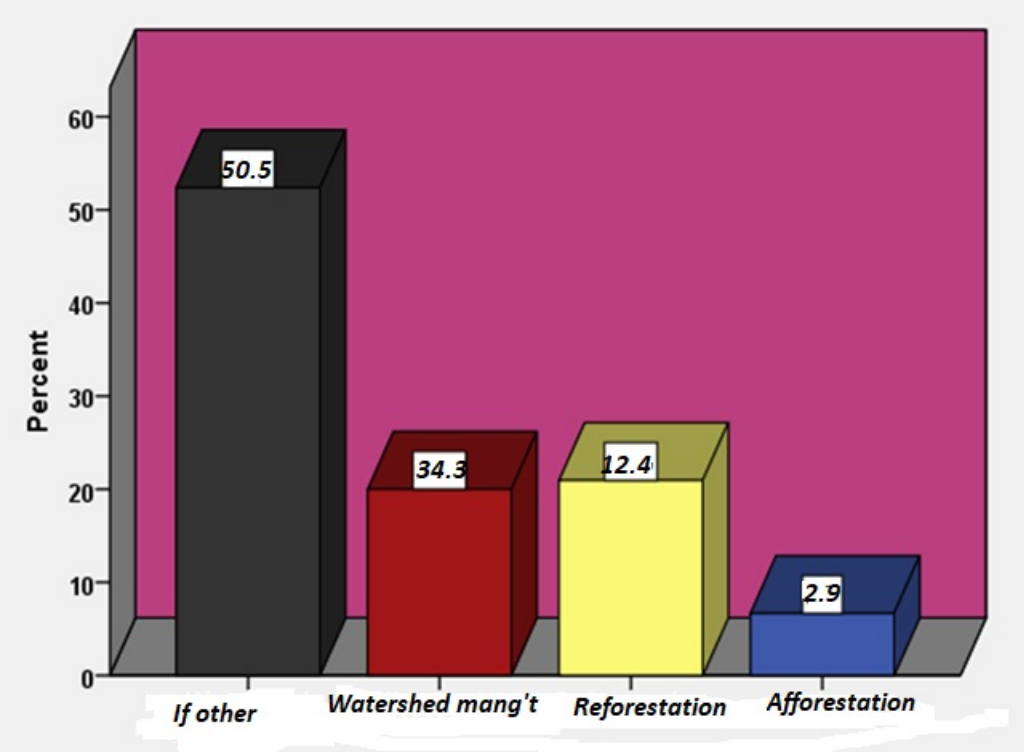
In a relation to mitigation measures, nearly half (50%) study communities have been applying different water conservation activities to minimize water shortage risks like integrated watershed management practices 34.3%), reforestation (12.4%) and Afforestation (2.9%).

As discussed in previous section, some households reported water shortage, therefore the assessment tried to capture the causes of water shortage and it found different driving forces. The major causes of water shortage from hand pump based water supply systems in the study area include: wells yield decrease due to drawdown of the water table with increased uses time (55.2%), mismatch between the demand and supply side (28.6%) and malfunctioning of hand pumps (16.2%). In connection to this, majority (96.2%) respondents reported that they try to uses water very economically during shortage time by reducing consumption. As reported by Abrams (1998) and RWSN (2009) such coping mechanisms can potentially compromise household health as they give priority for drinking and cooking than using the potable water for hygiene and sanitation. As a consequence, it makes little sense to try to develop optimum strategies, and what is needed is continuous evaluation and adaptation of strategies (Groves, 2006).

Table 4. 21: Mechanism of water consumption of the survey households

	Response	**Frequency (N)**	**Percentage (%)**
What kind of mitigation measures do the communities use to minimize water shortage risks in the long run?	Watershed management	36	34.3
	Afforestation	3	2.9
	Reforestation	13	12.4
	If other, specify	53	50.5
	Total	105	100.0
What is the reason behind the occurrence of shortage of water?	Decreasing of water volume	58	55.2
	Hand pump leakage	9	8.6
	Imbalance of water demand & supply	30	28.6
	I don't know	8	7.6
	Total	105	100.0
Do your families save the amount of water gained during water shortages?	No	4	3.8
	Yes	101	96.2
	Total	105	100.0
What strategy do the families mostly use to save the amount of water?	Reusing water	5	4.8
	Reducing daily consumption	100	95.2
	Total	105	100.0

