Financial Sustainability of Rural Water Supplies in Western Kenya

Comparing technology types and management models


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Preface

This report is the result of my Master Thesis for the Master of Civil Engineering, track Water Management with the specialization of Drinking Water Engineering. I did this project at the Sanitary Engineering Section at the Faculty of Civil Engineering and Geosciences at Delft University of Technology in cooperation with SNV Netherlands Development Organisation in Kenya. Both the supervision from the TU Delft and the supervision from SNV have been of great importance for my graduation work. I would like to thank all people who have contributed to my graduation project, especially the members of my graduation committee.

Luuk Rietveld has helped me from the first preparations to the last parts of my report. Especially his practical experience in the field has helped me with my research setup and with the thinking of practical recommendations. Doris van Halem has really helped me during our conversations just before I went to Kenya, during our Skype calls when I was in Kenya and during the meeting right after I came back. With Otto Kroesen I have not had much contact, but his input from the cultural and philosophical side has given a useful extra dimension to my research work. Chiranjibi Tiwari has been a great help during my proposal writing, during my period in Kenya and afterwards. He knew the field and really guided me through the research. I am really thankful that SNV has given me the opportunity to conduct my graduation work within their project.

Besides the graduation committee, many others have contributed during my graduation project. In Kenya I could not have done so much without my colleague and housemate Liz. She has really guided me in the office and in Kisumu and surrounding area and we made a lot of fun together. Also Abdi has helped me by introducing me to the right people of the Water Services Boards. In this respect I also want to thank John and Marloes of SNV, Daniel Obumba and Ibrahim Olouch of both Water Services Boards and Elisha of UNICEF Kenya. A special thank I want to give to the District Water Officers who have accompanied me during my field work. I have really enjoyed this time and the translation and transport were great!

At the end of this project I also really want to thank God. He has given me the strength, courage and wisdom to finalize this project! And last but not least I thank my lovely friend Tijn. He has been close to me (although I was part of the time in Kenya) and helped me with useful discussions about my research and a critical view at my work.

Summary

Introduction
In order to improve people's health worldwide, many efforts have been made in order to meet Millennium Development Goal 7c: reducing by half the proportion of people without sustainable access to safe drinking water and sanitation. Kenya is in the top ten of countries with the largest population without access to safe drinking water (UNICEF and WHO, 2012). Because most of these people live in rural areas, large investments are done in the Kenyan rural water supply. But recent studies show that many of the new water supplies stop functioning within a few years after implementation (MWI, 2007 and RWSN, 2007). Causes for this low 'post-construction sustainability' can be technical, institutional, financial, social or environmental. One of the most critical factors which is mentioned in literature is an adequate financing of operation and maintenance. This Master Thesis is about the post-construction sustainability of rural water supplies in Western Kenya, with a specific focus on the financial part of it (or financial sustainability).

In the rural water supply practice in Western Kenya, several water supply technologies exist. Some of these technologies require hardly any operation and maintenance (O&M), like springs, surface water catchment, rain water catchment and a well without a pump. These technologies are not included in the current research. Remaining technologies are a handpump and a motorized pump, both used for groundwater pumping.
Apart from the differences in technologies, several management models for rural water supply exist within Western Kenya: community management, government management, private management and institutional management. The latter one is not included in the current research because at these locations serving the community is in general not the main purpose. As the access to clean and safe water in adequate quantities is recognised as a human rights issue in Kenya (Constitution of Kenya, 2010), mechanisms for finding sustainable service delivery is a key national priority. As different management models are likely to result into different levels of sustainability, government of Kenya is in search of a most sustainable model for Kenyan context.

Objective
The objective of this study is to compare the financial sustainability of rural water supplies in Western Kenya. Within this comparison the aim is to compare different technology types, different management models and different combinations of these two. The final goal is that this comparison

can be used by the Government of Kenya and other supporting entities in the development of policies and projects for the rural water supplies.

Methodology
Data for this study is collected during interviews with the responsible persons for the water supplies. Data is collected about service level, O&M, financial management, cost recovery and finances. Service level includes system functioning, water quantity, walking distances and water quality. O&M includes who is responsible for the daily operation and pump check and for the maintenance arrangements and the days it takes between a breakdown and a repair. Financial management includes: responsibility for the finances, water tariff, tariff structure, bank account, bookkeeping and service cut-off for non-payment. Cost recovery includes the practice of the payments, the extent in which the income covers the O&M costs and whether replacement is expected to be a problem on the long term. The finances include the yearly income, costs and costs per user.

To all above mentioned factors scores are assigned depending on the output per criteria. The scores are also given a weighing factor. In this way, for every water supply a weighted score can be determined for all the four sustainability categories. In total 27 handpumps and 25 motorized pumps were evaluated.

Conclusions and recommendations
Out of all handpumps, the locations with community management and the locations with combined community and government management scored low. The communities were not able to collect enough money to keep the system functioning on the long term. The private managed handpumps scored good, especially in terms of cost recovery and quick response to breakdowns.

The motorized pumps scored low at the locations with combined community and government management and at the locations with government management. At the combined managed motorized pumps the responsibilities for O&M and financial management were not clear. At the government managed motorized pumps the payments were not good enough to cover the costs. At the community managed motorized pumps, the committees were well organized but they did not manage to make all users pay. At the privately managed motorized pumps, the responsibilities for O&M and financial management were not clearly defined but the financial situation was good. There was enough money for the O&M and for replacement on the long term.

Comparing the two technologies, the handpumps score higher on cost recovery and the motorized pumps score higher on O&M and financial management. At the handpumps it happens more often that the regular money collection is neglected. The responsible entities at the motorized pumps have more need to be organized because of the daily need for staff and money for e.g. fuel refilling. A negative side of the motorized pumps are the high costs per user per year, about nine times higher than at the handpumps.

Comparing the four management models, the differences were not big. The community managed locations have difficulties with making people pay. At the combined managed systems the responsibilities for O&M and financial management are not clear. At the government systems the costs (including high salaries of government staff) are too high for the amount of users. The privately managed systems score slightly higher, especially in terms of cost recovery.

Because of the fact that the water quantity is not sufficient at many locations and the walking distances are large, more water supplies are needed in the research area. It is recommended to focus more on handpumps than on motorized pumps for new water supplies. The reason for that are the high yearly costs at the motorized pumps. These costs make the motorized pumps less suitable for the rural areas of Western Kenya, where domestic income is low and people are not open to pay for their water. In some situations, with low water tables or high population density, a handpump is not feasible and than a motorized pump can be a good option for rural water supply.

It is also recommended that action is taken in order to improve users' willingness to pay. Four recommendations are:

- Activities for economic development like job creation and microfinance projects. When people get to spend more, they become more open to pay for water.
- Training in communities about the importance of clean water, which is not free. This includes basic insight in costs of water supply technologies.
- Training for responsible entities about dealing with sanctions against non-payment and about making finances more transparent.

In order to improve community management it is recommended that costs and responsibilities are shared within communities, local authorities and the central government. In the current situation, especially the tasks of the local authorities are not fully recognized: financing a part of major repairs of water supplies, monitoring the performance of individual facilities, conflict and problem resolution and retraining of mechanics and communities. For their monitoring task, the current study and other studies are used to constitute a basic half yearly performance monitoring.

Since the private management model scores high on financial sustainability, it is recommended that the Government of Kenya and development partners pay more attention to this option. In order to create a situation where private management is a serious option, several aspects need to be considered:

- The government need to contribute in investment costs. For e.g. the handpumps, they can contribute in the same way as in the current programmes with the community managed handpumps where the government pays 65% of the investment costs.
- Community sensitization is required about the option of a private handpump. People need to know about this option. And they need insight in the costs and possible revenue.
- Training is required for private owners of a water supply about water supply technologies, maintenance and dealing with financial management.
- Formal recognition and regulation of such private investors is necessary as they will be running water systems as businesses.

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Abbreviations

CBS	Central Bureau of Statistics
CDF	Community Development Fund
CDTF	Community Development Trust Fund
CIA	Central Intelligence Agency
DWO	District Water Office
D&S	Davis and Shirtliff
FAO	Food and Agricultural Organisation of the United Nations
FM	Financial Management
IRC	International Water and Sanitation Centre
KeFinCo	Kenyan-Finland Cooperation
KSh	Kenyan Shilling (1USD is ca. 80 KSh)
LVNWSB	Lake Victoria North Water Services Board
LVSWSB	Lake Victoria South Water Services Board
LVWSSP	Lake Victoria Water Supply and Sanitation Program
MP	Member of Parliament
MWI	Ministry of Water and Irrigation
NGO	Non-Governmental Organization
NWCPC	National Water Conservation and Pipeline Corporation
O&M	Operation and Maintenance
PHO	Public Health Office
RWS	Rural Water Supply
RWSN	Rural Water Supply Network
SDA	Service Delivery Approach
SNV	Netherlands Development Organisation
SKAT	Swiss Resource Centre and Consultancies for Development
SPA	Service Provision Agreement
SSA	Sub-Saharan Africa
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
WASREB	Water Services Regulatory Board
WHO	World Health Organization
WSB	Water Services Board
WSP	Water and Sanitation Program

1. Introduction

1.1 Research background

In the past decade many efforts have been made in order to meet Millennium Development Goal 7c: reducing by half the proportion of people without sustainable access to safe drinking water and basic sanitation, in the period 2000 to 2015. Working on this goal means improving people's health and well-being. Based on the last updates it can be said that the world is on track to meet the drinking water part of this goal. Nevertheless, some regions are lagging behind. Within these regions, particularly in Sub-Saharan Africa, most people with unimproved drinking water sources live in rural areas (UNICEF and WHO, 2012). This fact has motivated governments, non-governmental organizations (NGOs) and other entities to invest in safe water supplies for rural areas. Kenya, which is in the top ten of countries with the largest population without access to safe drinking water, is a good example of a country with large investments in rural water supply (RWS). But recent studies show that 57 percent of the past investments in rural water supplies in Kenya are unproductive (MWI, 2007). Infrastructure for safe water supply is implemented but after some months or years it does not function anymore. This low 'post-construction sustainability' of Kenyan rural water supplies is the subject of this Master Thesis.

1.2 Problem description

The situation where infrastructure for safe rural water supply is in place but does not function, is no exception in Kenya. For e.g. handpumps, a common water supply technology in rural Kenya, it is found that 30 percent of the existing handpumps does not function (RWSN, 2007). Causes for this low post-construction sustainability of rural water supplies are elaborated in more detail in chapter 3. Based on many studies, the financial factor turns out to be one of the major issues in the rural water sector (Lockwood and Smits, 2011). For that reason, the focus of the current study is mainly the financial part of sustainability. Financial sustainability includes amongst others tariff setting, money collection, actions against non-payment, bookkeeping and cost recovery (WSP, 2010). The finances are needed for the operation and maintenance (O&M), to keep the system functioning. For that reason, basic information on the service level and the O&M is also included.

Looking at rural water supply in Kenya, it differs per location who is the responsible person or institution for the finances. This responsible entity might be either the community, a local institute (like a school, church or hospital), the Kenyan government (Ministry of Water and Irrigation) or a private person (LVSWSB and LVNWSB, 2011). Each of these options comes with a different way of dealing with the financial management of the water supply. The Kenyan government and other supporting organizations (like SNV) wonder whether one of these 'management models' is more appropriate for achieving a higher financial sustainability of the rural water supply systems than another (SNV, 2011).

This appropriateness might also depend on the type of technology which is used for the water supply. Common technologies for rural water supplies in Kenya are handpumps or motorized pumps, used to pump groundwater from a well or borehole (LVSWSB and LVNWSB, 2011). For a handpump, a different management model might result in the best financial sustainability of the water supply, than for a motorized pump.

1.3 Objective and research questions

The current study aims to compare the financial sustainability of different combinations of technology type and management model, including also a basic comparison on technical sustainability. Two technology types are included, namely a ground water handpump and a ground water motorized pump. Three management models are included, namely community management, government management and private management. With the help of this comparative analysis, conclusions and recommendations on the financial sustainability of the technologies and the management models can be drawn. This input can be used by the Government of Kenya and other stakeholders who influence the way in which rural water supplies are managed.

The main research question which is used to reach the objective is:
In the context of rural water supply in Kenya, which management model is likely to have the best financial (and technical) sustainability and how does this depend on the type of technology that is used?

The following sub questions are used to answer this main question:

- *How does the financial (and technical) sustainability of a handpump depend on the applied management model?*
- *How does the financial (and technical) sustainability of a motorized pump depend on the applied management model?*
- *How does the financial (and technical) sustainability of a rural water supply service depend on the used technology type?*

1.4 Structure overview

Before the elaboration of the research questions this report starts with a chapter (2) with background information. This chapter includes general information about Kenya and information about rural water supply in Kenya, including the used water supply technologies and management models. Chapter 3 gives a literature review on approaches to RWS, on main indicators of RWS sustainability and O&M and on two management models for RWS. Chapter 4 describes the used methodology and chapter 5 presents and discusses the results of the data collection. The results are given per combination of used technology and used management model. Also the specific influence of the technology and the influence of the management model on the financial sustainability are discussed. The report ends with chapter 6, where conclusions are drawn and recommendations are given.

2. Background information

2.1 Kenya

Kenya is located in Eastern Africa, bordering the Indian Ocean (see map). With a surface area of 580,367 square kilometres and a population of about 41 million people, the population density is about 70 persons per square kilometre. The life expectancy at birth is 59 years and the population growth rate is 2.46% (CIA, 2011).

Kenya is independent from 1963 onwards (from the United Kingdom). Approximately 75% of the inhabitants of Kenya work in agriculture, the other 25% in industry and services. Most of the countries' income though comes from the services, related to tourism. Furthermore, Kenya exports products like tea, coffee, horticultural products, fish and cement (CIA, 2011).

Kenya is divided into five geographic regions, which partly go together with the provinces (see map). These regions are: the Lake Victoria basin, the Rift Valley and associated highlands, the eastern plateau forelands located just east from the Rift highlands, the semiarid and arid areas of the north and east and the coast (Britannica, 2011). The climate of Kenya varies from tropical along the coast to arid more inland. Most parts of the country have two rainy seasons, the 'long rains' from March to June and the 'short rains' from October to December. The highlands of Western Kenya have only one rainy season, from March to September. The average rainfall in Kenya is 630 mm, but it varies from less then 200 mm in northern Kenya to over 1800 mm around Mount Kenya (FAO, 2011).

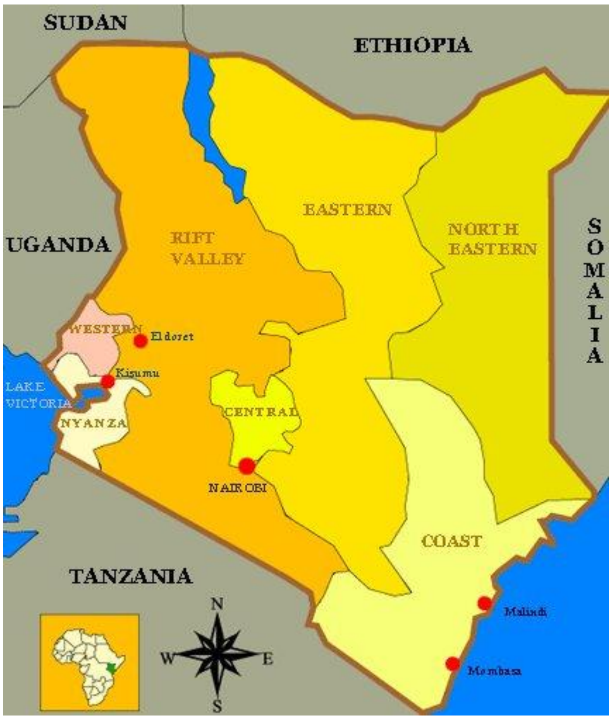

Figure 2.1 Map of Kenya (Kenya-Advisor, 2011)

2.2 Water supply in Kenya

The current activities in the Kenyan water sector are mainly guided by the Water Act 2002. This Water Act goes together with large reforms aiming at (amongst others) cost recovery by service providers and formalisation of service provision (MWI, 2002). The institutional structure of the Kenyan water sector is show in Figure 2.2. Drinking water supply in Kenya falls under the responsibility of the Ministry of Water and Irrigation (MWI) and eight Water Services Boards (WSBs), under the regulatory framework of the Water Services Regulatory Board (WASREB). The WSBs have the direct responsibility for the water supply in their region. The water provision itself is carried out by Water Service Providers. The WSBs and Water Service Providers have contracts with each other, called Service Provision Agreements (SPAs) (WASREB, 2011). Each WSB region is divided in districts and per district some office staff is organizing the local affairs from the District Water Office (DWO).

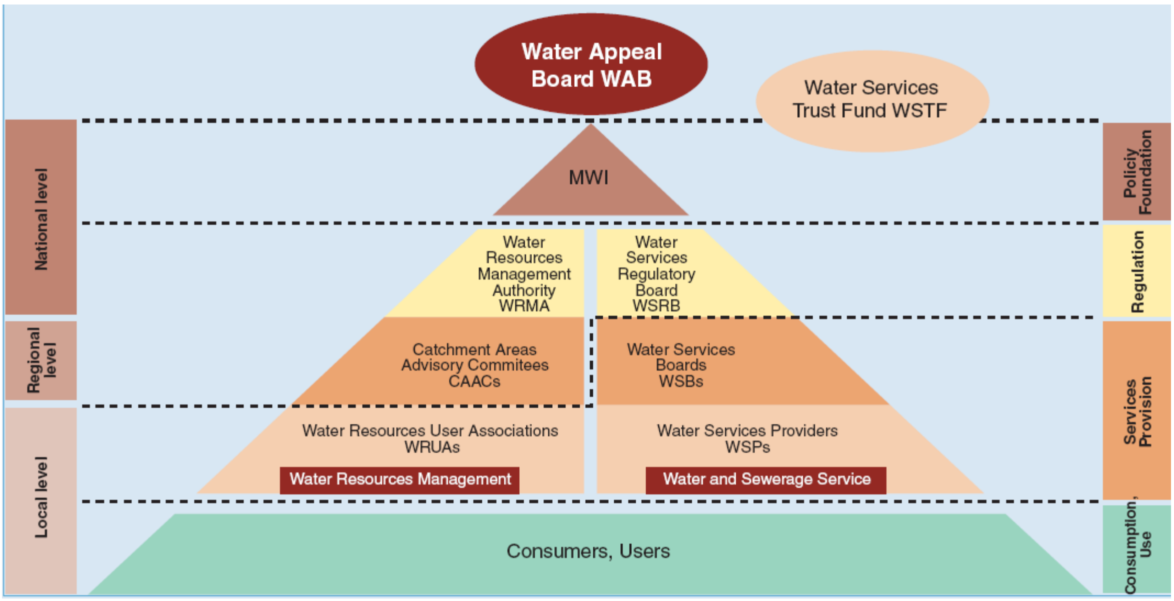

Figure 2.2 Functions and Roles of Institutions set up under Water Act 2002 ***(Kisima, 2008)***

78% of the inhabitants of Kenya live in rural areas of which 48% does not have access to safe drinking water (WHO/UNICEF, 2010b). The several types of drinking water sources which are used in rural Kenya can be found in Table 2.1. It is found that about half of the rural population in Kenya relies on groundwater. People get this groundwater either from a spring, a hand dug well without a pump, a well or borehole with a handpump or from a well or borehole with a motorized pump. In some cases extensions to a small piped network are in place.

