

Rural Water Supply Schemes Sustainability Assessment: A case of Habro District in
Oromia Region, Ethiopia



Tekabe Kinfe Mamo

A Thesis Submitted to the Department of Water Resource Engineering
School of Civil Engineering and Architecture

Presented in Partial Fulfillment of the Requirements for the Degree of Master's in Water
Resources Engineering (Water Supply and Environmental Engineering)

Office of Graduate Studies

Adama Science and Technology University

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Adama, Ethiopia

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Advisor: Andinet Kebede (PhD)

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DECLARATION

I declare that this thesis entitled “Rural Water Supply Schemes Sustainability Assessment; A case of Habro District in Oromia Region, Ethiopia” is my own work and has not been submitted to any university for similar purpose. The references used in this thesis are duly recognized by proper citations.

Tekabe Kinfu Mamo

Name of student

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I, the major advisor/supervisor of this thesis, hereby certify that I have closely advised/supervised the student while developing this thesis and read the draft thesis entitled “Rural Water Supply Schemes Sustainability Assessment; A case of Habro District in Oromia Region, Ethiopia” prepared under my guidance by Tekabe Kinfu Mamo. Therefore, I recommend the submission of the thesis to the department for further review and evaluation.

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APPROVAL PAGE OF MSC THESIS

I hereby certify that the recommendation and suggestion given by the thesis review committee are appropriately incorporated into the final thesis report entitled “Rural Water Supply Schemes Sustainability Assessment; A case of Habro District in Oromia Region, Ethiopia” by Tekabe Kinfe Mamo.

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Approval of Board of Reviewers

We, the undersigned, members of the Board of Reviewers of the thesis open defense by Tekabe Kinfe Mamo, have read and evaluated the thesis report entitled “Rural Water Supply Schemes Sustainability Assessment; A case of Habro District in Oromia Region, Ethiopia” and assessed the understanding of the candidate about the thesis research. This is, therefore, to certify that the thesis report is accepted and we recommend the implementation of the thesis.

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List of Abbreviations and Acronyms

DWs	Deep Wells
FGDs	Focused Group Discussions
HDWs	Hand-Dug Wells
NGOs	Non-governmental Organizations
GTP	Growth and Transformation Plan
NWI	National WASH Inventory
O&M	Operation and Maintenance
RWS	Rural Water Supply
RWSSs	Rural Water Supply Systems
SDs	Spring Development
SPSS	Statistical Package for the Social Sciences
SSA	Sub-Saharan Africa
SWs	Shallow Wells
UAP	Universal Access Program
UN	United Nations
UNICEF	United Nation's Children Fund
USAID	United States Agency for International Development
WASH	Water Supply, Hygiene and Sanitation
WASHCO	Water Supply Hygiene and Sanitation committee
WHO	World Health Organization
WPs	Water Points

Abstract

Sustainability of rural water supply (RWS) projects, and the benefits they provide are highly topical issue in the RWS sector; as the second Growth and Transformation Plan (GTP II) Ethiopia planned to put the nation at the level of the middle-income countries and new standard was formulated for the clean drinking water supply coverage. However, sustainability of rural water supply schemes are questionable. The objective of the study was to assess the sustainability of Habro District's RWS schemes, to understand the major causes of sustainability problem and to suggest the relevant remedial action. To explore the causes of the unsustainability, a purposive survey was undertaken covering nine (9) selected Kebeles of the District. The sample sizes of 41 water schemes (deep well, shallow well and hand dug well), 46 water-points and 160 households were considered using a combination of purposive and simple random techniques. Besides, qualitative data was collected through focused group discussions (FGDs) and key informant interviews. The FGDs involved water committee (water utility) members, selected women groups and kebele administration; and interviews were conducted with district Water Resource Office and world vision Ethiopia Habro area program heads and professional experts. Field observation and relevant document reviews on water source and water points schemes found in the selected kebele were the sources of the relevant information. Data collected were analyzed using mWater platform and SPSS version 27 statistical software. The result showed that the average sustainability score across water supply schemes was 4.64. This score indicated that the schemes were performing well on only 46.4 % of the system functionality and reliability, financial viability and cost recovery, water quality and quantity, community satisfaction and involvement and local governance and management. According to the district RWS schemes non-functionality rate assessment results, 37.5 % are functional, 35 % are partially functional and 27.5% not functional. For the water points, 59.8% are functional and 40.2% are not functional due to major reasons of operation and maintenance problem, depth (seasonal) problem and pump failure. Thus, the high rate of non-functionality of the water supply schemes, is significantly affecting the water supply coverage of the wereda. District was impacted by factors such as local governance and administration, as well as a lack of community satisfaction and involvement. While system functionality and reliability, financial viability, and cost recovery had the most effects. Also, the community participants in schemes implementation, management and monitoring were bad and the ability of water committees to manage the schemes had poor.

So, managing water schemes status to take immediate action using mWater technology and WASH business center was recommended. The WASH business center locates at the chosen area of center district kebele to water committee and water utility can access spare parts and these are the steps that need to be taken in order to improve the functionality as well as sustainability of rural water supply schemes.

Key words: non-functionality, mWater platform, sustainability, water schemes, Habro Wereda.

1. INTRODUCTION

1.1. Background

The sustainable provision of drinking water in sufficient quantity/quality is the cornerstone of rural development paradigms around the world. According to (WHO and UNICEF, 2021), only 74% of the world's population (5.8 billion people) benefited from safely managed drinking water supply projects in 2020. This confirms that about 26% of water-related projects did not achieve their objectives. Most of these projects are implemented in sub-Saharan Africa and poor Asia, where technology is poorly integrated (WHO and UNICEF, 2021).

According to UNICEF and WHO (2021), 87% of the world's population could have access to drinking water, with an improvement of 10 % over the last two decades. The report also stated that around 884 million people worldwide, 37% of whom live in sub-Saharan Africa, still use drinking water from unsafe sources. This is largely due to governments' traditional approach to rural water supply. The focus was on planning and building systems based on specific needs rather than on the sustainability and profitability of water services.

In Africa, 418 million people still lack access to basic drinking water, 779 million people lack basic sanitation (including 208 million who defecate outdoors), and 839 million people still lack access to basic hygiene (UNICEF , 2022). Issues like lack of resources, poor technology adoption, poor management, corruption, poor project management skills, etc. are the main reasons behind (Frederick et al., 2018).

In Africa, the use of wells is preferable to obtain drinking water, but there are major doubts about their functionality; the rate of non-functionality of these wells is very high. System functionality may be affected by inappropriate technology, such as poor design, unavailability or expensive spare parts, lack of professional technical support, drought or theft. In addition, there are other factors that influence sustainability such as social and institutional factors such as community participation and sense of ownership (Victor et al., 2023).

In Ethiopia, the national water supply coverage in 2018 according to the GTP-II standard is determined by the management information system to be 47, 57 and 49 % for rural, urban and entire areas, respectively. The rural water supply schemes non functionality rate of regional were 17.6% Benishangul-gumuz, 17.5% Oromiya, 48.4% Somalia, 19.1% Amhara, 19.6% Southern nations, nationalities and people, 21.2% Tigray, 21.5% gam-

bella, 25.2% Afar, 40.1% Harari and 22.3% Dire Dawa. Regarding the level of non-functionality of rural water systems, of the total 155,482 rural water systems inventoried, 29,204 (19%) were non-functional at the time of the inventory for various reasons. About 88% of the disruptions were reported for five main reasons: 52.1% due to problems with spare parts, 15.6% due to drying up of water sources, 7.8% due to water quality problems, 6.6% due to lack of technical personnel and 6.1% due to pump failure, the remaining 12% was due to other reasons such as lack of funds, lack of fuel and others (Water Development Commission, 2021). So, the study was conducted by using the mWater platform application because recently national inventory used management information system have own limitation.

Management Information System (MIS): It is true that the NWI-2 inventory has significant improvement compared to the first manual based national WaSH inventory (NWI-1) in that its automated geolocation tagging right at photographing completely removes human errors that could occur while reading from hand GPS and also transferring all recorded data by data encoders from paper based in to the system. It has also an exceeding advantage on avoiding a heavy and costly work inherent with paper-based inventory that involves duplication and transportation of tremendously huge number of paper-based templates and again moving back the filled templates to the regions for data encoding. But it has also limitations. The major limitations include among others were automated file naming by the software denied enumerators to control their work, Enumerators and supervisor are denied to visualize, check and edit recorded data once survey is ended, Restriction of maximum values of some data by the application software was another constraint and Both selective synchronization and removal not possible at all. Hence enumerators tend to hide their errors for fear of reworking the whole day recording be it bad or good. But

mWater Software application: Current status of schemes was done by using mWater Software application; which have the benefit of facilitate efficient data collection in rural areas, enabling better monitoring of water sources, usage patterns, and system performance. Also, Real-time data can help identify issues promptly, such as leakages, low water levels, or equipment malfunctions, Community Engagement Platforms that involve the community in monitoring and reporting water-related issues can enhance the sense of ownership and responsibility, contributing to the sustainability of water schemes, by analyzing historical data, these platforms can predict potential system failures, allowing for proactive maintenance. This can prevent major breakdowns and reduce downtime and Remote Monitoring for rural

water schemes, remote monitoring capabilities are valuable. It reduces the need for physical inspections, especially in challenging terrains, thereby saving time and resources.

Also, Sustainability is influenced by many factors technical and non-technical (Addis , 2012). In other research found that sustainability was related, strongly, to community participation (Mavhura & Manyena, 2018). Moreover, it was found that a strong correlation between community participation and management to the sustainability was obvious and effective community organizations, ability of the community to operate and maintain facilities, ability of the community to raise adequate user fees for purchasing spare parts, and strong backup support from external parties at the district level to solve major breakdowns were revealed by (Vrchota et al., 2020) as factors that contribute to the sustainability of water supply systems. However, their findings are not support technology and some of factors were included. In our research where more factors of sustainability were addressed and New and innovative monitoring tools are needed to achieve universal and equitable access to safe and affordable drinking water for all.

To assess sustainability of RWSSs of Habro District and recommend remedial measures. mWater application which is use data collection, analysis, and visualization capability platforms and SPSS version 27 statistical software was used. The expected results, percent and rate of non-functionality of hand-dug well (HDWs), shallow wells (SWs), deep well (DW), and water points (WPs) were determined.

1.2 Statement of the Problem

The sustainability of rural water supply (RWS) projects and the associated benefits are currently a major concern in the industry. Every year, national governments and international donor organizations invest huge amount of money in the implementation of projects, and despite increasing attempts to solve this problem, many of them still fail to maintain the expected benefits over a period of 15 or even 20 years (Lockwood et al., 2003).

In Ethiopia, the national water supply coverage in 2018 according to the GTP-II standard is determined by the management information system to be 47, 57 and 49 % for rural, urban and entire areas, respectively. Regarding the level of non-functionality of rural water systems, of the total 155,482 rural water systems inventoried, 29,204 (19%) were non-functional at the time of the inventory for various reasons. About 88% of the disruptions were reported for five main reasons: 52.1% due to problems with spare parts, 15.6% due to drying up of water sources, 7.8% due to water quality problems, 6.6% due to lack of technical personnel and 6.1% due to pump failure, the remaining 12 % was due to other reasons such as lack of funds, lack of fuel and others. (Water Development Commission, 2021).

This shows that non functionality of schemes is still ongoing, which means the sustainability of rural water supply are under question in Oromia region and study area.

In Habro District different types of water supply schemes are constructed by Government and non-government organization (NGO), may be successful but their sustainability may remain a challenge. Also, large numbers of projects implemented at huge costs often tend to have trouble with sustainability. The community remains without sustainable access to safe drinking water, in addition, large investment cost in RWSS is being wasted due to maintenance problem. Schemes are designed and implemented to meet specific goals and achieve desired changes. However, non-functionality of rural water supply schemes of pre construction, during construction and post construction phases within different aspects of non-functionality of RWSSs is critical to the district.

The technical explanations for the causes of sustainability and non-functionality are given by different researcher, Sustainability is influenced by many factors – technical and non-technical (Addis , 2012). In other research found that sustainability was related, strongly, to community participation (Mavhura & Manyena, 2018). Moreover, it was found that a strong correlation between community participation and management to the sustainability was obvious and effective community organizations, ability of the community to operate and maintain facilities, ability of the community to raise adequate user fees for purchasing spare parts,

and strong backup support from external parties at the district level to solve major breakdowns were revealed by (Vrchota et al., 2020) as factors that contribute to the sustainability of water supply systems but know a day's Non-functionality of schemes is one of the challenges affecting the sustainability of rural water supply. The goal of this study was find the reasons that these systems are not functional and understand the causes of sustainability problem of RWSSs which is series problem now days and come with solutions in Ethiopia in general and specifically in Habro District by Improving rural water supply schemes management using mWater software platform and using WASH business center to minimizing the non-functionality of schemes providing spare parts near to rural water schemes and ensuring the sustainability of these schemes, access to clean and reliable water sources for rural communities can be secured for generations to come.

1.3. Research Objective

1.3.1. General objective

The main objective is to assess sustainability of RWSSs and provide remedial measures in Habro District.

1.3.2. Specific objectives

The specific objectives listed below are specific to Habro District.

1. To assess the physical status of RWSSs.
2. To identify the causes of non-functionality of the water supply schemes in the area.
3. To assess the participation of the community in the rural water supplies and management aspect in the district.

1.4 Research Questions

1. What are the physical status of RWSSs?
2. What are the main problems that cause non-functionality of RWSSs?
3. What extent do the community participation for the rural water supply and schemes management?

1.5 Significance of the Study

This research will be helpful for better understand the causes of sustainability problem of RWSSs which is series problem now days and come with solutions in Ethiopia in general and specifically in Habro District thereby Improve rural water supply schemes coverage, and reliable water to rural community and increase the functionality rate of RWSSs.

Effective assessments provide valuable insights into the long-term viability of such schemes, allowing policymakers, implementers, and communities to identify potential challenges and develop solutions. By ensuring the sustainability of these schemes, access to clean and reliable water sources for rural communities can be secured for generations to come.

The result of this study will serve as base line information for those who are interested to conduct research study in depth of those factors individual to discover the problems of rural water supply schemes, especially, in the study area.

1.6 Scope and limitation of the Study

The study was focused on assessing the causes of sustainability of RWSSs in rural area of Habro District such as hand dug well, shallow well, spring development at spot and deep well and water points. Due to lack of water quality data at schemes and district level, and resource limitation, the research did not assess the chemical parameters of drinking water supply. Instead, its physical parameters (color, taste, Odor, temperature and turbidity) of selected water schemes are done.

1.7 Operational Definitions

mWater: The data collection, analysis, and visualization capability platforms in the WASH sector which is developed by the investment of USAID, UNICEF, World Bank, World Health Organization and different NGOs like water Aid and safe and which have over 100,000 accounts in 184 countries uses mWater to map, monitor and manage infrastructure and services. It began in 2012 with an investment from USAID development innovation ventures to use mobile technology to improve water quality monitoring Tanzania.

WASH Business Centre Model

World Vision and the WASH sector in general. Perhaps one-third to one-half of rural water points are non-functional. Widespread adoption of Community-led Total Sanitation (CLTS) due to ease of implementation leading to generally disappointing results of 5-10%pp increases in coverage when rigorously evaluated. The WV- 14 evaluation in 2017 found that only about 32% of all households in World Vision APS had access to basic sanitation, and for 8 of the 14 countries studied, this was not significantly higher than in non-WV areas. A recent pilot of the Nurturing Care Group approach, which delivers behavior change messaging with high frequency using a cascading women's group model, found reductions in unsafe drinking water of 75% and increases of handwashing indicators of as much as 50 percentage points, yet sanitation coverage increased only 7% relative to baseline (World Vision Ethiopia, 2022).

World Vision Ethiopia has been implementing WASH interventions across the country and reaching children and families with clean water supply, improved sanitation services and improved hygiene practices since 1975. However, as per the Ethiopian joint monitoring report (JMP), the sustainability of water schemes, sanitation facilities, and hygiene practices remain a challenge for the nation. The non-functionality rate of water schemes is high nationally at 11.2 %. Only 14% of the population has access to improved sanitation with 7%

basic and 7% limited-service levels, while 8% of the population has basic household hygiene service (World Vision Ethiopia, 2022).

To address these challenges, World Vision Ethiopia introduced the WASH Business Centers (WBC) initiative at the end of 2018. The WASH Business center is a one-stop center for production and sales of WASH products and services to communities, schools, and healthcare facilities at an affordable price. Products include latrine slabs, hand washing facilities, soap, and spare parts for water schemes, among others. Services such as repair and change of broken taps, laying pipes for water line extensions, and shower services are also provided by the centers. The WASH Business intervention set out to realize three intermediate outcomes. To make WASH products and services available that are acceptable and sustainable to targeted community; to make product and services affordable and priced to the value proposition and to make product and services accessible at one location. (World Vision Ethiopia, 2022)

Hand-dug wells: According to the Department of Water and Energy, hand-dug wells remain the most popular method of groundwater extraction in rural areas. However, since they are dug by hand, their use is limited to suitable soil types such as clay, sand, gravel and mixed soils with only small stones.

Hand-dug wells provide a low-cost, low-technology solution to rural water supply problems. Mining and casing is accomplished by human labor, usually by penetrating a borehole using various hand tools. The depth of the wells dug varies from 5 to over 20 meters. Digging a well less than a meter in diameter is impractical. A trench with a diameter of approximately 1.5 meters provides sufficient working space for the excavators and allows for a final internal diameter of approximately 1.2 meters after the well has been lined.

Shallow Well: According to the Ministry of Water and Power, this system is an advanced type of hand-dug well constructed in an accessible area using a medium-sized drilling rig and can reach greater depths than manual digging. The main advantage of using shallow wells over hand-dug wells is that 1) they can reach depths of up to 60 meters, 2) do not pose any danger during the dry season, and 3) are not easily contaminated.

Shallow bore wells are wells that are drilled with a drill and covered with a polymerization of vinyl chloride (PVC) or steel casing. These types of wells can be equipped with hand pumps for village level operation and maintenance (VLOM), and the diameter of the well is generally between 4 and 6 inches.

Deep Well: A deep well generally refers to a well drilled or dug deep into the ground to access groundwater for various purposes such as drinking water supply, irrigation or industrial use. The depth of wells can vary greatly, but deep wells are generally deeper than shallow wells. The specific depth at which a well is considered “deep” can vary depending on regional and geological factors. In some areas, a well may be considered deep if it exceeds a certain depth compared to the local average. Deep wells are often used in areas where shallow groundwater is insufficient or of poor quality.

Spring Development: According to the Department of Water and Energy, springs are groundwater outcrops that often appear as small ponds or wet spots at the base of hills or along river banks. springs are classified according to the conditions under which the water flows into them. 1) gravity depression spring, 2) gravity overflow spring, 3) artesian spring, 4) artesian fracture spring, 5) artesian overflow spring. All of these types of sources require different types of development structures.

Rural Water Supply (RWS): Refers to the provision of clean, safe water to rural communities through the construction of boreholes, protected wells and springs.

Functionality: Refers to the percentage of water points operating at a given time and is typically measured by a one-time inspection of the facility or water point to determine whether the system is currently operational. This is usually binary (yes, no). State, (Kassa, 2014).

Community: Community refers to a group of households in a particular area that uses one or more rural water supply services.

2. LITERATURE REVIEW

2.1 The Concept of Sustainability

The idea of sustainability first arose within the environmental movement and attempts to protect natural resources and ecological systems from over-extraction, and stresses. So, it has been extended to incorporate other dimensions like economic, social and institutional once. For example, the idea of economic sustainability is achieved only when a given level of expenditure can be maintained over time or is related to the resilience to risk of net benefit flows over time by the World Bank (Tadesse, 2013). The concept also incorporates institutional or managerial questions in that sustainability is achieved when prevailing structures and processes have the capacity to continue their functions over the long term (Lencha, 2012). Sustainable development involves the simultaneous pursuit of economic prosperity, environmental quality and social equity. Companies aiming for sustainability need to perform not against a single, financial bottom line but against the triple bottom line.

2.2 Sustainability in Rural Water Supply

New and innovative monitoring tools are needed to achieve universal and equitable access to safe and affordable drinking water for all. Various technologies and management schemes show potential to contribute towards achieving sustainable, universal water access, but evidence is needed to determine what works and avoid wasted investment (Vrchota et al., 2020)

There is a different type of definitions of sustainability in Rural Water Supply Systems (RWSS) used in different studies. The majority of these definitions are similar in nature but have slight differences in emphasis. The following three definitions emphasize on issues including; the flow of benefits, relationship between community management organization and external support institutions, efficiency, effectiveness, reliability and equity issues. Therefore, all have been applied in the context of this study, and is summarized as follows; Sustainability is best defined by (Vrchota et al., 2020) as ‘whether or not something continues to work overtime’. More specifically, it implies the ability to recover from technical breakdown in the scheme.