Source: Own survey, March 2021



Source: Own survey, March 2021

Figure 8:Mechanism of water consumption of the survey households

The finding shows that the majority of the households are practicing ***reducing daily consumption*** and ***watershed management*** as a mitigation measures to water shortage risks.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

The factors which play significant influencing on sustainability of hand pumps based rural water supply schemes as per this study were social, technical, financial, institutional and environmental factors. As far as social factors were concerned, the study has shown that communities have strong demand to fetch from potable sources and no problem with demand related social factor of hand pumps based rural water supply schemes sustainability. Users that played a role in demanding the improved water supply service and participated during the planning and site selection prosses of development of water supply hand pumps. Therefore, community participation in the development and sense of ownership related factor for sustainability of water supply scheme is satisfied. Women should be involved in any attempt to improve water supply. However, weakness with regard to women participation and water committee's performance in managing their water supply schemes. Therefore, women is prime collector and users of water supply, their participation in scheme development was restricted to catering. Furthermore, number of females in water committees (WCs) of sample hand pumps is not satisfactory and responsibility of women within WCs is limited to a mere membership in most cases of the survey households. The position of chairperson and secretary within WCs seems reserved for male members of WCs. Generally, the survey area has shown that women decision power on water scheme development and management issues curtailed by men dominance in contrary to their prime roles in collection and use of water supply service.

The survey shown that, WCs are not performing adequately in managing their water supply schemes. They lack interest, incentives and commitment for their current work, as they don't open pumps on time; they discriminate same users; some of them don't know their duties and responsibility; they did not mobilized community adequately; they did not fenced hand pumps properly, and also some hand pumps lack locks to safe guard from children and animals. Furthermore, study find out that WCs were not capacitated by implementing agencies to discharge their duties and responsibilities properly.

With regard to technical factors:- the study has found that functionality of hand pumps based rural water supply schemes depend on availability of local technicians and spare parts as well as construction quality for of the water supply schemes. The study also considered user friendliness and technical easiness of the hand pump technologies under the study community technical skill and knowhow. The technology choice has some problem for operation, maintenance and management by the communities and water committees. The water supply scheme constructed in study areas partly failed to attain required construction quality to ensure sustainability. Moreover, the water community are concerned by availability of trained technicians to handle maintenance with exception of hand pumps located in Dul Hodie kebele, got 02 sites.

Financial factors:, adequacy of users' contribution for hand pump based water supply sechemes O&M in the survey area is the other challenge. Majority of beneficiaries pay cash (money) for water they fetch from developed water supply schemes although the amount is not adequate. Moreover, few beneficiaries don't contribute at all and the minority do not contribute the feed on regular basis. This implies that regular financing mechanisms for O&M of hand pumps are not established yet in number of community in the survey area. However, the positive aspect concerning the payment is that a great deal of users support existence of user fees for water supply service. This attitude of respondents can be a good ground to establish regular user fee mechanism within beneficiaries in the study area. With regard to adequacy of the contribution, a great majority of the users agreed that the current amount of contribution is not adequate to cover all O&M costs.

Institutional factors related issues:- The analysis showed severe institutional support related problem for sustainability of rural community water scheme management as the WWRDO severe institutional support problems in terms of human power and material resources. In relation to this, the beneficiaries explained that the supervisions were limited as water supply schemes supervise come based on their request whenever problem happened on schemes. The questioner based survey assessed community need further support and it showed that the beneficiary require different support from GOs and NGOs to enhances sustainability of hand pump based rural water supply schemes. Furthermore, no adequate budget is allocated for the water supply office to fully discharge its duties and responsibilities.

Environmental factors:- yield of the water supply systems is among important issue regarding sustainability and service reliability of water supply schemes. In study area, some schemes were abandoned due to low yield. Furthermore, seasonal variation, population growth and non-functionality have impacted the adequacy of the water supply in the study community. With regard to water quality problem, the majority of users said that have water quality problem in their water schemes. However, some hand pumps abandoned because of water quality problems in the study area especially due to inappropriate site selection which emanated from poor and/or lack of feasibility study.