Table 2.1 Drinking water sources in rural areas of Kenya (Kenya National Bureau of Statistics, in (WHO/UNICEF, 2010a))

Drinking water source	Percentage of rural population
Piped water	11.0
Public tap/standpipe	6.2
Tube well or borehole	9.7
Protected dug well	12.9
Protected spring	11.0
Rain water	2.4
Unprotected dug well	6.4
Unprotected spring	7.7
Tanker truck provided	1.1
Surface water	31.3
Other non-improved	0.3

The water supply in the rural areas is organized differently from the water supply in the urban areas. In the urban areas the water supply is centrally organized with usually a piped network and big WSPs are established to manage water systems as per the licence from the WSBs. In the rural areas several different ways of organizing the water supply are found. Many service providers exist which are operating informally without signing a service provision agreement (SPA) with the local WSB. Examples of these service providers are community based organizations, individual water vendors, non-governmental organizations (NGOs), institutions (churches and schools) and water kiosk operators (Tiwari and Bonaya, 2011). And there are also systems which are still owned and managed by the government of Kenya. According to the current reforms, the government wants to hand these systems over to official Water Service Providers, but this contracting process for rural water supply projects has not been realized as envisaged.

The current study is conducted in Western Kenya, in Nyanza Province and Western Province. This is almost the wettest region of Kenya, with rainfall varying from 1000 to 1800 mm per year (Britannica, 2011). The water supply in this region falls under the responsibility of two WSBs, namely Lake Victoria South WSB (LVSWSB) and Lake Victoria North WSB (LVNWSB). The offices of these WSBs are respectively based in Kisumu and Kakamega.

2.3 Rural water supply technologies

2.3.1 Spring

Within the rural areas of Western Kenya several technologies for water supplies are found. The first option is a spring, a location where the groundwater naturally comes to the surface. Some of these springs are permanent and some dry up in the dry season. Two types of springs are found, namely unprotected springs and protected springs. In the last case, the water source is encased in concrete and water flows out from a pipe instead of seeping from the ground (see Figure 2.3). After the construction of this structure, the O&M consists of keeping the surroundings clean and repairing pipings or cracks in the structure (Brikké, 2000). But in case of proper construction these repairs are hardly needed. At some locations a spring with a high productivity is used to supply water to a larger area with the use of pumps, lifted reservoirs and piped extensions.

2.3.2 Surface water

Surface water from a river, stream or lake. At some specific locations within Western Kenya, surface water is pumped and treated for urban water supply. In the rural areas the use of surface water does mostly include an individual drawing of water with jerry cans. The only O&M here is the cleaning of the jerry cans. Contamination from various kinds of household waste is a major challenge in case of surface water.

Figure 2.3 Protected spring (picture A. Adams)

2.3.3 Hand dug well

A hand dug well without a pump. These wells are found within the homesteads of the rural families. Water is manually drawn from these wells using a bucket with a rope. O&M requirements for this technology are cleaning of the well site and drain, repairing of apron (if present) and rehabilitating with gravel or piping material (Brikké, 2000). The last activity, rehabilitation, is very rarely needed. As the depth of a hand dug well is restricted, these wells are common in places with a high water table.

2.3.4 Well or borehole with handpump

Within the parts of Western Kenya where less springs and surface water sources are found, many handpumps can be found (LVSWSB and LVNWSB, 2011). A handpump is a simple technology to manually pump groundwater from a well or borehole. Several types of handpumps exist, but they are very similar. In Western Kenya most handpumps are of the Afridev type, see also Figure 2.4. The above ground part of such a handpump consists mainly of the pump stand and the pump head with a spout and a handle, based on a concrete platform. The features within the underground part can be found in Figure 2.5. Within the rising main a plunger is placed. This plunger is connected to the handle by one or more pumping rods. During the up-stroke, the plunger lifts water into the rising main and new water comes through the foot valve into the cylinder. During the down-stroke, the foot valve closes and water passes the plunger to be lifted during the next up-stroke (Brikké, 2000).

Small repairs for the handpumps include the replacement of worn cup seals and washers, straightening of pump rods and replacement of corroded lock nuts. Major repairs include the replacement of the pump rods, plunger, foot valve, cylinder, rising main or pump handle (Brikké, 2000). For a complete list of all wearing parts of the Afridev handpump including their replacement intervals, see Annex 1: Replacement intervals of AFRIDEV handpump wearing parts. A typical maintenance schedule for a handpump is given in Figure 2.6. The expected lifetime of a handpump is 10 to 15 years (SKAT-RWSN, 2007).

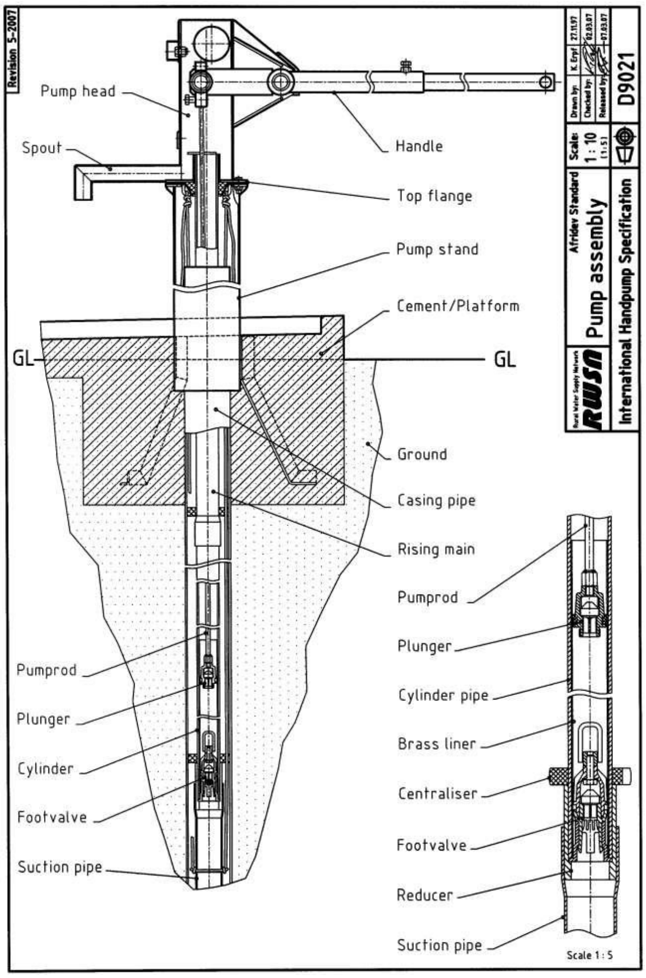

Figure 2.4 Handpump (picture A. Adams)

Figure 2.5 Afridev handpump features (SKAT-RWSN, 2007)

Daily:	■ Pump operation ■ Pump and base cleanliness ■ Wastewater drainage ■ Comments of users	**Weekly:**	■ Lubricate moving parts ■ Check tightness of nuts and bolts ■ Check security of pump on base
Monthly:	■ Check output rate ■ Check for condition of concrete base	**Yearly:**	■ Remove downhole assembly ■ Inspect and replace parts where necessary

Figure 2.6 Typical handpump maintenance schedule (Elson et al., 1999)

2.3.5 Well or borehole with motorized pump

The last technology which is found for rural water supply in Western Kenya is a well or borehole with a motorized pump, using either fuel or electricity as a source of energy. The common technology for this is a permanent submersible pump, used in a deep borehole (see Figure 2.9). Another option is a separate pump which is only put in the water source during the pumping hours. At wells or boreholes with a motorized pump, the water is pumped in a lifted reservoir tank with a pipe to the tap or to other extensions (see Figure 2.8). These motorised pumps can pump deep water and therefore more suitable when the water table is too low.

Daily operation of the motorized pumps requires some small activities like checking and refilling the fuel, start and stop the engine, checking and cleaning air filters and tightening of nuts and bolts. Other minor maintenance includes greasing, replacing filters and changing oil. Major maintenance includes the replacement of engine parts like the drive belt, nozzles, injectors, gaskets, bearings, or the fuel pump (Brikké, 2000). Figure 2.7 gives a more detailed overview of the maintenance activities for the situation where a fuel pump is used.

Activity	Frequency	Human resources	Materials and spare parts	Tools and equipment
Check liquid levels and add if necessary	Daily	Local	Fuel, engine oil, cooling liquid	Funnels, containers for liquids
Start and stop engine	Daily	Local		
Keep logbook	Daily	Local	Paper, pen	
Check air filter, clean or replace if necessary	Daily or weekly	Local	New dry paper filter, or kerosene and engine oil	Wrench
Check for oil and fuel leaks	Weekly	Local		
Tighten nuts and bolts	Weekly	Local		Spanners
Change engine oil	Every 250 hours	Local	Engine oil	Spanners
Clean or replace filters	Regularly	Local	Oil filter, fuel filter	Spanners, special tools
Decarbonize, clean injector nozzles, adjust valves, etc.	Every 500 to 2000 hours	Specialist		Spanners, brass wire brush, special tools
Replace drive belt	Regularly	Local	Drive belt	Spanners
Replace engine parts	Occasionally	Specialist	Nozzles, injectors, gaskets, bearings, fuel pump, etc.	Depending on part to be replaced
Repair engine mounting and housing	Occasionally	Local or area	Cement, sand, gravel, nuts and bolts, nails, galvanized corrugated iron sheets, wood, etc.	Trowel, bucket, hammer,chisel, saw, spanners, etc.

Figure 2.7 O&M Requirements for a diesel engine (Brikké, 2000)

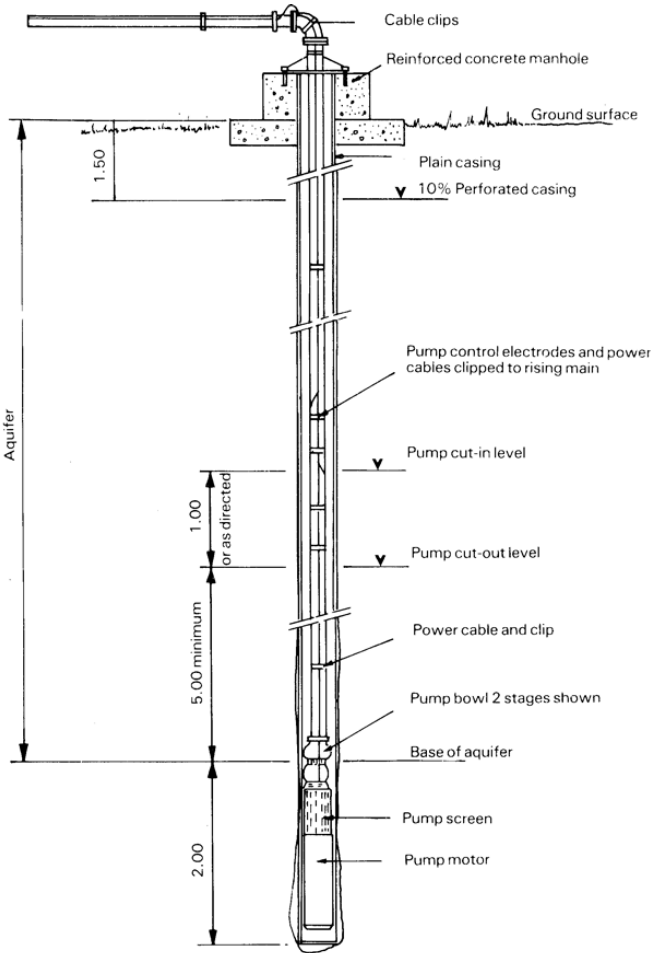

Figure 2.8 Water supply from motorized pump with elevated tank, generator house and tap (picture A. Adams)

Figure 2.9 Electric submersible borehole pump (Fraenkel, 1986)

2.4 Management models

The way in which the O&M and finances are managed differs per technology and per region. Five different management models for rural water supply in Western Kenya are found (LVSWSB and LVNWSB, 2011 and SNV, 2011).

1. Community management. This is the most common type of rural water supply management in Western Kenya and also in general in Sub-Saharan Africa. In this case an NGO or the Government of Kenya might have implemented the water supply and handed over the management to the local community. The community is fully responsible for all aspects of the water supply including the O&M and financial management. In most situations a small committee bears this responsibility.
2. Combined community and government management. This management model is comparable to the previous one, but in this situation the government still has a part of the responsibility. At some locations the water supplies are recently implemented and the government is still in de process of handing it over to the local community. At other locations the community is not found to be able to bear the responsibility and therefore the government did not completely hand over the water supply. Their technicians are still checking the pumps and conducting the repairs, although the community might pay for the spare parts.

3. Government management. Within this situation the whole management of the water supply is in the hands of the government, mostly executed by the local District Water Office. The existence of this management model is not according to the current Kenyan Water Act. This law states that water supplies should be handed over to communities or to private Water Service Providers. The reason that this type of management still exists, is that at some locations the government is not able to find people who are willing to take over the responsibility from them.
4. Public institution management. This includes water supply management by a school, church or hospital. This management model is common in Western Kenya. These water supplies are in first instance meant for the institution itself, rather than for serving the community. At some locations the water supply might serve the community, but it is often not the main purpose.
5. Private management. In this case a private person has his own water supply. In most cases these persons bought the pump themselves and after the installation they started selling water in order to make money out of it.

3. Literature review

3.1 Approaches of Rural Water Supply Management

In the last two decades of the previous century, rural water supply was largely provided by non-governmental and often non-national actors working under three basic (partly overlapping) principles and assumptions, namely (Lockwood et al., 2010b):

- Village Level Operation and Maintenance. This concept was introduced in the 1980s and related specifically to hand pumps or very small scale RWS. According to this concept, hand pumps should be easily maintainable, manufactured in-country, robust and reliable under field conditions and cost effective (Colin, 1999).
- Demand Responsive Approach. This concept was introduced in the early 1990s and its two main principles are: 1) water is an economic as well as a social good and should be managed as such and 2) water should be managed at the lowest appropriate level, with users involved in the planning (WSP, 2010). Within this approach consumer demands do guide the investment decisions. The more users make choices and commit resources in support of these choices, the more a project is demand responsive.
- Community Management. This concept is largely applied for rural water supply in Sub-Saharan Africa (SSA). Community management is 'a bottom-up development approach whereby community members have a say in their own development and the community assumes control – managerial, operation, and maintenance responsibility – for the water system' (Doe and Khan, 2004).

In summary it can be said that these approaches are mainly focused on implementation of water systems. But in many cases there has not been a good continuation after the implementation phase, mainly because of poor financial management and a lack of institutional follow-up support. Based on these lessons and new insights, a new approach on rural water supply is recently introduced. This approach is called the Service Delivery Approach (SDA). This approach 'emphasizes the entire life-cycle of a service, consisting of both the hardware (engineering or construction elements) and software required to provide a certain level of access to water' (Lockwood and Smits, 2011). Figure 3.1 shows differences between earlier approaches and the SDA.

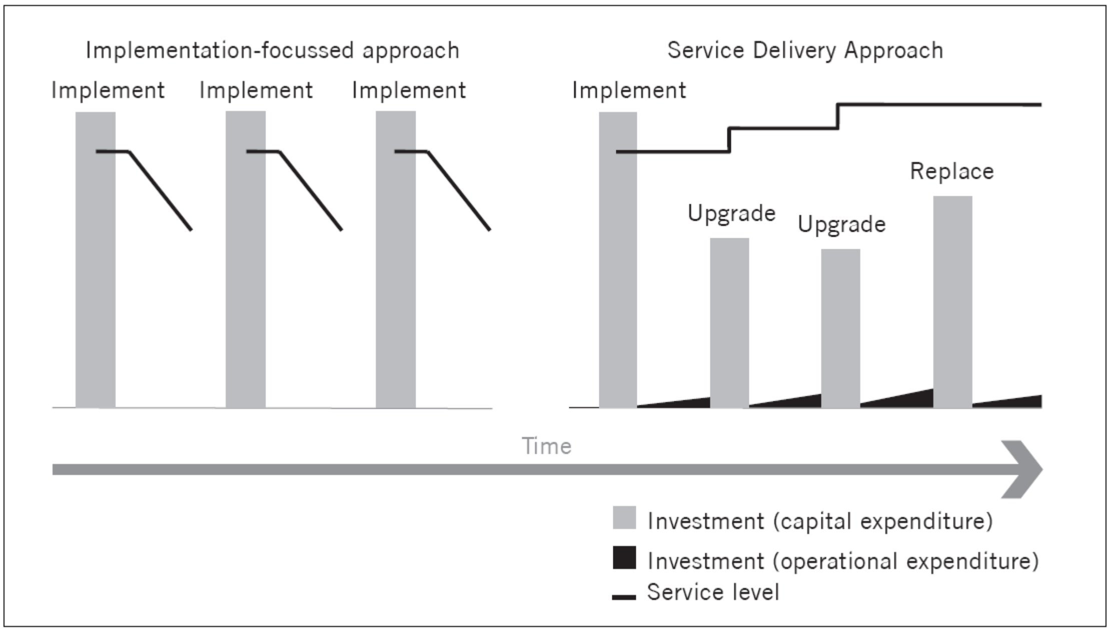

Figure 3.1 Water service delivery from the user perspective: repeated disappointment, or a Service Delivery Approach (Lockwood and Smits, 2011).

3.2 Sustainability of rural water supplies

3.2.1 General

A useful definition of sustainability of water systems is given within the framework of the Water and Sanitation Program of the World Bank (WSP), namely 'the maintenance of an acceptable level of services throughout the design life of the water supply system' (WSP, 2010). Determinants of sustainability include technical, institutional and social aspects, with sub-indicators and sources of data as indicated in Table 3.1. As mentioned in chapter 1, it is the financial management which is often mentioned as a major cause for the low sustainability of water supplies.

