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Technology choices in Water Supply and Sanitation:

Report on collaborative research, learning and networking between Ethiopia, Sudan and Kenya

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Acronyms

CPC	Community Project Cycle (Kenya)
DAP	Development Activity Programme (Ethiopia)
DWC	Drinking Water Corporation (Sudan)
EU	European Union
HCS	Hararghe Catholic Services (Ethiopia)
IDP	Internally Displaced Person
IHP	International Hydrology Programme (UNESCO)
ISWM	Integrated Sustainable Waste Management
MDG	Millennium Development Goal
NGO	Non-governmental Organisation
ODI	Overseas Development Institute
PAC	Practical Action Consulting
PSNP	Productive Safety Net Programme (Ethiopia)
RiPPLE	Research-inspired Policy and Practice Learning in Ethiopia and the Nile Region
RWC	Rural Water Corporation (Sudan)
Sida	Swedish Agency for International Development Cooperation
UNESCO	UN Educational, Scientific and Cultural Organization
UNICEF	UN Children's Fund
UWC	Urban Water Corporation (Sudan)
WESS	Water and Environmental Sanitation Services (Sudan)
WFP	World Food Programme
WIC	Water Irrigation Committee (Ethiopia)
WMC	Water Management Committee
WSB	Water Services Board (Kenya)
WSP	Water Service Provider (Kenya)
WSRB	Water Services Regulatory Board (Kenya)
WSS	Water Supply and Sanitation

Executive Summary

For practitioners, technological choice plays a huge role in designing water supply and sanitation (WSS) systems. Often considered in isolation, this study looks at factors that surround technological choice. This is by no means an exhaustive list of factors, but rather an attempt to start looking more closely at what factors should be considered when making technological choices, and how.

This report presents the key findings of a study undertaken by Research-inspired Policy and Practice Learning in Ethiopia and the Nile Region (RiPPLE) and Practical Action Consulting (PAC) in Ethiopia and Sudan in 2008. A sector review from Kenya was also carried out and included in the analysis.

The main purpose of this work is fivefold: to identify, document and compare factors affecting choice of WSS technologies in Ethiopia and Kenya through collaborative research; understand the links between the process of technology choice and its wider context related to participation, planning, governance and demand; to identify and establish potential for research and communication among practitioners; to develop capacity and establish channels of communication for strengthening the Nile region RiPPLE network; and propose further actions in collaborative research and communication. This study presents key findings with a view to sharing and learning from these experiences.

The methodology and fieldwork were developed by the research team, made up of members from organisations across the countries. As such, findings are both comparative and narrative-based. Based on 11 study sites, findings highlighted lessons to be learned in planning, participation, land rights, sustainability, accessibility, financing, growth and productivity, risk and vulnerability and sanitation.

Across the board, sustainability needs to be strengthened in planning processes by considering all of the above factors. Land rights issues are prominent in Ethiopia, where land is scarce, whereas maintenance and management were greater challenges in Darfur, Sudan, where the conflict has had serious damaging impacts on systems. Clear agreements on use of land and water have often been used to resolve conflict over access to water points. Feeding natural resource management into the planning stages can help maintain water levels, increasing the amount of water available. Community-based management seems to be a popular solution but, with more complex systems, such as motorised boreholes, it is more difficult for rural communities to perform maintenance, particularly in the case of breakdowns. More complex systems, often seen as the only viable solution, tend to require more long-term and often external technical and managerial support. Overall, there is strong evidence for the need for context-specific management solutions. Fee recovery schemes vary in their success, but most of the sites visited failed to demonstrate an understanding of how to reinvest in improving their water systems.

In conclusion, technology choices are often made by engineers, based on a number of considerations, including technical, environmental, policy and financial variables. The key factors identified above tend to affect the sustainability of the system, rather than technology choice. Sustainability, which is affected by all the identified factors, needs to be better considered throughout the project cycle. Finally, management of technologies and the natural resources around them is often the largest determining factor in the longevity and benefits of a service. Carrying out collaborative research and sharing and exchanging ideas and perspectives represent a unique opportunity for learning.

1. Introduction

This research report presents the key findings of a study undertaken by the Research-inspired Policy and Practice Learning in Ethiopia and the Nile Region programme (RiPPLE) and Practical Action Consulting (PAC) in Ethiopia and Sudan in 2008. The study was a joint research, lesson learning and networking exercise, with fieldwork carried out by researchers and practitioners in Ethiopia and Sudan. A sector review from Kenya is also included. The main purpose of this research is fivefold:

1. To identify, document and compare factors affecting choice of water supply and sanitation (WSS) technologies in Ethiopia and Kenya through collaborative research.
2. To understand the links between the process of technology choice and its wider context related to, for example, income and employment of poor people, local economic growth and management at local level.
3. To identify and establish potential for research and communication in WSS at different levels, from community groups to district/regional governments, between two countries, with a view to linking with other organisations in the region, especially in Sudan, Kenya, Uganda and Ethiopia.
4. To develop capacity and establish channels of communication in shared research and learning as a basis for strengthening the Nile region RiPPLE network and to identify avenues to further strengthen the network on this subject area.
5. To propose further actions in collaborative research, networking and communication in the region and to create links with other projects being undertaken by PAC and its partners.

The report was facilitated by PAC in Sudan and Kenya, along with the RiPPLE office Ethiopia and the Overseas Development Institute (ODI) in the UK. The field visit was initially planned for Kenya, but this was shifted to Sudan because of Kenya's post-election violence. PAC identified researchers and case study sites in urban/peri-urban areas in Sudan; in Ethiopia, this was done by Harar Catholic Services (HCS). Both of these organisations are partners in the RiPPLE research programme. Before the visits, a methodology was prepared and a work plan was discussed in each of the countries. It was agreed that the research would explore the following as guiding questions:

- How are technology choices made, at which stage in implementation and by whom?
- To what extent is demand factored into choice of technology, if at all, and how far is consideration given to possible management by communities?
- How far does choice of technology reflect issues of sustainability, cost benefit and cultural and other factors?
- What does the process of technology choice tell us about links between service delivery and wider sets of social and economic considerations, including income, employment, gender, disability and productive uses?
- Where does the real scope to influence technology choice exist to achieve greater benefits for the poor?
- What is the potential for networking and researcher collaboration on WSS technologies?

RiPPLE partners in Ethiopia and Sudan formed a joint research team to develop and examine these questions, to establish an operational research methodology and to agree the working concepts and context of analysis. Experienced local PAC technical staff from Kenya conducted a review on Kenya and provided a detailed description of two cases in particular. Team selection was carried out by PAC and RiPPLE management. The team comprised up to four people from local partner organisations, two representing RiPPLE staff and two representing PAC. After the visit, each team produced site descriptions, providing background information and key processes in the selection and management of technologies. The key findings in this report are based on these site description reports.