Coping mechanisms and mitigation measures:- In connection to this, the study analyzed the coping mechanism of study community whenever they face potable water shortage. The assessment also identified the possible coping strategies that the study households have been using, which include: reducing daily consumption, using open(unsafe) sources and rainwater harvesting. Regarding, mitigation measure, nearly half study communities have been applying different water conservation activities to minimize water shortage risks like integrated watershed management practices,reforestation and afforestation and some households reported water shortage,therefore the assessment tried to capture the causes of water shortage and it found different driving forces.

5.2. Recommendations

As this research is based on study of sampled rural water supply hand pumps in Kurmuk woreda, the following propositions mentioned have specific importance for the targeted woreda. However, it must also be viewed that some of the problems identified in this investigation are systematic and common to all other rural woredas in Benishangul Gumuz region. Therefore, part of the findings presented in this research may can be applicable to many other similar rural woredas in Ethiopia. Thus, the below are some of the recommendations drawn for improving the sustainability of hand pumps based rural water supply:

According to this study, the factors influencing sustainability of hand pumps based rural water supply schemes includes construction qualiy of the scheme, availability of shortage water, availability of spare parts and management related complications are found crucial factors for

sustainability of rural water supply systems. **Working to resolve these shortages is one of the recommendations for consistent functionality of rural water supply hand pumps.**

- Communty-based water management of the studied water supply hand pumps sounds for additional efforts to be exerted to make them effectively perform operation and manatenance and manage the supply schemes. The problem occurs when necessary inputs not provided for WCs such as: adequate water schemes and financial management trainings, working manuals and directives, by laws and legal status of the water committees to fully discharge their responsibilities. **Therefore, these important inputs should be fulfilled for water committees by implementing agencies. Furthermore, follow up and monitoring of the performance of the WCs should be conducted in regular basis.**
- Woreda water resource development and office and other relevant stakeholders working in the sector should develop new water schemes long-term plans to work with water and sanitation management committees in post implementations of rural water supply hand pumps.

- **Handpumps are mechanical devices:-** As result, their parts are subjected to wear through usage. Especially,fast wearing parts such as seal and rods can be easily mentioned by community level technicians. Therefore, spare parts supply chain should be established urgently in the survey area to avail this parts. To do so, the establishment of spare parts revolving fund by government and establishing at least one supply center in the woreda capital.

- **Improving women participation:-** Even though women are prime collectors and users of water supply services, their role and influence did not come in to light during schemes development and management in the study area. Therefore, necessary consultation and promotion should be done to involve women during planning, construction and management of water supply handpumps. The role of women's should go beyond catering to include active participation in decision making processes. **It is also important to improve women's position within the WCs, which is currently limited to a mere membership, through capacity enhancement interventions.**

- Low yield of wells and water quality problems has contributed for non-functionality of handpumps in the study area. The problem occurred because of inadequate drilling and inappropriate site selection. Therefore, necessary feasibility study should be conducted by relevant professionals before commencement of wells drillings. **Also, drilling supervision should be made by appropriate professionals in order to avoid yield deficiency of the wells and partial penetration of the aquifers (water bearing formation).**

- The study area must apply different water conservation activities to minimize water shortage risks like integrated watershed management to practices,and redusing daily consumption in the study area.

- At last, not least, institutional support of the WWRDO in terms of human power, material and financial resources should be enhanced through adequate allocation of budget for recruitment of staff, purchase of materials and logistics, and allocation of adequate recurrent and capital budget so that office can fully discharge its responsibility.

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Annex 1: Questionnaires to be filled by sample Households

A.A.U

School of Graduate Studies

College of Development Studies

This questionnaire is prepared as an instrument to conduct an academic research for the fulfillment of Masters of Science Degree (MSc) water resources management by Fikadu Bekele in Addis Ababa University College of development studies center for Environment and development studies. The objective of the study is conduct to sustainability of hand pumps based rural water supply in Kurmuk district. Therefore, your information in this survey is very important for the research hence you are kindly requested to give us your views and experiences as carefully as possible each of your answer has great contribution for the completeness of the research paper. Furthermore, the information you give will be used for only the academic research and will be kept confidential.