Table 3.1 Sub-indicators of sustainability (WSP, 2010)

Aspect	Sub-indicator	Source of data
Technical	Physical condition	Technical assessment
Institutional	O&M	Water committee interview
	Financial management	Technical assessment / water committee interview
Social	Consumer satisfaction	Household survey
	Willingness-to-sustain	Household survey

Apart from these general components of sustainability, in literature some practical issues are discussed which determine the sustainability of rural water supplies. According to the WHO Guidelines for Drinking Water Quality (WHO, 2011), the adequacy of a water supply is determined by:

- Water quantity. Basic access includes a water quantity of 20 litres per capita per day. Specific for drinking water, 2 litres per capita per day is estimated. Furthermore the water is used for food preparation, laundry and personal and domestic hygiene.

- Water quality. *E. coli* or thermo tolerant coliform bacteria must not be detectable in any 100 ml sample, the turbidity should be below 5 NTU and the water should have an acceptable color, odour and taste. Apart from these basic indicators, water can be tested on a whole range of chemical parameters (e.g. hardness, pH, metals, chlorides, etc.).
- Accessibility. Water should be accessible within one kilometre from people's homestead with a maximum round-trip of 30 minutes.
- Affordability. The costs of the water supply should be so that it is affordable for the households to use the water source. The costs should not make that people start using unimproved water sources or reduce their water quantities, which increases the health risks.
- Continuity/reliability. This is very important, since interruptions can make users using unimproved water sources. Several studies have indicated that interruptions are a cause for more diarrheal diseases (Majurua et al., 2010 and Hunter et al., 2009). The study of Hunter et al. (2009) even states that using unimproved water for a few days a year can make that almost all annual health benefits of the improved water supply are lost. The continuity is optimal if there are no interruptions in the water supply. Causes for interruptions can be power failure, excessive demands, engineering inefficiencies or seasonal variation in water availability.

3.2.2 Post-construction sustainability

A categorization of indicators for the post-construction sustainability of rural water supplies is found in a 'Literature Review and Desk Review of Rural Water Supply and Sanitation Project Documents' (Lockwood et al., 2010a). This study focuses specifically on post-construction sustainability of community managed projects and divides the contributing factors into the following five categories: 'technical', 'financial', 'community and social', 'institutional and policy' and 'environmental'. The list of factors that contribute to the post-construction sustainability of rural water supplies can be found in Annex 2: Factors for Post-Construction Sustainability of Rural Water Supplies. This list includes a rating of all factors in terms of critical importance for the post-construction sustainability.

The two factors which are given the highest critical importance rate are (1) an adequate tariff for recurrent costs and (2) external follow-up support. Related to the first factor the study states that cost recovery of rural water supplies is very problematic in many countries. Underlying factors for this problem are high poverty levels, lack of regular cash incomes and poor design of tariff structures. A study on water systems in Western Kenya mentioned the poor governance and mis-management of collected revenues by local water committees as a main cause for the low cost recovery (Tertiary International, 2012). Related to the second factor the study states that the need of external follow-up support is currently gaining broad acceptance within e.g. the World Bank but also within other water sector institutions. Such follow up support could come from any sources, such as private sector (supplying spare parts and technical services), local NGOs or government.

The following factors fall into the second level of critical importance for post-construction sustainability:

- Maintenance – preventive
- Spare parts availability
- Community management capacity
- User satisfaction, motivation and willingness to pay
- Continued training and support to sanitation and hygiene education interventions
- Water source production, quality and conservation

The two factors of this list with the most direct link to the finances are (1) the community management capacity and (2) the user willingness to pay.

User willingness to pay for water services, is widely discussed in literature. In a critical review of literature on willingness to pay for water services in low-income countries, different factors are mentioned which contribute to a low willingness to pay (Merret, 2002):

1. *where economic life is hard so that households need to take the greatest care over their domestic expenditure;*

2. *where there is a widely held view that certain public services should be free;*
3. *where persons or parties in political life give their support to non-payment;*
4. *where the quality of the public service is poor;*
5. *where the government is so manifestly corrupt that payments for public services are known to line the pockets of the power elite; and*
6. *where neither the government nor the public water utility is willing to exercise sanctions against non-payment because of the likely political and/or public health consequences.*

A recent research by SNV (Tertiary International, 2012), identified mis-management of water system or misappropriation of funds by local managers or water users committees as one of the key reasons for discouragement of local users to pay for water fees. As per the research in the study area, 52% and 69% of respondents cited this as a main reason fro not paying water fees in LVS and LVN WSB areas respectively.

3.2.3 Financial sustainability

In literature, a water system is described as being financially sustainable if there is full recovery of all costs (Cardone and Fonseca, 2003). After system construction these costs are the costs for operation and maintenance but also other cost for e.g. external governmental support. Figure 3.2 gives an overview of all cost components for a sustainable water service. Besides the cost components it gives an overview of possible sources of funding. For a water service to be financial sustainable, the total costs should match with the total available money.

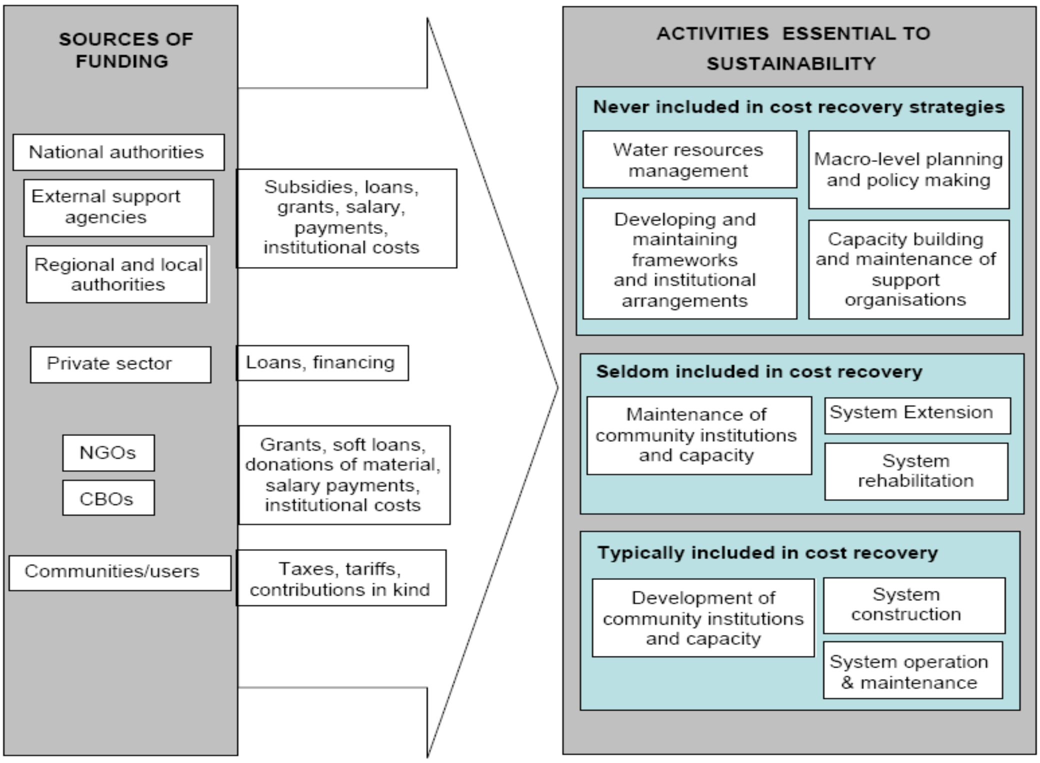

Figure 3.2 Sustainability requires the matching of ALL costs related to providing a sustainable service, with ALL the available sources of funding (Fonseca, 2003).

More specific principles for sustainable cost recovery are given in the WHO training package for O&M of rural water supply and sanitation systems (Brikké, 2000). The following seven key principles are given:

1. Identifying the cost implications of the project's characteristics and the environment
2. Maximizing the willingness to pay
3. Clarifying financial responsibilities
4. Optimizing operation and maintenance costs
5. Setting an appropriate and equitable tariff structure
6. Developing an effective financial management system
7. Organizing access to alternative financial sources.

The concept of financial sustainability is elaborated in more detail in the methodology chapter. That chapter explains the way in which the theory on (financial) sustainability is used in the practice of the research.

3.3 Operation and maintenance

Within the Water and Sanitation Program of the World Bank, the following definition of O&M is used: 'Operations refers to the daily management of the scheme (including pump operation, rationing, network surveying, recording and report writing), while maintenance deals with the activities that keep the system in proper working condition' (Castro et al., 2009). More specific, maintenance is 'the combination of all technical, administrative and managerial actions during the lifecycle of an item intended to retain or restore it to a state in which it can perform its required function' (EFNMS, 2011).

Three types of maintenance can be distinguished, namely (Harvey and Reed, 2004):

- Preventive: work which is planned and carried out on a regular basis to maintain and keep the infrastructure in a good condition. Its aim is an early detection of defects and avoidance of breakdowns or deterioration. Within rural communities this form of maintenance is often neglected. In an ideal scenario, active preventive maintenance is the main form of maintenance.
- Corrective/reactive: activities carried out as a result of breakdowns or infrastructure deterioration. This maintenance is mostly carried out because the system is not operating as intended. Rural communities mostly focus on this form of maintenance.
- Rehabilitation: activities carried out to correct major defects, in order to restore the water supply to its intended status.

In terms of finances, the costs for preventive maintenance are low, the costs for corrective maintenance are higher and rehabilitation is far more expensive than both other types.

The World Bank gives the following three key elements of O&M (World Bank, 2011):

1. An O&M plan including a task schedule with minimum: (i) activities; (ii) their frequency; (iii) who is responsible; (iv) the materials and spare parts needed; (v) the tools and equipment needed; and (vi) who covers the costs.
2. A policy for financing the O&M.
3. Training and capacity building for O&M.

3.4 Community management versus private management

3.4.1 Community management

One of the mentioned factors with a high critical importance for post-construction sustainability of rural water supplies, is the community management capacity. Insufficient community management capacity is a widely discussed problem. Within the community management concept, the community has the full control over the water supply system. But Harvey and Reed (2006) argue that community management can only be sustainable with appropriate institutional support, which is currently lacking in most cases. In their opinion, communities should get *'ongoing support from an overseeing institution to provide encouragement and motivation, monitoring, participatory planning, capacity building, and specialist technical assistance'*. They also distinguish between community participation and community management and they argue that the first is a prerequisite for sustainability and the second is not. The difference between participation and management is given in Figure 3.3.

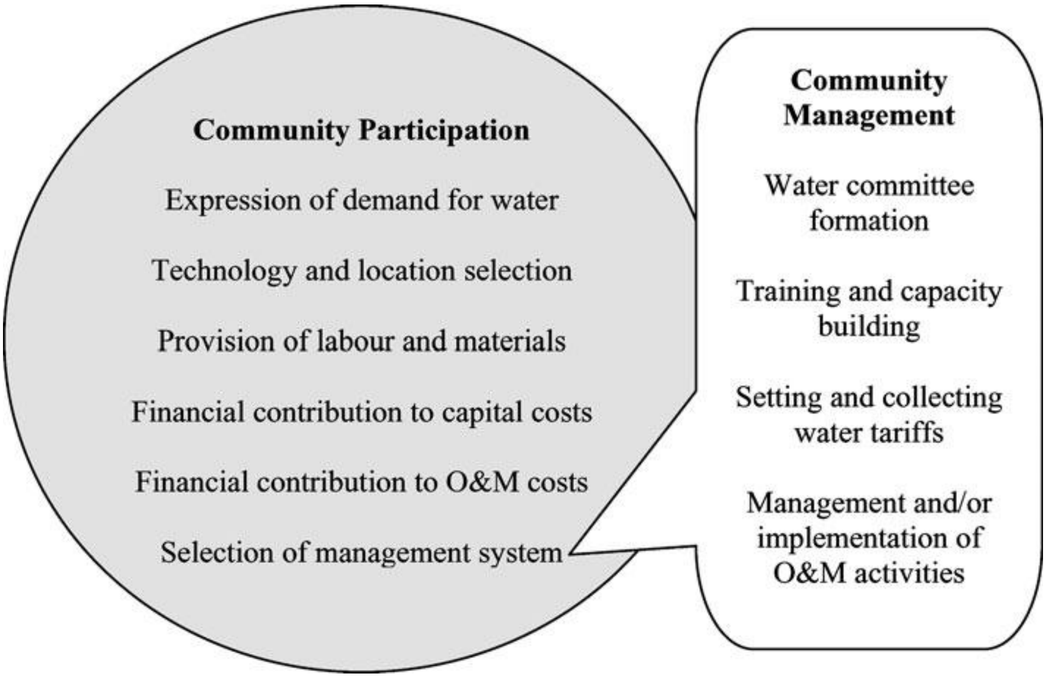

Figure 3.3 Segregated aspects of 'Participation' and 'Management' (Harvey and Reed, 2006)

Specific for handpumps, community management is a very common management option. But because of the O&M problems at the handpumps with community management, Baumann (2006) calls for a paradigm shift in how to tackle O&M. He is against the theory that communities can do everything by themselves and states that O&M is a shared responsibility between communities, local authorities and central government. Similar statements are found in many other documents that write about the O&M of rural water supplies (Harvey and Reed, 2006 and Lockwood et al., 2010a and Lockwood and Smits, 2011). The division of costs and responsibilities which Baumann proposes in his 'Community Management Plus' model is given in Table 3.2.

Table 3.2 Division of responsibilities and costs in Community Management Plus (Baumann, 2006)

Component	**Paid by**
Minor repairs including transport of mechanics	Community
Spare parts including transport	Community
Major repairs and borehole maintenance	Community 30% Local government 70%
Monitoring performance of individual facilities by the districts	Local government
Mechanics for conflict and problem resolution	Local government
Marketing social facilitation, retraining mechanics and communities	Local government
Monitoring performance of O&M system including supply chains	Central government

3.4.2 Private management

Compared to community management of rural water supplies, private management is totally different. In this situation the water system is owned by a private entity. The users pay this person or institution for the water and the owner on his turn is responsible for the O&M of the system. An advantage here is the clear ownership and responsibilities. In practice this management model often demonstrates very high levels of sustainability. *'There is a huge incentive for the owner to repair the pump rapidly since he or she is potentially losing money for every minute that the pump is out of operation'* (Harvey and Reed, 2004). But due to the high initial costs, this water supply option is not widely applied.

4. Methodology

4.1 Choice of technologies and management models

Within this study the financial sustainability of rural water supplies in Western Kenya, with different technology types and different management models, was evaluated. Not all the existing water supply technologies and management models were found to be relevant for this research. Rural water supply from springs, surface water and hand dug wells requires a minimum O&M and financial management. For that reason these technologies were not included in the current research, which focused on financial sustainability of rural water supplies. The two technologies which remain are a handpump and a motorized pump, both used to pump groundwater from a well or borehole.

Also in terms of management models, not all options were included in the current research. The institutional management was not included, because at these locations serving the community is not the first purpose. The other management models were included in the research, which are community management, community-government management, government management and private management. For government management only motorized pumps were included because a government managed handpump is hard to find in Western Kenya.

4.2 Data collection

All data was collected by interviewing the responsible persons per rural water supply system. On top of that a 20 liter jerry can of water was collected at the visited water supplies in order to see how the water supply works and what the discharge is. Water supplies in 11 districts were included. Figure 4.1 gives an overview of the visited districts. The districts were chosen in which water supplies of wells or boreholes with handpumps or motorized pumps are commonly found. This information, on which the choice for districts is based, was given by the people from the two WSBs who are responsible for the Rural Water and Sanitation Sector. The specific locations within the districts were chosen by the local District Water Officer. All visits of water supplies were accompanied by a person of the local DWO.

The questionnaire which was used at the interviews can be found in Annex 3: Questionnaire. At all locations the interview was done with the person(s) who is/are responsible for the finances and the O&M. In case of community management these persons were mostly members of the community committee which was assigned to deal with the water supply. In cases of community-government management, questions were asked both to the community members and the people of the DWO. In the cases of government managed water supplies the interview was done either with people from the

DWO or with the specific persons managing the water supply. In cases of private management, the interviews were done with the owner.

Table 4.1 gives an overview of the number of locations, per combination of technology type and management model.