The overall aim of the research was to develop more understanding on technology choices and opportunities for research collaboration and networking. It is important to note that the word 'technology' may have wider meaning. In this research, we started with the meaning of physical infrastructure provided or improved for WSS at the household, street or area level. However, during the research process, the teams preferred to use a wider definition, incorporating planning, design, management, operation and maintenance, as processes necessary to choosing and providing technologies. It was agreed that a definition of technology includes physical infrastructure, machinery and equipment, knowledge and skills and the capacity to organise, operate and maintain all of these.

This report also presents the methodology, as developed before the visits, and reflections on how far this was used. This is then followed by short summaries of the sites visited. Detailed site descriptions are included in the annexes. The main part of the research is the section on key findings, which includes our analysis. The report also includes some conclusions and some thoughts on the way forward from here.

Snapshots from the field study. Upper row: Ethiopia. Lower row: Sudan

2. Common practice in technology choice

Traditionally, development agencies and specialists would develop or import technologies as physical infrastructure, tools and machines from other parts of the world and apply them to the local situation, with very little, if any, modification to meet local needs and circumstances. This resulted in a number of failures as, after the initial excitement, technologies were soon abandoned. Learning from these failures, the emerging trend was to maximise participation and accept trial and error as an essential part of the process.

At the same time, there was greater recognition that hardware technology was only part of the solution, and that it had to work well in the wider physical, social and economic context. This shifted the focus of attention to more area-wide approaches and to promoting partnerships between actors. For example, participatory planning with users was considered the key to sustainability, with technology choices then made within the context of participatory appraisal and planning. Processes were developed to identify, profile and map the different actors and relationships existing within the sector. Identification of existing opportunities and barriers to working together were identified at the planning stage.

This change in terms of creating more space for users to participate, choose, own and manage led to greater use of approaches that helped in understanding the community's vision, and using this as the most important factor in the choice of technology. The role of the expert changed to that of facilitator to guide communities to search more deeply for solutions and strategies to achieve their goals.

People's ability to choose the most appropriate technology was further enhanced by the facilitator through the use of photographs and films and, if possible, by arranging exchange visits to places where a technology was actually working. In this way, users become the main decision makers in the choice of technology. Users, especially poor users, were offered more opportunities to participate in choice of technology, to decide on budgets and spending and, if possible, to manage some of the communal services to obtain more control of technology and outcomes, such as sustained income and employment from services.

In this participatory process, decision makers also learn the importance of different factors affecting choice of technology and the inter-linkages between these factors. For example, ability to operate and maintain a particular water supply technology depends on acceptability of regulatory organisations, as well as social and cultural norms. Poor people may be allowed to bypass regulations, as they cannot afford the high costs, although when development is facilitated by an external organisation, it is almost impossible to bypass government regulations and standards.

Regulations and standards are created for various reasons, for example, health, safety and comfort. Recently, a number of regulations have come into being as a result of environmental concerns. This has had important implications in terms of cost and ability of users to understand, own, operate and maintain various technologies.

Certain physical factors, such as distance, housing type and population density, also play an important role in the choice of technology. For example, in high density areas, people may not have enough space to construct a household sanitation system. Certain cultural considerations and beliefs also play a role in the choice of technology. This affects, for example, the use of water and materials for hygienic purposes and demand for water.

When it comes to the construction of physical infrastructure, it is common in many cultures for men to take a leading role in the decision-making process. This sometimes has the result of excluding women and children. As a result, certain technologies do not give full benefit to women and children.

While gender issues vary across cultures, the technology choice process must have clear guidance as to how it can be more gender sensitive. For example, in relation to sanitation, it is women and girl children who actively manage the cleaning of facilities and ensure regular use for the entire family. In addition, it is extremely important to take into consideration the specific needs of women, such as those regarding privacy, squatting position and disposal of sanitary towels, to ensure equitable use in the Nile region.

Similarly, there are special needs for elderly and disabled persons. When access to basic services is in short supply, older and disabled persons are worst affected.

3. Methodology

Before leaving for the site visits, the teams participated in a half-day workshop to understand the programme's perspective, work plan and reporting schedule. This also provided the teams with an opportunity to debate the guiding questions. The following is an edited outcome of some of those discussions.

In the process, the key RiPPLE focus areas and its approach were discussed. Subsequently, the workshop tied the methodology strongly to a project cycle of planning, implementation, operation and maintenance, impact and sustainability, as well as investigating the wider policy context. The team conducted its investigation using the following methods:

1. Project documentation: This was a review of existing documentation held by implementing agencies, such as project plans, evaluation reports and design specifications. The major limitation of relying overtly on project documents was that most documents were incomplete or unavailable. The team recognised the need for proper process documentation of project implementation for learning.
2. Observations (site visits): To supplement project documentation, and to obtain an overview of the physical structure of each site, the team was given a guided tour by representatives from the implementing agencies involved in the project cycle. These were mainly engineers who had worked or who were still working with communities, in conjunction with water management committee (WMC) members. Site visits aimed to allow the teams to understand and crosscheck historical perspectives. Photographs were taken where possible to give visual representations of what were often complex systems.
3. Focus group discussions: These were conducted with community members to give an overview of the level of community participation, management and understanding of the systems in place. Questions followed the project cycle, including planning, implementation, operation and maintenance, impact and sustainability. Sanitation was looked at briefly, but not fully incorporated into the discussions.
4. Key informant interviews: For key informants, questions focused on general policy and, where relevant, site-specific issues. It was decided that, owing to resource limitations, sanitation would be looked at separately and only when possible, making service delivery the main focus of investigation. Key informants were either government officials or implementing organisation representatives. Their role was to provide information on the bigger picture in terms of higher-level policy and approaches to project implementation.

Each team member was expected to draw up a summary of daily activities, from which site briefings would be drawn, supplemented by information extracted from project documentation. Owing to time constraints, the study was to be heavily narrative, as a precursor to further investigation.

Annex 1 contains methodology documents, including the full checklist for focus group discussions and key informant semi-structured interviews and the daily reporting templates.