Instruction for interviewer

1. Pleases introduce yourself. Then, please answer the questions by circling or choosing the best choice the respondent provided from the provided alternatives

Thanks in advance for your cooperation.

1. Name of interviewer: _____

2. Date of interview: _____

3. Interview conducted: in Kurmuk woreda

4. Kebele _____ 5. Community/Village _____

6. Name of Respondent: _____

Part I. Demographic and Socio-Economic characteristics of the respondents

1.1. Sex of respondent 1) Male 2) Female

1.2. Age of the respondent_____years old

1.3. What is your current marital status?

1) Single____2) Married____ 3) Divorced____ 4) Widowed ____5) Separated____

1.4. Members of family size?

1.4.1. Male: _____ 1.4.2.Femele:_____1.4.3 Total: _____

1.5. Household type 1) Male headed_____ 2) Female headed_____

1.6. Ethnic group?

No	Ethnic group	0=No 1=Yes
1.5.1	HH (wife and husband) from one group	
1.5.1.1	Berta	
1.5.1.2	Gumuz	
1.5.1.3	Amhara	
1.5.1.4	Oromo	
1.5.2	HH from mixed group	
1.5.2.1	Berta and Gumuz	
1.5.2.2	Berta and Amhara	
1.5.2.3	Berta and Oromo	
1.5.2.4	Gumuz and Amhara	
1.5.2.5	Gumuz and Oromo	
1.5.2.6	Amhara and Oromo	
1.5.3	if other specify _____	

1.7. Educational level of the household head

1) Unable to read and write (illiterate) ____ 2) First cycle (1-4), complete _____

3) Able to read and write (in formal education) _____4) college level _____

5) High school (9-12), complete _____6) second cycle (5-8), complete _____

1.8. What are the major sources of income to the household?

No	Sources of income/livelihood means	0= No,1=Yes	Average annual income (Birr)
1.8.1	Crop production		
1.8.2	Animal production		
1.8.3	Both crop and animal production		
1.8.4	Business/ trade		
1.8.5	Traditional gold mining		
1.8.6	Casual labor work		
1.8.7	Safety net PSNP		
1.8.8	Employment (salary based)		
1.8.9	Remittance (support of family or others)		
1.8.10	Skilled work (masonry, carpentry, blacksmithing, pottery, chimney)		
1.8.11	Other specify _____		

Part II: Functionality and magnitude of hand pumps based water supply service

2.1. Are you the beneficiary of developed potable drinking water from hand pump?

0= No _____1=Yes _____

2.2. If yes, what amount of water do you obtain from the hand dug well per day____litters?

2.3. What amount of water do you need per day_____litters?

2.4. Does the hand pump is currently functional? 0= No_____1=Yes_____

2.5. If your response to Q2.4 is "No'', when was it become non-functional_____years?

2.6. How frequent does it fails to render service?

1) Always (more than once in a year) _____ 2) Sometimes (in 2 to 3 years interval) ____

3) Rarely (in more than 3 years interval) _____4) not happened since constructed_____

2.7. How long does it take to fetch water_____minutes for round trip and queuing?

2.8 From which source do your households currently obtain drinking water?

1) River ____2) Unprotected spring ____3) Hand dug well fitted with Hand pump_____

4) Traditional hand dug well _____5) Shallow well fitted with Hand pump _____

Part III: Challenges (social, technical, financial, institutional and environmental factors) influencing sustainability of hand pumps based rural water supply

3.1. Issues related to Social Factors

3.1.1. Who selected the site for development of hand pump?

1) Community_____2) Government _____3) NGO_____ 4) all in collaboration_____

5) if other, specify ____

3.1.2. Have you participated in the development of the water supply hand pump?

0= No 1=Yes

3.1.2.1. If your response to Q3.1.2 is "yes", at which phase you participated?

1) during planning _____2) during construction ____3) Post-construction _____4) in all____

5) if other, specify ____

3.1.3. What was your contribution in development of hand pump?

1) Labor____ 2) Local material (e.g., Stone, sand, wood) ____ 3) both labor and local material____4) Money____ 5) all (money, labor, local materials) _____ 6) if other, specify ____