Includes, as part of its definition of sustainability, a statement that a system that reliably and sustainably meets the needs of 80% of the population while leaving the poorest 20% unserved cannot be counted a success. The incorporation of a measure of social equity in the definition of sustainability reflects, in part, a political or ideological position in terms of viewing access to basic services as a fundamental human right.

Swan (2006) defined rural water supply as sustainable if the systems are being used efficiently, effectively and equitably by users, can be managed and financed by users with limited external support and will continue to deliver benefits for a long period after project inputs.

2.3 Factors that Determine Sustainability

The factors that determine the sustainability of rural water systems are divided into two main categories. These are factors before and after implementation. Community participation, choice of technology, choice of location, response to demand, quality of construction, population and training are some of the factors that precede implementation. Post-implementation factors include technical support, community satisfaction, institutional and financial management, training, and willingness to sustain the water project (Addis , 2012).

The effective operation and maintenance (O&M) of rural water systems is an essential element of sustainability of water projects. Collaborative management of rural water supply systems in terms of operations and maintenance will only be effective if financial resources are available and frequent support is not provided (Addis , 2012). Budgeting sufficient funding for rural water supply systems is an important issue for sustainability and proper maintenance but not only one.

Providing sufficient budget resources for rural water supply systems is an important issue not only with regard to sustainable development and good maintenance. The choice of technology is also important. The fixed costs associated with installing wells and pumps have a significant impact on their number and location. Additionally, hand pump failures often result in extended service interruptions, resulting in high but avoidable financial, health and development costs. There are innovative ways to solve these problems. For example, a manually operated hand pump utilizes a gear transmission in the drive system to facilitate operation while increasing efficiency (Andres et al., 2018).

These studies suggest that even small increases in efficiency can have large results given the critical nature of hand pumps. Data show that aid payments contribute significantly, positively and significantly to improving access to WASH services in low- and middle-income countries, but also in low-income countries Low- and middle-income countries Income in middle-income countries. This percentage was higher in rural areas than in cities. Another recent study suggests that donors need to increase their assistance to WASH services in sub-Saharan Africa (Andres et al., 2018).

Structural constraints that limit access to WASH services (and that foreign assistance can alleviate) need to be identified and addressed. Technical factors affecting the sustainability of rural water supply systems include the choice of technology; technical skills required to operate and maintain the systems; Availability, availability and cost of replacement parts; Quality of project implementation. (Machado et al., 2019).

2.4 Sustainability of Water Supply in Ethiopia

The Ethiopian government (later the regional governments) adopted the National Water Resources Management Policy (Braga et al., 2009) to improve and maintain water supplies in rural and urban areas. The overall objective of this policy is to strengthen and promote the efficient, equitable and optimal use of water resources for sustainable socio-economic development. This policy is based on the principle that the water supply sector must ensure that Ethiopian citizens have access to water of acceptable quality to meet their basic human needs.

Subsequently, the government adopted the Universal Access Program (UAP) to improve water and sanitation in the country, achieving 100% water coverage in most rural areas (UNICEF/WSP, 2015) . To achieve this, the UAP understands that to ensure the sustainability of water supply systems, hand pumps must be manufactured locally and repaired by local technicians, and that pumps and generators in general must be standardized in this way to ensure operation and maintenance place to ensure at village level sustainable service. It is estimated that about 33% of rural water systems in Ethiopia are not operational at any time due to lack of funding for operations and maintenance, inadequate community mobilization and participation, and lack of spare parts (Gurmessa & Mekuriaw, 2019). Therefore, the UAP aims to rehabilitate and maintain existing water supply systems, develop a culture of conservation, and increase the sustainability of newly built water supply systems and new supply systems of existing water systems in the first two years of its seven-year plan (Abebe & Deneke, 2008) Sustainability is a water program that provides adequate service to the target community, with the desired quality and quantity of water dependent on their needs and the managing organization's ability to appropriately balance the size and complexity of the system.

2.5 Factors Contributing to Sustainability

Key factors contributing to the sustainable development of rural water systems include community participation and ownership, availability of spare parts and repair services, proper

operation and maintenance, provision of sufficient financial resources, capacity building and training, and utilization appropriate resources, technologies and materials. These factors ensure the long-term success and effectiveness of programs aimed at meeting the water needs of rural communities. (Machado et al., 2019)

2.6 Conceptual Frame Work of Rural Water Sustainability

From literature, sustainability problem of rural water supply schemes involves a number of factors that are internal and external to the community and depend on community, technical, management skill, Maintenance fund and nonfunctional factors and comprise sub factors that have considered improving sustainability of rural water supply schemes. Community participation should ensure in all phases of water supply scheme development and management. Locally recognized and organized gender sensitive water committee under take the responsibility of management of rural water supply schemes.

Regarding technical factors, water supply projects should consider village level operated and maintained schemes for ease of community management, adequately trained and skilled, technician under take minor maintenance of parts should be created within the user committee, spare parts supply system should be established in the way the community can access and afford them whenever maintenance needed, construction quality of schemes during water well drilling or excavation and head work construction should be supervised by relevant professional to avoid the problem.

However, in order to sustain and maintain the existence of regular contribution for O&M the amount of contribution should be based on user ability and willingness to pay, taking into account the minimum requirement over all O and M cost of the scheme and practice of saving the money. Regarding institutional and legal factors there should exist policies and legal framework under which water supply schemes are developed and managed and there should exist a room for private sector and capacitated local public institution responsive for monitoring and management.

With regards to environmental factors, in order to avoid the scheme service unreliability due to water quality and inadequacy of yield problem Integrated feasibility study on scheme type selection to the study environment to be sustainability (Daemane, 2015) Therefore, commencement of drilling for rural water supply schemes to avoid the water source inadequacy and to ensure the continuity of water supply. This study capitalize on “lasting beneficial changes in rural water services” as an interplay of factors stated above, and the status of

these determinant factors is going to be assessed combined in to five interdependent categories. This involves, community aspect; technical; financial; institutional and environmental aspect which are considered major areas that best serve the interpretation, discussions and analysis of the research study.

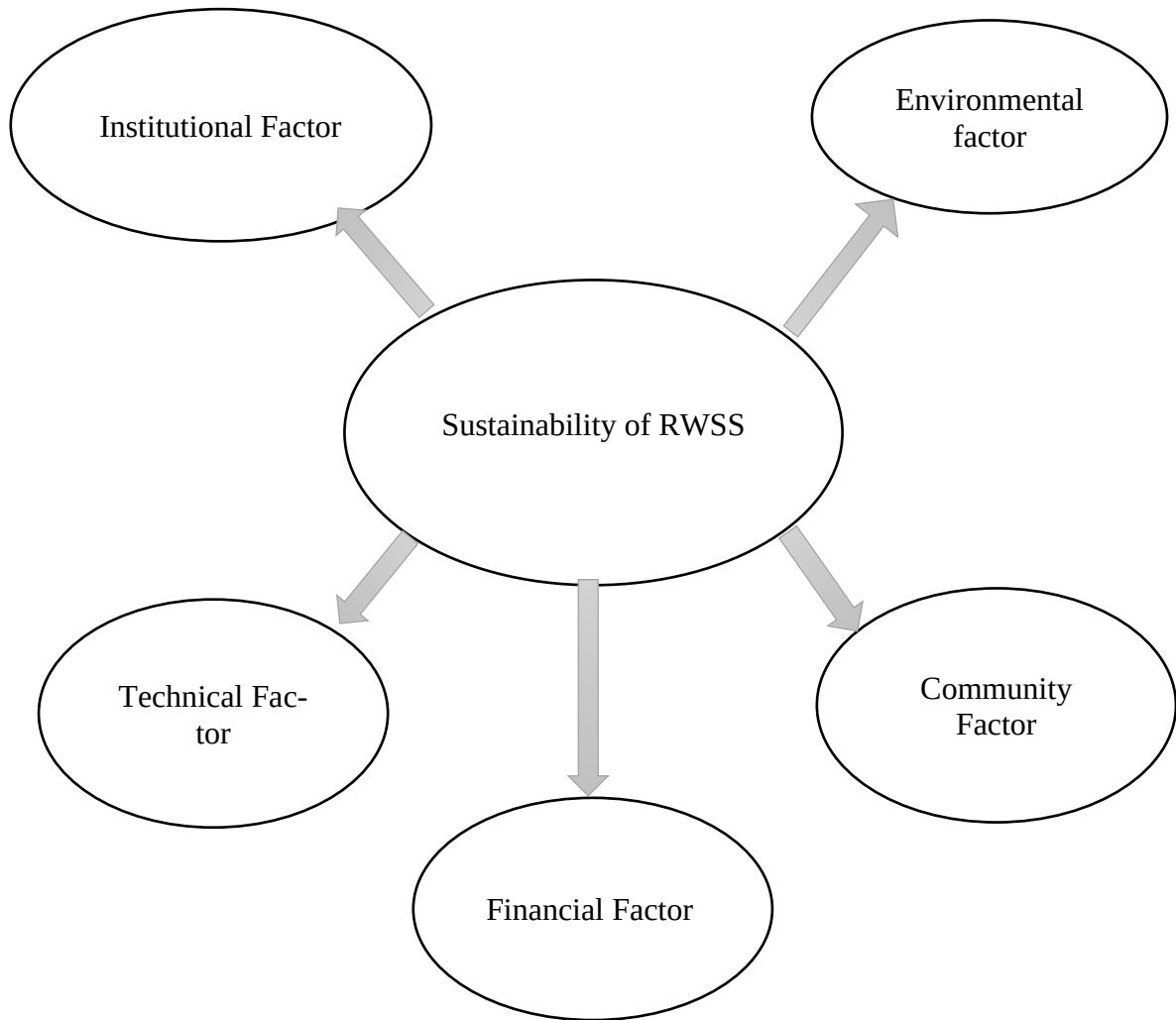


Figure 2.1 Conceptual frame works of RWSS (Daemane,2015)

Sustainability is influenced by many factors – technical and non-technical (Addis , 2012). In other research found that sustainability was related, strongly, to community participation (Mavhura & Manyena, 2018). Moreover, it was found that a strong correlation between community participation and management to the sustainability was obvious and effective community organizations, ability of the community to operate and maintain facilities, ability of the community to raise adequate user fees for purchasing spare parts, and strong backup support from external parties at the district level to solve major breakdowns were revealed

by (Vrchota et al., 2020) as factors that contribute to the sustainability of water supply systems. However, their findings are not support technology and some of factors were included. In our research where more factors of sustainability were addressed and New and innovative monitoring tools are needed to achieve universal and equitable access to safe and affordable drinking water for all. So mWater plat form was used.

2.7 Functionality and Non-Functionality of RWSSs

According to various studies conducted to RWSSs, scholars have produced definition concerning to functional sustainability or non-functional in the context of RWSSs. Lockwood and smith (2011) functionality refer to the percentage of water schemes working at any given time and is normally measured by a one-time check on a water facility or water schemes to determine whether the system is working at the time, and is normally a binary condition (yes/no). Functionality is percentage of improved water sources that are functional at time of spot-check (Ssozi & Danert, 2012). Functional schemes are those that have all of their components functioning and are in good working order. (Behailu et al., 2017). According to this definition, the achievement of functional sustainability is interdependent to the elements of functional sustainability before construction, during construction and post construction of rural water supply schemes.

Functionality is now one of the two top government priorities for action in Nepal. Functionality was assessed in 785 villages, and the hard evidence has led government to address functionality in the policy and increase training of implementers and scheme managers. The challenge was to create incentive and conductive environment for improved performance of implementers and scheme managers (Cronk & Bartram , 2017).

According to Daemane (2015), non-functionality of the water systems was established to be attributed to low water table 6.6 %, technical faults 10 %, poor operation and maintenance 40.7 %, lack of trained and active water committees 30 %, community initiative 3.3 %, literacy and sensitization 3.3 % and poor sitting 6.6 %.

The problems with rural water supply sustainability were a significant factor in Tanzania's decreased access to clean, safe water in rural areas. The findings of the water point mapping and the validation and inquiry process demonstrated that inadequate management of water sources due to accountability concerns among water sector actors, rather than technical challenges, was the primary cause of the non-functionality of several water points. (Armah, et al., 2018).

The delay in identifying defects and obtaining spare parts is a major challenge that contributes to the non-functionality of rural water schemes. The following were identified as contributing factors to the scheme breakdown: improper technology installation, improper usage of mono-lift pumps, a lack of skilled operators, and a failure to timely service motors. (Omarova et al., 2019).

In rural Zambia, non-functional water stations further limit access to a safe supply of water, according to SNV (2016). Issues include the absence of an efficient system for maintaining community water supply facilities, the scarcity of spare parts and incentives for WASH artisans to perform repairs, the imprecision of data regarding the condition of water points, and the insufficiency of local authorities in terms of organizing, carrying out, and maintaining water facilities. Non-functionality of schemes is one of the challenges affecting the sustainable provision and coverage increase in rural water supply. “In the case of water supply, if the water supply continues to be available for the period which it was designed in the same quantity and at the same quality as it was designed, the scheme is said to be sustainable and all of the many elements which are required for sustainability must have been in place” (Omarova et al., 2019).

However, previous research shows that most interventions targeting dysfunctional water systems in rural areas rarely incorporate systems thinking. In this context, a study was conducted in rural areas of Swaziland to systematically diagnose problems related to the non-functional rural water supply system. The network analysis results showed that user satisfaction, water supply unreliability, and repair and maintenance were priorities in the project, with relative centrality values ranging from 0.347, 0.319, and 0.222 respectively. It was determined that the program should prioritize user satisfaction. In addition to the high core value, user satisfaction has also led to feedback loops covering most of the issues identified by the program. However, to improve user satisfaction, efforts were required to ensure reliable water supply and develop a sense of ownership among users (Shongwe and Dlamini, 2021).

Due to a shortage of spare parts, insufficient community commitment and mobilization, and a lack of funding for operations and maintenance, 33% of Ethiopia's rural water delivery schemes are perpetually non-functional. (Gurmessa & Mekuriaw, 2019). The RWSS identify several responses for the high failures rate, including inappropriate technology selection; poor construction and lack of quality material, lack of community participation and subsequent sense of ownership, poor community organization or cohesion; lack of spare parts and professional support (Mohammed, 2021).

2.8 Causes of Non-Functionality of RWSSs

Causes of non-functionality of RWSS can be at different stage of scheme development or sustainability practice includes design, construction, operational and maintenance or management. In order to get insight into the primary reasons for non-functionality with various aspects of studies on rural water supplies, the researcher reviewed a few literatures.

The causes of non-functionality in the Southern Nations Nationalities Peoples Regional State and the Amhara Regional State were construction, yield quality, and mechanical issues.

Assefa et al. (2013) state that the primary causes of the non-functionality rate were the following: a lack of frameworks to encourage preventive maintenance of the schemes; inadequate O and M skills and knowledge at the District and Water Scheme Committee levels; poor access to spare parts; a lack of legal protection for Water Committees; inappropriate technology scenarios; and a low sense of ownership. Unproductive wells, a broken hand pump, a failed spring box, and a broken pump were the causes of total non-function. (Admassu et al., 2012).

2.9 Community participation and schemes sustainability

Participation plays a great role as a foundation of community development projects including water services in developing world. (Olajuyigbe, 2016), states that participation is a key instrument in creating self-reliant and empowered communities, stimulating village-level mechanisms for collective action and decision-making. Participation is also aimed at increasing the sense of ownership over the water supply within community members aimed at inculcating a sense of self-reliance and ownership to create equity in resource distribution. preposition that community participation is now a mainstream management theory. Hence, for any rural development initiative to thrive, community participation is required in order to create empowerment and ownership among the target group.

Participation” encompasses purposeful interaction among different stakeholders including international actors, national politicians and local government leaders who make decisions together with private sector contractors and the targeted beneficiaries who form part of this relationship .In his view, conflict is expected since each group has different interest, requiring some conflict resolution skills to manage them. the central role that women play in the

collection, management and use of water, as well as with the general sanitation of the household is well documented. However, the extent to which women continue to be meaningfully involved in management of RWS project benefits in the long-term can also be influenced by external factors. In the case of a communal water supply system, motivation and willingness must be generated on both an individual and collective basis, amongst both individual household users who pay a tariff and community members who volunteer time and are involved in system management. Taking broader perspective, external actors may also be motivated to contribute towards supporting community managed. RWSS local governments may perceive a political benefit, the private sector a profit motive and central government may see sustainable service provision as part of their broader development agenda. For whatever reason, and from whichever perspective, motivation is clearly a critical factor in post-project sustainability. Similarly, an adequate degree of social cohesion within a community is now considered by many to be a fundamental factor in sustainability. Full community participation promotes a proactive process in which the beneficiaries influence the development and management of development projects rather than merely receiving a share of project benefits and Community participation creates an enabling environment for sustainability by allowing users, as a group, to select the level of services for which they are willing to pay, to guide key investment and management decisions, and also to make choices and commit resources in support of these choices. (Mavhura & Manyena, 2018)

A previous study indicates that community contribution positively influences a community's sense of ownership toward the water supply systems, while the sense of ownership is often mentioned by other studies as positively influencing the sustainability of the water supply systems. (Kelly, et al., 2017).

2.10 Community Water Supply Schemes Management

Community management is the management option whereby communities, rather than government institutions or the private sector, have control over the management of their water supplies. The actual responsibility for the management lies ideally with a representative group of community people, often referred to as a water committee, chosen to take up this task. Although this group may for the involvement of local caretakers or small entrepreneurs, the committee remains in charge of ensuring a sustainable service and is accountable to the community at large. Supporting community management means taking into account that communities are made up of men, women and children of different socio-economic and cul-

tural backgrounds, with sometimes-conflicting interests and ideas. The concept of community participation implies that beneficiaries are involved in the development projects concerning them. However, the concept of community management refers to the capabilities and willingness of the community to be in control and determine the nature of development activities affecting them. In water supply and sanitation projects, community management refers to the fact that community exercises its responsibility of decision-making and becomes in charge of controlling the subsequent execution of these decisions during project development. Management refers to using expertise in coordinating the efforts of people to accomplish desired goals and objectives using available resources efficiently and effectively. It comprises planning, organizing, staffing, leading and controlling of the rural water supply schemes to meet the needs of its community and embraces the concept of doing this beyond the expected time (Mommen et al., 2017). In Ethiopia, the concept of community management in rural water supply was first perceived in the Amhara region in 2003, under a Finnish-Ethiopian bilateral Rural Water Supply and Environmental Program and RWS has been supporting the expansion of rural water supply services in Amhara since 1994, although financing via the CDF, (which later became, CMP), mechanism came later, being introduced on a progressive basis between 2003 and 2006. At large, community management refers to power and control on behalf of the beneficiaries, where its ultimate goal is not maximizing users' participation but rather optimizing it to achieve sustainability through human development (Behailu et al., 2016).

3. MATERIALS AND METHODOLOGY

3.1 Description of Study Area

Habro is one of the fifteen rural districts found in the West Hararghe Zone of Oromia Region. The District is segmented into 37 kebales of which 33 of them are rural kabales and four towns (Gelemso 01 and 02, Wachu and Belbeli). The district is located at about 396 km East of Capital Addis Ababa. It lies between 8.6667 latitudes and 40.3333 longitude. The district is bordered in the south by Darolebu, in the west and north by Guba Koricha, in the northeast by Kuni, and in the southeast by Boke. According to district agriculture and administration office, it has a total population of 267,674, of whom 136,514 are females and 131,160 Male.

The district has three-agro ecologic zones; namely, low land 22%, midland 61% and highland 17%. The annual rainfall ranges from 650-1000 mm and average temperature is 21.5 0c. Land use of agricultural practices of the district is 46700 ha, which covers 38% of cultivable land, 13% degraded/ land, 43% bush and grassland and 6% forest (natural and plantation) and grazing land, bush and grassland wetland took the remaining share. The average farmland holding size is 0.7 ha/HH, which is far less than sufficient to feed the whole families throughout the year.