4. Country and site contexts

4.1. Introduction to countries

1: Kersa and Meta woreda, East Hararghe zone, Oromia region, Ethiopia

2: Al-Fasher, North Darfur region, Darfur state, Sudan

3: Nairobi region, Kenya

Figure 4.1: Map of three countries and focus areas of studies

Before we present and discuss the key findings, it is important to understand the context of the three countries covered in this study, namely, Ethiopia, Sudan and Kenya. Located in East Africa, and being among the 10 Nile riparian countries, these three countries enable interesting comparisons in terms of geography, culture and government institutional structure in water interventions. Within each country, sites were chosen based on locations of partner organisations. In Ethiopia, these were regions where RiPPLE and HCS offices were based. In Sudan and Kenya, site locations were selected in areas where PAC was working. Figure 4.1 below shows the geographical location of the regions of the selected sites across the three countries.

4.2. Brief sector context in each country

4.2.1. Ethiopia

In Ethiopia, there is a standard procedure for project planning and implementation, based on Ethiopian government policy related to non-governmental organisation (NGO) work. The procedure relates to communities seeking assistance from local government or NGOs and/or local government providing assistance to prioritised communities. For a more detailed description of the Ethiopian governance and planning context, refer to Annex 2.

In the context of Ethiopia's federal system, the country is divided into nine regional states and two administrative towns, namely Dire Dawa Administrative Council and Addis Ababa Administrative Region. The sites visited are located in Oromia region, shown in Figure 4.1. At regional level, there are four levels of decentralised administration. Starting from the lowest tier, these are: kebele, woreda, zonal and regional. Put differently, regional states are subdivided into zones, which are then subdivided into woredas; woredas, are, in turn, subdivided into kebeles. With reference to kebeles, it is important to distinguish between peasant associations and urban dwellers' associations: the former refers to rural kebeles whereas the latter refers to urban kebeles. In combination, the kebeles are the administrative units that constitute the woreda.

There are government water offices at the woreda, zonal, regional and national level. Any intervention by NGOs needs approval from the regional, zonal and woreda levels. However, prior to any NGO intervention at regional, zonal and woreda level, it is mandatory for NGOs to register with the federal Ministry of Justice. In an attempt to harmonise donor interventions at regional and woreda levels, each NGO is assigned a geographic area in which it can operate.

The water sites visited by this study are in Kersa and Meta woreda, which lie in East Hararghe zone of Oromia regional state. These woredas were selected because they lie within the operating scope of HCS. Boxes 4.1, 4.2, 4.3, 4.4 and 4.5 provide brief descriptions of the selected sites.

Box 4.1: Kenchera – Lift and drip irrigation technology promotion

Kenchera is one of 12 villages in Lede-oda Mirrga Peasant Association of Dire Dawa Administrative Council. The village has 73 households, each household with an average family size of five members, whose livelihoods depend mainly on rain-fed mixed farming. The research looked at the drip irrigation being tested by farmers.

The water for irrigation comes from a hand-dug well, which has been reinforced to prevent collapse. This water is then pumped into a storage tank and distributed using various types of irrigation; furrow irrigation and three types of drip irrigation (pipe, tin and plastic bottle). This is the second intervention by HCS in the community. HCS is working in collaboration with Alumiya University, which conducts research on developing and improving drip irrigation technologies within the community.

The testing, carried out in full partnership with farmers, has shown the advantages and disadvantages of the different techniques. The farmers reflect on their preferred methods by describing the technologies and then listing their pros and cons. Furrow irrigation is simple but uses a large quantity of water, and leads to weed growth and soil compaction and cracking. The 'improved' drip irrigation saves water, is easy to manage and does not lead to problems with soil cracking, but evapo-transpiration is high. Traditional drip irrigation, which consists of plastic bottles buried near the root zones of plants, is also an efficient way to use water, but is harder to manage, as the bottles have to be opened and closed and refilled on a regular basis. A variant on the above, using 5 litre tins, was considered an improvement. A replication of the tin drip irrigation is being attempted on a nearby farm with an associated dug well (un-reinforced). However, the shortage of 5 litre tins has been cited as a potential limitation.

Some people here get drinking water from hand pumps or...

Well and pump that feeds tank

From hand-dug wells which are unprotected

Regardless of the merits of the technological innovations, issues relating to land rights were identified as being of crucial importance in this area. There had previously been problems with land rights and access to land to the extent that, in the second phase of the project, particular effort had to be made to resolve these. This was achieved by putting in place a legal binding tenancy agreement between the landowner and farmers.

Tank that feeds irrigation for farms

Different types of drip technology being tested out by farmers: Plastic bottles, Tin cans and 'improved' irrigation

Box 4.2: Goro Beyo – Spring-fed gravity system

Goro Beyo is a peasant association located in East Hararghe zone of Meta woreda, southwest of Dire Dawa town. Goro Beyo has a spring-fed gravity system, whereby water from the spring is channelled into a reservoir, where it is first stored and then distributed to four water points plus an irrigation pond. Prior to project implementation, the community used unprotected springs and ponds and experienced many problems with waterborne disease.

Overall, the system is managed by the community on the basis of traditional management practices embedded in modern water management structures, as suggested by implementing agents. This aims at improving transparency and accountability in the management of the spring-fed gravity water supply system.

Some of the advantages of the gravity-fed systems are that they are traditionally of low cost to run, and that they are generally better managed, maintained and operated, with a fixed tariff per household.

The system has benefited from sufficient availability of water to fill an irrigation pond, to allow for a multiuse system. Although the system has been highly useful in terms of an increase in productivity for irrigation beneficiaries, it has not had the same direct impact on non-irrigation beneficiaries. The system has also reached full capacity, with increased demand from outlying areas, and there is some interest and understanding on the part of the community with regard to expanding the system.

Again, land rights issues were identified as key, with access to a cattle trough denied by the owner of the land, as the land was being degraded by people accessing the water point. This issue was still under discussion at the time of writing.

Left: Gorobeyo is fed by a capped spring supply that helps increase the discharge of a spring

Water from the spring feeds two storage facilities. The storage pond (left) feeds irrigation channels and the storage tank (right) feeds the pump for drinking water, laundry and cattle troughs.

From left to right:
Distribution junctions are used to control where the water goes to farms, by appointed distribution managers.
Water runs freely from taps, as distribution points are not well-maintained.
A land issue with the local farmer, restricts access for villagers to the constructeed laundry facilities and cattle trough.

Box 4.3: Welteha Bilisuma – Motorised water supply

The project at Welteha Bilisuma pumps groundwater from a 66m borehole with a submersible pump and delivers it to a reservoir, from where it is gravity fed to distribution points. The scheme serves 800 households. The community was involved in the building work, such as constructing a road for vehicles (over 500 individuals). Researchers saw this as very positive, as the sense of community ownership was felt to be very important. The WMC is made up of community members (as standard practice); the two water caretakers and the two pipeline caretakers are also community members. Fee collectors are elected (all women). The management system reportedly works very well.