Table 4.1 Number of combinations of water supply technologies and management models

	Handpump	**Motorized pump**	**Total**
Community	16	7	**23**
Community – Government	5	3	**8**
Government	-	7	**7**
Private	6	8	**14**
Total	**27**	**25**	**52**

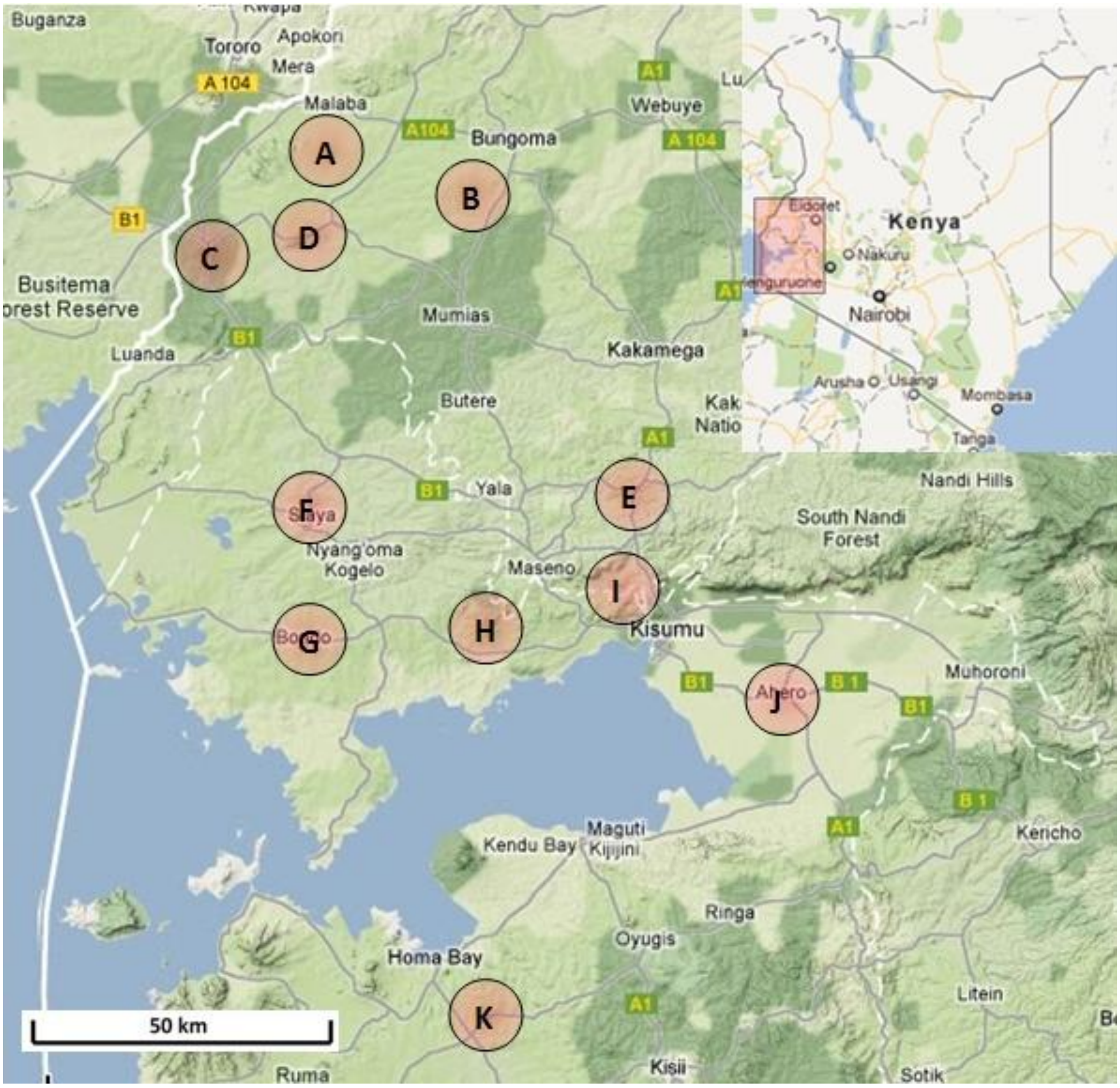

Figure 4.1 Visited districts, A-E in Western Province and F-K in Nyanza Province: A=Teso South, B=Bumula, C=Busia, D=Butula, E=Vihiga, F=Siaya, G=Bondo, H=Kisumu West, I=Kisumu East, J=Nyando, K=Homa Bay.

4.3 Choice of sustainability criteria

As explained in chapter 3, sustainability of rural water supplies can be divided in six different factors (WSP, 2010 and Lockwood et al., 2010a). Because of the focus on financial sustainability not all of these factors are (completely) included in the current analysis. See Table 4.2 for an overview of the sustainability indicators and the extent to which they are included in the analysis.

Because of the focus on financial sustainability, the financial management is the main indicator in the current study. Since the finances are needed for the O&M, to keep the system functioning, basic information on O&M and service level is also included. Part of the financial management is the collection of money. This is partly dependent on consumer satisfaction and willingness to sustain. But since a complete household survey is beyond the scope of this research these indicators are not included, apart from one question in the interview about reasons for non-payment. The last indicator is also not included, only the external financial support. But that specific part is included in the financial management indicator.

Table 4.2 ***Overview of sustainability indicators and extent of inclusion (WSP, 2010 and Lockwood et al., 2010a)***

Indicator	Description	Included in analysis
Financial management	How well is the system being managed financially?	Fully included - main part of the current study
O&M	Ability to maintain the system	Only basics included - detailed assessment required
Physical condition	System construction and functioning + water quantity and quality	Only basics included – detailed technical assessment required
Consumer satisfaction	Consumer satisfaction compared to the previous water source	Not included - household survey required
Willingness-to-sustain	User willingness to provide time + money + labour	Not included - household survey required
Institutional and policy	External support and supportive policies	Not included - detailed assessment required

With the help of existing studies (WSP, 2010 and Lockwood et al., 2010a and Rietveld et al., 2008), the included sustainability indicators are subdivided into 17 criteria. The criteria and their descriptions are given in Table 4.3. The criteria are subdivided into four categories, namely service level, O&M, financial management and cost recovery.

For all visited water sources, data on the mentioned criteria is used in order to judge the financial sustainability of the specific situation. The next section explains how these criteria are used in practice.

Table 4.3 Used sustainability criteria

	Criterion	Description
Service Level	System functioning	Is the system in function without problems?
	Water quantity	Is the water quantity sufficient?
	Walking distance	What is the longest distance from the water source to a user?
	Water quality	Are there problems with the water quality?
Operation & maintenance	Responsible person for daily operation and pump check	Is there a responsible person for daily operation and pump check?
	Responsible person for maintenance arrangements	Is there a responsible person for maintenance arrangements?
	Days to repair	How many days does it take between a breakdown and the repair?
Financial management	Responsible person for financial management	Is there a responsible person for the management of the finances?
	Water tariff	Is money collected on a regular basis?
	Differential tariff structure	Are the payments done per quantity of water?
	Bank account	Is the money put in a bank account?
	Bookkeeping	Are income and expenditures registered?
	Service cut-off for non-payment	Are defaulters excluded of the water service?
Cost recovery	% current in payment	Which percentage of the users is current with the payments?
	Tariff covers O&M	Is the money collection enough to cover the O&M costs?
	Can community replace the system	Is the responsible entity able to replace the system?

4.4 Application of sustainability criteria

The 17 criteria are given scores of 0 or 2 in case of two options and scores of 0, 1 or 2 in case of three options. Table 4.4 gives per criterion the reasons for assigning a certain score.

For all visited water sources these scores are assigned per criterion. After that the average score of all water sources per combination of technology type and management model and per criterion is taken. This value (between 0 and 2) is multiplied by 0.5, in order to get a number on the 0-1 scale. This makes it more convenient to analyze the results. In order to get a final score per category, the criteria per category are combined into one score. For this combining a weighing factor is assigned to every criterion. The applied weighing factors are given in Table 4.5.

Table 4.4 Score per used sustainability criterion

	Criterion	Score = 2	Score = 1	Score = 0	Comments
Service level	System functioning	Good	Small problems	No	Examples of 'small problems' include heavy pumping, leakages and parts which are about to break.
	Water quantity	Yes	Rationing required	No	'Rationing required' is about the dry season.
	Maximum walking distance (km)	<0.5	>0.5-1	>1	-
	Water quality	Good	Some problems	Bad	Problems include turbidity, salinity, rust or germs. Based on experience of interviewees.
O&M	Responsible person for daily operation and pump check	Yes	-	No	Examples of tasks: checking the pump, fuel and chemicals
	Responsible person for maintenance arrangements	Yes	-	No	Examples of tasks: contacting technician and buying spare parts.
	Days to repair	1-2	3-7	>7	-
Financial management	Responsible person for financial management	Yes	-	No	Examples of tasks: collecting money and keeping records.
	Water tariff	Yes	-	No	-
	Differential tariff structure	Yes	-	No	Meaning that water is paid per quantity.
	Bank account	Yes	-	No	-
	Bookkeeping	Yes	Incomplete	No	-
	Service cut-off for non-payment	Yes	-	No	-
Cost recovery	% current in payment	>90%	50-90%	<50%	-
	Tariff covers O&M	Yes	-	No	Based on income versus required expenditures and use of external funding sources.
	Can community replace the system	Yes	Doubtful	No	Based on income versus expenditures and on expectation of interviewees.

Table 4.5 Applied weighing factor per criterion

Criterion		Weighing factor
Service level	System functioning	0.2
	Water quantity	0.4
	Maximum walking distance	0.3
	Water quality	0.1
	Sum of service level factors	*1.0*
O & M	Responsible person for daily operation and pump check	0.2
	Responsible person for maintenance arrangements	0.3
	Days to repair	0.5
	Sum of O&M factors	*1.0*
Financial management	Responsible person for financial management	0.2
	Water tariff	0.2
	Differential tariff structure	0.1
	Bank account	0.1
	Bookkeeping	0.2
	Service cut-off for non-payment	0.2
	Sum of financial management factors	*1.0*
Cost recovery	% current in payment	0.3
	Tariff covers O&M	0.5
	Can community replace the system	0.2
	Sum of cost recovery factors	*1.0*

5. Results and discussion

5.1 General data

The current study includes 27 handpumps and 25 motorized pumps. General information on these handpumps and motorized pumps can be found in Table 5.1.

Table 5.1 General data on visited water supplies

	Handpumps	**Motorized pumps**
Total number	27	25
Number per district	A:2, B:1, C:6, D:1, E:0, F:3, G:7, H:4, I:0, J:2, K:1	A:2, B:3, C:0, D:1, E:2, F:5, G:2, H:2, I:2, J:1, K:5
Depth of water source	8-75 m, average 24 m	18-130 m, average 76 m
Installation year	1985-2011, average 2000	1979-2010, average 2000
Population served	150-1200, average 321	100-10000, average 1872
Costs per user per year	1-89, average 26 KSh	24-628, average 242 KSh
Maximum walking distance	0.5-5 km, average 1.6 km	0.2-5 km, average 2.4
In function	26, 7 with problems	23, 1 with problems
Water quality	12 no data / 10 good / 5 problems	6 no data / 14 good / 5 problems
Water quantity sufficient	19	21

Looking only at these general data it is remarkable that at eight handpumps and at four motorized pumps the water quantity is not sufficient. A handpump is meant for about 250 users, but at 10 of the 27 locations the amount of users was above 250. On top of that, the walking distances are long. Based on these three facts, it can be concluded that there are not enough water sources in the research areas.

5.2 Outcome sustainability criteria

To each combination of technology type and management model a character is assigned. These characters are given in Table 5.2. The average output per sustainability criterion and per combination is given in Table 5.3. The criteria are divided into four categories namely service level, O&M, financial management and cost recovery. Per category a weighted score is given, using the weighing factors as given in chapter 4. Table 5.4 gives an overview of the averages of total yearly income and total yearly recurrent costs.

With the help of Table 5.3 and Table 5.4 it is possible to make a quick comparison between two or more combinations of technology and management model, based on one or more of the criteria and on the yearly income and expenditures. In the next sections all combinations of technology and management model will be analyzed in more detail. An overview of all collected data (which was the input for Table 5.3 and Table 5.4 can be found in Annex 4: Overview collected data.

Table 5.2 Assigned character per combination of technology and management model

	Community	Community – Government	Government	Private
Handpump	A	B	-	C
Motorized pump	D	E	F	G

Table 5.3 Output sustainability indicators for combinations A-G

	Criterion	Factor	A	B	C	D	E	F	G
Service level	1. System functioning	0,2	0,81	1,00	0,75	0,86	1,00	0,93	0,94
	2. Water quantity	0,4	0,84	0,80	0,75	0,79	1,00	0,79	0,81
	3. Maximum walking distance	0,3	0,31	0,00	0,83	0,00	0,33	0,20	0,38
	4. Water quality	0,1	0,67		1,00	0,80	1,00	1,00	0,79
	Weighted service level score		**0,66**	**0,58**	**0,80**	**0,57**	**0,80**	**0,66**	**0,70**
O&M	6. Responsible person for daily operation and pump check	0,2	0,44	0,20	0,67	1,00	0,67	1,00	1,00
	7. Responsible person for maintenance arrangements	0,3	0,69	0,80	0,83	1,00	0,67	1,00	0,88
	8. Days to repair	0,5	0,31	0,00	0,67	0,50	0,00	0,30	0,25
	Weighted O&M score		**0,45**	**0,28**	**0,72**	**0,75**	**0,33**	**0,65**	**0,59**
Financial management	9. Responsible person for financial management	0,2	0,81	1,00	0,50	1,00	0,67	0,86	0,63
	10. Water tariff	0,2	0,63	1,00	1,00	1,00	1,00	0,86	1,00
	11. Differential tariff structure	0,1	0,00	0,60	1,00	1,00	1,00	0,86	1,00
	12. Bank account	0,1	0,40	1,00	0,17	1,00	0,50	0,86	0,38
	13. Existence of bookkeeping	0,2	0,44	0,80	0,33	0,86	0,50	0,79	0,50
	14. Service cut-off for non-payment	0,2	0,25	0,40	0,83	0,57	1,00	0,86	0,63
	Weighted financial man. score		**0,47**	**0,80**	**0,65**	**0,89**	**0,78**	**0,84**	**0,69**
Cost recovery	15. % current in payment	0,3	0,20	0,60	0,75	0,50	0,75	0,57	0,75
	16. Tariff covers O&M	0,5	1,00	0,00	1,00	0,71	0,00	0,14	0,75
	17. Can community replace the system	0,2	0,25	0,10	0,92	0,42	0,00	0,43	0,69
	Weighted cost recovery score		**0,61**	**0,20**	**0,91**	**0,59**	**0,23**	**0,33**	**0,74**

Table 5.4 Average income, recurrent cost and costs per user in KSh per year (100 KSh = 1.18 USD)

	Income	Recurrent costs	Income – costs	Costs per user
A	6400	6200	200	17
B	8000	9700	-1700	15
C	47500	11000	36500	53
D	243000	169000	74000	243
E	No data	No data	-	-
F	531000	729000	-198000	272
G	170000	88300	81700	209

5.3 Comparing management models for handpumps

5.3.1 Community management

Community management is the most common management model for handpumps in Western Kenya (LVSWSB and LVNWSB, 2011). The main reason for this is the fact that handpumps are mostly implemented by NGOs or government entities, who focus on serving the whole community and not a single private person (Harvey et al., 2003). After the implementation they hand over the management to the community.

The community managed handpumps have a medium score for service level and cost recovery and low scores for O&M and financial management. The pumps were functioning well and the water quantity was sufficient. The only backside in terms of service level was the walking distance from the users to the water point (an average maximum walking distance of 1.7 kilometres). The O&M score was low because the responsibility for daily operation and pump check was not clear and the time between a breakdown and a repair was three or more days. The costs per user were low (on average only 17 KSh per user per year).

The low score for financial management had several reasons:

- Only ten out of the sixteen locations did have a water tariff. At the other locations money was only collected when a repair was needed. This resulted in a long delay between the breakdown and the repair. Someone had to go around making people contribute to the repair. This takes time and results in a situation where not all users contribute. The handpumps at the location without a water tariff where on average two years older than the handpumps at the locations with a water tariff. A water tariff had been in place during the first years of use, but over time the collection of money was neglected and stopped.
- In the cases with a water tariff, this money was paid per month. People could use as much water as they wanted, without paying extra money.
- In the rainy season the handpumps were hardly used because people collected the rainwater and in these months users did not pay their monthly contribution.
- Only at nine of the sixteen locations there was a bank account to save the income from the water.
- At twelve of the sixteen locations there was no or only incomplete bookkeeping. During the implementation phase somebody might have been appointed to keep records, but only at four locations the records were still kept completely.
- At twelve of the sixteen locations there was no service cut-off for non-payment. Community members understood people's financial problems and did not want to exclude their fellow community members from using the water source. The responsible person continued to bother the defaulters, but without any further consequence in case of non-payment. And the fact that the tariff was not paid per amount of water means that there was nobody (like a money collector) at the handpump to check who takes water.

Only at one of the locations more than 90% of the users was current with the payments and at ten locations less than 50% of the users was current with the payments. Both in the situations with the monthly water tariff and in the situations without the tariff, there were many problems with the payments. Water was considered to be a free good. You can either use it straight from nature or with the help of free technologies brought by the government or NGOs. And the fact that there was hardly any consequence for non-payment did also not motivate people to pay. On top of that it happened that the users did not trust the money collector. They expected or knew that this person did not use all money for the handpump and therefore they did not want to pay.

Although the bad payments, the score for cost recovery was not low. The payments were just enough for the daily operation and minor maintenance. The average yearly income at the community managed handpumps was 6400 KSh and the average yearly costs for small maintenance was 6200 KSh. In general there was almost no saving of money. Therefore it would not be possible to conduct major repairs (a new pump rod for example is about 3000 KSh (UNICEF, 2011a)). It is notable that despite of the bad payments the collected money was enough to cover the O&M costs. The cause for this was in first instance the low O&M costs. Twelve of the sixteen handpumps were less than five years old. In these first 5 years only small parts like rubbers need to be replaced. Replacement of more expensive parts like pumprods, centralizers and footvalve, occurs normally only later than five years after implementation.

At nine of the locations the current handpump was not the first pump. At only one of these locations the community paid the new pump, which took three years to collect enough money. At the other locations the community got help from either a government fund or from an NGO in order to get a new pump. It seems that this is the normal course of business: a community uses a handpump until the time of a major breakdown. From then they wait for assistance from the government or an NGO or they search themselves for external funding sources.

One last remarkable thing is what happened with the collected money from the water tariff. At the locations with the water tariff a management committee was in place which was also conducting other community projects. Examples of these projects were farming projects or other small businesses. This can have both positive as negative consequences. The positive part is that the community makes money with those projects which can become available for the O&M of the handpump. The negative side is that at the moment that money is needed for the handpump it might be used already for other purposes. For that reason it might be better to keep the money for the water separate from money for other projects.

5.3.2 Combined community and government management

Handpumps with a combined community and government management is not a common situation in Western Kenya (LVSWSB and LVNWSB, 2011). All five included handpumps with this management type where implemented with a joint program of the Kenyan Ministry of Water and Irrigation and UNICEF. After implementation, the government wanted to hand over the management to the local community. The visited handpumps within this category were less than two years old and the management was still not handed over completely. The people of the DWO were still doing the regular pump check and conducting the repairs. The community did only pay for the spare parts, thus not for the labour of the DWO technicians.

The combined managed handpumps got a good score for the financial management, a medium score for service level and a low score for O&M and cost recovery. The service level scores were in general good, apart from the average maximum walking distance of 2.7 kilometres. The O&M score is low because the responsibilities were not clearly defined. It was not clear which tasks belong to the DWO and which tasks belong to the community. This resulted in long delays in repairs.

The financial management scores were good. The responsibilities were clearly defined; there was a community committee with a chairman, a secretary and a treasurer. There was a water tariff at all locations, there was a bank account and bookkeeping was done. The downsides of the combined managed handpumps were the non-differential tariff and the fact that only at two of the five locations there was a service cut-off for non-payment. The reason for this was the same as at the community managed handpumps.

The yearly income at the combined managed handpumps was lower than the yearly recurrent costs (respectively 8000 and 9700 KSh per year). The costs for the technicians for pump check and repair were paid by the government. The communities expected not to be able to realize major repairs or full replacement on the long term.