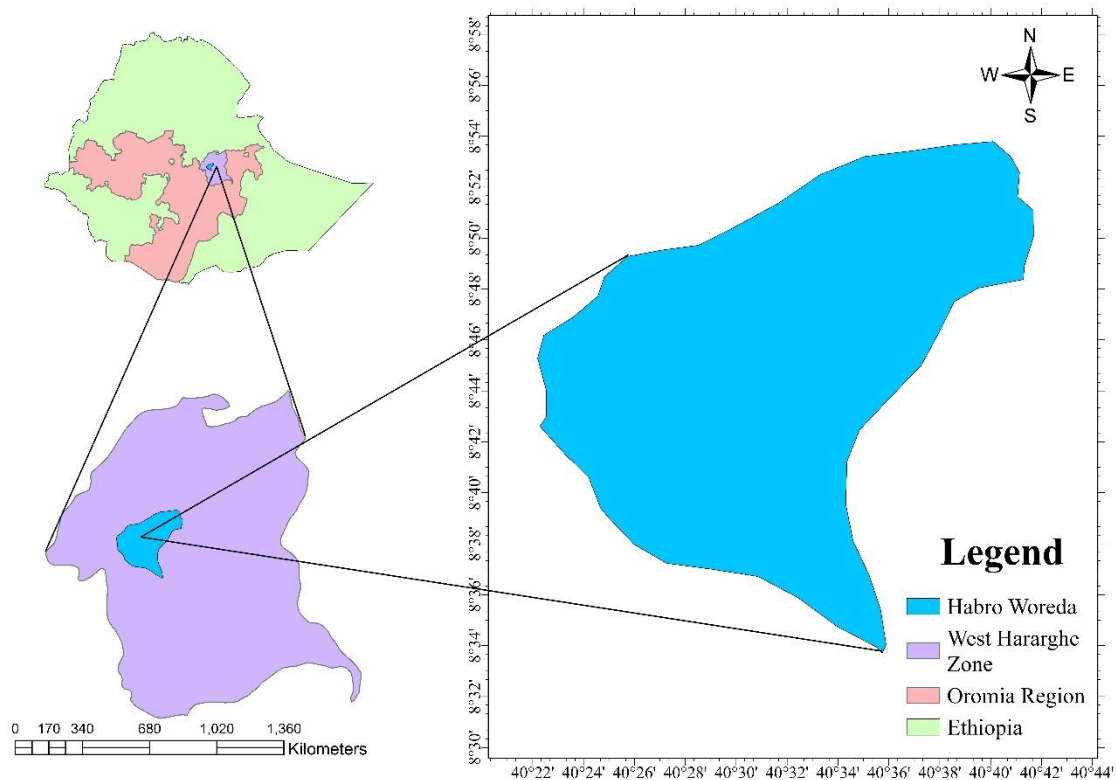


Figure 3.1 Study Area

3.2 Data Sources Types and Methods of Collection

The study included both qualitative and quantitative data. Primary data sources included community water user households, WASH committees, district water resource experts, and water specialists from non-governmental organizations. The individual households in the community served as the major source of data. In addition, secondary data were gathered to supplement the primary data. The government, non-governmental organizations, publications, unpublished papers, websites, annual reports, books, and previous research projects were the main sources of secondary data.

3.2.1 Primary data collection method

Household survey prepared questionnaires: The purpose of the household survey was to determine household rural water supply schemes arrangements of households. Questionnaires will be developed with questions and answers are will gather through observation by enumerators (a researcher). The household questionnaire under the following Six components: General information, Current status of schemes, technical factors, financial factors, Institutional factors and social factors.

Key informant interview (KII): Appropriate checklists will be established from which interviews are conducted with key informants (stakeholders) in the water supply sector to bring to light the present state of sustainability of rural water supply systems related to functional and developments of the water supply projects for the way forward along the water supply beneficiaries.

Generally, 3 key informant interviews (KIIs) will be conducted. The researcher are interviews who are thought to be knowledgeable about the topic and the place in question, District water office, World vision Ethiopia Habro area program and Zonal water office professionals and heads. World vision is focus area because it works more development program more than 13 years. The interviews will be carried out by different techniques depending on the informant's available time. The duration of the interview varied for different informants due to the scope and content of the questions.

Focus group discussions (FGDs): In the chosen sample kebeles, the researcher will hold three FGDs with representatives from the water committee (water utility), women's organizations, and kebele administration. Various checklists are utilized by the researcher for every Focus Group Discussion.

Transect walks and field observations: Observation is a key component in the formulation of hypotheses. By regularly seeing a phenomenon, a researcher might become very familiar with what they are seeing. Because phenomena cannot speak, they are unable to provide information about their behavior, feelings, or activities. Moreover, observation does not require people's willingness to provide a variety of personal details. This allows the observer to directly verify the accuracy of what is observed. A few participants expressed a dislike of discussing personal matters with an outsider. Utilizing mWater, observation techniques were employed to evaluate the schemes' current status, development, and functional sustainability. The results were compared with checklists to evaluate the reliability of the data Collected.

3.2.2 Secondary data collection method

The researcher used journals, governmental and non-governmental publications, prior studies, accessible books, annual and inventory reports from District offices of water resource development, Zonal water offices, and regional offices on the socioeconomic conditions of the study area as additional primary tools for secondary data collection.

3.3 Sampling Techniques and Sampling Size

The water sector was represented by various governmental and non-governmental organizations (NGOs) such as WASH, World Vision, Food Security (Seftnet), and others. The sample frame included the Habro District Water, Resource, and Energy Office, as well as the Institutional Water Supply Project. The study will take into account the sustainability problem and sample frame of RWSSs constructed between 2011 and 2021, since the majority of rural water supply designs have a 10- to 15-year design duration. The necessary data were collected by interviews, Focus group discussion (FGD), Key informant interviews (KII) and field observations. The study employs a combination of purposive and simple random sampling methods to choose sample kebeles, water supply schemes/water points and households.

Selection of Sampling Households: Due to the similar socioeconomic conditions in the area, simple random sampling was used to select households or beneficiaries of water supply schemes, giving each beneficiary an equal chance to be a sampling unit and representative sample size of households from the consumers of the schemes. This was done in order to meet the study's objective of sustainability. The results of the sample size computation of water supply projects, house hold population, and number of kebele were taken into consideration. The family The study area's sample size The water supply sample projects, house hold population of number of targeted kebele will be compute using Slovene's formula (Kirsch & Thorn, 2013). the sample size computation formula.

$$n = \frac{z^2 pq}{d^2} \text{-----Equation 3.1}$$

Where, n = sample size, of household

P = proportion in target population estimate to have particular character 10% = 0.1

$q = 1-p = 1-0.1 = 0.9$,

Z = Standard normal deviate, set at 1.645 corresponding to 90% confidence level

d = degree of accuracy desired, set at 0.05 - 0.02.(chosen 0.4). Therefore

$$\frac{1.645^2 * 0.1 * 0.9}{0.04^2} = 152.214 \text{ approximately the sample size to be } = 160$$

The sample size for sustainability and the sustainability problem were determined using the procedure above.

Selection of Kebeles: The total number of habro district rural kebeles are 33 all of them are having water supply schemes but the quantity of the schemes was difference between them.

The District Administration Office claims that although the District's agro-ecology is divided into four distinct zones, all of its Kebeles share a common socioeconomic background and cultural context.. Out of the four distinct to studying are select under two zone which have more schemes coverages.

Selection of Water Supply Schemes: Rural water supply schemes sample were computed using the sample size computation formula (Umulisa, 2012).

$$S_s^* = \frac{Z^2 p x (1-p)}{c^2} \text{-----Equation 3.2}$$

$$s_s^* = \frac{1.96^2 (0.3)(1 - 0.3)}{0.1^2} = 80.67$$

$$S_s = \frac{S_s^*}{1 + \left(\frac{S_s^* - 1}{pop}\right)} \text{-----Equation 3.3}$$

$$S_s = \frac{80.67}{1 + \left(\frac{80.67 - 1}{160}\right)} = 53.85 \sim 54$$

Whereas pop = Population (water scheme sample frame) from which sample of water scheme are to be drawn,

c = margin of error 1 expressed as decimal (c=0.1),

SS = Adjusted sample size to achieve determined confidence level and interval (for finite population),

Z = Standardized normal deviate value at 5% level of significance ($Z_{0.05/2} = 1.96$).

SS*= Unadjusted sample size for a very

P = Percentage population picking a choice expressed as a decimal(p =0.3)

3.4 Method of Data Analysis and Quality management

Before keying into the SPSS (Statistical Package for the Social Sciences) software for further processing and analysis the collected data were coded, entered, and checked for consistency and quality managements these were preserving and maintaining the data quality is very useful in statistical analysis.

In order to achieve good data quality and result, the trainings are given to data collectors and how to interview and carryout recording observations for completeness, accuracy, and clarity carefully. Beneficiary activities. However, most of the available date is collected by researcher, which, good for managing our data quality the data, both quantitative and qualitative, gathered through each tool organized, analyzed and interpret to meet the objectives of the study. For data analysis, combinations of quantitative and qualitative methods were used. The quantitative data collected through household survey/questionnaire/ was organized and analyzed in a way that first the responses for the close-ended questions were edited, coded and feed to computer by applying appropriate software.

3.5 Sub indicators of Sustainability

3.5.1 System Functionality and Reliability

System functionality and reliability are crucial aspects to consider when assessing the sustainability of rural water supply schemes. Functionality refers to the system's ability to provide a consistent and adequate water supply, while reliability relates to the system's ability to operate consistently over time. Both factors are essential for ensuring the long-term success and effectiveness of these schemes.

3.5.2 Financial Viability and Cost Recovery

Financial viability and cost recovery are crucial elements in assessing the sustainability of rural water supply schemes. Adequate financial resources are necessary to ensure the long-term operation and maintenance of these schemes, as well as to cover the costs of construction. Cost recovery mechanisms, such as user fees or tariffs, are essential to generate revenue that can be reinvested in the scheme's maintenance and expansion. Additionally, financial viability is crucial to attract external investments and secure funding for future projects. Therefore, the ability of a scheme to recover costs and maintain financial stability plays a significant role in its overall sustainability.

3.5.3 Water Quality and Quantity

Water quality and quantity are essential topics to consider in assessing the sustainability of rural water supply schemes. Ensuring access to clean and sufficient water is crucial for maintaining the health and well-being of communities. Therefore, it is imperative to monitor and evaluate the quality and quantity of water sources to ensure a sustainable water supply for rural areas.

3.5.4 Community Satisfaction and Involvement

Community satisfaction and involvement are crucial factors in the sustainability assessment of rural water supply schemes. They ensure the long-term success and effectiveness of such projects. Engaging community members in decision-making processes, addressing their concerns, and fostering their ownership and participation are essential for achieving high levels of satisfaction and involvement.

3.5.5 Local Governance and Management

Local governance and management play a crucial role in the sustainability of rural water supply schemes. Effective governance and management ensure that resources are utilized efficiently, stakeholders are actively involved in decision-making processes, and maintenance and monitoring activities are regularly conducted. Additionally, strong local governance structures and institutions create an enabling environment for the sustainable management of water resources and promote community participation, ultimately contributing to the long-term viability of these schemes.

3.5.6 Environmental Impact and Sustainability

Rural water supply schemes sustainability assessment includes examining the environmental impact and sustainability of such projects. This entails evaluating the potential harm to aquatic habitats, soil erosion, deforestation, and carbon emissions. Sustainable practices can be implemented by promoting water conservation, reducing pollution, and employing renewable energy sources, ensuring long-term environmental preservation.

3.6 Scoring

Indicator score on a set of questions. The sub-indicator's overall score was determined by adding up the points assigned to each question on a zero–two scale and converting it to a ten-point system. A community that scores poorly on half of the parameters, therefore, is given a score of five. A community that achieves flawless scores on all parameters is awarded ten. A community with zero points is one that does poorly in every category. (Katz & Sara, 2004).

3.6.1 Scoring Methods

According to (Katz & Sara, 2004) conducted a study (Making Rural Water Supply Sustainable) for the World Bank through UNDP under the Water and Sanitation Program (WSP). There are four types of questions in the survey. Most questions have maximum 2 points.

Scores of the indicators are calculated to fit 10 points scale that the sum of scores of the sub-indicators be divided by the number of sub-indicators and multiplied by 4.

Overall sustainability score was calculated by averaging the four sustainability indicators' scores

I. Type 1: Yes/No Questions

The response received a score of +2 if it shown good performance in that indicator category; a score of +1 if it did not demonstrate either positive or bad performance; and a score of zero if it did not contribute. (Katz & Sara, 2004)

II. Type 2: Ordinal (Ranking) Question

The response that showed improvement in that indicator category received a score of +2, the response that showed no improvement at all received a score of +1, and the response that made no contribution received a score of zero. (Katz & Sara, 2004)

III. Type 3: Multiple-choice questions Occasionally, multiple choice questions were substituted for multiple yes/no questions while adhering to the same scoring guidelines.. The purpose of this question is to find out whether people perceived the sub-project as being initiated inside the community (and thus based on demand), or outside the community.

IV. Type 4: Open Questions: - Some questions ask numerical answers.

3.6.2 Sustainability Scores

Sustainability scores vary widely within the sample. This distribution reveals that some systems are sustainable, some clearly are not. Communities scoring lower than 5.0 would be considered unsustainable, based on conditions at the time of the survey. Systems scoring between 5.0 and 6.67 are considered "potentially sustainable, "and systems scoring above 6.67 sustainable (Katz & Sara, 2004)

Measuring sustainability in the water supply system is a challenging endeavor since it depends on a variety of factors that differ between communities and change over time. The primary social, technological, institutional, and financial determinants of sustainability at the community level are measured by the metrics used in this study. Several survey instruments were used in the study to gauge each of these variables. It gathered data on institutional factors from head, professional expert, and stakeholders; financial factors from water committee, community and kebele administration, and interviews; social factors from local governments, kebele water committee, and households; and, finally, environmental factors from

stakeholders and field observation. The technical factors were assessed by plumbers, scheme operators, caretakers, and artesian. These categories were divided into five sub-indicators of sustainability: System functionality and reliability, water Quality and quantity, community satisfaction and involvement, financial Viability and cost recovery and Local governance and management to sustain the system each community's sub-indicators were given a score on a ten-point scale. The overall sustainability was determined by averaging the weighted scores of the various sub-indicators and converting it to a ten-point system. A system that has a low sustainability score is not functioning well in the majority of institutional, technical, and social components that are thought to be critical to system sustainability; on the other hand, a system that receives a high score is functioning well in most aspects, and is likely to be sustained even if performance in a few key areas worse ((Katz & Sara, 2004).

3.7 Data Collection Instruments

To gather primary data, several techniques and tools for data collecting were used. Given that the primary data source for the research used a mixed method comprising of a household survey, interview, document review and current status of schemes assessment; and mWater software application were used iPhone mobile tools and motorcycle for transport.

There is different date collection instrument technology like MIS technology and mWater software application.

Management Information System (MIS): It is true that the NWI-2 inventory has significant improvement compared to the first manual based national WaSH inventory (NWI-1) in that its automated geolocation tagging right at photographing completely removes human errors that could occur while reading from hand GPS and also transferring all recorded data by data encoders from paper based in to the system. It has also an exceeding advantage on avoiding a heavy and costly work inherent with paper-based inventory that involves duplication and transportation of tremendously huge number of paper-based templates and again moving back the filled templates to the regions for data encoding. But it has also limitations. The major limitations include among others:

- Relative complexity to understand the operation of the data collection devices and data collection templates by district staffs with modest professional qualification,
- Automated file naming by the software denied enumerators to control their work (identify what is what, and on which survey they are doing).

- Restriction of maximum values of some data by the application software was another constraint
- Short live of battery powers and limited electric power coverage in the country side to recharge batteries,
- Enumerators and supervisor are denied to visualize, check and edit recorded data once survey is ended.
- Both selective synchronization and removal not possible at all. Hence enumerators tend to hide their errors for fear of reworking the whole day recording be it bad or good.

mWater Software application: Current status of schemes was done by using mWater Software application; which have the benefit of

- **Data Collection and Monitoring:** Platforms like mWater can facilitate efficient data collection in rural areas, enabling better monitoring of water sources, usage patterns, and system performance. Also Real-time data can help identify issues promptly, such as leakages, low water levels, or equipment malfunctions.
- **Decision Support:** Data analytics tools integrated into such platforms can provide actionable insights for decision-makers. This can aid in optimizing resource allocation, maintenance schedules, and overall system efficiency.
- **Community Engagement:** Platforms that involve the community in monitoring and reporting water-related issues can enhance the sense of ownership and responsibility, contributing to the sustainability of water schemes.
- **Predictive Maintenance:** By analyzing historical data, these platforms can predict potential system failures, allowing for proactive maintenance. This can prevent major breakdowns and reduce downtime.
- **Resource Optimization:** Efficient use of resources, including water and energy, can be achieved through data-driven insights. This is crucial for sustainability, especially in areas with scarce resources.
- **Financial Management:** Technology can assist in transparent financial management of water schemes, ensuring that funds are used effectively for maintenance, repairs, and improvements.
- **Remote Monitoring:** For rural water schemes, remote monitoring capabilities are valuable. It reduces the need for physical inspections, especially in challenging terrains, thereby saving time and resources.

- **Capacity Building:** Platforms may include training modules to build local capacity for maintaining and managing water systems. This is crucial for the long-term sustainability of rural water schemes.
- **Compliance and Reporting:** These platforms can help in ensuring compliance with water quality standards and regulatory requirements. Automated reporting features can streamline the process of meeting documentation and reporting obligations.
- **Integration with Other Systems:** Integration with other community development initiatives, such as healthcare or education, can lead to a more holistic approach to rural development.

3.8 The Process of using mWater Application

- 1) First, Interview questionnaires developed in the mWater data collection tools.
- 2) Second, mWater data collection software platform configured in the enumerator of android mobiles.
- 3) Third, mWater data collection will be conducted in selected kebeles.

Three assistants were also engaged to facilitate the data collection process. The advocates possessed sufficient expertise and familiarity with rural water delivery initiatives. and using mobile application; one Electro mechanical, one water facility expert and one Water resource engineer, will be participate in the research work. They must work in Habro district water, Resource and energy office. Survey questions are designed to provide a comprehensive understanding of the sustainability issue surrounding the rural water supply network.

Research method flow chart

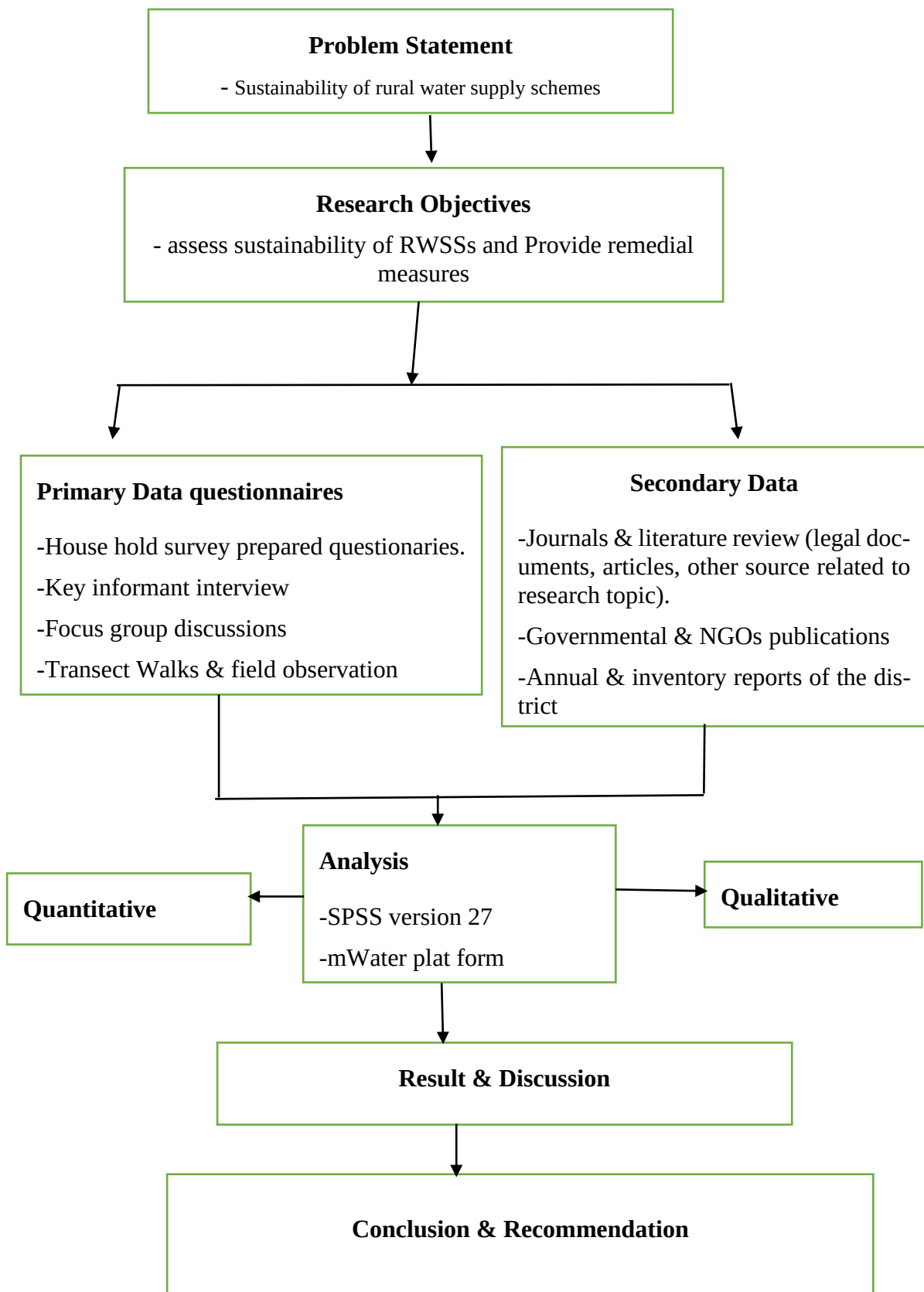


Figure 3.2 Research method flow chart

4. RESULTS AND DISCUSSION

4.1 Information's about respondents

4.1.1 The Respondents' Level of Education

Education is a tool for a country's socioeconomic development and a fundamental component of all development initiatives, including those pertaining to water supply. This is due to the fact that educated citizens are more likely to participate in and be involved in water supply and management projects. Transferring knowledge and technology is also made easier in a community made up of educated individuals.