The community has seen an improvement in the health of humans and animals owing to a lower incidence of waterborne disease. In addition, the borehole has meant reduced time and effort among women and children in fetching water. There are plans to buy another motor with the revenue generated by the water points. This may be used to expand the system, or to replace the current one in case of failure.

Negative points identified were low level of bookkeeping skills within the WMC and a lack of focus on sanitation. Motorised systems require fuel and recent fuel price increases have led to increases in fees charged. This has had an effect on community water usage.

System is a motoried pump which feeds storage tanks, with distribution points that are fed by gravity. The functioning distribution points are the taps where water is collected for domestic use.

Women and children queue for water, which is charged per litre, For every container, the fee-collector collects money, which is then reconciled with the meter readings.

Problems with the system: When families cannot afford the water, particularly with rising fuel prices, they resort to original, unprotected water sources.
Shower facilities are in the middle of the village, and women don't feel as protected, and prefer to bathe at home.
Laundry facilities are blocked because they don not have adequate controls.

Box 4.4: Millennium Village – Gravity-fed system, sanitation interventions

The water system in Olan-Oulla was developed after previous interventions were destroyed by flooding. Before the project was set up, villagers were using water from an unprotected source. In fact, the name of the village means 'leeches', because of the presence of leeches in this water source. Unusually, it was the strongest members of the household (men) who typically had to collect the water, owing to the inaccessibility of the spring, so it is their time which has been freed.

Prior to the system installation, the leeches in the unprotected water caused several health problems.

With the reconstruction of the spring-fed system, an integrated programme approach was implemented, including water supply, sanitation promotion, watershed management and irrigation, alongside cross-sector interventions in education and health. The system had been running for about four months at the time of visit, and already impacts were being seen in areas such as sanitation (showers, latrines), with now coverage of pit latrines now reaching 50% of households. Water was also used for livestock, irrigation and house construction (which uses mud). This has the attendant effect of reducing deforestation, mainly because mud substitutes for wood in house construction.

The capped spring has allowed for increased yield. Terracing in the hills is part of watershed management

Alongside WSS interventions, there have been simultaneous interventions in health, education and environment, as Millennium Village is a pilot for testing out cross-sectoral programme interventions. Overall, the heavy investment has had a major impact with regard to lifting people out of poverty.

The obvious question seems to be: Will these benefits be sustained once the heavy financial support is removed?

The water from the spring, goes via a storage tank to distribution points and cattle troughs. Farmers can now grow produce for sale.

Alongside water and sanitation interventions, the NGO introduced brick making to reduce reliance on wood for buildings, and home management programmes including domestic facilities such as laundry and improved stoves.

Box 4.5: Ifa-Jalela and Kufanzik – Two kebeles sharing one water system

Ifa-Jalela and Kufanzik are two adjacent kebeles that share the same source, through a relay system. The water system originally served Ifa-Jalela, where the borehole is located, and was extended to serve Kufanzik. This owed to the fact that there was no technical alternative to provide Kufanzik with water. The water system also provides a point for laundry and shower facilities. Prior to the implementation of the scheme, residents accessed water from open ponds or an intermittent stream (3km from the settlement) and thus experienced high levels of waterborne disease.

The system has been plagued by technical and managerial problems, with breakages and leakage as well as tension between the two kebeles. This had led to slow filling of the reservoir and an increase in the amount of fuel needed and subsequently cost to the users. However, the community reported improvements in the health of the people and their animals. In addition, communities reported that the new system has led to reduced time expended in water collection.

Management problems were identified as the main reason for the failure of the system, with a recent audit indicating misappropriation of funds. This led to the dissolution of the WMC. At the time of writing, an interim management committee had been established, with further investigation and conflict resolution being taken on by local government. Lack of communication between kebeles and resentment at having to rely on another kebele's water supply were cited by the community as problems. This site highlighted issues surrounding ownership of and rights to water, with both communities perceiving the owner of the land to be the owner of the water.

Left: Due to the mismanagement, most taps have not seen water in months.
Below: The design engineer listens for water filling the tank in Kufanziq for the first time in months.

From Top down: Motorised pump which feeds storage tank, that is dispersed by gravity to pumps in Ifa-Jallela. The pump also feeds a second storage tank on the border with Kufanziq (right).

Villagers have to resort to original unprotected sources for water, because of poor management.

Despite lacking access to water, Kufanziq has 100% latrine coverage, but handwashing remains a challenge.

4.2.2. Sudan

Sudan is the largest country in Africa, with varied cultures and ethnicities. Darfur is one of Sudan's regions, divided into three federal states: West Darfur, South Darfur and North Darfur, which are coordinated by the Transitional Darfur Regional Authority. Owing to the Darfur conflict, the region has been in a state of humanitarian emergency since 2003. Sites visited in Sudan were located in the state of North Darfur.

In Sudan, no clearly stated government policy and operational framework guide work with NGOs in the water and sanitation sector. Most NGO activities are humanitarian in nature, working with refugees and internally displaced persons (IDPs). The Drinking Water Corporation (DWC) is an umbrella body for all water-related government initiatives, covering Water and Environmental Sanitation Services (WESS), the Urban Water Corporation (UWC) and the Rural Water Corporation (RWC). The UN Children's Fund (UNICEF) and the government of Sudan have a five-year masterplan that provides policy guidelines in water, health, education and primary health care. A more detailed description of the Sudanese planning and governance context is included in Annex 3.

The sites visited in North Darfur are located in the region in which PAC Darfur operates. Boxes 4.6, 4.7, 4.8 and 4.9 provide site descriptions for Sudan.

Box 4.6: Azagarfa – Water harvesting dam

The Azagarfa water harvesting project is located 33km north of Al-Fasher, the capital of North Darfur. A dam retains floodwater for the purposes of irrigation, but construction has not been completed owing to the conflict. As such, only five families are able to use the dam system for irrigation.

Other natural ponds are used for fetching water for domestic purposes, livestock and brick production. Boreholes and hand-dug wells for drinking water have been constructed at different times by different agencies.

An attempt to improve a natural pond to increase its capacity resulted in damage to the rainwater streams that fed the original pool. As a result, no water drained into the 'improved pool', rendering it useless.

Generally, management and fee collection of the hand-dug wells are carried out by trained villagers trained (two from each village). Fees collected are spent on maintenance and salaries, with little scope for building up savings. The ponds (hafirs) are not monitored and fees are not charged for use, partially as a result of the conflict. It has been suggested that, with a management system in place, the pond could be rehabilitated and water quality improved.