It is not clear whether the more positive financial management score of community and government managed handpumps compared to the community managed handpumps is related to the age of the handpumps. In the cases with community managed handpumps, the situation was better in the first years but deteriorated slowly. In first instance the appointed community committee took their tasks seriously, but over time they neglected the money collection and the maintenance more and more. This fact makes it likely that the higher financial sustainability for the combined managed handpumps is related to the short period that the handpumps were in use. They were still under supervision of the DWO people and the communities were still active in money collection and bookkeeping. But it is not clear whether this situation will continue in the coming years or whether it will deteriorate like in the situations of the fully community managed handpumps.

5.3.3 Private management

Privately managed handpumps are also not common in Western Kenya (LVSWSB and LVNWSB, 2011). In total six handpumps with this management type were included and on average the sustainability criteria scores are higher than for the community managed and combined managed handpumps.

The service level and the O&M score were good, although the responsibilities for daily operation and pump check are not clear at two of the six locations. Compared to the other two management models for handpumps, in the case of a privately managed handpumps there was less time between a breakdown and a repair. A reason for this might be that the money collection was good and that the money from the water was a source of income for the household, which falls away in case of a breakdown. The costs per user per year are higher than at the other handpumps.

A differential water tariff was in place at all privately managed handpumps and at five of the six locations it was not possible to take water if you did not pay. But still the financial management score is only 0.65. The reason for this is that at private managed handpumps there is no specific bank account for the water issues and bookkeeping was only properly done at one of the five locations. The fact that people paid per quantity of water made it also less logical to keep records, since there were no 'members' who had to pay per month.

The cost recovery score for the privately managed handpumps is high. The payments for the water were good and this money was enough to cover the O&M costs. On top of that at five of the six locations it was expected that there would be even enough money to conduct a major repair or full replacement. The average yearly costs at the privately managed handpumps was 11,000 KSh. This is higher than at the community managed handpumps because more attention is paid to the maintenance and spare parts are replaced more often. The average yearly income is 47,500 KSh, which is considerably higher than at the community managed handpumps. This income results in a situation with enough money for regular O&M, replacement and extra profit.

5.3.4 Conclusions and discussion

Table 5.5 gives a summary of the sustainability scores for the handpumps. The combined managed handpumps scored lowest, apart from the financial management. The community managed handpumps scored slightly higher, with mostly medium scores but a low score for financial management. The privately managed handpumps scored medium on financial management but high for the other criteria, especially for the cost recovery.

Table 5.5 Summary of sustainability scores for handpumps

	A	B	C
Service level	0,66	0,58	0,80
O&M	0,45	0,28	0,72
Financial management	0,47	0,80	0,65
Cost recovery	0,61	0,20	0,91

Looking at the community managed handpumps, the most striking matter was the trouble with the payments. The users were not willing to pay for the water and the communities did really have difficulties with making people pay. In chapter 3 several factors are given which contribute to a low willingness to pay for water (Merret, 2002). Especially the first two of these reasons *('where economic life is hard so that households need to take the greatest care over their domestic expenditure'* and *'where there is a widely held view that certain public services should be free')* were mentioned in the interviews as reasons for people not to pay. The fifth reason *('where the government is so manifestly corrupt that payments for public services are known to line the pockets of the power elite')* was not given in this way, but in the way that the money collector was using the money for personal purposes. The last reason *('where neither the government nor the public water utility is willing to exercise sanctions against non-payment because of the likely political and/or public health consequences')* was not given by the interviewees but from the collected data it is clear that at locations without consequences for non-payment the payments were also worse. On top of these six reasons, there is the fact that people are not willing to pay because of other options of taking water from free (unprotected) water sources.

Although the first two reasons remain in the cases of handpumps with private management, the payments were better in these cases. People were not allowed to take water if they did not pay, so there was simply no option of non-payment. People who were not willing to pay did not use the water source.

Because of the bad payments at the community managed handpumps, there was just enough money for the regular O&M. But it is questionable whether the collected money will also be enough in case of major repair. And in case of full replacement (10-15 years after implementation) there will surely not be enough money.

At the private managed handpumps there was enough money for the O&M and also replacement was not expected to be a problem. The payments were good and the owners of the handpumps made profit with selling water. But apart from that, only people who are not really poor can afford to implement an own handpump. The owners did also have income from other activities, so even in case that the money collection from the water was not sufficient, they expected to have enough money for a new handpump.

Although the payments were better if there is service cut-off in case of non-payment, this fact is not only positive. In case of service cut-off, people use unimproved water sources instead. Western Kenya is a region with enough water and many options to take free water from unimproved water sources. Using these water sources has a negative impact on public health. Also the higher costs per user at the private managed handpumps makes it more likely that people decide to use unimproved water sources.

Another backside of private management is the cost of investment before you can make profit out of it. This investment is a barrier for a private person to start an own water supply. The investment for the handpump itself is about 65,000 KSh, which can be recovered in two years in case of an average profit of 35,000 KSh per year. But apart from the handpump itself, there is the cost for the well itself including the concrete construction. The total costs for this are estimated to be between 250,000 and 500,000 KSh, depending on the type and depth of the well or borehole (Harvey et al., 2003 and UNICEF, 2011b)

Based on above conclusions, the following recommendations can be given:

1. Training is required in order to make the users aware of the importance of clean drinking water and the need of paying for the water.
2. Community management committees need training in order to understand the importance of a service cut-off in case of non-payment and to apply this measure effectively.
3. The current form of combined community and government management has negative consequences for the time between a breakdown and a repair. It is recommended that the responsibility for daily operation, pump check, maintenance arrangements and financial management are handed over completely to the community committee. The government can only help in case of major repairs and the government can be responsible for monitoring of the performance, conflict resolution and retraining of mechanics and communities (like Baumann (2006) states).
4. Private management for handpumps got good results in terms of financial sustainability. In order to deal with the barrier of the investment costs, the government can invest in such projects in the same way as they invest in the community managed handpumps.

5.4 Comparing management models for motorized pumps

5.4.1 Community management

The community managed motorized pumps scored low on service level, good for O&M and financial management and medium on cost recovery. The reason for the low service level is the long walking distance, the maximum walking distance was on average 3.1 kilometres.

At all the seven included motorized pumps with community management, a well-organized community committee was in place. The responsibilities for O&M and finances were clarified, there was a (differential) water tariff, they had a bank account for the income from the water and they kept records of the income and expenditures.

But at three of the seven locations less than 50 percent of the users was current with the payments. At these locations there were extensions to houses and users got a monthly bill. The bad payment resulted at only one of these locations in a situation where there was not enough money for the regular O&M. For the locations without extensions there were also two cases where the income was not sufficient for the O&M. At these locations, only a few people used the water supply so that the income was too low to cover the costs. The yearly recurrent costs at the community managed motorized pumps were on average 169,000 KSh and the average yearly income 243,000. The average costs per user per year were 243 KSh.

Comparable to the community management for handpumps, also at the motorized pumps the communities had difficulties with a service cut-off for non-payment. The committee does not want to exclude the fellow community members of using the water supply. And another comparable point is that also at the motorized pumps, the communities were not able to replace the system. In case of a major breakdown they were dependent on government funds or other donors.

5.4.2 Combined community and government management

Only three locations with a combined community and government managed motorized pump were included. These motorized pumps scored good for service level and financial management and low for O&M and cost recovery. The government was still doing a part of the tasks because the community was not yet able to manage the water supply on its own. These locations were in the process to the community management. But the maintenance still took place via the DWO, which was a long lasting process for every repair. This was partly caused by the fact that there was not enough clarity about the responsibilities for the O&M and finances related tasks like checking the system, calling a technician, collecting money and keeping records. But still the score for financial management was good because a (differential) water tariff was in place and there was service cut-off for non-payment.

At all combined managed motorized pumps, financial problems occurred. One of the systems was in the starting up phase and at the other two locations the amount of users was low. The systems could supply water for a few thousands of people, but in these situations only a few hundred people were using the water service. This resulted in a low income and a lack of money both for the O&M and surely also for a replacement. The government was still paying where the income from the water was not sufficient. Specific data on recurrent costs per year at the combined managed motorized pumps, were not available.

The reason for the low amount of users differs per location. At one location there were many other water sources, like handpumps, with cheaper water. At another location the people used to pay a fixed amount per month and after the water tariff was changed to a price per quantity of water, they went to other water sources.

Figure 5.1: Example of a 'water office' where users have to pay their monthly bill (picture A. Adams)

5.4.3 Government management

Seven government managed motorized pumps were included, of which five had extensions to houses. The motorized pumps with government management scored good on O&M and financial management, medium on service level and low on cost recovery.

For O&M and financial management, the scores were positive: clarified responsibilities both for O&M and for financial management, a differential water tariff, a bank account, reasonable bookkeeping and after some time a service cut-off in case of non-payment. But at the locations with house connections, there were many defaulters. Users were not willing to pay. After their debts reached a certain point, they were disconnected. Or the users just paid a small part of their debts in order to avoid disconnection. In the end, the total income from the water was low. But still the same amount of employees remained, with all a good standard government salary. This resulted in a situation with high costs and low income. At six of the seven locations the income from the water tariff was lower than the costs. The average yearly income was 530,000 KSh while the average yearly costs were 730,000 KSh. The costs per user per year were on average 272 KSh. The systems continued to work because the government paid for the extra costs.

Another problem with the government management was the time it took to conduct repairs. All the income first went to the central Water Services Board and all costs were paid from there. But in case of a breakdown, a proposal for the repair had to be written before the money for the repair became available. This could take weeks up to months.

5.4.4 Private management

Eight boreholes or wells with a motorized pump and private management were included, of which only one had extensions to houses. The systems scored high for cost recovery and medium for the other factors. At the privately managed locations the payments were better than at the other motorized pumps. The water was sold per quantity and most people paid. At three locations not all people paid, the owner did not want to exclude people with financial problems from using his water source. The good payments resulted in an average yearly income of 170,000 KSh (209 KSh per user per year). This money was enough to cover the recurrent costs (on average 88,000 per year) and to make profit out of it. Also replacement was at five of the eight locations not expected to be a problem.

5.4.5 Conclusions and discussion

Table 5.6 gives a summary of the sustainability scores for motorized pumps. The combined managed motorized pumps got the lowest scores, especially on O&M and cost recovery. The government managed motorized scored also low, especially on cost recovery. The community managed and private managed motorized pumps scored better. The community managed ones scores especially high on O&M and financial management and the private ones on cost recovery.

Table 5.6: Summary of sustainability scores for motorized pumps

	D	E	F	G
Service level	0,57	0,80	0,66	0,70
O&M	0,75	0,33	0,65	0,59
Financial management	0,89	0,78	0,84	0,69
Cost recovery	0,59	0,23	0,33	0,74

In terms of cost recovery it is notable that the combined managed and the government managed motorized pumps have low scores of respectively 0.23 and 0.33. At the government managed pumps the payments were bad, but also at the combined managed handpumps, the income did not cover the costs. This situation is understandable because the government wanted to hand over all water supplies and remained only with the systems which were not profitable enough to hand over to a company or community. At these water supplies there were problems with the payments, high costs for O&M (including staff salaries) and too few users to covers the costs. On top of that there were large delays in maintenance due to the bureaucratic government system.

Comparing the other two management options for motorized pumps, community management and private management, the financial situation is better at the privately managed water supplies. The people at the locations with the community management, take their water business tasks more serious (with a special bank account and bookkeeping of income and expenditures), but this does not result in a better financial situation. There are many problems with the payments at the community managed motorized pumps. These problems occur mainly at the locations with house connections (for community management three of the seven locations). Of the privately managed motorized pumps, only one of the eight locations had house connections. This difference in amount of house connections explains the worse payments at the community managed locations. At the privately managed motorized pumps, the absence of proper bookkeeping and a bank account for the income from the water resulted in the lower score for the financial management.

In terms of possibilities for replacement the privately managed systems score higher than the community managed ones. At the community managed motorized pumps there were not enough savings for a replacement. At the privately managed motorized pump, only at two of the eight locations financing a replacement is not expected to be possible.

In literature it is found that community management is more suitable for small water supplies than for bigger water supplies (Kleemeier, 2000). But in the current study, community management scores higher here at the motorized pumps than at the handpumps. Apparently the communities take more initiative in organizing themselves in case of a motorized pump, compared to the situation with a handpump.

Based on above conclusions, several recommendations can be given (of which some are similar to the ones for the handpumps):

1. Community management committees need training in order to understand the importance of a service cut-off in case of non-payment and to apply this measure effectively.
2. The current form of combined community and government management has negative consequences for the time between a breakdown and a repair. It is recommended that the responsibility for daily operation, pump check, maintenance arrangements and financial management are handed over completely to the community committee. The government can only help in case of major repairs and the government can be responsible for monitoring of performance, conflict resolution and retraining of mechanics and communities (like Baumann (2006) states).
3. It seems that the government managed motorized pumps are in a quite hopeless situation with enormous costs and bad payments. It is not clear how this situation can be changed.
4. Private management for motorized pumps got good results in terms of financial sustainability. In order to deal with the barrier of the investment costs, the government can invest in such projects in the same way as they invest in the community managed motorized pumps. On top of that, both technical and administrative training is recommended for private water service providers.

5.5 The influence of the technology type on the financial sustainability

At the motorized pumps, the yearly costs per user were high. These high costs were mainly the costs for the fuel or electricity. The average O&M score for the motorized pumps was medium. The responsible entities were well organized, but still the period between a breakdown and a repair was long. At the motorized pumps the need to be organized is high because there are always people needed for the daily operation (pump check, fuel refill, etc). The financial management score at the motorized pumps was high. There was a differential water tariff, a bank account, bookkeeping and service cut-off in case of non-payment. The cost recovery score was low for the motorized pumps. Although the payments were better than at the handpumps, at 13 of the 25 motorized pumps, the income was not enough to cover the high costs for O&M.

Table 5.7 gives the average scores for all criteria per technology. The handpumps score high on service level, low on O&M and financial management and medium on cost recovery. The motorized pumps score low on service level and cost recovery, medium on O&M and high on financial management. The costs per users per year are about nine times higher at the motorized pumps, compared to the handpumps (242 and 26 KSh per year respectively).

Table 5.7 Average scores per water supply technology type

	Criterion	Weighing	Handpumps	Motorized pumps
Service level	1. System functioning	0,2	0,83	0,92
	2. Water quantity	0,4	0,81	0,82
	3. Walking distance	0,3	0,37	0,24
	4. Water quality	0,1	0,80	0,87
	Weighted service level score		**0,68**	**0,67**
O&M	6. Responsible person for daily operation and pump check	0,2	0,44	0,96
	7. Responsible person for maintenance arrangements	0,3	0,74	0,92
	8. Days to repair	0,5	0,38	0,30
	Weighted O&M score		**0,50**	**0,62**
Financial management	9. Responsible person for financial management	0,2	0,78	0,80
	10. Water tariff	0,2	0,78	0,96
	11. Differential tariff structure	0,1	0,33	0,96
	12. Bank account	0,1	0,46	0,71
	13. Existence of bookkeeping	0,2	0,48	0,68
	14. Service cut-off for non-payment	0,2	0,41	0,71
	Weighted financial management score		**0,57**	**0,80**
Cost recovery	15. % current in payment	0,3	0,40	0,63
	16. Tariff covers O&M	0,5	0,88	0,48
	17. Can community replace the system	0,2	0,37	0,46
	Weighted cost recovery score		**0,63**	**0,52**

The O&M score at the handpumps is low because the responsibilities are not clearly defined. Especially for the daily operation and pump check, it was not clear who the responsible person was. At the handpumps the need for a responsible person for daily operation and pump check is not high and therefore the whole O&M is easily neglected at those locations. The financial management score is low because only 9 of the 27 handpumps had a differential water tariff. At the other eighteen handpumps, six handpumps did not have a water tariff at all. Bookkeeping was complete only at 8 of the 27 handpumps and a service cut-off for non-payment only at 11 locations. The medium cost recovery score was a result of low scores for the payments and the ability to replace the system and a high score for the question whether the tariff covers the O&M.

At the motorized pumps, the yearly costs per user were high. These high costs were mainly the costs for the fuel or electricity. The average O&M score for the motorized pumps was medium. The responsible entities were well organized, but still the period between a breakdown and a repair was long. At the motorized pumps the need to be organized is high because there are always people needed for the daily operation (pump check, fuel refill, etc). The financial management score at the motorized pumps was high. There was a differential water tariff, a bank account, bookkeeping and service cut-off in case of non-payment. The cost recovery score was low for the motorized pumps. Although the payments were better than at the handpumps, at 13 of the 25 motorized pumps, the income was not enough to cover the high costs for O&M.

In summary it can be said that at the motorized pumps the responsible entities are better organized. But the final situation in terms of costs per user and cost recovery is still better at the handpumps. The required finances at the handpumps are so much lower than at the motorized pumps, that even with a better organized committee it is hard to collect enough money to cover the recurrent costs.

Based on these conclusions, a few recommendations can be drawn:

1. At the handpumps, training is needed in order to become better organized.
2. The costs are so much higher at the handpumps than at the motorized pumps, that in the rural areas of Western Kenya (if possible) a handpump is preferred over a motorized pump.

5.6 The influence of the management model on the financial sustainability

Table 5.8 gives the average scores for all criteria, per management model. The community managed systems got a low financial management score and medium other scores. The low score at the community managed systems was mainly because the water tariff, which was absent at 6 of the 23 locations and was not differential at the locations with a community managed handpump. On top of that, only at 8 of the 23 locations a service cut-off for non-payment was applied.

The systems with a combined community and government management got a high score for financial management, a medium score for service level and a low score for O&M and cost recovery. The O&M score is low because the responsibilities for daily operation, pump check and maintenance arrangements were not clear. This resulted in a period between a repair and a breakdown of more than a week. The low cost recovery score at the combined managed systems was because the tariff did not cover the O&M costs and the communities were not able to replace the system on the long term.

The systems with government management got a medium score for service level and O&M, a high score for financial management and a low score for cost recovery. In terms of financial management all scores were high, but this did not result in a good service level and cost recovery. The costs were high because of the high number of well paid employees. Together with the moderate payments, the income was not enough to cover the O&M costs.