Table 4.1 Educational status of the respondent

Educational Status	Frequency	(%)	Valid (%)	Cumulative (%)
Illiterate	62	38.75	38.75	38.75
Read and write	44	27.5	27.5	66.25
Primary	28	17.5	17.5	83.75
Secondary	18	11.25	11.25	95
Collage and above	8	5	5	100
Total	160	100.0		

Table 4.1 shows that 62 respondents, or 38.75% of the sample, were found to be illiterate, whereas 27.5% of the respondents could only read and write. Comparably, just 11.25% of respondents had completed secondary school (9–12), 17.5% of respondents had completed primary school (1–8), and 5% of respondents had completed college or above. Based on the results, it was determined that the district's rural illiteracy rate was 38.75%, which is higher than the literacy rate. This in turn may be a major contributing factor to the mismanagement of rural water supply initiatives.

4.1.2 Season of Non-functionality of Water Schemes Occurs

The non-functionality of water schemes are occurs in winter (bega) time that is 46.88 % of schemes are not functional as 75 respondents indicate, 29% of schemes are not functional during Summer (keremt) and Winter (bega) time as 47 respondents, and also 23.75% of schemes are not functional during summer time. The result shows as during summer season more schemes are not functional do you to community high need of water supply over pumping and silt around the pump tackle rotation of the impeller this leads the pump to failure, so well needs maintenance and cleaning.

Table 4.2 Season of non-functionality of water schemes occurs

Season	Frequency	%	Valid (%)	Cumulative (%)
Winter (Bega)	75	46.88	46.88	46.88
Summer (Keremt)	38	23.75	23.75	70.63
Both	47	29.37	29.37	100
Total	160	100.0		

4.1.3 Responsible of collecting water for domestic uses

As seen in Figure 4.1, the majority of respondents 47% confirmed that mothers and children were in charge of gathering water for household purposes. Children were primarily responsible for this task, according to 27% of respondents, mothers were responsible for 24%, and fathers were responsible for 2% of respondents. Based on the finding was safe to say that in the rural areas of Habro District, mothers and children were mostly in charge of gathering water.

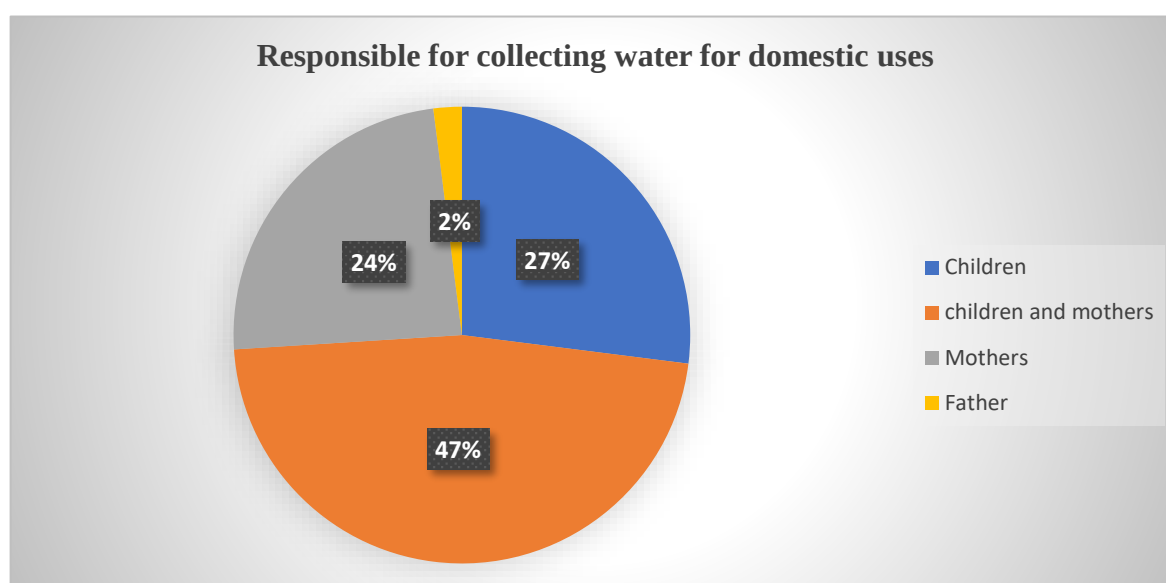


Figure 4.1 Responsible of collecting water for domestic uses

4.2 Existing Water Supply Schemes Situation

4.2.1 Summary of Typical Rural Water Supply schemes

There are 269 distinct kinds of rural water supply schemes in 2022, according to statistics from the Habró District Water Resource Office. The plans include water points (WP), spring developments (SPRs), deep wells (DWs), hand-dug wells (HDWs), and shallow wells (SHWs). 6.7% of spring developments were hand-dug wells, 17.1% were shallow wells,

4.8% were deep wells, and 59.5% were water points. A total of 87 distinct types of water supply systems, or 32.3% of district water schemes, are surveyed in the study region across the 9 (nine) kebeles. The water points for DWSs 12, SHWs 13, HDWs 16, and 46 are distributed. In the area under observation, spring development is nonexistent (not constructed).

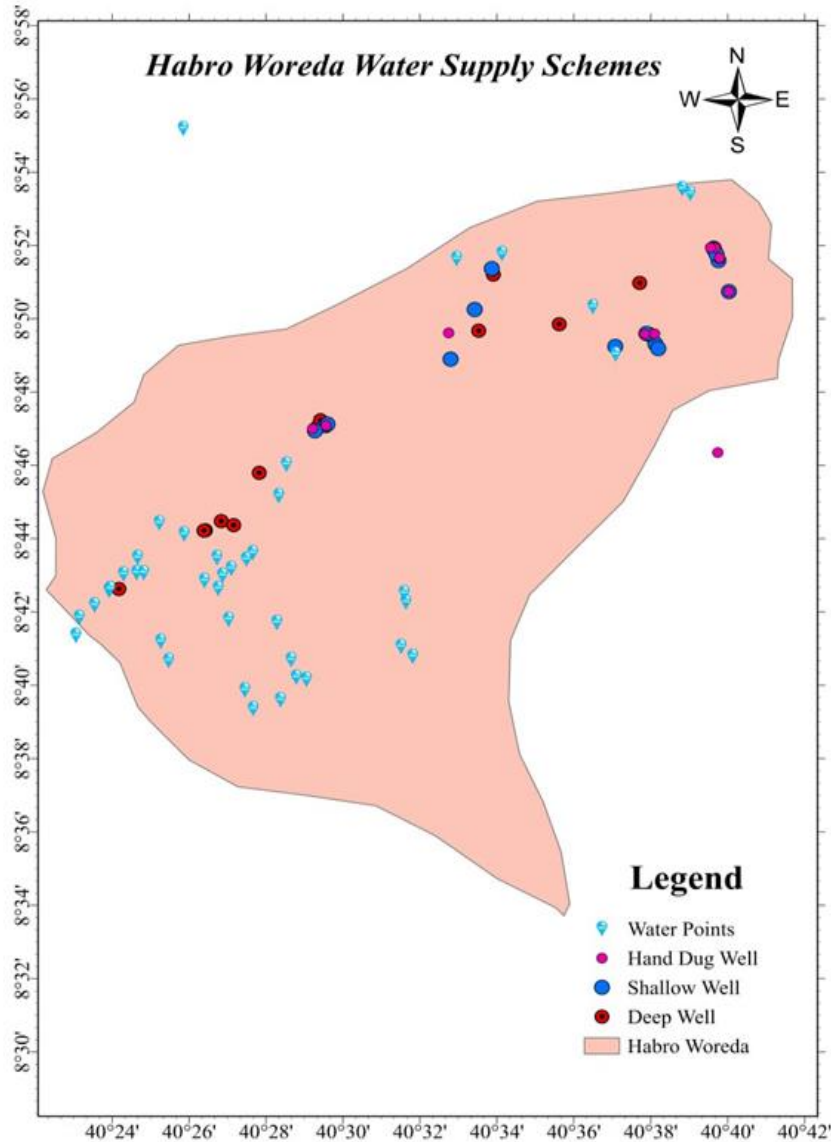


Figure 4.2 Map of Habro district selected water supply schemes

4.2.2 Water Supply Schemes and their Functionality Status in the District

There are 269 distinct kinds of rural water delivery schemes as of 2022, according to the data provided from the District Habro District Water Resource Office. Spring developments (SPRs), hand-dug wells (HDWs), shallow wells (SHWs), deep wells (DWs), and water points (WPs) are the plans. 6.7% of the spring developments were hand-dug wells (17.1%),

shallow wells (11.9%), deep wells (4.8%), and water points (59.5%) made up the distribution. As can be seen from the above explanation the dominant rural water supply scheme type was WPs 83(30.9%), HDWs were 38(14.1%), SHWs 31(11.5%) and DWs are 8(3%) are functional and the other WPs 77(18.6%), HDWs were 8(3%), SHWs 1(.4%) and DWs are 5(1.9%) are not functional. from a total of 41 water schemes and 46 water point about 9 sampled kebeles. Based on the researcher's field observations conducted at the time of the survey, which involved 16 HDWs, 13 SHWs, and 12 HDWs, it was discovered that, while the left was functional with issues at the time of the survey, six HDWs, five SHWs, and 25 WPs were nonfunctional. As beneficiaries and KII both noted, the bulk of functional schemes were having trouble providing service that is, they were experiencing frequent disruptions and low yield which will be covered in more detail in the next section. When their primary sources of potable water supply run out, many program participants turn to secondary sources such far-off water sources in a town that is quite remote from their home, a conventional well, unprotected springs, and rivers. Current Water Supply Situation in selected kebeles' field observation during the time of survey 16 HDWs, 13 SHWs,12 DWS water schemes and 46 WPs were observed.

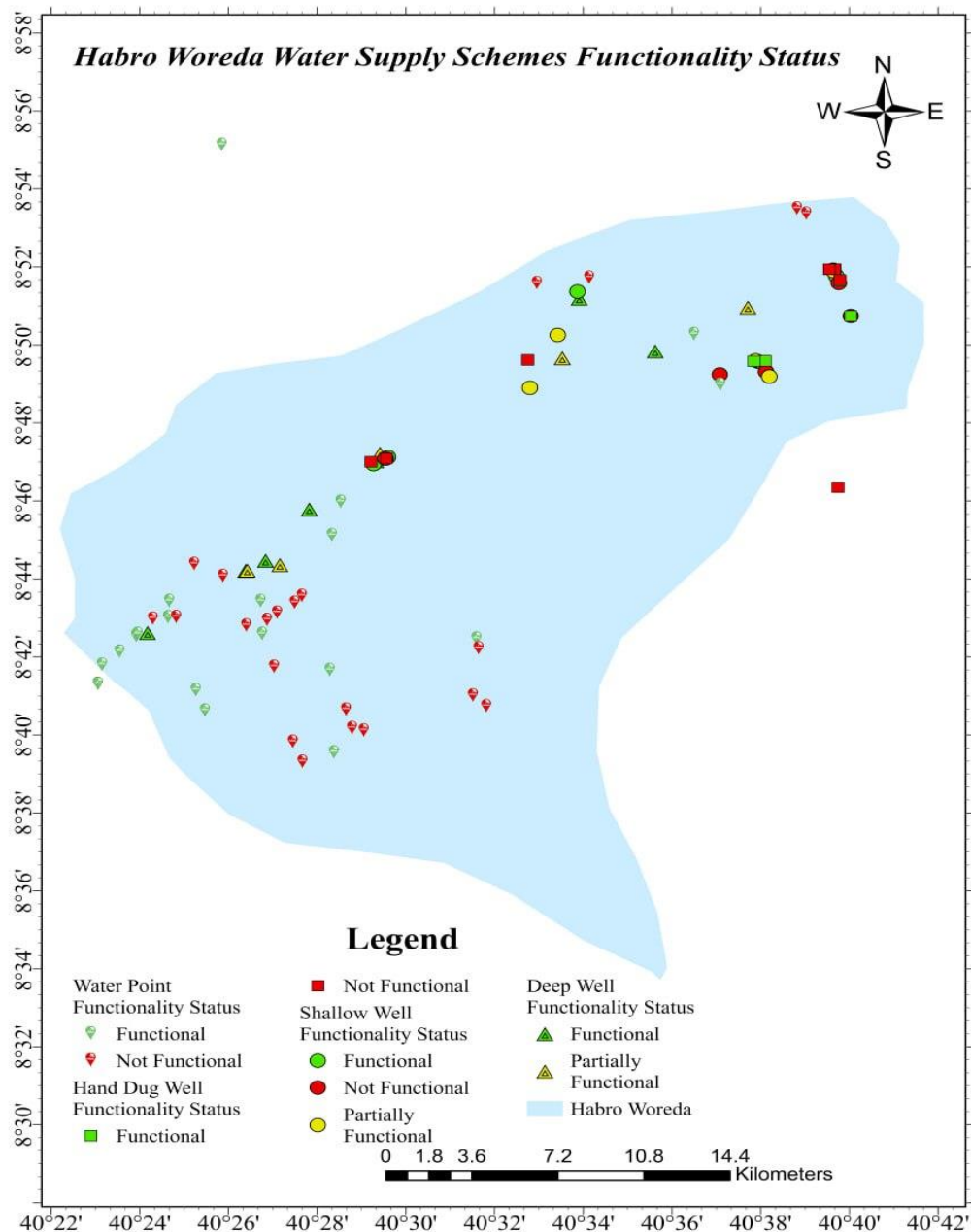


Figure 4.3 Map of Habro district Selected Water Supply Schemes Functionality Status

From those 15 functional, 11 nonfunctional & 14 partially functional. Based on the survey of 41 water schemes 37% are fully functional, 28% were non-functional, and 35% had partially functional.

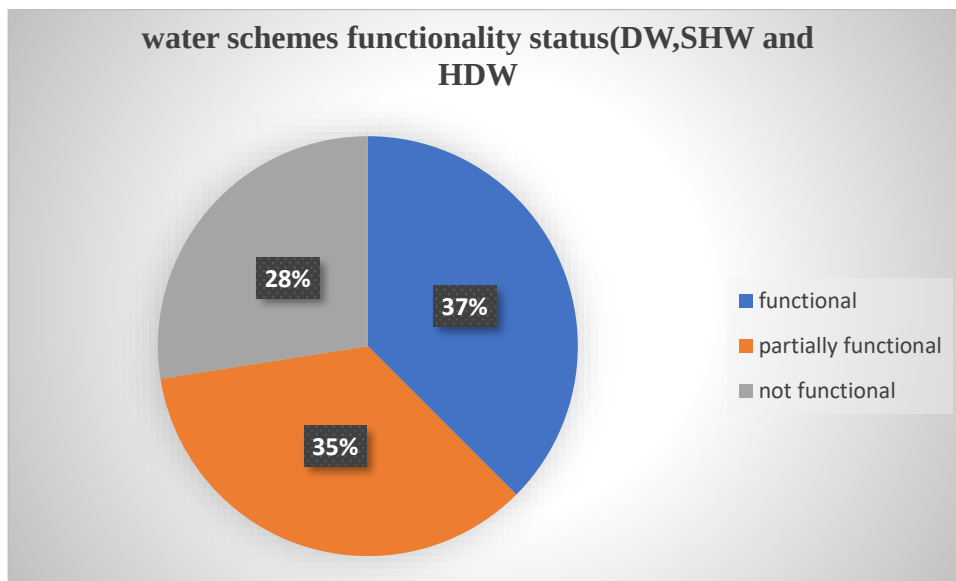


Figure 4.4 Current water supply situation in selected kebeles

With regard to the main problems to the non-functionality of water supply schemes, the following result were obtained from the surveyed households in the table 4.2, among the sample 160 HHs respondents 15% were indicated pump failure 20% replied that the depth problem/seasonality, 36.25% Operation & Maintenance problems, 13.75% reported as construction quality problem, 6.875% reported as design problem and 8.125% reported as site selection problem. Reported that problem of how to operate and maintain were high problem to the non-functionality (unsustain) strategies for the provision of water. The aforementioned findings indicate that the primary issues pertaining to the non-functionality and sustainability of water supply schemes are inability to operate and maintained, depth problem(seasonality) and pump failure are stated respectively.

Table 4.3 The main problems for partially function and nonfunctional of water supply schemes

Main Problems	Frequency	(%)	Valid (%)	Cumulative (%)
Pump failure	24	15	15	15
Depth problem (seasonality)	32	20	20	35
Operation and maintenance problem	58	36.25	36.25	71.25
Construction quality problem	22	13.75	13.75	85
design problems	11	6.875	6.875	91.875
Site selection problems	13	8.125	8.125	100.0
Total	160	100.0	100.00	

The results indicate that the primary issues with rural water supply programs were operation and maintenance this problem comes due to timely not service of shallow wells and deep well, lack of spare parts and less water committee training. also, construction quality problem comes due to poorly community participations during site selection, design and types of technology.so to solving those problems to evolve the community during site selections and technology types, good training for water committee and community and to address the spare parts for all implementing water supply schemes and focusing on service of the shallow well and Deep wells is must be done by zonal and reginal water office using service rigs.

4.2.3 Functionality and Technology Types

Four types of rural water supply schemes technology were exited in the district namely Spring Development, Hand Dug Well, Shallow Well and Deep Well were considered in this study to assess the sustainability with different technology types. From this four-technology type survey observation done on HDWs, SHWs, and DWs water supply schemes technology types. Therefore, from this three technology type survey observations and survey respondents on Hand Dug Well, Shallow Wells, Deep Wells because there is no constructed Spring development in the selected study area, Shallow Wells are the most sustainable technology types that can sustain other technology types. Because of in Habro District Shallow wells technology was more implemented other technology types also functional. On field observation most Shallow Wells was old their construction time but still functional where as other

technology types were failed or semi functional not long time used even if during one year from construction time.

Table 4.4 Type of water supply scheme and its functionality status

No.	Scheme Type	Conditions (status) of water schemes						
		Functional-ity	per-cent	non-functional-ity	Per-cent	Partial-functional-ity	Per-cent	To-tal
2	HDW	5	31.3	6	37.5	5	31.2	16
3	SHW	4	30.8	5	38.5	4	30.8	13
4	DW	1	8.4	0	0	11	91.7	12
5	Sum	10	70.4	11	76	20	153.7	41

As clearly shown in table 4.3 above and figure 4.5 and 4.6 below, there were 41 water schemes in the selected study area. Of the total number of the water schemes, 15 were functional, 11 were non-functional while 14 were partially functional respectively.