Alongside the WMC, there is also a 'popular committee', which is made up of members of the community. The role of this group is to present requests/problems from the community to the WMC and to monitor its performance. The existence of this 'popular committee' is seen as important to the success of the project, since it ensures accountability and transparency as well as better integration of village-level development programmes.

The design of the Azagarfa design worked using locally available materials and local skills. However, a combination of silting, the conflict preventing completion and restrictions on maintenance has caused the dam to fail. The nearby hafir provides water to local populations, several thousands of heads of cattle and brick construction.

Box 4.7: Fasher Hafirs – Twin ponds

Fasher Hafirs (ponds) are located 11km east of Al-Fasher town. The twin ponds are used by 60,000 people and their livestock. The main water source for this area is surface water, with groundwater sometimes available, from 11 hand-dug wells (of which eight were operational at the time of writing). Other parts of the Fasher Hafir system include a pump and storage system, which were no longer in use, owing to the conflict.

The community contributed to the construction of the water ponds with labour paid for by the government; the wells were also constructed using local labour, as part of a participatory development process.

In 2008, the community felt the need to re-establish its own WMC to mitigate ongoing damage to the water system. Initial management was taken on by the government. This was thwarted at the start of conflict, at which point access became unregulated. Generally, tariffs and user fee collection are mandatory in any water system in Sudan. The tariff for the use of these ponds is set by the Water Corporation and fees are paid in advance. The new WMC set tariffs based on Water Corporation tariffs, to cover operation and maintenance costs.

Owing to the limited access to groundwater, it is believed that water from the ponds is used for human consumption, with adverse implications for human health. There is therefore an urgent need to set up a system to treat the water. Access to water for domestic use and livestock in such close proximity could address the multiple needs of the community. However, special care would have to be taken to avoid contamination, and the ongoing conflict in the area makes improving any water source a difficult prospect.

Twin hafirs feed the nearby water yard, through wells. There used to be a storage tank, but this has gone into disuse due to the conflict. There is currently no control over access. Disused wells are guarded against people or animal falling in and the water is not treated.

Local NGO works with women groups to create nurseries, but access is thwarted by the conflict.

Comparing technology choices in cattle troughs: metal sheet troughs are easier to move around and carry, in comparison to concrete ones, which are sited.

Box 4.8: Golo dam and Shugra boreholes – Supplying the town of Al-Fasher

The town of Al-Fasher (population 300,000) is served by several water sources, of which two were studied: Golo dam, a surface water dam with three reservoirs, supplies water during the rainy season and the Shugra boreholes, a set of 20 boreholes across two villages, supply water during the dry season. Golo dam has had its capacity reduced by half owing to silting, and this is of concern in an area with a growing population. The government at this stage does not seem to have the capacity or resources to rehabilitate the reservoir.

Planning, design and construction was carried out by the DWC, with the village of Golo created to supply labour for the construction process. The residents of Golo have relatively easy access to the water, but it is untreated, so there is high incidence of waterborne disease.

The government of Sudan signed a declaration in 1990 to supply the villagers in the area with water and electricity in return for the use of the groundwater on their land. However, there seem to be some problems with delivery: pumps bought to install the network are still in storage. Again, at this site, the conflict makes work difficult – any construction projects have to be carried out after negotiation with the rebels controlling the area.

Golo dam (left) and sub-dam (middle) provide most of Al-Fasher's water. Golo's main dam runs dry towards the end of the rainy season, and there is reliance on the sub-dam, as well as the Shugra boreholes. Shugra boreholes feed storage tanks (right) in sShugra, and then the water is pumped to Al-Fasher town, whereas the water from Golo dams is pumped directly to Al-Fasher town and stored there.

Box 4.9: Al-Fasher – Privately owned borehole

This well was dug manually in 1947 for irrigation purposes, and currently has a depth of 47m (deepened from 39m). The owner now uses a motorised pump to access the water, powered by the mains supply or a diesel backup generator. The water is pumped into storage tanks where horse carts are filled by water purchasers. Contamination of water in open tanks has been identified as a potential health hazard.

Fees go towards maintenance (which was problematic in the past owing to limited availability of spare parts), fuel expenses and income for the owner's family. The rate charged for water varies over the year, with the owner able to charge higher prices in the dry season when there is greater demand.

The owner is registered with the local government but refuses to pay any tax, as he feels he is not served by the local government (for example, when he applied for help to maintain the pump he was refused).

The water is pumped up from the well, to a storage tank and then fills water tanks pulled by horses.

4.2.3. Kenya

Kenya comprises eight provinces, each of which is subdivided into districts (wilaya). Districts are then subdivided into divisions (taarafa) and further divided into locations (mtaa) and in turn, sublocations (mtaa mdogo). Nairobi, the capital, is a full administrative province. The government supervises the administration of districts and provinces.

In order to address the problems associated with access to and provision of water and sanitation services in Kenya, the government has embarked on reforms in the water sector under the framework of the Water Act 2002. The Act aims to provide harmonised and streamlined management of water resources and water supply. The Ministry of Water and Irrigation, supported by water service boards (WSBs), is spearheading the implementation process. The reforms also aim to coordinate the various actors involved in the water sector and to ensure that policy formulation, regulation and service delivery roles are clearly delineated, with each role carried out by a separate entity within a coordinated framework. The Ministry of Water and Irrigation is no longer directly involved in management of water services. Its key responsibility is to undertake policy formulation, sector strategy development, research and training, sector coordination, planning and financing. The Water Services Regulatory Board (WSRB) is responsible for the regulation of water and sewerage services, including development and maintenance of quality standards and issuance of licenses for service provision. WSBs have the legal responsibility to provide water and sewerage services within their prescribed areas of jurisdiction under license from the WSRB. Their tasks include holding or leasing and developing water assets, contracting water service providers (WSPs) (their main agents in provision of water services) and preparing plans for improvement of services, including expanding service coverage and reviewing tariffs. WSPs are the entities through which the WSBs provide water and sewerage services under appropriate agreements entered into with the approval of the WSRB. The WSPs may be community groups, NGOs or private companies, including those set up by local authorities for the specific purpose of operating water services.

In Kenya, the PAC team conducted a review of an urban sanitation programme in Kibera, Nairobi, and a rural water supply programme in Kabuku (Box 4.10). A more detailed description of Kenya and the sites studied there is included in Annex 6.

Box 4.10: Kabuku water project

Kabuku is a community-managed water supply scheme, initially completed in 1979. It ran until 1988, before the community sourced funding for rehabilitation from Sida in 1993. The Kabuku water supply project is a pumped system from a spring and serves a population of about 2500 people, through a mixture of household connections and public tap-stands.