Table 5.8 Average scores per management model

	Criterion	Weighing	A+D	B+E	F	C+G
Service level	1. System functioning	0,2	0,83	1,00	0,93	0,86
	2. Water quantity	0,4	0,83	0,88	0,79	0,79
	3. Walking distance	0,3	0,24	0,13	0,20	0,57
	4. Water quality	0,1	0,71	1,00	1,00	0,88
	Weighted service level score		**0,64**	**0,69**	**0,66**	**0,75**
O&M	6. Responsible person for daily operation and pump check	0,2	0,61	0,38	1,00	0,86
	7. Responsible person for maintenance arrangements	0,3	0,78	0,75	1,00	0,86
	8. Days to repair	0,5	0,35	0,00	0,30	0,50
	Weighted O&M score		**0,53**	**0,30**	**0,65**	**0,68**
Financial management	9. Responsible person for financial management	0,2	0,87	0,88	0,86	0,57
	10. Water tariff	0,2	0,74	1,00	0,86	1,00
	11. Differential tariff structure	0,1	0,30	0,75	0,86	1,00
	12. Bank account	0,1	0,59	0,86	0,86	0,29
	13. Existence of bookkeeping	0,2	0,57	0,69	0,79	0,43
	14. Service cut-off for non-payment	0,2	0,35	0,57	0,86	0,71
	Weighted financial management score		**0,59**	**0,79**	**0,84**	**0,67**
Cost recovery	15. % current in payment	0,3	0,30	0,64	0,57	0,75
	16. Tariff covers O&M	0,5	0,91	0,00	0,14	0,86
	17. Can community replace the system	0,2	0,30	0,06	0,43	0,79
	Weighted cost recovery score		**0,60**	**0,21**	**0,33**	**0,81**

The privately managed systems got a medium score for financial management and high scores for the other criteria. Compared to the other management models, the repairs took less long at the locations with private management. The payments were good at these locations and the income was enough to cover the O&M costs. Also the expectations for replacement were far better at the privately managed systems than at the other locations, only at two of the fourteen systems the owner was not able to replace the system on the long term.

In summary it can be said that the privately managed systems got the best results, mainly because of the good payments. These payments were enough to cover the O&M costs, to conduct a replacement without external assistance and to make profit out of the selling of water. The combined community and government managed systems got the worst results; mainly because the responsibilities for daily operation, for regular pump check and for maintenance arrangements were not clear. At these locations the repairs took longer than a week. On top of that, the communities at these locations were not able to conduct major repair or full replacement on the long term.

6. Conclusions and recommendations

6.1 Conclusions

The financial sustainability of 27 handpumps and 25 motorized pumps for groundwater pumping in rural areas of Western Kenya is evaluated. The water supplies are evaluated in terms of service level, O&M, financial management and cost recovery. Both the handpumps and the motorized pumps are evaluated in combination with one of the four management models: community management, combined community and government management, government management or private management.

For the handpumps, the community managed and the combined managed systems score low. The communities are not able to make users pay and to collect enough money to keep the system functioning on the long term. Reasons for this from the user's side are their limited financial resources, their view that water should be free and the misappropriation of their money. But a main other reason is that there is no sanction against non-payment. Private management got high scores at the handpumps for almost all criteria, especially for cost recovery. However, private management has also backsides: the negative effect of the service cut-off in case of non-payment is that people use unimproved water sources instead. Another backside of private management is that it requires high investments of the owner.

The motorized pumps score low at the combined managed and the government managed systems. At these locations the government is not able to hand over the system to the community or to an independent Water Service Provider. The systems are not profitable, the income is not enough to cover the costs. At the community managed motorized pumps, the communities are good organized for the financial management and the O&M arrangements. And although quite some users are not current with the payments, the income is at most locations enough to cover at least the O&M costs. The privately managed motorized pumps score slightly lower than the community ones, because the responsibilities for O&M and financial management are less clear at these locations. But in terms of cost recovery the privately managed systems score again high.

Comparing the two technologies, the motorized pumps score better, especially on financial management. The handpumps score higher on user costs and cost recovery. The handpumps are more sensible for a situation where money is not collected on a regular basis. The motorized pumps are less sensible in this respect because of the daily need for staff and money for e.g. fuel refilling. The good score for cost recovery at the handpumps is related to the low costs at these locations. The average total costs per user per year are about nine times higher for the motorized pumps than for the handpumps.

Comparing the four management models, the differences are not big. The community managed locations have difficulties with making people pay. At the combined managed systems the responsibilities for O&M and financial management are not clear. At the government systems the costs (including high salaries of government staff) are too high for the amount of users. Only the privately managed systems score higher, especially in terms of cost recovery.

Answering the main research question it can be said that both for the handpumps and the motorized pumps, the private managed systems got the best scores and the combined or government managed systems got the worst scores for financial sustainability. Community management scored low at the handpumps and good at the motorized pumps.

6.2 Recommendations

6.2.1 Technologies

Since the water quantity is not sufficient at a quarter of the locations and the walking distances are long, it can be said that more water supplies are needed in the research area. Several technologies can be chosen for new water supplies and both a handpump and a motorized pump are a good option within Western Kenya. A general characteristic of the motorized pumps are the high costs per user per year. These costs make the motorized pump less suitable for the rural areas of Western Kenya. Within these areas the domestic income is low and people are not open to pay for their water. It is therefore recommended for the Government and supporting entities to consider these costs in the process of technology selection. Most likely this will lead to a focus on more low-cost technologies like the handpump. But not in all areas the handpump will be feasible. A handpump can only pump groundwater from a limited depth. In cases where the water table is too low (approximately more than 40 meter below surface level), handpumps do not function well (Harvey et al., 2003). Also at locations with a high population density, it might not be feasible to work with handpumps.

Thus if feasible, handpumps are preferred above motorized pumps. But the final decision will be dictated by the topography, the water table and the population density. In contrast, the choice of management model is purely within human control. This process of management model selection, development and institutionalisation needs careful attention of the Government of Kenya and development partners.

6.2.2 Willingness to pay

A general problem with which all rural water supply management models in Western Kenya have to deal, is the low willingness to pay for water. Recommendations regarding this willingness to pay are given, based on four mentioned causes:

1. In the research area economic life is hard, so that households need to take the greatest care over their domestic expenditures. This makes that people are less willing to pay for water. Economic development within the region will make that the people get more money to spend, and their willingness to pay for water will increase. For the government and other supporting entities, this gives an extra reason for investment in economic development of Western Kenya. Examples of activities are job creation and microfinance projects.
2. Within the rural areas of Western Kenya, there is a widely held view that water should be free. You can either use it straight from nature or with the help of free technologies brought by the government or NGOs. This mindset makes that people are not willing to pay. Training is needed within the communities about the need of clean water. People need to get a better

understanding of the importance of clean drinking water and that this is not for free. They should get some basic insight in the costs for technologies which bring clean water.

3. Independent of the management model, the responsible entity should be trained about sanctions against non-payment. Understanding is needed that people stop paying if there is no sanction against non-payment. And responsible entities also need to get practical guidelines for developing and applying sanctions (e.g. service cut-off or penalties).
4. One other reason which makes users not willing to pay, is misappropriation of the money. Users know that their money is not only used for the water supply but also for people's own pockets. Therefore, the finances for the water supply should be more transparent. Especially in the situation of community management it is important that the finances are checked by a second and third person. Making the finances more transparent is also a subject for the training for the responsible entities.

6.2.3 Community management

Community management will be highly improved if the sanctions against non-payment function properly. But more needs to be done in order to make the community management sustainable. In this respect, a useful contribution is given by Erich Baumann (2006) in his article 'Do operation and maintenance pay?' (see also table 3.2 earlier in the report). First of all he gives a practical division of responsibilities for both maintenance tasks and costs. Based on the idea that O&M of rural water supplies is a shared responsibility between communities, local authorities and central government, he proposes the following division:

Community:	Minor repairs including transport of mechanic
	Spare parts including transport
	30% of major repairs and borehole maintenance
Local government:	70% of major repairs and borehole maintenance
	Monitoring performance of individual facilities by the districts
	Mechanisms for conflict and problem resolution
	Marketing social facilitation retraining mechanics and communities
Central government:	Monitoring performance of O&M system including supply chains

In practice in Western Kenya, the situation is partly already like this. But especially the tasks of the local government (e.g. district water departments) are not fully recognized. The proposed sharing of costs for major repairs is comparable with this 30%/70% division, but it is not formally put down. This results in a long period between a major breakdown and the help of the local authorities in it. Therefore the sharing of costs should be put down formally beforehand, so that in case of a breakdown no time is lost with discussions about who is paying. The practical execution of major repairs can be outsources to local contractors or self-employed artisans (Brikké, 2000).

A second issue is the task of the local authorities regarding monitoring the performance of individual facilities. Based on the current study and several other studies (Brikké, 2000 and Harvey and Reed, 2004), it is recommended that the performance of rural water supplies is monitored every six months. This half yearly performance monitoring should include at least basic information on service level and system management. Table 6.1 gives a list of basic indicators, including the source of information. All questions can be asked and discussed in an interview with the responsible committee or person, but for most indicators the information from the interview can be combined with data from own observations. Scores can be assigned per indicator in the same way as in the current study. This results in Table 6.2. In annex 5 a datasheet is given which can be used for this half yearly performance monitoring. The half yearly performance monitoring is not necessarily done by the local authorities themselves. They can choose to delegate this to the private sector.

Table 6.1 Performance indicators and information sources for basic performance monitoring

Indicator	Information source
1. System functioning	Own observation + interview
2. Water quantity	Discharge test + interview
3. Water quality	Laboratory test + interview
4. # days out of use + causes	Interview
5. Responsible persons for O&M and finances	Interview + compare names with previous snapshot
6. Bookkeeping	Books + interview
7. % current in payment	Books + interview
8. Finances available for maintenance	Books + interview
9. Spares and equipment available	Visit suppliers + Interview
10. Technical skills available	Interview

Table 6.2 Scores for performance indicators

Indicator	Scores
1. System functioning	0. Not 1. Functioning with problems (e.g. heavy pumping or leakages) 2. Good
3. Water quantity	0. Not sufficient 1. Rationing required 2. Sufficient
4. Water quality	0. Not within standards 1. Small problems (e.g. turbidity or salinity) 2. Good
5. # days out of use + causes	0. >3 per 6 months 1. 1-2 per 6 months 2. 0
6. Responsible persons for O&M and finances	0. Names and responsibilities not available 1. Names and responsibilities partly available 2. Names and responsibilities available
7. Bookkeeping	0. No 1. Incomplete 2. Good
8. % current in payment	0. <50% 1. 50-90% 2. >90%
9. Finances available for maintenance	0. No funds available for maintenance when needed 1. Available but not sufficient for most expensive maintenance 2. Funds available and sufficient for most expensive maintenance process
10. Spares and equipment available	0. Not available when needed 1. Available but not for all repairs 2. Available for all repairs when needed
11. Technical skills available	0. Technical skills not available for maintenance when needed 1. Some technical skills for maintenance but not for all 2. Technical skills for all maintenance processes available

The basic performance monitoring can be linked to the third issue for the local authorities: retraining of mechanics and communities. Subjects for this training are for water users the importance of clean drinking water and the costs of clean water, for responsible entities the way of dealing with the finances and maintenance and for mechanics a technical training. But it is likely that during the performance monitoring more specific problems or conflicts come to light. These issues should be included in the retraining activities. The training itself can be done by the district water departments, but it is also possible to bring external consultants or nongovernmental organizations in (Brikké, 2000). But it is recommended that the overall responsibility lies at the local authorities. They can process and analyze the information from the half yearly performance monitoring and determine the content of the retraining programmes.

The last task is the one for the central government: monitoring performance of O&M system including supply chains. This performance monitoring focuses not on the individual facilities but on the overall performance. This includes also the production of water supply technologies, spare parts and tools. Small-scale industries can be included in the process of manufacturing spare parts and tools. And local shops can have their contribution in the provision of spare parts.

6.2.4 Private management

Although community management is common for handpumps, private management scores better on financial sustainability. But to this option only little attention is given within the policy of the Government of Kenya and other supporting entities. It is recommended that the option of private management of rural water supplies is further elaborated. Four important issues in this respect are:

- The barrier of investment costs. Especially for the water supplies with a motorized pump it is recommended for the Government and development partners to consider ways of financing initial investment costs, so that private persons or enterprises can come on-board with limited financial risks. But also for handpumps it is recommended that implementation becomes possible for the private sector in the same way as the current community managed handpumps. In the main handpump program in Western Kenya (which is a collaboration of the Government of Kenya and UNICEF), communities can apply for a handpump and contribute 35% of the initial investment (either in money or in labour). It is recommended that this sharing can also be used for private persons or enterprises who want to start a water supply. Next to that it is possible to use microfinance options, to make finances available for private investors on the basis of sound business plans.
- Community sensitization is required about the option of a private handpump. People need to know about this option. And they need insight in the costs and possible revenue.
- Training is required for private owners of a water supply. First of all they need basic understanding of the technology and its maintenance requirements. Next to that they need to know about mechanics for repairs and locations for spareparts. And training is needed on financial administration (tariff setting, bookkeeping, sanctions against non-payment, etc.)
- Formal recognition and regulation of such private investors is necessary as they will be running water systems as businesses.

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Annex 1: Replacement intervals of AFRIDEV handpump wearing parts

(SKAT-RWSN, 2007)

Drawing Number	Description of spare part	Qty per pump	Approximate Lifetime	Recommended Replacement Interval
	Pump head with Pump handle			
B2024	**Fulcrum pin assembly** (Fulcrum pin C2025, Sleeve C2026, Pin C1027,	1	5 to 8 years	replace as required
	Hexagonal nut C1018, Washer C1028)			
B2033	**Hanger pin assembly** (Hanger pin C2034, Sleeve C2035, Pin C1027,	1	5 to 8 years	replace as required
	Hexagonal nut special C2027, Washer C1028)			
B2028	**Rodhanger assembly** (Hanger bush C2029, Connector C2030, Retainer	1	5 to 8 years	replace as required
	bush C2031, Sleeve C2032, Hexagonal bolt C1105)			
C2044	**Bearing bush outer** (Polyacetal, injection mouldeded)	**4**	**1 to 2 years**	**every year**
C2045	**Bearing bush inner** (Polyamide, injection mouldeded)	**4**	**1 to 2 years**	**every year**
	Pumprods			
B2207	**Toprod assembly** (Mild Steel rods, with hexagonal coupler)	1	3 to 5 years	replace as required
B2214	**Pumprod assembly** (Mild Steel rods, with hexagonal couplers)	1 to 15	3 to 5 years	replace as required
C2212	**Centraliser** (Nitrile Rubber, for threaded Pumprods and FRP Rods)	**1 to 15**	**2 to 3 years**	**every second year**
C2109	**Centraliser** (Nitrile Rubber, for Pumprods with Hook & Eye connectors)	**1 to 15**	**2 to 3 years**	**every second year**
	Rising main			
B2106	**Riser pipe assembly** (PVC-U, Riser pipe C2129 with Socket C2261)	1 to 15	3 to 5 years	replace as required
C2046	**Riser pipe** (PVC-U, Riser pipe with Bell-end)	1 to 15	3 to 5 years	replace as required
C2042	**Top sleeve** (PVC-U)	1	3 to 5 years	replace as required
C2043	**Flapper** (HDPE or Rubber,)	1	3 to 5 years	replace as required
C2076	**Centraliser 6"** (Rubber, for 6" casings)	2 to 15	3 to 5 years	replace as required
C2077	**Centraliser 5"** (Rubber, for 5" casings)	2 to 15	3 to 5 years	replace as required
C2078	**Centraliser 4.5"** (Rubber, for 4.5" casings)	2 to 15	3 to 5 years	replace as required
C2079	**Centraliser 4"** (Rubber, for 4" casings)	2 to 15	3 to 5 years	replace as required
	Pump Cylinder			
B2297	**Cylinder assembly** (PVC-U Cylinder C2072, Socket C2261, Suction pipe	1	5 to 8 years	replace as required
	C2262, Brass Footv. receiver C2299, Brass Liner C2073, O-Ring C1020)			
B2071	**Cylinder assembly** (PVC-U Cylinder C2072, Reducer C2080, Suction pipe	1	5 to 8 years	replace as required
	C2081, POM Footvalve receiver C2074, Brass Liner C2073, O-Ring C1020)			
	Plunger and Footvalve			
B2085	**Valve body assembly** (C2086/87 spinwelded, POM Plunger & Footvalve)	1 to 2	3 to 5 years	replace as required
C1011	**O-Ring** (Nitrile rubber, for Brass Footvalve A2298)	**1**	**2 to 3 years**	**every second year**
C2088	**Bobbin** (Nitrile rubber, for all Plunger & Footvalve types)	**2**	**2 to 3 years**	**every second year**
C2758	**Cup seal** (Nitrile rubber, for Brass Plunger A2266)	**1**	**2 to 3 years**	**every second year**
C1021	**O-Ring** (Nitrile rubber, for Plastic Footvalve A2096 or A2265)	**1**	**2 to 3 years**	**every second year**
	Other parts			
C2059	**Gasket** (Rubber, for Stand assembly B2055)	1	5 to 8 years	replace as required
C2095	**Compression cone** (Rubber, for holding the Rising main pipe)	1	5 to 8 years	replace as required

Note:
The expexted lifetime of the AFRIDEV Handpump is between 10 to 15 years. However, the lifetime of such technical equipment is determined by many factors:

a) Pump material and/or workmanship not as per specification,
b) Inadequate preventive maintenance or no maintenance,
c) Pump damage due to incorrect, exessive or abusive operation,
d) Water quality (salinity, silt or sand etc.),
e) Climatic and environmental conditions,
f) Poor finishing of the Borehole or wrong (poor) installation of the pump,
g) any other possible irregularities.