Figure 4.5 Non- functional HDW & WP type in selected kebeles'

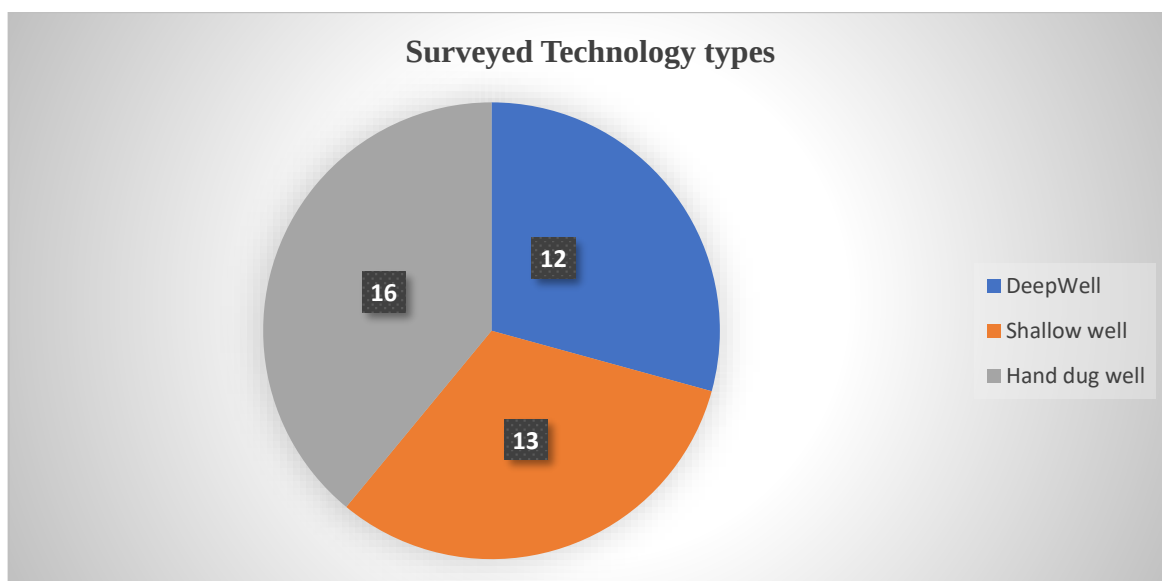


Figure 4.6 Surveyed scheme types of water supply schemes in the district

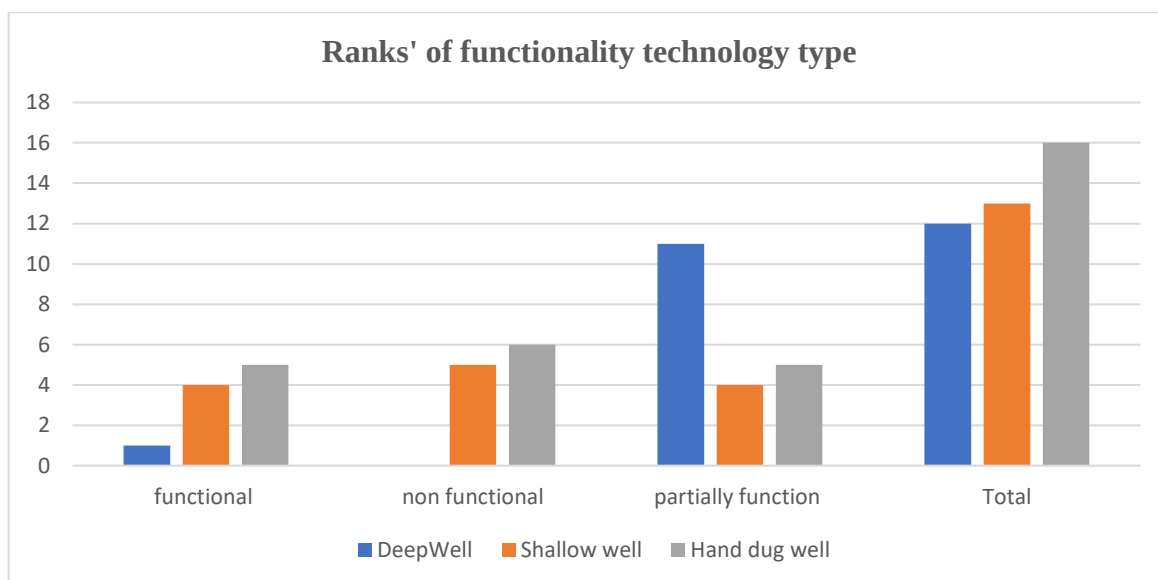


Figure 4.7 Ranks' of functionality technology types surveyed in the district

4.3 Factors Affecting the Sustainability of Rural Water Supply Schemes

Water supply access is a basic human right. However, a number of socioeconomic (financial and communal), technical (O and Ms), institutional, and environmental constraints limit the availability of water in remote areas. For a variety of reasons, the intended recipients of development initiatives such as water supply programs may not immediately benefit from them, especially in rural parts of developing nations like Ethiopia. According to certain studies from Ethiopia and other developing nations, inadequate and inappropriate technology, along with inadequate water supplies and substandard physical structures, are the reasons behind the shortcomings of certain water projects. Each respondent of the KII from Habro

District Water Resources and Energy Office identified the multifaceted nature of the primary issues with rural water supply schemes. "No service of shallow and deep wells after construction, less O and M of schemes and poor schemes management between different services delivery this is due to less focus on O and M rather than construction new schemes in government and NGOs, weak financial capacity of the district, inappropriate technology, inappropriate use of the existing schemes by the water committees, the water committees are weak and unable to operate the schemes," is how they summarized the main issues. The bulk of the population lives in rural areas, making it extremely difficult to reach the Habro District water resources development offices. They also lack the necessary spare parts and personnel to perform the necessary services.

Based on this, the researcher carried out a survey to identify the primary issues influencing the functionality of rural water supply schemes, which include the following:

4.3.1 Technical Factors

Technical aspects include the standard of scheme design and construction, the technical expertise required for operations and maintenance, the choice of suitable technology, and the accessibility, cost, and availability of spare parts. The water system may fail before its intended lifespan is completed due to subpar construction or the use of inferior materials. A total of 50% of respondents stated that a lack of sufficient spare parts was the primary reason why the water supply was not sustainable, followed by a lack of technically qualified labor for operations and maintenance (31.9%), issues with scheme type selection (11.9%), and poor construction (6.2%).

Table 4.5 Major technical problems constraints of schemes sustainability

Technical problems	Frequency	Percent
Insufficient spare parts and equipment	80	50
Inappropriate choice technology or scheme	19	11.9
Unsuitable design/poor construction quality	10	6.2
Insufficient technical proficiency to do O & M	51	31.9
Total	160	100.0

Community tools and spare parts are another significant issue that makes rural water supply schemes unsustainable since they have a detrimental effect on community water supply schemes' sustainability. According to Thorsten II (2007), plans won't be viable without a

consistent source of replacement parts and a few skilled workers to maintain and repair the water supply. When assessing whether or not the local technicians had the tools needed to complete repairs, 50% of the respondents reported that the villagers lacked the tools needed to complete maintenance and repairs, including spare parts. People were forced to obtain water from unprotected or dangerous sources as a result. Particularly, focus group talks with Bareda water committees According to Kebele, the water committees frequently purchased replacement parts from the market, but their sizes did not correspond with the key components of the schemes. Over time, this issue has produced even more needless output. According to FDG, the District Water Office ought to provide support for such technical issues to the people as well. This suggests that in addition to cost, the study area's accessibility to spare parts has implications for time and energy. Communities that are farther from the center suffer more than others. Similarly, data from a development office key informant and the district water and energy resources shows that "local communities are not well equipped with spare parts, tools and other equipment." In order to address this issue, The WASH business centers purchased various spare parts based on the type of water supply schemes technology and sold to various schemes found in the district and institution, as per the District Water office's aim to collaborate with NGOs on the project.



Figure 4.8 Lack of spare part and Tools non-functional schemes

One of the elements affecting the sustainability of water delivery schemes is the choice of appropriate technologies, which includes choosing ones that are affordable, simple to use, easy to maintain, and easily available. Technologies were deemed appropriate if they would be inexpensive, environmentally friendly, and socially acceptable. Consequently, user communities must be included in selecting technologies and these Hand dug wells installed with hand pump technology choice should be simple at community level to operate and maintain. Three are different types of technology namely shallow well, deep wells and protected spring are available in the district. These technologies were unevenly distributed throughout the district due to factors related to water source and capital. The water source, capital and electricity power of shallow well and deep wells other factors forced the District water resources and energy office to use Hand dug well type more than shallow wells and deep wells. Similarly, less developed scheme was spring development due to less spring source in the district.

A crucial element of any industry dealing with water delivery networks is O and M. Without continuously ensuring that their own water supply schemes continue to function for an extended period of time, sustainability cannot be fully achieved. The community's ongoing operation of the systems is their effective O and M. It necessitates the community's availability of qualified technicians. Maintenance tasks are the responsibility of the water committees, who received training only once during the schemes before being turned back to the community. Users were not sufficiently trained by technicians to operate the water supply infrastructure. In a similar vein, water committee members and female group representative respondents in the study area's sampled water supply schemes reported that no technicians (caretakers) were trained in any community, and that their support and accomplishments were not motivating enough for trained technicians, leading to the community seeking outside assistance even for minor technical issues. The inability of local technicians to maintain and operate their water supply systems was evaluated. Table 4.6 displays the high proportion. While 23% of respondents indicated that there was a local technician for O and M of the scheme, 77% of respondents stated that there were no local technicians who maintained and repaired when the scheme failed to deliver the service. The HDW water delivery schemes were primarily impacted by the absence of technical expertise since the pump handle vibrated, made strange noises, and broke. The installed pump wasn't fixed or maintained.

Table 4.6 Local Technicians available in water supply schemes for O & M

Local Technicians on schemes	Frequency	Percent
Existence of local technician on schemes	37	23
Lack of local technician on schemes	123	77
Total	160	100

From the key informant interviews with district water resource office professionals and head capacity building was given for WASHCO are focus on training how to manage the schemes and technician, but no provision of spare parts and support maintenance tools are not given for water supply schemes WASH committee. was not provided local technician training. By this reason community were not adequately prepared and enabled them to carry out effective O and M and the technicians did not train the users how to operate properly the water supply scheme. Training for water committees improves sustainability by building capacity and commitment. Due to lack of trained water committees and awareness creating practices in water resources O and M in the District are money water supply schemes are non-functional like Jarso and ude2 HDW in bareda kebele, said2 and ganda kemer HDW in laga bera and some of the shallow wells in selected water schemes were nonfunctional schemes. The District Water Resources and Energy Office responded to the KII survey by mentioning that while some village water committees received training from the office, it was insufficient due to a lack of funding. Based on the community's response to the field observation, the researcher might draw the conclusion that many lack the necessary tools to manage and maintain their water supply systems. Even in cases where communities have system operators, they are not adequately equipped or prepared to do their jobs.

The lack of district specialists' monitoring and control throughout construction led the key informants from the kebele administration to further endorse the schemes' subpar construction quality.

Supplying replacement parts, equipment, and instruction for rural water supply projects WASHCO refers to the proper operation and upkeep of the water supply and system. Because WASHCOs are closer to the schemes than external agencies, water supply systems operated by users themselves will therefore be more sustainable than those managed by the latter. If the WASHCOs are unable to oversee the programs, they must increase their ability and readiness to assume control over their water supply systems by receiving sufficient train-

ing in technical, financial, and overall system management as well as access to outside resources. The rural water management committees in Habro District are composed of the following members: a chairperson, a secretary, a cashier, two operators, and two more members based on the water resource and energy office criteria. Of those four committee members, two are women; however, during focus groups with women groups, the participation of women in the committee members is lower.

The deep groundwater table is the reason why every project built in the district is motorized, according to the survey report of key informant interviews with district water resource office professionals and head and focus group discussions with the water committee. Various types of pumps have been installed by different organizations. the submersible pump-equipped schemes. Furthermore, many implementers have installed generators of various brands. Direct electric sources are used in some of the designs. Due to the lack of documentation in the district water resource and energy office and the removal of the generators' specifications, it was challenging to identify the brand of the generators.

4.3.2 Financial Factors

Water committees must properly manage the schemes by carrying out O and Ms, collecting users fees, setting fetching times, and working out their duties and responsibilities. However, community payment and pay fees, as well as financial management, are crucial to the successful operation of water schemes. Adopting a cost accounting system for O and M is also necessary. It is necessary to provide cost estimates and expenditure statistics that are precise and insightful. Benefits from well-managed water supply schemes are enhanced and made sustainable; recipients are expected to pay for at least O and Ms.

There was no explicit financial or human resource support for the WASHCos in the key informant interviews with district water resource office professionals, the head, and focus group discussions with the water committee habro district water resource and energy office strategic and annual plan. The office professionals claimed that the only direct support available was assistance with little malfunctions or poor administration. They clarified that the office does not get funding for upkeep, growth, or the creation of new schemes; rather, the District management provides an annual budget solely for office management expenses. The office uses donor funds, if it's fortunate enough to receive them, to buy essential spare parts and hand tool kits for small repairs and expansion, Since the source is unpredictable, it is challenging to incorporate this in the annual plan. but it is difficult to include this in the annual plan as the source is not predictable. Only hand tool kits and spare parts given by

World Vision's Habro area programme were seen in certain WASHCo offices during the field inquiry. Information from the Water Resource and Energy Office indicates that the amount released by the District Administration for the fiscal years 2022 and the budget proposed by the office varies significantly.

The district water specialists stated that the office's actual capacity in terms of personnel, funding, and logistics was not taken into account in the previous five-year strategic plan.

The lack of incentives caused discouragement in many WASHCo members. Regarding WASHCO accountability, there is a lack of clarity among consumers, WASHCos, and the District Water Resource and Energy Office. Neither the community nor the Water Resource and Energy Office have received frequent reports from any committee regarding finances or other activity. The majority of WASHCos lack financial documentation, have subpar financial management systems, and don't have legal income collecting receipts for any of its committees.

The plans run by females In contrast to schemes run by males, there was sound financial management. Furthermore, users are happy with these committees' managerial abilities. According to the experts, committee members are mismanaging scheme finances and do not wish to communicate with the community or the district Water Resource and Energy Office. Major factors affecting the management of schemes, as reported by the WASHCos and the specialists of the district Water resource and energy office, include: lack of incentives for the WASHCos.

According to information provided by the district Water resource and energy office experts, there is typically no comprehensive audit of their financial and material.

4.3.3 Institutional factors

A water board is an often elected, voluntary group that represents the community in talks and choices regarding every facet of regional water management. The committee needs to include representatives from all facets of the community, including men and women, wealthy and poor, and organizations residing in various places, in order to successfully serve the interests of the community it represents. (Bolt and Fonseca, 2001).

Rural water utilities' ability to function economically and socially depends on their institutional framework. Financial stability, asset ownership and management, service delivery models, supervision and regulation, and operational risk management are all impacted by institutional architecture. Obtaining safe and inexpensive drinking water for everyone is one

of the explicit goals of the Sustainable Development Goals (SDG6). To promote sustainable development and utilization of a more sophisticated water supply program, water implementing agencies urgently need to offer technical and managerial support, especially to rural populations in the district water sector. Therefore, even though communities can take on a lot of the responsibility, external sources of support are still needed, notwithstanding certain conditions pertaining to institutional support and governance. Future system decisions may likewise fall outside the purview of the community, despite the fact that the community can actively participate in system management and does not currently own the repair areas. The office should continue to serve the community in addition to paying for the construction. Such assistance could take the form of proper systems administration training, financial management instruction, technical procedure execution and maintenance, assurance of spare part affordability and availability, close supervision of the Water Commission, and provision of unclassified equipment tools that are beyond technical capabilities. Recipients. According to Table 4.9, The support type offered by implementing agencies 50.6 consists of maintenance, spare parts, and other technical assistance. Training, spare part availability, maintenance, and technical assistance make up 30% of the total responses, while the remaining 19.3% come in second. It stated: technical, financial, spare part, and training support.

Table 4.7 Interest of community from Implementing Agencies

Interest Types	Frequency	(%)	Valid (%)	Cumulative (%)
Maintenance, spare parts & other technical assistance	81	50.6	50.6	50.6
Training, spare parts, Maintenance & technical assistance	48	30	30	80.6
Training, spare parts, financial & technical assistance	31	19.3	19.4	100
Total	160	100.0	100.0	

Experts in office management claim that the absence of a permanent office manager has resulted in significant issues with daily operations. The director of the Water and Energy Resources Office for the Habro District stated that he was overworked and didn't have much time for office work. Currently, one of the Office Manager's main responsibilities is overseeing the District Tax Administration. Experts also mentioned that some WAHCs delay

reporting issues to the office, which results in delays in maintenance and operations. It was discovered that the Habro Region World View Program offers an alternative viewpoint and stance regarding the significance of collaboration with other industry businesses. The program manager states that the district-level steering committee was established by the NGO to provide a forum for stakeholders to convene quarterly to deliberate on issues related to sanitation and water delivery. In the meetings, the organization's results from the previous quarter are assessed, and the following three-year plan is reviewed and approved. He continued by saying that the sector offices were not actively involved in the steering committee, in spite of the NGO's efforts. The World Vision program manager claims that because the organization has been effectively collaborating with the WASHCos for 13 years, it has no trouble merging their operations. Integrating operations with those of other sector actors is a challenge since they are more concerned with short-term goals than long-term group outcomes. At steering committee meetings, he continued, branch offices are able to learn about World Vision's plans and strategies, but World Vision is not given the chance to hear what the branch offices have in mind. As a result, sector offices the District Water and Energy Office in particular should take the initiative to integrate the efforts of numerous stakeholders. The District Water Resources and Energy Authority Chairman stated that because the sector offices lacked experience and involvement in their daily operations, it was exceedingly difficult for the authority to bring together other sector offices and pertinent parties. He continued by saying that the district government, another significant position, ought to be in charge of mainstreaming initiatives and stakeholders.

4.3.4 Social factor

According to WASHCos participating in other programs, the selection criteria for current WASHCo members in the case of FGDs were: social acceptance, credibility, literacy and inclusion of women. Experts from the district Water Resources and Energy Authority confirmed that the main selection criteria were gender sensitivity, willingness to do unpaid work, lack of additional social responsibility and literacy. They added that because of her husband's influence, it was difficult to find a man who could write and read and would be willing to volunteer for. During the women's focus group, it was noted that the election did not specify the date and duration of membership. He added that a person remains a member indefinitely unless they act illegally. The Commission's term of office is not limited and members carry out their duties as long as they are accepted by the community.

The role of women in the schemes has been greatly minimized by the cultural influence of men. District water resource and energy office experts said that WASHCos organized by World vision can be taken as a very good model owing to the active role of women in decision making.

Women are generally on the correct track to make decisions on their own issues in schemes created by World Vision; in other schemes, it appears that women have been elected only as a formality. The low level of female participation is ascribed to inadequate community awareness-raising and advocacy on the side of implementers and the district office for water resources and energy. Additionally, it can make it harder for women to make decisions about their own problems, such setting tariffs, enhancing service delivery, and managing programs effectively. Four of the seven posts (chairperson, finance head and secretary, scheme supervisor, cashier, purchaser, storekeeper, and one member) have been awarded to women in the World Vision Habro Area Program's WASHCos. Furthermore, women have held important roles including those of the chair, cashier, storekeeper, and purchaser. The World Vision Office's WASH experts stated that this accomplishment is the outcome of the NGO's ongoing efforts to disrupt the cultural dominance and power of men over women through sensitization and promotion.

4.3.5 The Environmental factors

The best management strategies are those that include the whole groundwater recharge areas or groundwater catchments in order to handle the connected challenges of groundwater quality and quantity (WHO, 2006b). Conserving, preserving, and improving water resources is essential to exploiting the resource in a sustainable manner, as stated in the Ethiopia Water Resource Development Policy and the Oromia regional water resource, mine, and energy biro strategic plan (MoWR, 1999; BoWR, 2007). There was no conscious attempt made during the field study to protect the groundwater supply and increase its production. Nonetheless, it was noted that the community was using the Safety Net program in some areas to restore degraded fields.

4.4 Broad Reasons for scheme type Non-functionality

The following factors were used to assess the general main causes of non-functionality of RWSSs: financial, institutional, technical (supply of spare parts and tools, O and M); management of operational and maintenance (management and mechanical); and others (social, cultural, and gender).

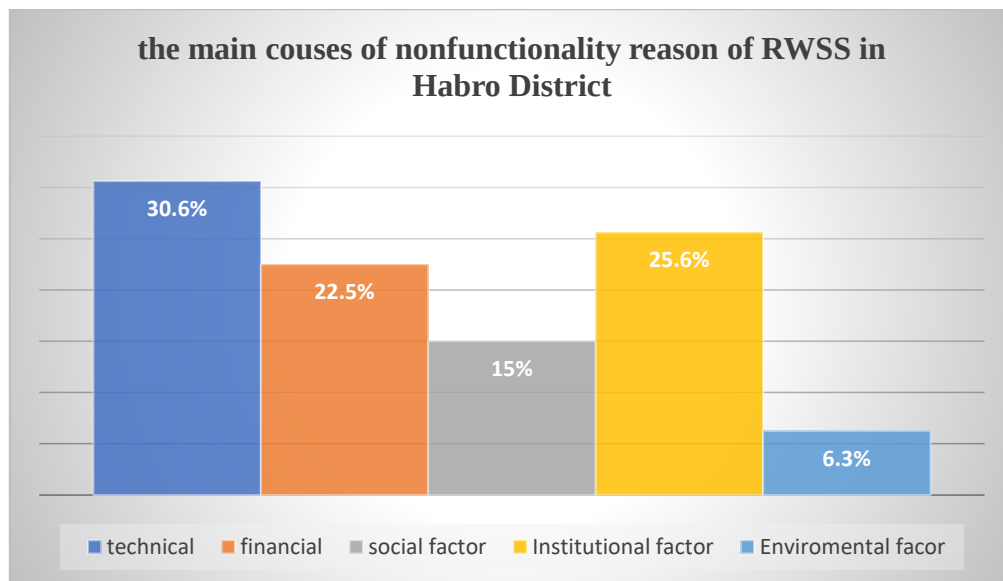


Figure 4.9 Main causes of non-functionality reason of RWSS in Habro District

Comparing the primary cause of non-functionality of scheme type fig 4.9 to the other primary cause of non-functionality of rural water delivery schemes in the study region, the technical reason for non-functionality accounted for 30.6% of the total.

4.5 Community participation and scheme management

The community's socioeconomic status and the accessibility of replacement parts should be taken into account while choosing a technology. In order for the communities to manage and run the technology at the village level on their own, they should be included in its selection. As it is thought to boost the sense of ownership, community participation both during and after project implementation is a major challenge for sustainability and plays a significant role in the creation of improved water schemes. For the development of the water supply plan, the community must make educated decisions. Site selection, the kind of water supply technology, their role and responsibility in contributing, and follow-up are all included in this step.