Kabuku now provides an example of strong financial management – through metering, effective pricing and fee collection; its income is reliable. Annual income generated is about US$11,000, with US$9000 going on operation and maintenance costs and the surplus going towards extension and rehabilitation.

The Kabuku group members, registered as a society, own the water supply collectively, with rules on membership, governance, management and ownership of assets. The members elect a management committee and hold it and the staff accountable through approval of the annual budget.

Members, management committee members and staff all receive detailed and extensive training covering management; bylaws; key features of water supply; finance and accounting; budget preparation and record keeping; staff supervision; and operation and maintenance.

To improve on management and use of water, each member of the Kabuku project is given a meter that is regularly serviced; readings are taken on monthly basis. Non-members pay a set tariff for water from the public tap-stands.

From the point of view of the group members, this scheme is successful. There is cohesion within the group, they pay their bills and receive a good service. The group's financial sustainability is helped by its ability to set its own tariffs. Accurate and clear financial accounts are important to maintaining trust among members.

5. Key findings from Ethiopia and Sudan visits

5.1. Planning procedures and practices

In Ethiopia, information about community needs in water and sanitation are held at the woreda level, but the community voices its needs at kebele level, which is then channelled to the local woreda Water Office. The woreda Water Office then prioritises community needs. Further to prioritisation by both woreda and NGOs, a feasibility study is conducted. Users are supposed to participate at every level, from needs identification to planning, apart from some technical design, such as depth of boreholes, which is carried out by water engineers. This research did not assess the quality of the participation.

In Ethiopia, much of the decision-making happens at woreda or regional-level offices, in conjunction with implementing NGOs.

Local government supervises implementation, carries out training and provides follow-up support. Implementing NGOs coordinate with the community in planning and implementation, provide training for community members and government staff, arrange maintenance kits, kick-start funds and manage a phase-out strategy. National policy stipulates the need for participation but, in most cases, regional governments do not have the resources to practise this. It is also important that government mainstreams participation in its programmes and activities. In view of this, the main driver for participation seems to be NGOs, partly because national policy creates space for them to facilitate it. In the case study sites, HCS plays a central role in ensuring participation in community water management processes at woreda level. The woreda system may not have the resources and motivation to mainstream participation: such support is provided by HCS.

In the case of the Golo dam and Shugra boreholes near Al-Fasher in Sudan, the planning, design and construction process was carried out entirely by the DWC with the aim of making water available to Al-Fasher town. Local people were employed as labourers, and some are still employed by the DWC. The village of Golo was created to provide a source of labour for the dam, and has since grown to around 1500 people. In Golo, discussions with the community reflected little involvement in the planning, design and maintenance of the system, as water supply is managed by the DWC. A significant proportion of workers at the Golo pumping station are from the local village. The village itself has easy access to the water point. A trip to the water points is on average 15 minutes one way, with the longest journey taking 30 minutes.

The women interviewed reflected that there were hardly any queues, and fetching water was a relatively smooth process, unless there was a problem at the pumping station. Water is used solely for drinking and watering livestock, with some cultivation on the periphery of the reservoirs, fed by the overspill from the reservoirs and pipes. However, because water from Golo is untreated, there is high incidence of waterborne disease.

It is clear that people are satisfied with the availability of water and the technology used at the pumping station, particularly as it continues to provide employment for some of the local villagers. The technical design by DWC did not see consultation with the community, nor did it give community members a range of options, but this does not create any problems as long as the water supply is reliable. It is not certain from the field notes whether users are aware of water quality and links between this and incidence of certain diseases. They may need better knowledge to measure water quality and to report on this to the responsible office. In the case of sanitation, planning with the people and ownership is also important: as we learned from Kibera, Kenya, demand and sustained use of sanitation facilities can be challenging.

In Sudan's Fasher ponds, the system was planned and constructed by the government using heavy duty machines. During the construction process, the community contributed local labour paid for by the government. The supplementary hand-pumps (11, of which eight are functioning) in the area, were constructed by WESS and PAC, an NGO, both of which are active in the area. In implementing the hand-pumps, both the agencies have followed a community-based approach, allowing the community to contribute local labour and resources.

In the case of Kabuku, Kenya, the water supply has been serving the community for 28 years and the technologies were planned and are owned and operated by the community. The Fasher and Kabuku examples reveal that the process of technology management after construction is extremely important to ensure long-term and sustained use. Learning from the Fasher ponds suggests that being able to access water for domestic use and livestock can address communities' multiple use needs. However, those designing systems need to take special precautions against cross-contamination.

RiPPLE has identified a need to look at mechanisms for increasing transparency, accountability and effectiveness. This must be seen not only at government level, but also at levels where other organisations interact. In the case of Ifa Jalela and Kufanzik, the project faced a pre-existing situation of poor management and corruption. In Ifa Jalela, a lack of training, unclear systems and a lack of accountability by the WMC led to corruption. The government identified these weaknesses and responded by dissolving the committee, putting in place a temporary manager.

In Kufanzik, even local users suggested employing a government official to manage the system, to be paid out of a cost recovery scheme, as it was felt that the scheme was too large to manage without outside assistance. One of the key research questions emerging on this regards the role of government in improving accountability and effectiveness of community-managed systems.

Conflict can easily take place among community representative groups, community members and government structures. Large-size schemes may need government systems to ensure accountability, but in many low-income countries governments are considered corrupt by the community and people do not like to deal with government agents. In this debate, the role of a 'whistle blower' and a neutral, trustworthy regulator is important. In rural areas, the only recognised organisations available are local government structures.

Indigenous community processes could play an important role in promoting accountability. For example, in Welteha Bilisuma and Goro Beyo, the WMC blueprint utilised by HCS was adapted by the community to include local institutional elements for increased transparency, accountability and effectiveness. This is particularly true for the Goro Beyo irrigation team. The size of the committee was also altered: the norm is to have a seven-person committee for any size of project.

Experience among study participants highlighted the need to take on flexible management systems; for instance, big water systems may need more than seven committee members. Further, schemes that use complex technology and/or cover more than one community may need external support from NGOs, government or the private sector to complement community-based management approaches. In Sudan, experience showed that communities found it more difficult to manage larger systems without government management support. In Ethiopia, the best-managed systems were modified by the community to enable better management.

With reference to technology choice, certain technologies, such as water meters, could provide better potential for accountability. The use of water meters in rural Kabuku helps in charging fees and creates relatively better systems of transparency.