Annex 2: Factors for Post-Construction Sustainability of Rural Water Supplies

(Lockwood et al., 2010a)

Table 2: Most Commonly Cited Factors For Post-Construction Sustainability

Category	Factor	Rating
Technical	Maintenance – preventative	2
	Spare parts availability	2
	Maintenance – major repairs or replacement	4
	Electricity supply and affordability	4
	Standardisation of components (especially for hand-pumps)	4
	Tools and equipment availability (especially for hand-pumps)	4
Financial	Adequate tariff for recurrent costs	1
	Adequate tariff for capital replacement or system expansion costs	3
Community and Social	Community management capacity	2
	User satisfaction, motivation and willingness to pay	2
	Involvement of women	3
	Social capital or cohesion	3
	Continued training and capacity building	3
Institutional and Policy	External follow-up support	1
	Continued training and support to sanitation and hygiene education interventions	2
	Private sector involvement in goods, services and management contracts	3
	Legal frameworks for recognition of water committees and ownership	3
	Supportive policy and regulatory environment	3
	Clarity over roles for operation and management	4
Environmental	Water source production, quality and conservation	2

Rating key: 1 = of highly critical importance; 2 = of critical importance; 3 = of less critical importance; 4 = of limited importance

Source: Author's estimates based on review of literature sources

Annex 3: Questionnaire

Comparing the Financial Sustainability of different RWS Management Models in Western Kenya – December 2011 to February 2012 – Alida Adams – The Netherlands

Questionnaire **Date:**

1. Location	
2. Used technology (including protection)	
3. Depth of the water source	
4. When and by whom was the well/borehole made?	
5. Who paid the well / borehole and the pump?	
6. How many people use water from this source?	
7. What is the longest distance people walk for this water point?	
8. Do all people for whom this water point is the nearest source, use this water point?	
9. Where are the two nearest water points (type + distance + always water)?	
10. Is the water point in function?	
11. Discharge in L/s (time required to fill a jerrycan of X litres)	
12. Is there water for 24 hours/day, also in the dry season?	
13. When was the last time that there was no water for more than two days and what was the reason for that?	
14. At which times can people come for the water?	
15. Are there any problems with the quality of the water?	
16. Are chemicals used? If so, how often are they applied?	
17. Who checks the fuel/power/chemicals?	
18. Who buys the fuel/power/chemicals? (and from where?)	
19. Who checks whether the pump and the water are still okay?	

20. What happens if the pump needs a repair? (+ days to repair)	
21. Who buys the spare parts? (and from where?)	
22. Who does the repairs? (+ from where?) - Preventive - Reactive	
23. What are the costs for the following components per year?	
a. Wages (see 17-22)	
b. Fuel +transport	
c. Electricity	
d. Chemicals + transport	
e. Spare parts + transport	
f. Tools for maintenance	
g. External assistance (training, technical advice, etc.)	
h. Savings for replacement	
i. Other costs	
24. How much do the users pay for their water?	
25. How, when and by whom is this payment collected?	
26. Where is the money kept?	
27. Are the expenditures and incomes registered and checked by a second person?	
28. How do the records look like?	
29. Do the payments happen as they should, in terms of amount and paying in time?	
30. If not, why not?	
31. What is the consequence for a user if he does not pay?	
32. What costs are covered with the user's payment? (Including other expenditures)	
33. If not all, how are the other costs covered?	
34. Are these other funding sources paid as planned? And if not, why not?	
35. What if the system needs major repairs, major rehabilitation or full replacement?	
36. What are your recommendations on improvements of the (financial) situation?	

Visit nearest water points

Annex 4: Overview collected data

No.	Type	Date	District	Sub-location	Water source	Depth (m)	Year	Implementer	Used by all	Nearest alternatives
1	A	7-12-2011	Kisumu West	Nyikwa Kanyando	Shallow well	24	2009	MWI/UNICEF	yes	Stream 2 or 6 km
2	A	19-12-2011	Busia	Mulimani	Shallow well	8	2009	MWI/UNICEF	no	(un)protected springs, own wells
3	A	20-12-2011	Busia	B. West Mwenda Pole	Shallow well	15	2009	MWI/UNICEF	no	Spring or shallow wells
4	A	20-12-2011	Busia	Bukhayo West Sikulu	Shallow well	8	1992 / 2007	KeFinCo / CDF	no	Own wells + springs
5	A	20-12-2011	Busia	Busibwabo	Shallow well	15	2010	MWI/UNICEF	no	Own wells + springs
6	A	21-12-2011	Busia	Ochude	Borehole	70	1988 / 2001	KeFinCo / community	no	Springs and shallow wells
7	A	21-12-2011	Busia	Buckayo East	Borehole	75	1988 / 2000 / 2011	KeFinCo / CDF / MWI/UNICEF	no	Streams, springs, own wells
8	A	19-1-2012	Siaya	Koyeyo	Shallow well		1996 / 2009	Care International / MWI/UNICEF	no	River 1 km
9	A	25-1-2012	Nyando	Kakola	Shallow well	20	1994 / 2009	Kwaho / MWI/UNICEF	yes	Own wells + lake 3 km
10	A	25-1-2012	Nyando	Kochogo	Shallow well	20	1993 / 2010	Kwaho / MWI/UNICEF	yes	Other handpumps 0.5 km
11	A	9-2-2012	Butula	Marachi East	Borehole	73	1985 / 2007	KeFinCo	no	own wells, small springs 0.5 km
12	A	10-2-2012	Bondo	Central Asembo	Shallow well	20	1996 / 2009	The Netherlands - LVWSSP / UNICEF	no	dam/ponds 1 km
13	A	14-2-2012	Teso South	Asinge	Borehole		1985	KeFinCo	no	river 3 km, other borehole 2 km
14	A	14-2-2012	Teso South	Asinge market	Shallow well	9	1986	KeFinCo	yes	stream 3 km
15	A	15-2-2012	Bumula	Masielo	Shallow well	8	1989 / 2007	KeFinCo / County council	yes	temporary streams
16	A	16-2-2012	Bondo	North Sakwe	Shallow well	14	1997	Lake Basin Development Authority	no	springs
17	B	6-12-2011	Kisumu West	Apakadongo	Shallow well	21	2010	MWI/UNICEF	yes	Stream 2.5
18	B	6-12-2011	Kisumu West	Siala	Shallow well	9	2010	MWI/UNICEF	yes	Stream 3.5
19	B	7-12-2011	Kisumu West	Wach Mon Tek	Shallow well	14	2011	MWI/UNICEF	no	Lake 8 km
20	B	13-12-2011	Siaya	St. Vincent Kakojo	Shallow well	14	2010	MWI/UNICEF	no	Ponds, own wells
21	B	13-12-2011	Siaya	Otweyo	Shallow well	28	2010	MWI/UNICEF	no	Own wells
22	C	2-2-2012	Homa Bay	Ndhiwa	Shallow well	32	1990 / 1998	CARE International	no	own wells
23	C	10-2-2012	Bondo	Central Asembo	Shallow well	26	2003	Owner	no	other handpumps, piped water
24	C	16-2-2012	Bondo	Central Asembo	Shallow well	21	2011	owner	no	other handpumps
25	C	16-2-2012	Bondo	Central Asembo	Shallow well	23	2011	Owner	no	community handpumps
26	C	16-2-2012	Bondo	Central Asembo	Shallow well	26	2008	owner	no	other handpumps
27	C	16-2-2012	Bondo	Central Asembo	Shallow well	18	2008	owner	yes	handpumps, own wells, springs
28	D	7-12-2011	Kisumu West	Kowi	Borehole	100	2005	MWI	no	Stream 4 km, lake 8 km
29	D	14-12-2011	Siaya	Sigomre	Borehole	76	1992	KeFinCo + NWCPC	no	river, unprotected spring, handpump
30	D	20-1-2012	Vihiga	Lugaga	Spring		2008	CDF + friends from Canada	no	Springs and permanent streams
31	D	26-1-2012	Nyando	Holo Rucho	Borehole	52	1996 / 2010	Kenyan-Netherlands / CDF	no	Ponds 1 km
32	D	10-2-2012	Bondo	Central Asembo	Borehole	91	2006	MWI	no	piped water, own wells
33	D	13-2-2012	Teso South	Angorom	Borehole	45	2008	MWI	no	own wells, river 2.5 km
34	D	15-2-2012	Bumula	Kabula	Borehole	61	1994 / 2008 / 2009 / 2011	KeFinCo / MWI / CDF	no	handpump 1 km, own wells
35	E	14-12-2011	Siaya	South Alego / Tingwangi	Borehole	73	2003 / 2011	Kenyan&Egyptian Gov. / MWI	no	River 2 km
36	E	15-2-2012	Bumula	Masielo	Borehole	76	2006	MWI	no	own wells, springs
37	E	15-2-2012	Bumula	Bumula	Borehole	65	1991 / 2011	KeFinCo / MWI	no	handpump 1 km, own wells
38	F	6-12-2011	Kisumu West	Holo	Borehole	120	2008	MWI/UNICEF	yes	Streams 5 or 7 km
39	F	15-12-2011	Siaya	Sega	Borehole	54	1992	KeFinCo + MWI	no	Streams or shallow wells
40	F	2-2-2012	Homa Bay	Ndhiwa	Borehole	130	? / 1998 / 2000	MWI	no	handpumps, own wells
41	F	3-2-2012	Homa Bay	Rodi	Borehole	120	2000	County council	yes	boreholes, pond 1 km
42	F	8-2-2012	Kisumu East	Mkendwa Kanyakwar	Springs		1979 / 2005 / 2010	MWI	yes	water vendor from Kisumu
43	F	9-2-2012	Butula	Butula	Borehole	80	1985 / 2011	KeFinCo / MWI	no	own wells, springs
44	F	13-2-2012	Teso South	Amukura	Borehole	55	1991	KeFinCo	no	handpumps, springs
45	G	19-1-2012	Siaya	Koyeyo	Shallow well	21	2004	Private person	no	Rivers 2.5 & 3 km, handpump 1.5 km
46	G	19-1-2012	Siaya	South East Alego	Borehole	128	2004	Private person	ca. 75%	Permanent stream 1.5 km + own wells
47	G	24-1-2012	Vihiga	Jepkoyai	Borehole	55	2003	The salvation army	no	Springs + streams 1 km
48	G	1-2-2012	Homa Bay	Rodi	Borehole	47	2009	Owner	yes	Municipal borehole 0.5 km
49	G	2-2-2012	Homa Bay	Ndhiwa	Shallow well	18	2002	Owner	no	own wells
50	G	2-2-2012	Homa Bay	Ndhiwa	Borehole	114	2008 / 2008	Owner	no	own wells, ponds, streams
51	G	7-2-2012	Kisumu East	Kogony West	Borehole		2010	Owner	yes	Piped water supply, spring
52	G	10-2-2012	Bondo	Central Asembo	Borehole	100	1993 / 2007	Owner	yes	handpumps, springs 1 km

No.	Type	In function?	Q (L/s)	Always water?	Users	Distance (km)	Water quality	Costs per user/year (KSh)
1	A	Yes, but rubbers sworn out, pumping difficult	0,33	yes	180	2		56
2	A	Yes	0,33	Dry season sometimes not for few hours	250	0,5		17
3	A	Yes	0,27	yes	250	1		1
4	A	Yes	0,29	yes	200	1		13
5	A	Yes	0,33	Dry season sometimes not for few hours	150	1,5		
6	A	Yes, but some small problems	0,19	yes	1000	5		20
7	A	Yes	0,24	yes	300	1		
8	A	Yes	0,25	Dry season sometimes not	150	2	rust	
9	A	Yes	0,21	yes	200	0,5	ok	9
10	A	Yes, but pumping heavy, technician needs to	0,29	Dry season sometimes not for few hours	250	1	a bit saline	3
11	A	yes	0,18	yes	300	1	ok	17
12	A	Yes	0,22	yes	200	1	a bit salty	
13	A	yes, but about to break	0,31	yes	1200	3	metal particles, wurms	1
14	A	no	x	yes	400	3	ok	25
15	A	yes	0,25	yes	250	2	ok	27
16	A	yes	0,19	yes	300	1,5	little bit saline	17
17	B	Yes	0,21	yes	400	3		34
18	B	Yes	0,33	yes	180	3		65
19	B	Yes	0,21	Dry season only little, well not deep	150	3		
20	B	Yes	0,24	yes	600	1,5		
21	B	Yes	0,20	yes	450	3		8
22	C	yes	0,20	water level goes down	180	0,5	ok	89
23	C	yes, but problems with rods	0,13	yes		0,5	ok	
24	C	yes	0,25	dries up when a lot of water is used	180	0,5	ok	
25	C	Yes, but some small problems	0,09	sometimes not for some time (10 min)	160	1	ok	
26	C	yes, but with leakage	0,24	yes	160	0,5	ok	63
27	C	yes	0,14	yes	300	1	ok	8
28	D	Yes		yes	600	4		234
29	D	Yes	2,50	yes	6800	3		
30	D	Yes		yes	5000	x	rainy season higher turbidity	79
31	D	Yes	0,13	yes	600	3	ok	183
32	D	Yes		yes	200		ok	628
33	D	yes		yes	200	1,5	some rust from pipes	24
34	D	no	x	yes	700	4	ok	310
35	E	Yes		yes	5000	1		
36	E	yes		yes	200	2	ok	166
37	E	yes		yes	250	1	ok	
38	F	Not as planned	0,36	yes	400	5		215
39	F	Yes	1,94	Dry season sometimes not for few hours	3000	3		206
40	F	yes		not always because of power cuts	3000	2	ok	189
41	F	yes		yes	300	0,5	ok	727
42	F	yes		yes	10000		ok	131
43	F	yes	x	yes	4000	x	ok	354
44	F	yes		yes	800	4	ok	1120
45	G	Yes	0,08	Dry season sometimes not for few hours	180	2		142
46	G	Yes		yes	1000	1,2	ok	211
47	G	Yes		yes	900	5	ok	78
48	G	Yes, pump is not working properly		Dry season litte water but still enough	250	0,2	a bit saline	233
49	G	yes		yes	200	0,5	ok	328
50	G	Yes		yes		5	some germs & little bit salty	
51	G	yes		yes	250	3	ok	264
52	G	Yes		yes	100	0,5	little bit saline	

No.	Type	Buying chemicals	Pump check	Buying spareparts	Doing repairs	Days to
1	A	Community	Community	Community	Technician	
2	A	Caretaker	Caretaker	Community	Trained committe members or external technician	
3	A	PHO person	Trained members	Community	Minor: trained members, major: MWI	
4	A	Treasurer	Treasurer	Technician	Technician	
5	A	x	Trained members	Trained persons	Minor: trained members, major: technician	
6	A	PHO person	x	Technician	Technician	>6
7	A	x	x	Technician	Technician	
8	A	x	Community	x	Technician	
9	A	x	Chairlady	Technician	Technician	7
10	A	x	x	Technician	Technician	7
11	A	x	x	Technician	technician	months
12	A	committee	caretakers	Technician	technician	
13	A	DWO person	technician	Technician	technician	2-7 days
14	A	x	x	community	technician	1-2 weeks
15	A	Community	x	Technician	technician	1 week
16	A	x	x	committee	technician	1 week
17	B	DWO person	Community	Community	DWO technician	
18	B	DWO person	MWI person	Community	DWO technician	
19	B	MWI person	Community	Community	DWO technician	
20	B	PHO person	x	Technician	Technician (via DWO)	
21	B	PHO person	Community	Technician	Technician (via DWO)	
22	C	DWO person	Person from Homa	Person from Homa Bay	Person from Homa Bay	
23	C	owner	owner	Technician	technician	
24	C	owner	owner	owner	technician	2 days
25	C	x	x	Technician	technician	
26	C	owner	owner	owner	technician	3 days
27	C	owner	x	owner	technician	3 days
28	D	Community	Committee	Technician	Technician	
29	D	x	Plumbers	Plumbers	Plumbers + external specialists	
30	D	Manager	Pump attendant	Community	Pump attendant or DWO	
31	D	x	Committee	Technician	Technician	
32	D	x	Pump attendant	Technician	technician	2 days
33	D	pump attendant	Pump attendant	committee	Technician or DWO person	
34	D	committee	pump attendant	Plumbers	plumbers	months
35	E	x	Pump attendant	anybody	DWO person	months
36	E	committee	Committee	committee	DWO person	
37	E	x	x	Technician	Technician	
38	F	DWO person	MWI person (full	MWI person	DWO person	
39	F	Manager	Pump attendant	Technician	Employed technician or MWI technician	>6
40	F	DWO person	DWO person	DWO person	DWO person	
41	F	County council treasurer	Pump attendant	Technician	DWO person	some months
42	F	x	Operator	Technician	Plumbers + external specialists	2-7 days
43	F	x	DWO person	DWO person	DWO person	2 days
44	F	x	Pump attendant	Technician	DWO people	2 weeks
45	G	Family	Family	Family	Technician	
46	G	x	Manager	Specialist from D&S	D&S technician	
47	G	x	Caretaker	Treasurer	Plumbers + external specialists	3 weeks
48	G	x	Caretaker	Technician	Technician from Nairobi	
49	G	owner	owner	owner	owner	
50	G	x	owner	DWO person	DWO person	
51	G	x	Money collector	Technician	Technician	3 days
52	G	x	owner	Technician	technician	

No.	Type	Tariff	Water price	Collecting money	Bank	Financial	Payments in practice
1	A	yes	40KS / month	Treasurer	yes	yes	ok
2	A	yes	50 KS/month or 5-10 KS/L	Caretaker	yes	yes	Only in dry season
3	A	yes	30 KS / month	Secretary	yes	?	Only in dry season
4	A	yes	10 KS/month or 5 KS/20L	Treasurer	no	yes / ?	Many difficulties
5	A	yes	30 KS / month	Committee members	yes	yes / ?	Only in dry season and some people just take water
6	A	no	x	Only if there is a problem	no	x	Difficult, no money in the community to pay for this
7	A	yes	10 KS/month	Committee members		x	x
8	A	yes	20 KS / month	Chairman	no	yes	20% not current
9	A	no	x	Only if there is a problem	no	x	many do not pay
10	A	no	x	Only if there is a problem	no	x	Not everybody contributes
11	A	no	x	leader	no	no	some do not pay
12	A	yes	30 sh/month or 3 sh/20L	caretakers	yes	yes / ?	half of the people has problems
13	A	yes	100 sh/year	Treasurer	no	yes	difficult, but in the end people pay
14	A	no	x	leader	no	yes / ?	some do not pay
15	A	no	x	Chairman	no	yes / ?	only 50% contributes
16	A	yes	10 sh/month	Secretary	yes	yes / ?	chairperson took all money > people stopped paying
17	B	yes	2KS / 20L	Committee members	yes	yes	ok
18	B	yes	2KS / 20L	Committee members	yes	yes	ok
19	B	yes	2KS / 20L	Committee members	yes	yes	Sometimes late, but ok
20	B	yes	20KS /month	Money collector	yes	only in dry	People complain and don't want to pay
21	B	yes	2KS / 20L or 50/month	Money collector		yes	Only in dry season
22	C	yes	3 sh/20L	Owner	no		ok
23	C	yes	4 sh/20L	owner	no	no	ok
24	C	yes	relatives 3 sh/20L, others 4	someone from compound	no	no	ok
25	C	yes	3 sh/20L	owner	no	yes	some poor people get water for free
26	C	yes	3 sh/20L	someone from compound	yes	yes / ?	only some widows get water for free
27	C	yes	2 sh/20L	someone from compound	no	no	relatives+widows+old people do not pay
28	D	yes	5KS / 20L	Money collector	yes	yes	ok
29	D	yes	5 KS / 20L or 300+/month	People come to office	yes	yes	Rainy season bad
30	D	yes	600+ KS / month or 4 KS / 20L	Office girl + water kiosk		yes	55/130 pay
31	D	yes	2 KS / 20L	Treasurer		yes	ok
32	D	yes	2 or 3 sh/20L	Pump attendant	yes	yes	ok
33	D	yes	3 sh/20L	Money collector	yes	yes	people go to other places because of the water price
34	D	yes	3 sh/20L or 250+/month	Money collector	yes	yes / ?	75% current
35	E	yes	2 sh/20L	Pump attendant	no	partly	ok
36	E	yes	2 sh/20L	Committee members	yes	?	many people go somewhere else because of the water price
37	E	yes	2KS / 20L	x		x	x
38	F	no	x	x		x	x
39	F	yes	400+ / month	Staff		yes	Many difficulties
40	F	yes	400+/month	DWO	yes	yes	few defaulters
41	F	yes	3 sh/20L	Pump attendant	combined	yes / ?	ok
42	F	yes	500+ sh/month	Office staff	yes	yes	some have troubles
43	F	yes	500+ sh/month	DWO	combined	yes	ok
44	F	yes	300+/month	DWO people	yes	yes	ok
45	G	yes	5 KS / 20L	Family		x	Sometimes after 1 day, but ok
46	G	yes	5 KS / 20L	Manager water kiosk		yes	ok
47	G	yes	260+ KS month or 5 KS / 20L	Treasurer		yes	Not always ok
48	G	yes	3 KS / 20L	Caretaker	x	yes	Some people who don't have money don't pay
49	G	yes	3 sh/20L	owner	no	no	some pay later
50	G	yes	3 sh/20L	Money collector	combined	yes / ?	not everybody pays
51	G	yes	3 sh/20L	Money collector	combined	partly	ok
52	G	yes	3 sh/20L	someone from compound	combined	yes / ?	ok