Participants of FGD and KII also confirmed that users or beneficiaries were not fully participated, much of the work has been done by project implementing agencies, government and representative of water committee members and the room for wider community representation is not in place. Even in the case of those with “during construction” responses, the community understanding of participation goes to the point of contributing cash and during the prime time of project construction. But in some cases, every input of the projects comes from implementing agency and end users’ contribution and inputs are neglected. The major causes for water systems are failure has been the lack of communities’ participation in the rural

water supply schemes. In other words user's involvement in every phase of local water supply development and contribution to their power in the construction, operation, and maintenance is very important for the sustainability of the schemes. With regard to local community participation in the implementation, management and monitoring of the schemes the findings shown that 32% of the sample households had good participated, 20% fair participated, 48% respondents bad participated implementations, managements and monitoring aspects of the schemes.

Table 4.8 Distribution of community participants in schemes implementation, management and monitoring

Levels of participation	Frequency's	Percent
Good	51	32
Fair	32	20
Bad	77	48
Total	160	100

It is possible to conclude from these findings that the community is involved in some capacity in the creation, administration, and oversight of programs. The bulk of users, though, did not contribute sufficiently. This implies that the experiences and knowledge of local communities are not taken into account when implementing, managing, and overseeing programs that may affect sustainability.

Appendix three household Survey questioner on part 4 community participation on financially results shown figure 4.10 that 19.4% contributed rural water supply projects development through financial contributions, 11% through the provision of locally available materials (such as wood, sand, and stone), and 25.5% through the provision of labor. Only 2.5% of the participants indicated that the community was involved in the site selection process, 4.6% in election water committees, and 37% in the form of financial donations, labor-related local materials, and information.

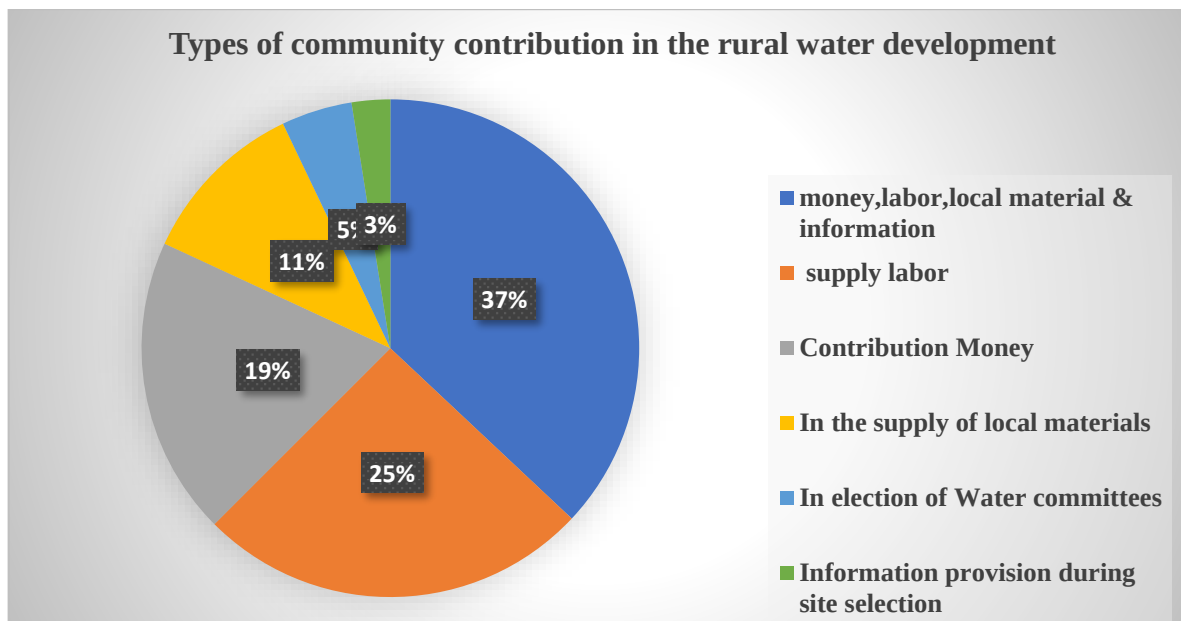


Figure 4.10 Types of community contribution in the rural water development

We can conclude that there is a high degree of community involvement in the labor, financial, and local material and information supply. From the start of construction to its conclusion, the users' contributions were also reported by the KII and Select-ed Women groups as unskilled labor and locally available materials like stone, wood, and sand. However, the majority of the time, the site is chosen by professionals from the Zonal Water Office, the Woreda Water Resource Office, or any other organization.

Managing rural community water supply means operating and maintaining the system and supply of water as planned. Water supply schemes that are controlled by users themselves, as opposed to external agencies, will therefore be more sustainable because communities, and particularly women, are closer to the schemes than do external agencies. Communities must be strengthened in their ability and willingness to assume ownership and responsibility for managing their water supply systems if they are unable to manage the schemes. This can be done by providing them with access to outside supports and by providing them with appropriate training on the technical, financial, and overall management of the systems.

According to ministry of water mine and energy the rural water management committees are seven one chairperson, one secretary, one cashier and two other members. however, in habro District, the water management committees four or three as house hold survey result; FGD and KII also confirmed. Concerning the ability of water committees to manage the schemes 46% of the respondents had poor to manage the schemes while 33% were fair and remaining

21% good. This shown their indifference of the respondents believed that water committees have one of the means to manage the scheme in sustainable ways.

Respondent's opinions on the ability of Water committees to manage the scheme Water committee in carrying out their duties responsibilities and proper manage the schemes through collecting of user's fee, carrying out operation and maintenances, fixing time of fetching,

Table 4.9 Respondent's opinions on the ability of Water committees

Household opinions	Frequency	Percent
Good	37	23
Fair	46	29
Poor	77	48
Total	160	100

coordinating the schemes, keeping its satiations and report to the Habro District water resources development office if there is any problem beyond their capacities of the user. (Domínguez et al., 2019), stated most of drinking water supply schemes are malfunctioned due to lack of ownership on the schemes. Ownerships developed by the community's consider the schemes as their personal properties. Users' satisfaction in yields, its location, quality and regularity are taken as the major indicators to measure the level of ownership. During household's survey to evaluated the sense of ownership of the community 38% of the households believe that developed water schemes belongs to the community, 43% respondents indicated that the existing water supply schemes belongs to the government, while the remaining 19% they don't know to whom the water schemes belong.

Table 4.10 Distribution of respondents on the senses of ownership

Senses of ownership response	Frequency	Percent
Community	61	38
Government	69	43
We don't know	30	19
Total	160	100

Community contribution of payment and management of the existing resources is a key factor in the successful operation of water schemes. There is also a need to adopt system of cost accounting for operation and maintenance. It is essential for providing accurate and meaningful cost estimates and expenditure data. If improved water supply schemes are to be managed properly and make the benefits sustainable, beneficiaries are expected to cover at least cost of operation and maintenances.

Contribution is influential to create a sense of ownership than all activities that are conducted at the beginning of the project. People may be enthusiastic to build the system because they need water, but the sense of ownership may grow slowly through regular activities towards the system (Ainsworth, 2020). However, this hypothesis needs further clarification.

community monthly in cash contribution, i.e., the monthly water fee, is much more influential than the in-kind contribution at the beginning of the project to sustain rural water supply systems in Indonesia. Previous studies indicate that it is important to involve the community in the planning and construction of the water system (Kelly et al., 2017). These activities positively influence the sense of ownership of the community towards the system and then lead to the sustainability of the system (Ambuehl et al., 2021). However, our findings imply that local community participation in money, in-kinds, beginning of the project(planning) and construction of water schemes but also, the local community participation in the implementation, management and monitoring of the schemes through life time of the projects.

4.6 Measuring overall sustainability using majors' sub-indicators

4.6.1 System functionality and reliability (SFR)

Ten questions from the technical questionnaire served as the basis for evaluating the system's operation and dependability. Ten questions about rural water systems were included in the poll. The overall performance of a water system as well as the building condition are measured by the System Health and Reliability Index. A flawless evaluation of the system's dependability and performance shows that there are no obvious flaws in the water supply system, and it is free of pollutants and of excellent construction quality. The assessor and data collectors evaluated the water system's overall quality following a thorough inspection. Ten technical assessment questions and interviews with the Water Commission provided the basis for the data for this sub-indicator. The degree to which the community effectively handles the institutional and organizational facets of system maintenance is gauged by the System Functionality and Reliability Score. A flawless score meant that the community had a skilled and knowledgeable system operator who could handle simple maintenance. For significant repairs, the operator needs to be able to locate assistance and have access to tools, spare parts, and system instructions. Lastly, since the system was built, a city with a perfect score won't see a drop in water flow; instead, there must be enough water flow to meet the needs of the community.

4.6.2 Financial viability and cost recovery (FVCR)

Financial management data was based on 10 questions asked by the technical assessment, water users and the Water Commission. The investigators obtained this information from interviews, discussions with the water commission, and research into factors that influence the sustainability of the DWSS. Most WASHCos do not adequately record and protect revenue from water sales. The best programs have enough income to cover even major repairs. However, in most programs, fee setting is not community-focused and does not take into account the poor and marginalized.

4.6.3 Water quality and quantity (WQQ)

water quality tests were not conducted due to lack of time and resources. From the interview with Habro District and WASHCO, it is clear that there are no major problems with chemical water quality in the District. For rural water delivery systems to operate dependably, their capacity which should be proportionate to the number of users must be con-

sidered. According to the respondents, issues with water functionality were also a contributing factor in the community's water scarcity. The increased number of beneficiaries and water scarcity during the drought period, according to IOS participants of the Water Commission and administrative officials from Kebele and KII of the District Water Resources and Power Authority, caused the municipal water supply of most water supply systems to be inadequate. season, inadequate excavation depth, and pump failure are among the most significant ones; nevertheless, O and M, a shortage of replacement parts, a lack of shared property, and a lack of quality water commissioners are the most crucial ones.

Table 4.11 Water supply schemes sufficient to the community.

Are existing water sources being sufficient	Frequency	Percent
Yes	53	33
No	105	66
They don't know	2	1
Total	160	100

Regarding the water safety and suitability of the study, as shown in table 4.11 above, 33% of respondents said the water supply sources were sufficient for the beneficiary, 66% said the water supply sources were insufficient, and 1% said they were unsure.

Participants in the District's FGD and KII reported issues with turbidity, tests, and bacterial contamination in a few of the water wells. In the research area, turbidity from over-pumping and water odor were the main causes of water quality issues in the majority of water delivery schemes. Water quality can be inferred from community assessments and current scheme inspection statistics, even in the absence of a water quality test (SNV, 2013). In addition to the inspection, a household survey was conducted to find out how the community felt about the quality of the water they obtained from the water schemes. The physical water quality (taste, color, odor, temperature, and turbidity) of the visited water schemes was found to be generally good, with the exception of the bareda site HDWs and bosoytu water schemes. Problems with water quality were discovered.

Communities also claim that odor problems are caused by water schemes that are not routinely cleaned. Water scheme users of Bareda HDWs lament that open defecation occurs

uphill from the well. On scheme, the researcher verifies this via fieldwork. Surface water can enter the well due to cracks in the HDW apron, which lowers the quality of the water. There were problems with turbidity in seven of the water supply systems that were observed, odor and test problems in one scheme, test problems in three schemes, and no problems in the other schemes.

4.6.4 Community Satisfaction and Involvement (CSI)

The responses to ten questions from the home surveys served as the basis for the consumer satisfaction data. The average score of all 10 households polled in each community is represented by the community's score. All community members would need to grade their service as good in order for the community to receive a score of 10. Their water pressure, the amount of hours it is available, and the water's taste, color, and quantity would all satisfy them. They would stop using alternative water sources, claim higher water usage, and use water for new uses. Consumer satisfaction data was based on answers to 10 questions from the household surveys.

4.6.5 Local governance and management (LGM)

Ten items from the household questionnaire and focus group talks with WASHCOs are used to calculate scores. The indicator gauges how much community people, WASHCOs, and the District water office feel accountable for managing their water system. If this category receives a perfect score, then everyone in the community feels that they own the water system. The public would anticipate that future upkeep, repairs, and system replacement would be covered by the community.

4.6.6 Environmental impact and sustainability

The best management strategies are those that include the whole groundwater recharge areas or groundwater catchments in order to handle the connected challenges of groundwater quality and quantity (WHO, 2006b). Water resource conservation, protection, and enhancement are essential to exploiting the resource in a sustainable manner, as stated in the Ethiopia Water Resource Development Policy and the SNNPR strategic plan (MoWR, 1999; BoWR, 2007). There was no conscious attempt made during the field study to protect the groundwater supply and increase its production. Nonetheless, it was noted that the community was using the Safety Net program in some areas to restore degraded fields.

Table 4.12 Water schemes-based score each-sub indicator of sustainability, overall sustainability

Sub indicators of sustainability						
kebele name	SFR	FVCR)	CSI	WQQ	LGM	Sustainably
Potentially sustainable (overall sustainability score between 5.00 -6.67)						
Ude1	4.5	6.3	5.6	5.5	5.4	5.46
geteta2	5.5	5.8	4.5	5.6	5	5.28
Gende Bulcha	5.5	5.8	5.5	5.5	5.5	5.56
Gerbi teka4	5.4	4.5	5.4	5.9	5.8	5.4
kemer	5.5	4.5	6	5.4	5.9	5.46
Zeyni	5	4.5	6.5	5.5	5.5	5.4
Milino	5.5	4.9	6.8	5.4	5.1	5.54
shadi	5.3	5.4	6.4	5.4	5.8	5.66
Gerbi teka3	5.4	5.5	5.1	4.9	4.8	5.14
defo 2	4.8	5.8	6.4	5.2	4.9	5.42
ude 3	5.2	5.2	5.6	4.9	5.5	5.28
muktar	6.5	5.8	6.7	4.9	4.4	5.66
Balbaleti	4.9	5.2	4.8	5.7	6.7	5.46
kelada2	4.9	4.8	5.4	5	6.2	5.26
Shira	4.5	5.5	6.3	5.7	6.2	5.64
Un sustainable (overall sustainability score of <5.0)						
Ude2	3.5	3.9	4	4.2	3.7	3.86
Geteta1	2.5	2.7	3.1	3.8	2.1	2.84
hamido	4	3.5	4.1	4.3	3.7	3.92
guto	3.6	3.8	4	4.1	3.9	3.88
Sukaye2	4.5	4	4.1	4	3.8	4.08
Gerbi teka 1	5	4.7	4.9	5	4.8	4.88
saide2	3.6	3.4	4.5	4.4	4.1	4
saide1	1.9	3	4.6	6.5	3.5	3.9
Ize	1.7	1.8	4.5	5.5	3	3.3
dalo	3.4	3.2	4	4.2	3.9	3.74
garbi goba	4	5.1	4.6	5.2	4.3	4.64
defo 1	3.4	3.8	4.4	4.7	4.5	4.16
Hat'ure D'ad'i	3.7	4.1	3.9	5	4.2	4.18
Ganda Maadaraa	4	4.5	5	5.5	4.7	4.74
chirecha	4.6	3.9	3.8	3.9	4.4	4.12
Wachu	5.1	5	4.9	4.8	5	4.96
Sukaye1	3.5	4.5	4.4	4.7	5.1	4.44

mada jalala 2	4.8	4.7	5.1	5.3	5	4.98
weday	5.1	6	4.1	3.9	4.2	4.66
kelada1	4	3.5	4.2	5.1	4	4.16
Gerbi teka2	4.2	4.5	4	5.3	3.9	4.38
Shira	5.1	4.4	4.6	5.4	4.8	4.86
Madera	3.8	3.9	2.9	2.8	4	3.48
mada jalala 1	4	3.9	3.6	5	4.7	4.24
jarso	5	4.1	5	5.1	4.3	4.7
laga bera	3.9	3	3.7	3.8	3.5	3.58
Average	4.4	4.45	4.8	4.93	4.63	4.64
Average overall sustainability =4.64						

Filled this score using Appendix four Answers Code and Sustainability Weighting Scores

4.7 Overall Sustainability Scores

The ability of a system to continue providing the desired advantages for a predetermined amount of time is known as overall sustainability. The average of the five sub-indicators represented the overall sustainability score for each community. Across all projects, the average sustainability score was 4.64. Only 46.4% of the projects' criteria system functioning and reliability, financial feasibility and cost recovery, water quality and quantity, community involvement and satisfaction, and local government and management were showing good performance, according to this score. The results for each sustainability sub-indicator and the total sustainability score, as shown in table 4.9, show that the sub-indicator ratings were consistent across schemes. Projects with low overall sustainability scores typically have lower-than-average scores throughout the board.

Overall, the study's findings indicate that system functionality and reliability were the most influential sub-indicators in the evaluation of sustainability overall, while the study area's water quality and quantity had the least influence.

4.7.1 Sustainable schemes

Table 4.12 demonstrates that certain sustainable plans have achieved higher scores for overall sustainability as well as for each of the five sub-indicators. The sub-indices of water quantity and quality, community involvement and satisfaction, local governance and management, and financial viability and cost recovery were being studied by the others.

4.7.2 Potentially sustainable schemes

Among 41 water supply schemes sampled, 15 (or 36.5%) had the potential to be sustainable; the majority of the water Potentially sustainable schemes for water supply had good local

governance and management, and some of them had reliable and functional systems; however, their financial viability and cost recovery were lacking, with the exception of a small number of schemes that did not take any system requirements into account.

4.7.3 Unsustainable schemes

Table 4.9 shows that out of the total sampled water supply schemes, 26 (63.4%) had low sustainability in terms of their ability to recover costs and maintain financial viability, as well as in terms of water quality and quantity, community involvement and satisfaction, and local governance and management. These schemes also failed to take into account any criteria for setting tariffs or charging the same fee to every beneficiary over an extended period of time. Very little usage capacity was available, and accounts were not kept up to date. Members of the committee acknowledged the inadequate local administration and governance for system upkeep. For such rural schemes, willingness and ownership to sustain the schemes that have not taken into consideration Assesses community support for sustaining the water system, as well as ongoing assessment and training to improve their performance, are required. Concerns include how the community views tariff levels, its financial ability to maintain the system, and its willingness to pay for upgrades. Out of 41 water supplies, the one with the lowest consumer satisfaction score was one where the water supply had stopped working at the time of the survey because of poor management. The community was not happy with the quantity, quality, or quality of water discharged despite the community-based scheme's attempts to implement intermittent water supply. Good financial sustainability, cost recovery procedures, and system functionality are combined with a robust, well-organized community base.

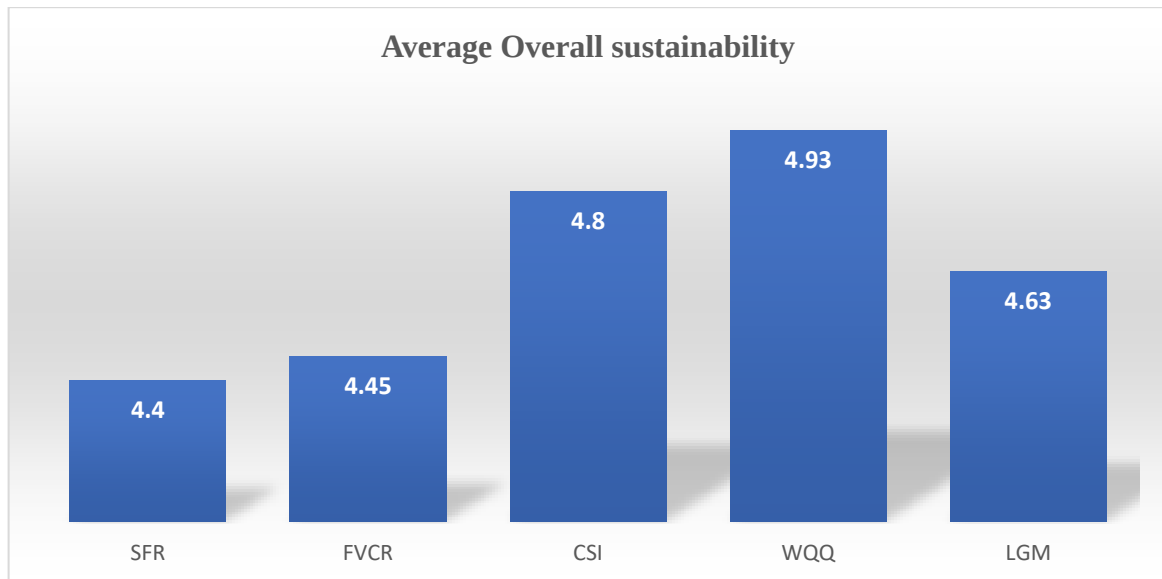


Figure 4.11 Average scores of sub-indicators distribution in the study area

Where, SFR= system functionality and reliability, FVCR= Financial viability and cost recover, CSI= community satisfaction and involvement, WQQ= water quality and quantity, LGM= Local governance and management.