3.1.4. Do you feel that the developed hand pump belong to you too (sense of ownerships)?

0 =No 1 =Yes

3.1.5. Do women participate during water scheme development? 0= No 1=Yes

3.1.5.1. If your response to Q3.1.5 "No" what do you think the reason behind their nonparticipation?

1) Burden of home activities____2) Religions reason ____3) Cultural reason ___4) Non-permitting husband_____5) Not interested_____6) if others, specify____

3.1.6. Is there established management system for the developed water supply hand pump?

0=No 1= Yes

3.1.6.1. If your response to Q3.1.6 is "Yes", who manages the hand pump?

1) Water committee____ 2) Government____ 3) NGO____4) nobody___5) I don't know___6) if other, specify ____

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

0= No 1=Yes

3.2. Related Technical Factors

3.2.1. Have you been informed of the advantage, costs and disadvantages of the potential technologies or schemes type to be installed? 0=No 1=Yes

3.2.2. Who selected the type of the existing scheme (technology choice)?

1) Governmental office____ 2) NGOs____ 3) NGO & Response governmental office in collaboration____4) community &local leaders____ 5) Governmental office, community &NGOs____ 6) I don't know____7) if other, specify_____

3.2.3. Did the preliminary study conducted before scheme selection to develop?

1) Yes ___2) No ___3) I don't know____

3.2.4. How do you evaluate the construction quality of the water supply scheme?

1) Very Good ___2) Good ___3) fair ___4) Poor ___5) Very Poor___6) I don't know____

3.2.5. Is the water scheme hand pump is simple to operate and suitable to the users?

0= No 1=Yes

3.2.6. Are there local technicians for the operation and maintenance work? 0= No 1=Yes

3.2.7. Is the training on the hand dug well pump scheme operation & maintenance given to the technician or the water committee? 0= No 1= Yes

3.2.8. Which major technical problems have you encountered to make the water supply scheme properly function and sustain the service to the community?

1) Lack of adequate spare parts and tools_____

2) Inappropriate technology/pump type selection_____

3) Lack of the technical skill to carry out operation & maintenance____

4) Poor construction quality_____5) if other, specify_____

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

1) Training on proper use while fetching water _____2) Fencing and locking the pump _____

3) Doing both (1 &2) _____

3.2.10. What do you think are the difficulties related to the fitted hand dug well pump technology?

1) Hard to move the handle___2) easily wearing and breaking parts; ___ 3) if other, specify___

3.2.11. Are spare parts are available and easily accessible at community level when needed?

0= No 1= Yes

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

1) Purchase on market___2) provided/supplied by regional/zonal/woreda water offices/government agency___3) Donated by NGOs ___4) I don't know___5) if other, specify__

3.2.13. Is the price of spare parts affordable at community level when needed? 0=No 1= Yes

3.2.14. If the price is not affordable what you will do?

1) Abstain from maintenance until sufficient money collected from beneficiary ___

2) Appeal to government office or ___4) I don't know ___

3) Request NGO for support (donation) ____5) if other, specify____

3.3. Related to Financial Factors

3.3.1. Who financed the developed water supply hand pump?

1) Community__2) NGO__3) Government__ 4) All in collaboration __5) if other, specify ___

3.3.2. Do you pay cash (money) for the developed water supply service? 0= No 1= Yes

3.3.2.1. If your response to Q3.3.2 is "Yes", how much do you pay? Birr/ household/month_____

3.3.3. Do you support the idea of paying water tariff/user fee? 0= No 1= Yes

3.3.3.1. If your response to Q3.3.3 is "Yes", what is your reason for supporting water payment?

1) For scheme maintenance____

2) To pay for water attendant and guard salary____

3) To construct other scheme if this get ruined/completely damaged____

4) if other, specify____

3.3.3.2. If your response to Q3.3.3 is "No", why not?

1) Lack of awareness about its importance____ 2) Dissatisfaction with the service____

3) Water is natural gift, so no need of payment___ 4) I don't have confidence on water committee; ____5) I don't have financial capacity___6) if other, specify ____