The key indicator for transparency, accountability and effectiveness is the reliable operation and maintenance of systems. In the cross-border scheme of Ifa Jalela/Kufanzik, where the technology used depended on cooperation between both areas, an overarching board to manage the relationship was put in place, but this failed because it lacked authority.

A factor of safety against floods is built into all schemes, but in the case of Olan-Oulla/Millennium Village, the original scheme, which could withstand regular annual floods, was destroyed by a 'freak' flood, and villagers had to revert to their old water-collecting practices for two years. The new scheme took this into account and was designed to resist flood damage to a greater extent.

In Kenchera and Goro Beyo, where some system components are on private land, further legally binding agreements are required with the landowner. On the other hand, the owner may be adequately compensated with another piece of land or other forms of compensation. Land ownership issues tend to be linked with traffic or productivity. For example, in Goro Beyo, the land owner restricted access to a cattle trough because of the livestock and human traffic across his land. In other areas, locating storage tanks on private land, which attract less traffic, was often freely allowed without any form of compensation. In Kenchera, land ownership issues from the first phase were based on the perceived ownership of produce from the land by the landowner's family, despite informal tenancy agreements. Legally binding agreements with tenants in the second phase provided some form of security for tenants. Private ownership of assets was recognised and integrated at project planning and design stages. Some assets are of relatively small size, such as a boreholes or piping, but anecdotal evidence suggests that private ownership adds incentives and leads to better operation and maintenance, by linking assets directly to an individual's livelihoods or income.

In Azagarfa, North Darfur, lack of a management committee, tariff setting and fee collection at the hafir has significantly affected the sustainable use as well as quality of the available water. Introducing a management system could enable the provision of funding for rehabilitation and even the treatment of the surface water. Formation of a management committee with people who are interested in working together to improve access to water and sanitation could be the answer.

Overall, the motivation and resources to sustain participation and to promote community ownership in technology choice is still weak at local government level. There is a shortage of resources to improve the process and, often, user participation is least prioritised. HCS has successfully filled those gaps and demonstrated approaches which reflect that such support may be needed for a much longer period than just the planning, design and initial few years of operation.

With large-scale schemes, such as motorised boreholes, participation is often heavily dependent on some form of technical knowledge. As such, community participation is limited to planning the positioning of system components and operation and maintenance management. It is often difficult to provide the community with an in-depth understanding of a system with which to make informed technology choices. As a result, support for large-scale systems needs to carry on beyond implementation and phasing out.

5.2. Stakeholder roles

Role of different actors was identified as being an area in which RiPPLE could identify useful learning points. This research focused on different roles in technology choice. The generic project approach in Annex 2 explains the roles of the various groups in planning a project in Ethiopia. Project requests come from the community; the community also participates in site selection and provides labour for construction and, in some cases, land. Community committees participate in implementation and management after a scheme has been planned. Local government supervises implementation, performs training and provides follow-up support. Implementing NGOs facilitate the community role in planning and implementation, provide training and maintenance kits, kick-start funds and manage the phase-out strategy. What we do not know is the extent to which we can standardise these inputs through government processes within other countries.

In Ethiopia, the key barriers found preventing different groups from taking an active role in local water governance were as follows:

- A standard application of a seven-member WMC blueprint was applied regardless of the complexity of the system, with villages were allowed to elect committee members.
- With regard to the WMC, there is a lack of refresher training, maintenance kits and literacy in management hampers long-term maintenance and sustainability.
- Local government is meant to provide ongoing support but lacks capacity in logistics and financial and human capital to provide proper support.
- Although there WMCs have an equal opportunity policy, this is not reflected consistently in practice. Most WMCs are overwhelmingly male and females tend to be fee collectors outside of the WMC. We do not know how these committees are represented by different tribes and what capacity and skills already exist in the community to engage with government systems.

In Sudan, DWC policy is for communities to be responsible for the management of small systems, i.e. hand-pumps, whereas larger systems, such as water yards and hafir, are under the jurisdiction of the DWC. However, in some areas, the conflict has prevented the DWC from being able to manage larger systems. In Fasher, the community took over the management of the hafir when its sustainability was threatened. Generally, women are not prominent in the WMCs of these systems.

Having a management system that aims to address the spectrum of community needs, especially women, is essential.

In Kenya, members of the Kabuku group made a monetary input at the start of the project and manage the system. Members are registered as a society with its own bylaws and receive training in all managerial aspects.

In short, actions and capacity of stakeholders are a key determinant of how sustainable a system is. Generally, in terms of water management, committee structures should be more context specific and tie in, as much as possible, with existing managerial institutions, or be flexible enough to be adapted by communities. In other cases, external stakeholders, outside of beneficiaries, are better suited to managing systems and keeping the system accountable and transparent.

5.3. Land ownership

As expected, land ownership was another issue arising as a point of contention in many cases. In Ethiopia, where land is a scarce resource in comparison with Sudan, conflicts had arisen over land ownership in most of the sites visited, particularly in the Ifa Jalela/Kufanzik case, where the water accessed by both communities is on land belonging to Ifa Jalela. As the water source and collecting chambers for both kebeles are on Ifa Jalela's land, the water is referred to as 'Ifa Jalela water'; as a result of this perceived ownership, bribes (or additional payments/non-agreed payments) are demanded from Kufanzik residents who want to access the water. Pipes have been sabotaged so that extra fuel money can be demanded and so that lack of water being delivered to Kufanzik can be blamed on this rather than on managerial failure. To counter these problems, Kufanzik residents in particular suggested that a local government official manages the scheme, since it is too large to be managed by the community.

Conflict can wreck havoc on access to water, especially in areas that suffer from land scarcity.

At the Kenchera site, the extended family of the farmer on whose land the water source and cultivable land are situated felt unhappy with the farmer group benefiting from the land. Tensions had led to the use of the land for cultivation being suspended for five years. In this new phase, a group of farmers approached the landowner with support from HCS and attempted to overcome the problem by signing a partnership tenancy agreement recognised by the kebele administration. The involved parties were the landowner and the villagers who will use the water supply for irrigation. This agreement entitles members to use the land for five years, with a certain annual payment for this right. The group has also agreed to allocate a certain portion of the land to the landowner for cultivation. The enhanced capacity of the community enabled resolution of the difficult issues and integration of private ownership within the system.