Sustainability is influenced by many factors – technical and non-technical (Addis , 2012). In other research found that sustainability was related, strongly, to community participation (Mavhura & Manyena, 2018). Moreover, it was found that a strong correlation between community participation and management to the sustainability was obvious and effective community organizations, ability of the community to operate and maintain facilities, ability of the community to raise adequate user fees for purchasing spare parts, and strong backup support from external parties at the district level to solve major breakdowns were revealed by (Vrchota et al., 2020) as factors that contribute to the sustainability of water supply systems. However, their findings are not support technology and some of factors were included. In our research where more factors of sustainability were addressed and New and innovative monitoring tools are needed to achieve universal and equitable access to safe and affordable drinking water for all. So mWater plat form was used and the study area data was interred in mWater software platform to manage rural water supply schemes and WASH business center manual are given to the water resource and energy office of the district to minimizing the non-functionality of schemes and ensuring the sustainability of these schemes.

5 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The goal of the research was to assess the sustainability of Habro District's RWS schemes, to understand the major causes of sustainability problem and to suggest the relevant remedial action.

The researchers found that the district's coverage of rural water supply schemes was lower than that of district water resource reports. This was attributed to the unreliability of many non-functional technology types present in the district as well as the non-functionality of some schemes that were deemed functional but were not during site observation.

Based on mWater and SPSS version 27 statistical software analysis results average sustainability score was very high, that means the projects' criteria system functioning and reliability, financial feasibility and cost recovery, water quality and quantity, community involvement and satisfaction, and local government and management were showing poor performance, which means the sustainability of rural water supply are under question in study area. The sustainability of water delivery projects in Habro District was impacted by factors such as local governance and administration, as well as a lack of community satisfaction and involvement. while system functionality and reliability, financial viability, and cost recovery had the most effects.

The community participants in schemes implementation, management and monitoring was bad and the ability of water committees to manage the schemes had poor to manage the schemes.

According to observations made during the investigation of factors influencing the sustainability of rural drinking water schemes in the Habro area, 37.5% of these schemes are functional, 35% are partially functional, 27.5% are nonfunctional and from 46 water points surveyed their functionality status 59.8% functional and 40.2% are not functional.

This shows that non functionality of schemes is still ongoing and across all projects and the majority of community in the study area use unprotected water sources for domestic purposes. Due to poor community participation, inadequate community skills for operation and maintenance, as well as a lack of technical experts and relevant training at the Kebele (community level), inaccessibility, and a lack of reasonably priced instruments, lack of spare parts

at the community level and Local governance and administration had the least impact on the overall sustainability of water delivery schemes.

5.2 Recommendation

A typical objective of rural water delivery projects is sustainability, and several types of instruments have been developed to measure it.

Long-term sustainability requires a water supply plan. The district water resource office is concentrating on managing water schemes by using mWater technology and WASH business center at the chosen area of center district kebele to water committee and water utility can access spare parts and these are the steps that need to be taken in order to improve the functionality of rural water supply. To guarantee the long-term sustainability of water schemes and timely maintenance, training on practical system operation and maintenance is required for the water committee, caretakers, and local technicians.

The Wared Water Resource Office and WASHCos a steady supply of water depends on the infrastructure pumps, storage tanks, pipelines, etc. being maintained on a regular basis.

Participation and assistance from the neighborhood are essential. Involvement from the community guarantees water supply system ownership, appropriate use, and upkeep from WASHco and community. The community must be involved from the beginning to the conclusion and community maintain the schemes which is done by their capacity. So, pay for operations, upkeep, and repairs, sustainable financial sources like user fees, community donations, or government assistance are done regular bases.

The focus of NGOs and the government should be on enabling WASHCOs to provide maintenance tools and training. By doing this, they can help assure the long-term functionality of the water supply system by teaching and empowering local people or groups to manage, operate, and maintain it.

In the O and M of the water delivery system, appropriate decision-making, accountability, and transparency are ensured by effective management structures and governance models. So, the policymaker in order to formulate different structure like change WASHco to water utility they may focus on the implementation of management structure and governance.

Mechanisms for ongoing assessment, monitoring, and feedback make it easier to spot problems early and make the adjustments required for long-term functionality.

Efficiency and dependability can be decrease by implementing innovative water supply techniques and adopting suitable and sustainable technologies. using automatic on and shut the system (pumps, water point etc.)

More research and analysis are required to determine the quality of water that influences the long-term viability of rural water projects.

REFERENCES

- Abebe, H., & Deneke, I. (2008). The sustainability of Water Supply Schemes. A case study in Alaba Special woreda. *RiPPLE Research-inspired Policy and Practice Learning in Ethiopia and the Nile region*.
- Addis , H. B. (2012). Factors affecting the sustainability of rural water supply systems: The case of Mecha Woreda, Amhara Region, Ethiopia. *Doctoral dissertation, Cornell University*.
- Admassu, S., Collick, A., & Ayele, M. (2012). *Water Supply and Sanitation in Amhara Region: Learning and Communication Research Repor*. Bahir Dar, Ethiopia: WaterAID and Bahir Dar University.
- Andres, L., Chellaraj, G., Das Gupta, B., Grabinsky, J., & Joseph, G. (2018). Why Are So Many Water Points in Nigeria Non-Functional? An Empirical Analysis of Contributing Factors. *Water Global Practice*.
- Armah, F. A., Ekumah, B., Yawson, D. O., Odoi, J., Afitiri, A.-R., & Nyieku, F. E. (2018). Access to improved water and sanitation in sub-Saharan Africa in a quarter century. *Department of Environmental Science, School of Biological Sciences, College of Agriculture and Natural Sciences*,.
- Assefa, M. (2013). Strategies to reduce the non-functionality of water supply schemes in. 36 *WEDC International Conference*. Nakuru, Kenya.
- Behailu , B., Hukka, J., & Katko , T. (2017). Service failures of rural water supply systems in Ethiopia and their policy implications. *Public Work Manag Policy* .
- Behailu, B., Suominen, A., Katko, T., Mattila, H., & Yayehyirad, G. (2016). Comparison of community managed projects and conventional approaches in rural water supply of Ethiopia. *Environmental Science and Technology*.
- Braga, B., Flecha, R., Thomas, P., Cardoso, W., & Coelho, A. (2009). Integrated Water Resources Management in a Federative Country: The Case of Brazil. *International Journal of Water Resources Development*.
- Cronk , R., & Bartram , J. (2017). Factors influencing water system functionality in Nigeria and Tanzania: a regression and Bayesian network analysis. *Environ Sci Technol* .

- Daemane, M. (2015). The Analytic Conceptual Framework for Comprehending Factors Essential to Realize Sustainability in Rural Communities' Water Supply Systems. *Human Social Science*.
- Frederick, A. A., Bernard , E., David , O. Y., & Justice , O. (2018). Access to improved water and sanitation in sub-Saharan Africa in a quarter century. *Regional Water and Environmental Sanitation Centre Kumasi* .
- Gurmessa, B., & Mekuriaw, A. B. (2019). What determines the operational sustainability of rural drinking water points. *Water Sanitation and Hygiene for Development*.
- Katz, T., & Sara, J. (2004). *Making Rural Water Supply Sustainable: Report on the Impact of Project Rules*. World Bank.
- Kelly, E., Lee, K., F. Shields, K., Cronk, R., Behnke , N., Klug, T., & Bartram, J. (2017). The role of social capital and sense of ownership in rural community-managed water systems: Qualitative evidence from Ghana, Kenya, and Zambia. *Rural Studies*.
- Kirsch, I., & Thorn, W. (2013). *Technical Report of the Survey of Adult Skills (PIAAC)*. Chile.
- Lencha, A. T. (2012). Rural water supply management and sustainability in Ethiopia with special emphasis on water supply schemes in Adama area. *NM011 Sustainable Development - Master's Programme 120 HEC*.
- Lockwood, H., & Smits, S. (2011). *Supporting rural water supply : moving towards a service delivery approach*. Rugby, UK: Practical Action, IRC and Aguaconsult.
- Lockwood, H., Bakalian, A., & Wakeman, W. (2003). Assessing Sustainability in Rural Water Supply: The Role of Follow-up Support to Communities.
- Machado, A., Alberto , J. N., Quindeler, N., & Alves, L. (2019). Critical Factors for the Success of Rural Water Supply Services in Brazil. *Water 11(10):2180*.
- Mavhura, E., & Manyena, B. (2018). Spatial quantification of community resilience in contexts where quantitative data are scarce: The case of Muzarabani district in Zimbabwe. *Geography and Enviroment*.
- Mohammed, A. (2021). Evaluation of Rural Water Supply Schemes Sustainability in Dessis Zuria Woreda South Wollo Zone, Amhara Region, Ethiopia. *MSC, Thesis Bahir Dar Institute of Technology*.

- Mommen, B., Humphries-Waa, K., & Gwavuya, S. (2017). Does women's participation in water committees affect management and water system performance in rural Vanuatu? *Waterlines*.
- Olajuyigbe, A. E. (2016). "Community Participation and Sustainability Issue: An Evaluation of a Donor-Driven Water Sector in Ikaram Millennium Village Project, Nigeria. *Journal of Social Sciences*, Vol.4 No.6.
- Omarova, A., Tussupova, K., Hjorth, P., Kalishev, M., & Dosmagambetova, R. (2019). Water Supply Challenges in Rural Areas: A Case Study from Central Kazakhstan. *International Journal of Environmental Research and Public Health*.
- Shongwe, M., & Dlamini, S. (2021). A systems approach to investigating non-functionality in rural water schemes: a case study. *Sustainable Water Resources Management*.
- SNV. (2016). *Functionality of rural water supply system: Integrated training package for post construction support service team*. Nepal.
- Ssozi, D., & Danert, K. (2012). Achieving Sustainability of Rural Water Supply Services Through application of Water Point National Monitoring of Rural Water Supplies. *RWSN-IFAD Rural Water Supply Series, Volume 5*.
- Tadesse, A. (2013). Rural Water Supply Management and Sustainability: The Case of Adama Area, Ethiopia. *Water Resource and Protection*.
- UNICEF. (2022). *UNICEF Annual Report 2022*. New York: UNICEF, Division of Global Communication and Advocacy.
- UNICEF, & WHO. (2019). *Progress on household drinking water, sanitation and hygiene 2000-2017. Special focus on inequalities*. New York: United Nations Children's Fund (UNICEF) and World Health Organization.
- UNICEF/WSP. (2015). Water Supply and Sanitation in Ethiopia; Turning Finance into Services for 2015 and Beyond. An AMCOW Country Status Overview. *Open Access Library Journal*.
- Victor, D. M., Célestin, D., & Martin, T. (2023). Assessing the functionality of water supply handpumps in a Sub-Saharan Africa rural environment: a practical application in eight councils in the Mvila Division, Southern Cameroon. *Water, Sanitation and Hygiene for Development*.

Vrchota, J., Pech, M., Rolínek, L., & Bednář, J. (2020). Sustainability Outcomes of Green Processes in Relation to Industry 4.0 in Manufacturing: Systematic Review. *Sustainability*.

Water Development Commission. (2021). *National WASH inventory-II and MIS*.

WHO and UNICEF. (2021). *Progress on household drinking water, sanitation and hygiene 2000-2020: five years into the SDGs*. Geneva.

World Vision Ethiopia. (2022). *A working manual for the WASH Business center initiative in World Vision Ethiopia*. Addis Ababa, Ethiopia: World Vision Ethiopia.

Appendix

Appendix one Tables on selected kebele

Table 7.1 Functional Status of RWSS in the study area.

No.	Kebele	Water point Name	Scheme type	Sample HHs	GPS Reading		
					X	Y	Z
1	bareda	Ude1	HDW	8	8.865417	40.66057	1724
	bareda	Ude2	HDW	7	8.865713	40.66115	1727
	bareda	Geteta1	SHW	9	8.864928	40.66071	1724
	bareda	hamido	HDW	6	8.859829	40.66268	1713
	bareda	guto	SHW	12	8.861038	40.66313	1712
	bareda	geteta2	HDW	5	8.862717	40.66179	1715
2	bosoytu	Sukaye2	HDW	8	8.826911	40.5458	1671
	bosoytu	Gende Bul-cha	HDW	12	8.826524	40.63499	1677
	bosoytu	Gerbi teka 1	SHW	8	8.826219	40.63246	1679
	bosoytu	Gerbi teka4	HDW	23	8.85613	40.56444	1791
3	lage bira	saide2	HDW	14	8.784755	40.49243	1739
	lage bira	saide1	HDW	11	8.784817	40.49267	1736
	lage bira	Ize	HDW	16	8.783376	40.48684	1759
	lage bira	kemer	HDW	5	8.785403	40.49326	1744
	lage bira	Zeyni	SHW	4	8.782404	40.48785	1754
	bosoytu	Milino	DW	18	8.83087	40.5937	1728
4	melka bello	dalo	DW	16	8.827915	40.55878	1680
5	chafe 12	shadi	DW	19	8.853432	40.56511	1710
	Laga bira	garbi goba	DW	17	8.787178	40.49025	1752
6	defo	defo 1	DW	18	8.737132	40.44036	1732
	bosoytu	Gerbi teka3	SHW	12	8.826371	40.63077	1678
	melka bello	Hat'ure D'ad'i	HDW	14	8.815008	40.54661	1732
	chefe13	Ganda Maadaraa	HDW	13	8.83757	40.55702	1743
	defo	defo 2	DW	17	8.737017	40.43977	1735
	bareda	ude 3	HDW	14	8.865685	40.66121	1730
	bareda	chirecha	SHW	13	8.865685	40.65917	1730
	bareda	Wachu	DW	17	8.849626	40.62852	1735
	bareda	muktar	SHW	17	8.860551	40.66305	1709

	bosoytu	Sukaye1	HDW	8	8.82073	40.61794	1676
7	mada jalala	mada jalala 2	DW	21	8.7395	40.45264	1737
8	balbaleyti	Balbaleti	DW	23	8.710479	40.40289	1728
	bareda	weday	SHW	14	8.77248	40.66236	1719
	bareda	kelada2	SHW	20	8.845695	40.66719	1698
	bareda	kelada1	SHW	14	8.845695	40.66719	1698
	bosoytu	Gerbi teka2	SHW	12	8.826675	40.63145	1677
	bosoytu	Shira	SHW	10	8.821902	40.63533	1673
	bosoytu	Madera	HDW	8	8.819817	40.63657	1677
	mada jalala	mada jalala 1	DW	24	8.741329	40.44725	1730
9	kufa	Shira	DW	31	8.763275	40.4637	1745
	lage bira	jarso	SHW	15	8.784738	40.49222	1736
	lage bira	laga bera	DW	24	8.783893	40.48863	1754

Appendix two Sub Indicators Questions

Sub-indicator questionnaires

I. System functionality and reliability

1. what is water system Functional status?
2. what is the main problem to the partially function and non-functionality of the schemes?
3. Does the water point provide a continuous supply of water?
4. How many days in the past two weeks has water been unavailable from this source?
5. Water available at all time of the year from this source?
6. In the past 365 days(12months), how long has the water point been out of action due to technical failure?
7. Is there any water leakage in your water supply scheme?
8. How do you evaluate the current status of the water supply scheme in provision of the Service?
9. How do you evaluate the construction quality of the water supply scheme?
10. Does the construction is supervised by guide line and check list?

II. Financial viability and cost recovery

1. Are user fees or tariffs being Collected
2. What is your perception on tariff level?
3. Do you have problems in paying tariff (ability to pay)?
4. Are external funds available (from outside the community) to cover the cost of major maintenance?
5. Does community had financial capacity to sustain the service?
6. Stated reasons why respondents pay water fee?
7. Did the scheme have bank account or financial record?

8. Do they control the income from the tariff?
9. Does the tariff Cover Operation and maintenance and Cost recovery of capital cost?
10. Did you assign financial person?

III. Water quality and quantity

1. Do you think the water supply source now you are using water quality problem?
2. Do you imagine that the water supply you have is sufficient and safe for household use?
3. How much water per day does your household usually need for domestic purpose?
4. Does deep wells and Shallow wells are giving their design quantity of water?
5. What is the main reason of decreasing quantity of schemes?
6. How much drinking water do you use per day from the main source?
7. Have you protected the sources of water from any pollution?
8. Is there any detectable physical water quality parameter?
9. How do you evaluate the water quality of the scheme?
10. What are the main physical parameter observed in your schemes.

IV. Community satisfaction and involvement

1. Are you satisfied by technology type?
2. How satisfied are you with your drinking water quality?
3. Are you satisfied with number of hours avail?
4. Are communities participating during planning, design and construction stage?
5. Are you satisfied with your water discharge?
6. Are you satisfied with the job performed by the WASHCOs providing water service?
7. What is dissatisfaction you on the service delivered?
8. Do you satisfied with your water pressure?
9. Are you satisfied with number of hours avail?
10. Are you satisfied with water resource support?

V. Local governance and management

1. Is there a guideline or structure for coordination mentioning the responsibility of each stake holder?
2. Is there support from local administration?
3. Is there Coordination through regular meeting, joint planning and monitoring
4. Who is Currently managing the water point?
5. Did community water committee manage water user?
6. Did water committee actively participate at every management level of water point?
7. Who collected fee management responsibility?
8. Who set and manage the price of the water fees?
9. Evaluation of financial contribution & management in water scheme
10. The capacity of water committee to manage the finance

Appendix three Questionnaire

Household Survey Questionnaire

Dear respondent, my name is Tekabe Kinfu from Adama Science and Technology university. I conducted my thesis on Rural Water Supply Schemes Sustainability Assessment; A case of Habro District in Oromia Region, Ethiopia. The aim of this questionnaire is to collect data needed for thesis and to make the paper fulfilled document and problem solver your kindness help is needed. The information that you provide is highly important for the success of this research. Moreover, the information you provide is used only for academic purposes and it will be kept strictly confidential. I highly appreciate in advance to your kind cooperation.

Part 1: General Information

1. Name of interviewer_____
2. consent for Interview_____
3. Date of interview_____
4. Name of kebele and Village. _____
5. Age:
 - (1) 15-30
 - (2) 31-45
 - (3) 46- 60
 - (4) above sixty
6. Sex:
 - (1) Male
 - (2) female
7. Marital status:
 - (1) Married
 - (2) Unmarried
 - (3) widow/widower
 - (4) divorced
8. Educational status:
 - (1) Illiterate
 - (2) can read and write without having formal education
 - (3) Primary school
 - (4) Secondary school
 - (5) College and above
9. Occupational status:
 - (1) Farmer
 - (2) Government employee
 - (3) Merchant
 - (4) Labor work
 - (5) Others specify
10. How many family members you have in your house including you._____

Part 2: Current Water scheme statues

1. provide information about type of water supply systems?
 - (1) Surface water-gravity flow scheme
 - (2) surface water –pumped
 - (3) protected dug well
 - (4) unprotected dug well
 - (5) protected spring
 - (6) unprotected spring
 - (7) borehole or tubewell
 - (8) rain water
 - (9) Other
2. what is water system Functional status?
 - (1) Functional
 - (2) partially Functional but in need of repair
 - (3) not Functional
 - (4) No longer exists
3. If your response to Q 2 is “partially functional and Not functional” what do you think is the main problem to the partially function and non-functionality of the schemes?
 - (1) pump failure
 - (2) Depth problem(seasonality)
 - (3) Operation & Maintenance problem
 - (4) Construction quality problem
 - (5) Design problem
 - (6) Site selection problem
4. Does the water point provide a continuous supply of water?

The respondent should consider the past 365 days(12 months) when answering, therefore taking into account potential seasonal variability.