3.3.4. How much money are you willing and able to pay for the service per month_____?

3.3.5. Do you/your family/regularly pay for the water supply service? 0= No 1= Yes

3.3.6. Who set the price of the water fees?

1) Community___ 2) Government ____3) NGO ____4) Water committee ___5) All in collaboration; ____6) if other, specify ____

3.3.7. Do you think the water fees collected from the beneficiaries is adequate to cover all operation & maintenance costs of the hand pump? 0= No 1= Yes

3.4. Related Institutional factors

3.4.1. Is there follow up and supervision by the stakeholders about the status of the water schemes? 0= No 1= Yes

3.4.2. Do the community/water committee receives any external support from government to enable them effectively manage their water supply hand pump? 0=No 1= Yes

3.4.3. Do your community get support from NGO in relation to managing the water supply schemes to make properly functional and sustainable? 0=No 1=Yes

3.4.3.1. If yes Q3.4.3 what support your community (your hand dug well user community and committee) from NGO

1) Training___ 2) Material ___ 3) Technical ___ 4) Financial support___ 5) if other, specify___

3.4.4. What types of supports are needed by the community to make the water supply hand pump functional for long period of time?

1) Spare parts___ 2) quality construction___ 3) local technician___ 4) in all____

3.5. Related Environmental Factors

3.5.1. Do you remember in which season the water supply hand pump was developed?

1) During the dry season___ 2) During the wet___ 3) No season dependent; ___4) I don't remember___5) if other, specify ____

3.5.2. Do you think the existing water supply source is adequate to the beneficiaries?

0= No 1= Yes

3.5.3. Do you think the water supply source now you are using has water quality problem?

0= No 1= Yes

3.5.4. If your response to Q 3.5.3.1 is "yes" what kind of water quality problem you observed?

1) Contamination by external leaked organisms ____2) Turbidity___3) Taste____4) if other, specify___

3.5.5. If Q3.5.3.2. Yes, Season of water quality problem Occur

1) Summer ___2) Winter ____3) Spring____4) Autumn___5) Round the year____

3.5.6. What is the cause of water quality problem?

1) Construction/crack ____2) Disinfection problem____ 3) Drainage problem____

3.5.7. How do you evaluate water quantity and quality of the water supply schemes you are using?

1) Very Good ____2) Good____ 3) fair____ 4) poor ____5) very poor____

Part IV: Coping mechanisms of the community in times of water supply shortage and schemes non-functionality

4.1. Is water which you get from hand dug well sufficient for your household domestic (drinking, cooking, cleaning) 0= No 1= Yes

4.2. If your use of water from main source does not cover the entire household utility purposes, what type of adaptation strategies do your families use?

1) using open sources ____2) Rain water harvesting___3) Buying from water vendors___

4) if other, please specify___

4.3. What kind of mitigation measures do the communities use to minimize water shortage risks in the long run?

1) watershed management___2) Afforestation___3) Reforestation___4) if other, specify__

4.4. Does water shortage occurs from the hand pump schemes? Do you have water shortage from the water point throughout the year? 0= No 1= Yes

4.5. If your answer to question Q 4.4 is yes, when the water shortage is happened?

1)Summer(Kiremt)__2)Winter(Tseday)__3)Autumn(Bega)__4)spring(Belg)___5) Throughout the year___

4.6. What is the reason behind the occurrence of shortage of water?

1) decreasing of water volume ____2) hand pump leakage____3) imbalance of water demand and supply____4) I don't know____

4.7. Do your families save the amount of water gained during water shortages? 0) No 1) Yes

4.8. If your answer to question Q 4.7 is yes, what strategy do the families mostly use to save the amount of water?

1) Reusing water___2) Reducing daily consumption___3) if other, please specify___

Thank you again!!!

Annex 1: Focus group discussion questions for Water Committee and selected Women groups

Dear discussion participants

My name is Fikadu Bekele. As a master student at Addis Ababa University, college of development studies, Center for Environment and Development I conduct research on the sustainability of hand pumps based rural water supply in Kurmuk Woreda. The survey may take about 30-40 minutes time to complete. I would like to declare that the information collected through this questionnaire will be used only for academic research purpose; confidentiality of personal data is assured. I highly appreciate your cooperation and I thank you in advance for taking your time to fill in this survey questionnaires!