What if user doesn't pay?	Costs covered with users' payment	Other funding sources
Kicked out of the group	Repairs, chairs, tent, plates	?
old&vulnerable people are allowed, others can buy if they don't pay monthly	Maintenance, farming	x
Not allowed to take water	No expenditures yet	x
No measures	Repairs, chlorine, padlock	x
People continue to take water	Fence, poultry + cows	x
x	Maintenance	x
Not allowed to take water	Maintenance	CDF
x	Al	x
x	Maintenance	x
x	Maintenance	x
no consequence	all	x
they still collect and promise to pay later		x
negotiate	all	x
x	all	x
x	all	x
x	all	x
Not allowed to take water	Repairs	MWI
x	Repairs + other projects (chairs, goats, etc.)	MWI
x	Maintenance + growing groundnuts	MWI
Mostly elderly people, not possible to disallow them	Planned: grow tomatos	x
They buy per jerrycan, only very vulnerable people take water for free	Maintenance + common shambaa, fertilizer, seeds, sacks, plot rent	x
Refuse to take water	Maintenance and household money	x
no water	combined	x
no water	all	x
x		x
Does not happen	all	x
no water	all	x
Does not happen	Maintenance + chemicals + fuel + collector + cleaning + food for	MWI
disconnected	Salaries (manager, clark, plumbers, watchmen), electricity, repairs	CDF
Only encouraging to pay	All	Extra money from
x	All	x
everybody pays		x
no water		
x	all, but wages are too low and no money for extensions	MWI/CDF/well wishers
no water	fuel and wages	MWI / CDF
no water	partly	MWI
x	x	x
x	x	MWI
disconnected	All, but via SiBo company	x
disconnected		MWI
no water	all	MWI
disconnected after 4 months		MWI
warning and disconnected	Part of total costs	MWI
disconnected		MWI
x	All	x
x	Part of the family money	x
After 3 months disconnected	All	x
x	All	x
they can draw water with a bucket		
no consequence	all	x
no water	all	x
everybody pays	Part of total costs	income from guests

What in case of major breakdown?	Recommendations
Use savings from bank account	Sell jerrycans of water at other locations
x	x
x	Make profit out of the money with a chicken project
CDF or call DWO	Training for committee members
Technician	Somebody to check for people who don't pay
Collect money with community	Electricity + water selling
CDF or just go to the spring	
Enough money	open bank account, chlorine in the well, fencing against animals etc.
We cannot do anything	fencing
We cannot do anything	Artician should come, pump is heavy and cracks in superstructure
search for assistance from NGO	Piped water supply will reach up to this area soon
raise money to buy a new pump	fencing
Consult DWO or other government bodies	change to motorized pump
it would not be used anymore, maybe look for external assistance	pipe needs to be replaced, spare parts too difficult to get and too far
Call local MP for assistance	x
use rope and bucket	new committee
MWI	Use water for agriculture, extend it with electricity + tank
MWI	x
x	x
Loan from the bank	increase earnings by agriculture
x	Training + spanners, less dependent on technician
buy a new pump or write a proposal for funding	making well deeper + fencing
replace	replace pump rods
buy new one	x
?	using electricity
buy a new one	using electricity
buy a new one from other income of the owner	fencing
x	Electricity instead of fuel + additional water point + pickup for selling water
Spreaded payments	Get legal rights, so that water office is allowed to force defaulters
Seek for assistance from government or donors	second water source to meet increasing demand, solar power to reduce costs, bottling water
ask neighbours and friends to help or look for a donor	extensions with extra tanks, spare pump
go to the bank and take the money	power connection, use the same energy to start a posho mill
seek advice from DWO	extensions, connect to electricity, more storage
MWI/CDF, but really difficult	seek grant from CDTF to extend the system
it will remain like that, but we will ask for assistance	help from DWO for connecting to power
?	more house connections to get more money
x	Meters at extensions + records + sell water for business
MWI	x
SiBo company	Improve service so that people will be more willing to pay
Will take very long, dependent on the (slow) government	reservoirs
New pump via county council, but will take long	Reduce time that it takes to repair
New pump via WSB, takes long	more staff, spare pump, solve bureaucracy problem
ask MWI	increase storage capacity, more house connections
MWI is still responsible	second borehole, labour more skilled and better payments, community sensitization to understand the need of clean water
Might be dificult, maybe change to cheaper pump	Buy a big plastic tank, pumping only once a week
Enough money	generator because of the power cuts
take a loan	extensions to other points, bigger water tank
Not sure	Repairing pumping system
not able to buy a new pump	installing culverts
able to buy a new pump	generator, bigger tank, extensions
buy a new pump	x
use money from other income	get rid of salinity

No.	Type	Income	Money collector	Technician	Fuel/electricity	Chemicals	Spareparts	Other costs	Total costs	Profit	Comments
1	A	12000	x	x	x	5000	5000	x	10000	2000	
2	A	9600	x	x	x	2200	2000	x	4200	5400	
3	A	9000	x	x	x	300	0	x	300	8700	No maintenance yet
4	A	3000	x	1000	x	560	1100	x	2660	340	
5	A	5400	x	?	x	x	?	x	0	5400	No expenditures yet
6	A		x	x	x	x	20000	x	20000		No regular water tariff
7	A	3000	x	x	x	x	x	x	x		No expenditures yet
8	A	2880	x	?	x	x	?	x	?		No expenditures yet
9	A		x	x	x	x	1800	x	1800		No regular water tariff
10	A		x	x	x	x	700	x	700		No regular water tariff
11	A	5000					5000		5000	0	No regular water tariff
12	A								0	0	
13	A	3180	x	x	x	x	1750		1750	1430	
14	A	10000	x	x	x	x	10000	x	10000	0	No regular water tariff
15	A	6800	x	x	x	800	6000	x	6800	0	No regular water tariff
16	A	7200	3000	x	x	x	2200		5200	2000	
17	B		2700	450	x	1500	9000	x	13650		
18	B		2700	450	x	1500	7000	x	11650		
19	B		x	x	x	x	x	x	0		No expenditures yet
20	B	8000	x	x	x	x	x	x	0	8000	No expenditures yet
21	B	8000	1200	450	x	x	2000	x	3650	4350	
22	C	30000	-	-	-	6000	10000	-	16000	14000	
23	C	46800	x	x	x	400	15000	x	15400	31400	
24	C								0	0	
25	C								0	0	
26	C	50400					10000		10000	40400	
27	C	63000	x	x	x	x	2500	x	2500	60500	
28	D		9600	12000	78000	6000	30000	4800	140400		
29	D		?	?	?	?	?	?	?		mainly house connections
30	D	792000	17000	x	192000	22000	80000	84000	395000	397000	17000=sum of several allowances
31	D	78000	6000	2000	84000	x	x	18000	110000	-32000	Income 10000/month including phone charging
32	D	57600	72000	x	29700	x	15000	8800	125500	-67900	Earlier collection ca 1000, now other
33	D	24000	18000	x	9900	x	980	x	28880	-4880	
34	D	264000	33600	15600	60000	x	96000	12000	217200	46800	
35	E		?	?	?	?	?	?	0		just rehabilitated
36	E	33000	12000	x	12100	x	9000	x	33100	-100	
37	E								0	0	
38	F	0	36000	see	x	30000	20000	x	86000	-86000	Pump not implemented, no collection yet
39	F	960000	Via SiBo	Via SiBo	228000	312000	78000	X	618000	342000	mainly house connections
40	F	360000	x	x	366000	x	200000	x	566000	-206000	
41	F	186000	90000	x	120000	8000	?	?	218000	-32000	
42	F	360000	660000	x	630000	x	15000	x	1305000	-945000	
43	F	840000	576000		360000		420000	60000	1416000	-576000	
44	F	480000	516000	x	360000	x	20000	x	896000	-416000	
45	G	72000	x	x	18000	6000	1500	x	25500	46500	Income: over 70000/yr
46	G	301000	36000	X	15000		160000	X	211000	90000	Spareparts=once per 5 years new pump of
47	G	70000	19200	x	60000	x	25000	19000	70000	0	Replacement: now twice in 8 yr, 60000
48	G	440000	20000	x	28200	x	10000		58200	381800	
49	G	75600	-	-	58800	4800		1900	65500	10100	
50	G	172800	51840	x	60000	x	10000	x	121840	50960	
51	G	59400	66000	x	?	x	?	x	66000	-6600	
52	G								0	0	

Criterion	Weighing	A																	B						C						
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**AVGA**	**17**	**18**	**19**	**20**	**21**	**AVGB**	**22**	**23**	**24**	**25**	**26**	**27**	**AVGC**
1. System functioning	**0,2**	1	2	2	2	2	1	2	2	2	1	2	2	1	0	2	2	0,81	2	2	2	2	2	1,00	2	1	2	1	1	2	0,75
2. Water quantity	**0,4**	2	1	2	2	1	2	2	0	2	1	2	2	2	2	2	2	0,84	2	2	0	2	2	0,80	1	2	1	1	2	2	0,75
3. Walking distance	**0,3**	0	2	1	1	0	0	1	0	2	1	1	1	0	0	0	0	0,31	0	0	0	0	0	0,00	2	2	2	1	2	1	0,83
4. Water quality	**0,1**								1	2	1	2	1	0	2	2	1	0,67							2	2	2	2	2	2	1,00
5. Responsible person for daily operation and pump check	**0,2**	0	2	2	2	2	0	0	0	2	0	0	2	2	0	0	0	0,44	0	2	0	0	0	0,20	2	2	2	0	2	0	0,67
6. Responsible person for maintenance arrangements	**0,3**	2	2	2	2	2	0	0	2	2	0	2	2	2	0	0	2	0,69	0	2	2	2	2	0,80	2	2	2	0	2	2	0,83
7. Days to repair	**0,5**						0			1	1	0		1	0	1	1	0,31					0	0,00			2		1	1	0,67
8. Responsible person for financial management	**0,2**	2	2	2	2	2	0	2	2	0	0	2	2	2	2	2	2	0,81	2	2	2	2	2	1,00	2	2	0	2	0	0	0,50
9. Water tariff	**0,2**	2	2	2	2	2	0	2	2	0	0	0	2	2	0	0	2	0,63	2	2	2	2	2	1,00	2	2	2	2	2	2	1,00
10. Differential tariff structure	**0,1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,00	2	2	2	0	0	0,60	2	2	2	2	2	2	1,00
11. Bank account	**0,1**	2	2	2	0	2	0		0	0	0	0	2	0	0	0	2	0,40	2	2	2	2	2	1,00	0	0	0	0	2	0	0,17
12. Existence of bookkeeping	**0,2**	2	2	0	1	1	0	0	2	0	0	0	1	2	1	1	1	0,44	1	2	2	1	2	0,80	1	0	0	2	1	0	0,33
13. Service cut-off for non-payment	**0,2**	2	2	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0,25	2	0	0	0	2	0,40	2	2	2	0	2	2	0,83
14. % current in payment	**0,3**	2	1	1	0	0	0		1	0	0	0	0	1	0	0	0	0,20	2	2	1	0	1	0,60	1	2	2	1	2	1	0,75
15. Tariff covers O&M	**0,5**	2	2	2	2	2	2		2	2	2	2	2	2	2	2	2	1,00	0	0			0	0,00	2	2	2	2	2	2	1,00
16. Can community replace the system	**0,2**	2	0	1	0	1	1	0	2	0	0	0	1	0	0	0	0	0,25	0	0	0	1	0	0,10	2	2	2	1	2	2	0,92

Criterion	Weighing	D								E				F								G								
		28	**29**	**30**	**31**	**32**	**33**	**34**	**AVGD**	**35**	**36**	**37**	**AVGE**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**AVGF**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**AVGG**
1. System functioning	**0,2**	2	2	2	2	2	2	0	0,86	2	2	2	1,00	1	2	2	2	2	2	2	0,93	2	2	2	1	2	2	2	2	0,94
2. Water quantity	**0,4**	2	1	0	2	2	2	2	0,79	2	2	2	1,00	1	0	2	2	2	2	2	0,79	1	2	2	1	2	2	2	1	0,81
3. Walking distance	**0,3**	0	0		0		0	0	0,00	1	0	1	0,33	0	0	0	2			0	0,20	0	0	0	2	2	0	0	2	0,38
4. Water quality	**0,1**			1	2	2	1	2	0,80		2	2	1,00			2	2	2	2	2	1,00		2	2	1	2	1	2	1	0,79
5. Responsible person for daily operation and pump check	**0,2**	2	2	2	2	2	2	2	1,00	2	2	0	0,67	2	2	2	2	2	2	2	1,00	2	2	2	2	2	2	2	2	1,00
6. Responsible person for maintenance arrangements	**0,3**	2	2	2	2	2	2	2	1,00	2	2	0	0,67	2	2	2	2	2	2	2	1,00	2	2	2	2	2	2	2	0	0,88
7. Days to repair	**0,5**					2		0	0,50		0		0,00		0		0	1	2	0	0,30			0				1		0,25
8. Responsible person for financial management	**0,2**	2	2	2	2	2	2	2	1,00	2	2	0	0,67	0	2	2	2	2	2	2	0,86	0	2	2	2	0	2	2	0	0,63
9. Water tariff	**0,2**	2	2	2	2	2	2	2	1,00	2	2	2	1,00	0	2	2	2	2	2	2	0,86	2	2	2	2	2	2	2	2	1,00
10. Differential tariff structure	**0,1**	2	2	2	2	2	2	2	1,00	2	2	2	1,00	0	2	2	2	2	2	2	0,86	2	2	2	2	2	2	2	2	1,00
11. Bank account	**0,1**	2	2	2	2	2	2	2	1,00		0	2	0,50	0	2	2	2	2	2	2	0,86	0	2	2	0	0	2	0	0	0,38
12. Existence of bookkeeping	**0,2**	1	2	2	2	2	2	1	0,86	0	1	2	0,50	0	2	2	1	2	2	2	0,79	0	1	2	2	0	1	1	1	0,50
13. Service cut-off for non-payment	**0,2**	2	2	0	0	2	2	0	0,57		2	2	1,00	0	2	2	2	2	2	2	0,86	2	2	2	0	0	0	2	2	0,63
14. % current in payment	**0,3**	2	0	0	2	1	2	0	0,50		2	1	0,75	0	0	1	2	1	2	2	0,57	2	2	1	1	1	1	2	2	0,75
15. Tariff covers O&M	**0,5**	2	2	2	2	2	0	0	0,71	0	0	0	0,00	0	2	0	0	0	0	0	0,14	2	2	2	2	2	2	0	0	0,75
16. Can community replace the system	**0,2**		2	0	1	2	0	0	0,42	0	0	0	0,00	0	1	1	1	1	1	1	0,43	0	2	2	1	0	2	2	2	0,69

Annex 5: Data sheet for half yearly performance monitoring

Indicator	Interview		Extra observations		Comments
1. System functioning	☐ ☐ ☐	0. Not 1. Functioning with problems (e.g. heavy pumping or leakages) 2. Good	☐ ☐ ☐	Own observation	
2. Water quantity	☐ ☐ ☐	0. Not sufficient 1. Rationing required 2. Sufficient	☐ ☐ ☐	Discharge test	
3. Water quality	☐ ☐ ☐	0. Not within standards 1. Small problems (e.g. turbidity or salinity) 2. Good	☐ ☐ ☐	Laboratory test	
4. 4. # days out of use + causes	☐ ☐ ☐	0. >3 per 6 months 1. 1-2 per 6 months 2. 0		-	
5. Responsible persons for O&M and finances	☐ ☐ ☐	0. Names and responsibilities not available 1. Names and responsibilities partly available 2. Names and responsibilities available	☐ ☐ ☐	Compare names with previous snapshot	
6. Bookkeeping	☐ ☐ ☐	0. No 1. Incomplete 2. Good	☐ ☐ ☐	Books	
7. % current in payment	☐ ☐ ☐	0. <50% 1. 50-90% 2. >90%	☐ ☐ ☐	Books	
8. Finances available for maintenance	☐ ☐ ☐	0. No funds available for maintenance when needed 1. Available but not sufficient for most expensive maintenance 2. Funds available and sufficient for most expensive maintenance process	☐ ☐ ☐	Books	
9. Spares and equipment available	☐ ☐ ☐	0. Spares and equipment not available when needed 1. Spares and equipment available but not for all repairs 2. Spares and equipment available for all repairs when needed	☐ ☐ ☐	Visit suppliers	
10. Technical skills available	☐ ☐ ☐	0. Technical skills not available for maintenance when needed 1. Some technical skills for maintenance but not for all 2. Technical skills for all maintenance processes available		-	

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