 - (1) Water is available all day, every day.
 - (2) Water is available every day, but not all the time.
 - (3) Water is available most days.
 - (4) Water is available only on a small number of days.
 - (5) Don't know
5. How many days in the past two weeks has water been unavailable from this source?
 - (1) _____ day
6. Is Water available at all time of the year from this source?
 - (1) yes
 - (2) NO
 - (3) Don't Know
7. In the past 365 days(12months), how long has the water point been out of action due to technical failure?
 - (1) Not at all
 - (2) Less than one week
 - (3) Less than one month

- (4) More than one month
 - (5) Rarely Functional
 - (6) Don't Know
8. Is there any water leakage in your water supply scheme?
 - (1) Yes
 - (2) NO
 - (3) Don't Know
 9. when the non-functionality/shortage of water of the schemes mostly occurs?
 - (1) summer
 - (2) winter
 - (3) both
 10. How do you evaluate the current status of the water supply scheme in provision of the Service?
 - (1) Good
 - (2) fair
 - (3) Poor
 11. Does your schemes have change its discharge after construction?
 - (1) Yes
 - (2) No
 - (3) I don't know
 11. If the Q 11 answer is "yes" what is the reason? _____

Part 3: Technical factors

1. Are there local technicians for operation and maintenance work?
 - (1) yes
 - (2) no
2. Is the rural water scheme simple to operate and suitable to the users?
 - (1) Yes
 - (2) No
3. 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/scheme type selection
 - (3) Inappropriate design/poor construction quality
 - (4) Lack of the technical skill to carry out O & M
4. If there is a complicated breakdown, do you know where to get support from
 - (1) yes
 - (2) No
 - (3) Don't Know
5. Do you know where to gate Access to Spare parts?
 - (1) Yes
 - (2) No
 - (3) Don't Know
6. How do you evaluate the construction quality of the water supply scheme?
 - (1) Good
 - (2) Fair

- (3) Poor
- 7. Does the local community participate in the implementation, management & monitoring of the schemes.
 - (1) Good
 - (2) Fair
 - (3) Bad

Part 4: Financial Factors

1. Are user fees or tariffs being Collected
 - (1) Yes, as agreed
 - (2) Yes, only when there is a breakdown
 - (3) Yes, but not as agreed
 - (4) No
 - (5) Don't Know
2. What is your perception on tariff level?
 - (1) Expensive
 - (2) Fair
 - (3) Inexpensive
 - (4) I don't know
3. Do you have problems in paying tariff (ability to pay)?
 - (1) Yes
 - (2) No
 - (3) Sometimes
4. Does the tariff Cover Operation and maintenance and Cost recovery of capital cost?
 - (1) Yes
 - (2) No
5. Stated reasons why respondents pay water fee?
 - (1) Salary of guard
 - (2) it will cover O & M cost and salary guard
 - (3) it will cover O & M cost
6. Are external funds available (from outside the community) to cover the cost of major maintenance? This refers to maintenance that cannot be covered by user fees and community resource
 - (1) yes
 - (2) No
 - (3) Don't Know
7. Does community had financial capacity to sustain the service?
 - (1) Yes
 - (2) No
 - (3) don't know
8. Who is Currently managing the water point?
 - (1) Community members
 - (2) WASH Committee
 - (3) Local government`
 - (4) Public operator(utilities)

- (5) Private operator
 - (6) Institution (e.g school, health Centre, religious institution)
 - (7) Household
 - (8) Nobody
 - (9) Don't Know
9. What types of community contribution in the rural water development
- (1) Money
 - (2) Supply labor during the construction
 - (3) Supply local materials (stone, sand & wood)
 - (4) Information provision during in site selection
 - (5) In election of the water committees members
 - (6) Money, labor, local material & information

Part 5: Institutional factors

1. Is there a guideline or structure for coordination mentioning the responsibility of each stake holder?
 - (1) Yes
 - (2) No
2. Is there support from local administration before and after construction of schemes?
 - (1) Yes
 - (2) No
3. Is there a structural link between WASHCO and the District/NGOs regarding to visit you, supervise you, supported you with maintenance?
 - (1) Yes
 - (2) No
4. How many time audit your financial and capital resources?
 - (1) Two times per year
 - (2) One time per year
 - (3) No audit
5. Do you have plan to maintain the non-functional water supply schemes?
 - (1) There are clear plans to fix the water point
 - (2) They want to fix the water point but plans are unclear
 - (3) The water point has been abandoned
 - (4) Don't Know
6. Did the scheme management and administration training given to the community by the scheme provider?
 - (1) Yes
 - (2) No
7. DO you know what types of support (assistance) of WASHCO and the community needs to ensure sustainability of water supply schemes?
 - (1) Maintenance, spare parts and other technical assistance
 - (2) Training, spare parts, maintenance and technical assistance
 - (3) Training, spare parts, financial and technical assistance

Part 6: Social factors

1. Is everyone in the community able to access the water point?
Please record in the comments who is not able to access the water point and why, for example is it due to their caste, disability, lack of money, or culture and beliefs.
 - (1) Yes
 - (2) NO
2. Does the management of the scheme involves women and treats users fairly?
 - (1) Yes
 - (2) No
3. Educational status:
 - (1) Illiterate
 - (2) Can read and write without having formal education
 - (3) Primary school
 - (4) Secondary school
 - (5) College and above
4. Occupational status:
 - (1) Farmer
 - (2) Government employee
 - (3) Merchant
 - (4) Labor work
 - (5) Others specify
5. Does community had financial capacity to sustain the service?
 - (1) Yes
 - (2) No
 - (3) don't know

Checklists for Focus Group Discussion

Part 1. Checklists for Point of Discussion with water committee (water utility)

members

Date of discussion_____ Kebele_____ Village_____

Rural Water Supply scheme type & status_____

1. How do you become community water committee ?
 - (2) by election of water user community
 - (3) by kebele administration
 - (4) by district water resource and energy office
 - (5) by zonal water resource and energy office
1. What is the composition of WASHCos in terms of gender, religion, economic status, location in the kebele?
 - (1) Men to women ratio
 - (2) Religious composition
 - (3) Poor vs rich
 - (4) Distant users vs users near by

2. Do you have a legal registration certificate?
 - (1) Yes
 - (2) No
3. To whom are you accountable?
 - (1) Kebele administration
 - (2) District water resource office.
 - (3) Zonal water resource office
4. Do you report to them?
 - (1) Yes
 - (2) No
5. Are users aware of their rights and responsibilities in water service delivery?
 - (1) Yes
 - (2) No
6. What do you think are the major reasons for the breakdown/non-functionality?
 - (1) Pump failer
 - (2) Are there design problems?
 - (3) Are there construction problems?
 - (4) Is it technology selection?
 - (5) Water quality problems?
7. Did the beneficiaries pay user fees regularly?
 - (1) Yes
 - (2) No
8. If Q3 is “No”, why do you think the reasons and what measures have been taken to solve the
 Problem? _____
9. Do you have a system to support people who cannot pay for the service?
 - (1) Yes
 - (2) No
10. What are the main sources of income for operation and maintenance costs?
 - (1) community water fee
 - (2) Support from District
 - (3) NGOs
11. How does the committee manage their financial resource? Do you have bank account or financial record?
 - (1) Yes
 - (2) No
12. Do you audit your financial and capital resources?
 - (1) Yes
 - (2) No
13. What can you say about the general water supply and demand in the village?
 - (1) Insufficient for domestic activities?
 - (2) People also use unsafe alternative sources?
 - (3) Competitive uses for agriculture and domestic activities?

Part 2: Checklists for Point of Discussion with Selected women groups

Date of discussion _____ Kebele _____ village _____

Scheme type and status _____

1. Are women allowed to participate in public activities?
(1) Yes
(2) No
2. What do you think are the reasons that prevent you and other women from Participating in the water committee? _____.
3. Does the management of the scheme involve women?
(1) Yes
(2) No
4. Are women actively participating in community water committee?
(1) Yes
(2) No
5. Who is most frequently responsible for collecting water for domestic uses in your household?
(1) Children
(2) Both children and mothers
(3) Mothers
(4) Father
6. Have you faced the problem with the water supply scheme none functional?
(1) Yes
(2) No
7. If Q 5 “yes”, what do you think are the major reasons and where do you get water at that time? _____
8. What do you recommend to alleviate the problem of the scheme and make it functional for long time?
9. How many women you think should be members of total water committee?
(1) 2
(2) 3
(3) 4
(4) Above 4
10. Do you think representation of more women in the water committee is good for the Society? Why? or why not? _____.

Part 3: Checklists for Point of Discussion with kebele administration

Discussion day _____ Kebele _____ Got / Village _____

Schedule type and condition _____

1. How do you ensuring the effective implementation, management, and oversight of schemes?
2. what is your responsibility after the construction of water schemes?
(1) Infrastructure development monitoring and financial management

- (2) Community engagement and maintenance
3. Are there barriers to stop you from performing your roles and responsibilities?
 - (1) Yes
 - (2) No
 4. Do you perceive the roles and responsibilities of stakeholders (such as district water resource office, NGOs, CBOs and the community) working in the area of WASH interventions?
 - (1) Yes
 - (2) No
 5. Do you work with the stakeholders?
 - (1) Yes
 - (2) No.

If no, why? _____ If yes, how? _____

6. How do you support the WASH activities in the Village?
7. Do you supervise the WASH activities being undertaken in the village?
 - (1) Yes
 - (2) No.

If yes, how? _____ If no, why not? _____

8. What do you think should be done to sustain the water supply schemes in the kebele?

Checklist for Key informant interviews (KII)

Dear interviewee, this interview is meant to conduct Rural Water Supply Schemes Sustainability Assessment; A case of Habro District in Oromia Region, Ethiopia, and to identifying the causes of non-functionality of the water supply schemes in the area than to provide possible remedial measures of sustainability of RWSSs, and thereby make invaluable contribution towards the future development, management and sustainability of rural water supply schemes. To that effect, I would like to assure you that all information gathered will be used solely for the study purposes only and the identity of the community members, who share their view, or that of any individual within the community and organization will not be revealed.

Part 1: District water office professionals and heads

General Details

1. Name of organization _____
2. Date of survey _____
3. Interviewee background information

Name _____, Sex _____, Age _____

Educational qualifications_____

Past work experience _____, Position in the organization_____

Service years in the organization _____, Major responsibility, _____

4. How do you explain the functionality of the schemes developed in the District?
 - (1) Functional
 - (2) Partially functional
 - (3) Not Functional
5. How long do they perform after construction? (give special examples of difference)
 - (1) Two year
 - (2) Five year
 - (3) Ten year
 - (4) Fifteen year
6. Which schemes fail more recurrently and why?
 - (1) Deep well
 - (2) Shallow well
 - (3) Hand dug well
 - (4) Spring development
7. Which schemes perform for a longer period of time without failure? Why?
 - (1) Deep well
 - (2) Shallow well
 - (3) Hand dug well
 - (4) Spring development
8. Does the schemes' capacity/ability to meet the water demand of user communities?
 - (1) Yes
 - (2) No
9. Are there population pressure on the schemes beyond the designed population?
 - (1) Yes
 - (2) No
10. How is scheme location in relation to user communities?
 - (1) Near
 - (2) Average
 - (3) Far
11. Are there any basic functionality differences in schemes developed by the government?
(District/zone/region/fund) and NGOs?
 - (1) Yes
 - (2) No
12. If Q 11 is yes, why? _____.
13. Are there any complaints by the user community on the quality (taste, odour, colour) of the water delivered?
 - (1) Yes
 - (2) No

14. Do you have criteria for WASHCo selection?
 - (1) Yes
 - (2) No
15. In what ways do you support WASHCos Capacity building?
 - (1) Spare parts provision
 - (2) Support maintenance tools
 - (3) Giving technicians for major scheme failure maintenance
 - (4) Given trainings to them
16. What opportunities are there to make WaSHCos perform effectively and efficiently?
17. Do you do regular follow-up and supervision of the schemes and WASHCos?
 - (1) Yes
 - (2) No
18. What factors affect your efficiency of implementation? In what ways?
 - (1) Knowledge
 - (2) Budget
 - (3) Integration with relevant stakeholders
 - (4) Logistics
19. What factors most affect the sustainability of water supply schemes in the District?
 - (1) Spare parts: availability, price, local providers
 - (2) Design and construction problems
 - (3) Water quality problems
 - (4) Poor stakeholder communication
 - (5) WASHCo inefficiency
 - (6) Low community awareness
 - (7) Low community participation
20. What do you think should be done to effectively and efficiently sustain the functionality of schemes? _____.

Part 2: NGO professional and Head

1. Name of organization_____
2. Date of survey _____
3. Interviewee background information

Name_____, Sex____, Age_____, Educational qualifications_____

Past work experience _____, Position in the organization_____

Service years in the organization _____, Major responsibility, _____
4. What is the main focus area of your organization regarding WaSH-related activities?
 - (1) New schemes construction
 - (2) rehabilitation
 - (3) Capacity building
5. How do you see your relations with other actors in the sector?
 - (1) Good
 - (2) Fair

- (3) Bad
6. Is there an external body that assesses the performance of your activities?
 - (1) Yes
 - (2) No
 7. Do you engage the community during the pre-feasibility and feasibility study of the project in problem identification, prioritization, site selection, project design selection, technology and service level selection?
 - (1) Yes
 - (2) No
 8. How does the local community participate in the implementation, management and monitoring of the scheme?
 - (1) Good
 - (2) Fair
 - (3) Bad
 9. How is the nature of the scheme you installed in the District? (Type of technology, number, water volume, design period, service lifespan, beneficiaries, type of water use, beneficiary intended at design period versus current no. of users, community participation, population consideration) (document review)
 - (1) Good
 - (2) Fair
 - (3) Bad
 10. Do you have any selection criteria for scheme technology and standards the implementation of the scheme as per the design?
 - (1) Yes
 - (2) No
 11. Do you think that the communities empowered technical aspect, financial aspect, organization aspect to run the schemes and Management of Water Service?
 - (1) Yes
 - (2) No
 12. Do you have management strategies of the schemes you have constructed?
 - (1) Yes
 - (2) No
 13. Do you handle issues related to O&M of the water schemes and availability of spare parts?
 - (1) Yes
 - (2) No
 14. Do you visit and supervision the WASHCOs per year?
 - (1) Yes
 - (2) No
 15. What efforts do you put in place to make the water supply systems sustainable including those developed by you and others?
 - (1) spare parts provision
 - (2) maintenance service
 - (3) Training

16. Do you evaluate performance of water schemes in the villages you have constructed so (considering: quality of water, quantity of water, satisfaction and reliability to users) ?

(1) Yes

(2) No

17. Give your comments on what should be done for the water service delivery to be sustainable?

Part 3: Zonal water office professionals and heads

1. Name of organization_____

2. Date of survey _____

3. Interviewee background information

Name_____, Sex _____, Age_____, Educational qualifications_____

Past work experience_____, Position in the organization_____

Service years in the organization _____, Major responsibility, _____

4. Do you believe that zonal water office meet main objectives of the regarding to rural water supply in the habro District?

(1) Yes

(2) No

5. Does the zonal water office provide Post construction (maintenance tools ,spare parts, and technical training) for district to sustain the rural water supply?

(1) Yes

(2) No

6. Is there any water point inventory done by your office?

(1) Yes

(2) No

7. If yes how frequent is it and what are the criteria's to define the status of a water point and what lessons are learned from the previous inventory? _____.

8. What are the major factors affecting rural water supply scheme sustainability and identified by your office? What are the strategies your organization using to alleviate such problems and ensure rural water supply scheme sustainability? _____.

9. Are the availability, accessibility and affordability of spare parts organized?

(1) Yes

(2) No

(3)

10. Do you know how many and type of water supply technology are functional and non-functional in zonal level?

(1) Yes

(2) No

Appendix four Answers Code and Sustainability Weighting Scores

Question Text, Answers Code and Sustainability Weighting Scores

I . System functionality and reliability				
Q-ID	Question text	Answers	Answers code	Weight
T17	have spar part problem	Yes	A	2
		No	b	0
T18	trained in operation	yes	A	2
		No	b	0
T21	Operators have capacity to op.	good	A	2
		fair	B	1
		don't know	C	0
T20	operator has access to tools & spares	yes	A	1
		no	b	0
T19	if not, operator knows where to get tools	Yes	A	1
		No	b	0
T20	operator has done major repair	Yes	A	2
		No	b	0
T22	operator can get help	Yes	A	2
		No	b	0
T23	operator has manuals	Yes	A	2
		No	b	0
T24		Yes	A	2

	provide a continuous supply of water	No	b	0
T25	Past two weeks unavailable from this source	Yes No	A b	2 0
T26	Water available at all time of the year from this source	Yes No	A b	2 0
T16	Is there water leakage in your water supply scheme	Yes No	A B	2 0
T27	provision of the Service is good	Yes No;	A B	2 0
T15	construction quality of the scheme are good	Yes No	A B	2 0
I. Financial viability and cost recovery				
T35	user fees or tariffs being Col-lected	Yes No	A B	2 0
T36	tariff level consider your income	yes No	A B	2 1
T41	capacity to sustain the service	Yes No	A B	2 0
T37	Do you know why to pay water fee?	Yes No	A B	2 0
T39	scheme have bank account	Yes No	A B	2 0

T40	Do you gate external funds	Yes	A	2
		no	B	0
T38	tariff Cover Operation and maintenance	Yes	A	2
		No	B	0
II. Water quality and Quantity				
H50	water quality problem	Yes	A	2
		No	B	0
H52	water supply you have is sufficient for household use	Yes	A	2
		No	B	0
H51	protected the sources of water from any pollution	YES	A	2
		NO	B	0
H53	quantity decrease	Yes	A	2
		No	B	0
H54	Do you know why decrease discharge of schemes	Yes	A	2
		No	B	0
III. Community satisfaction and involvement				
H55	technology type	more less same	A b c	2 0 1
H56	satisfied with your water pressure	very somewhat no	A B C	2 1 0
H57	satisfied with # of hours avail	very somewhat no	A B C	2 1 0
H58	satisfied with quantity	yes no depends on the season	A B C	2 0 0
H59	drinking water quality	good fair poor depends on the season	A B C D	2 1 0 0

H60	overall satisfaction with service	good	A	2
		fair	B	1
		poor	C	0
V. Local governance and management				
T5	Is there a guideline or structure for coordination	yes	A	0
		no	B	2
T6	Is there support from local administration	yes	A	2
		no	B	0
T7	managing the water schemes	good	A	2
		fair	b	1
		poor	c	0
T42	Did the income fee audited	Yes	a	2
		No	b	0
T9	collected fee management	yes	a	2
		no	b	0
T10	set and manage the price of the water fees	yes	a	2
		no	b	0
T11	capacity of water committee to manage the finance	good	a	2
		fair	b	1
		poor	c	0

Appendix Five Giving orientation and training for enumerators

Definition of Key Terminologies

- What is a household? A household is a group of people who usually live in the same place, sleep in the same place and eat food prepared from a common kitchen or cooking pot.
- Who is Youth? Children under the age group of 12-18 years
- Why Following the Sampling Method is Important: Each household selected by the sampling method has been chosen to represent a group of households in a community. This selection is not biased and failure to follow the sampling methods will lead to bias in the survey results.

Roles and Responsibilities of the Researcher

- Identify target groups and Kebeles and classified them into villages or clusters.
- Liaison with the government offices for their participation at all level that is pertinent to the work;
- Arrange appointment with the informant groups, including the government offices, other partners, and community;
- Coordinate the fieldwork;
- Recruit enumerators for the surveys and administer the data gathering process;
- Assign Cluster ID/Name(01 to 10) and source ID(1 to 4) and share for each data collectors.
- Cover the cost of the survey-
- Gain consent from each respondent
- Code and record responses according to tool
- Adjust plans as decided by Researcher and government office.
- Submit completed survey completion of survey on daily basis.
- Ensure data collectors locate correct houses.

- Observe the data collection process. If there is any mistake and give correction Where necessary, without interrupting the process, give advice to the enumerator. to improve or address the situation.
- Be available at all times in case a problem arises and solve the issues with the survey.
- Count records and organize them by household, survey or water supply system (scheme type)– are any records missing?
- Check through a sample of records for data quality.
- Seek feedback from enumerators to adjust and improve the process if necessary

Data Quality Control

- Who is responsible to data quality? All of are say me. not we
- Quality checking will happen during the data collection process, not afterwards;
- This is with the realization that quality of the data will always be better if the enumerators know someone will be there for checking the surveys;
- Samples of surveys will be checked from each enumerator, Checking will be made for correct recording consistently;

Communication Skills and Interview Protocol

- Dress appropriately.
- Present official document/certificate from organization or project if necessary.
- Be punctual (if appointments have been made).
- Do not enter the house unless you are invited.
- If you remain outside, do not ask for a chair; sit on the porch, steps, etc.
- Tell people how long the questionnaire will take.
- Do not accept lunch (unless it would be rude to refuse).
- Do not give gifts to interviewees.
- Thank interviewees at the end.

Effective Interviewing Techniques

1. Introduce yourself and the purpose of the survey.
2. Maintain confidentiality:
 - Do not interview the respondent in the presence of others (unless he/she indicates otherwise).
 - Explain that all answers will be kept confidential.
3. Ask questions exactly as written or with minor changes that were agreed upon during the training.
4. Wait for a response; be silent, then probe.
5. If the respondent doesn't understand or the answer is unclear, ask the question again, making as few changes in wording as possible.
6. Do not suggest—by tone of voice, facial expression, or body language—the answer you want.
7. Do not ask leading questions, questions that signal the correct answer or that suggest the answer you would like.
8. Try not to react to answers in such a way as to show that you approve or disapprove.
9. If one answer is inconsistent with another, try to clear up the confusion.
10. Try to maintain a conversational tone of voice; don't make the interview seem like an interrogation.
11. Know the local words for sensitive/delicate topics.
12. Use neutral probes (e.g., anything more?) How to ask the questions (Continued)
 - Be neutral, calm and polite throughout the interview.
 - Never suggest answers to the respondent.
 - Do not change the wording or sequence of questions.
 - Handle hesitant respondents tactfully.
 - Do not create expectations about assistance based on the responses