Date of discussion_____Woreda_____Kebele/Village_____Handpump status_____

1. When does the committee established? (Before scheme construction, during scheme construction, after scheme construction)

2. How the water committee does manage their financial resource? Do you have bank account and /or financial record?

3. How and from where the spare parts are obtained when needed? Which part of pump fail most commonly?

4. What supports (financial, technical and others) have been given to the community /committee from the external (government and NGOs) to sustain the water supply service?

5. From your past experience, what are major problems encountered in relation with your water supply hand pump and service delivery?

6. How do you see the role of women in managing the water supply hand pump schemes?

7. How do you elaborate the impact of lack of access to adequate water on the lives of women?

8. Have you faced the problem with the hand pump non-functionality? (Yes/No), if 'yes', from where do you get water at that time? What do you think the reason for the problem?

9. How do you evaluate functionality of the hand pump?

10. What solutions do you recommend to be done for hand pump water supply scheme to be functional sustainably in your community and elsewhere in the woreda?

Thank you for your collaboration!!!

Annex 3: Key informant interviewing for Woreda and Community member Peasant association a leader in the study area

Dear key informants

My name is Fikadu Bekele. As a master student at Addis Ababa University, college of development studies, Center for Environment and Development I conduct research on the sustainability of hand pumps based rural water supply in Kurmuk Woreda. The survey may take about 30-40 minutes of your time to complete. I would like to declare that the information collected through this questionnaire will be used only for academic research purpose; confidentiality of personal data is assured. I highly appreciate your cooperation and I thank you in advance for taking your time to fill in this survey questionnaires!

Date of discussion_____Woreda_____Kebele/Village_____Hand pump status_____

1. What are the major goals or objectives of the establishment of your organization in relation to rural water supply hand pumps?
2. Do you prefer hand pump technology among others? (Yes/No)

    2.1. If "Yes" what is the reason? What type and mark of hand pumps do you prefer? Why?

3. How do you evaluate the status of hand pumps implemented by your office and others in woreda/ kebele level now?
4. Are spare parts and toolkits readily available, affordable at woreda and community level? (Yes/No), if 'No', where do you get it?
5. What problems are faced by your organization/ office to make the rural water supply hand pump sustainable?
6. What is the role of your organization regarding sustainability based rural water supply hand pump related technical, financial and others? How does your office undertake major repairs that are beyond the financial and technical problem of the community /Woreda/ Zonal water desks? Are there well trained professionals for the same?
7. What are the major problems/causes for rural water supply hand pumps failure in the Woreda?
8. What responsive measures have been taken by the woreda water office to improve the status of hand pumps?
9. What are the major challenges associated with rural water supply hand pumps in the woreda?

10. What interventions mechanisms/strategy do you recommend to alleviate existing problem in the water supply sector and to enhance sustainability of hand pumps based rural water supply hand pump in the study area?

11. In what ways the participation of the local communities taken into consideration during the development of the water supply schemes?

12. Is your choice of technology includes development of rural hand pumps? (Yes/No). If "Yes" why you selected hand pump as technology option?

13. How do you handle issues related to operation & maintenance of the hand pumps and availability of spare parts?

14. What are your strategies to ensure long-term sustainability of the water supply hand pumps you installed?

15. What do you think are the major challenges based rural water supply hand pumps failure in the Woreda?

16. What major problems did you observed from your experience in relation to proper functioning of the hand pumps or that contribute to non-functionality?

17. What solutions do you recommend to alleviate the problems of non-functionality and improve the status of the hand pumps to serve the community for long period of time?

18. When was water hand pump developed? By whom?

19. What was drinking water source before construction of the scheme?

20. How do you compare the service of drinking water before and after the construction of the hand pump? What benefits obtained by using developed hand pump?

21. Is the hand pump is functional now and it giving proper service to community now? (Yes/No)

22. 1. If "No", what major problems are there in connection with service delivery?

23. When it became non-functional? What do you thinks the reason for the pump failure? What solutions do you recommended to avoid such total failure of hand pump?

24. What do you recommend to be done by user community and government to make water supply hand pump serve community for long period without a problem?

Thank you for your collaboration!!!