A comparison of the Millennium and Goro Beyo schemes shows that location and type of access to water impact whether or not land ownership becomes an issue. Both these villages have similar technologies – a spring-fed system with a storage tank and distribution points. In Goro Beyo, where access to a cattle trough has been blocked, water distribution points are located on private land, entailing a great deal of human and cattle traffic. The landowner found that his cultivable land was being damaged particularly by cattle, which affected his livelihood, and he was not adequately compensated. The storage tank in Goro Beyo was also located in the middle of private-owned farmland, but attracted minimal traffic, so the landowner was seemingly unaffected (and indeed benefited from overspill). In Millennium Village, water distribution points were on communal land and access was by means of communal pathways, therefore traffic did not pass over private land. The Millennium scheme also had storage tanks sited on private land, with no problems with the landowner.

In Shugra in Sudan, the government signed an agreement in 1990 to give villagers free water and electricity in return for the use of the water situated on their land.

Some important research questions need to be explored here with regard to assets and conflict, regulations on ownership of water resources and government processes to deal with such situations. An understanding of the resources (land or water) and their perceived ownership is crucial to technology choice and situation of system components. Such an understanding could prevent future conflict and help put in place processes for their sustained and long-term use. Designing systems that ensure that paths of access to water points are on communal land might be one way of reducing conflict within and between communities.

5.4. System sustainability

The long-term sustainability of WSS technologies depends on several factors, including the robustness of the technology, its proper maintenance, community capacity, fee recovery, resolution of conflict and management issues. Operational sustainability also depends on the ability of the community or local government to mobilise resources in case of a large repair need. The site descriptions collected by the visiting teams looked mainly into technical aspects.

As mentioned previously, water supply schemes are designed to resist normal flooding, although in some cases there are risks of major freak floods that can destroy the system. In other schemes, such as the improved natural pool in Azagarfa, an existing water source may become damaged if poorly designed and/or implemented. A design that avoids such risks increases the cost of the infrastructure. To deal with such difficult decisions in the choice of technology, good interaction is needed among designers, users and local government. What need to be avoided are situations such as that at Millennium Village, where the scheme was destroyed by a flood and nothing was put in place for two years, leaving villagers to revert to unsafe practices. An important research question arises in such cases: what to do with the previous infrastructure? There are indications that users would like to keep such infrastructure as a back-up. In Kibera, Kenya, old sanitation blocks continued to be used by women to fill their hygiene and sanitation needs. Eventually, the new system at Millennium Village was partially constructed with recovered pipes.


Designing systems that can be easily maintained is a challenge for rural communities who have limited access to spare parts.

This also highlights the importance of a community having an understanding of the technology so that members are then capable of rehabilitating the system with minimal support. In Welteha Bilisuma, the community took the initiative to get components of their system maintained, utilising their savings and training. In contrast, Millennium Village had the savings to fix the spring system but felt unable to take the initiative to undertake the rehabilitation, waiting instead for external support and mobilisation. In Kabuku, phase two of the self-help water project ensured complete installation so that the community could manage and rehabilitate the system when necessary. Ensuring a community understands a technology and has access to adequate support can help improve its chances of maintaining a water system.

Maintenance concerns are also important for long-term sustainability. For all motorised sites, spare parts are a problem. For example, in Welteha Bilisuma, some of the necessary spare parts are available only in Addis Ababa. Fuel can be a problem, bearing in mind the rising prices. The capital and operational costs of a system are also important for wider uptake and replication. We believe that both training and improving access to spare parts are vital. The technologies selected must use local spare parts and should not depend on imported parts or skills; otherwise, after a breakdown, users need to wait for a long time or repair may not be possible at all. This is a challenge for large and complex schemes in particular, as these require a high level of technical knowledge in the case of major rehabilitation, e.g. Golo dam or Ifa-Jalela/Kufanzik.

Among the major barriers hindering sustained use of technologies is conflict. It is common in community-managed schemes for community groups to be unable to overcome internal differences, which can lead to delays in maintenance, poor operation and ultimate abandonment of the whole scheme. In some cases, conflict is external and it is beyond community capacity to do anything about it. The problem of maintenance is aggravated in Sudan by the ongoing strife: the area outside Al-Fasher town is under the control of rebel factions and, as such, maintenance and rehabilitation have to be carried out through negotiation with rebel groups. Design persons need to be aware of all these risks, so that technologies can be made more resistant.

Agreement on the use of the land is another important consideration in the choice of technology and the management processes surrounding it, particularly with regard to cultivable land near irrigation schemes. It has been suggested that, in the case of Kenchera, the fairly short-term (five-year) nature of tenure with the landowner is a disincentive to joining the scheme. If shorter-term land tenure agreements become the norm, this will stop the private sector becoming more involved on a long-term basis and deter other groups (farmer groups, householders, etc.) that may need more long-term security from joining. On the other hand, short-term tenure offers the chance to look into alternatives if performance is not satisfactory.

Regular maintenance is important to sustain use. Despite promises by local government, and policies that ensure handover from implementing agency to local government, they may not have enough capacity to maintain it. The capacity of Golo dam in Sudan has been reduced by approximately half on its design because of silting. As such, its sustainability is under threat. Engineers interviewed stated that rehabilitation would make a significant impact in terms of providing for the water needs of the growing population of the town of Al-Fasher. They went on to identify as a constraint limited government capacity to carry out proper maintenance and rehabilitation (particularly in light of the ongoing conflict), even when resources are available.

5.5. Universal access to water

Universal access to water has been identified by RiPPLE as an important research area. This depends on a number of factors, some of which have already been discussed, such as problems and tensions surrounding land access (either community members accessing water on land belonging to an individual or one community accessing water on land owned by another community). In the sites studied, several ways of dealing with land issues have been suggested to mitigate problems. There may also be scope for further work on developing a clearer framework for access to land in such cases.

Mere provision of infrastructure services is not enough. One important issue picked up during the visit and discussions was the risk of inequality of access within the same community. Once access is provided, there is a need to look into impacts and economic outcomes. For example, if a certain number of residents can access a scheme and not others, inequalities may be created or existing ones increased.

In the case of Goro Beyo, members of the cooperative who access the irrigation system are able to earn up to Birr 7500 annually, whereas those who do not earn on average Birr 1500.

Equitable growth is always challenging in the short term and it is common for those with more resources and power to benefit first and most. Equitable economic outcomes from access to water are only possible if capacities are built across community groups to benefit economically from access to and use of water, whether directly or indirectly. This should be considered within the larger effort to determine how technologies can benefit all.

In Gorobeyo, villagers with access to irrigated land, have seen their incomes increase by more than 300%.

At the Kenchera site, where water is scarce, simple technologies have been demonstrated to reduce water use and improve its efficiency. Different technology choices are being tested by farmers, with significant uptake by other farmers in the area even before the testing phase is complete. This is because farmers understand the technology and because it uses highly accessible and available materials. This type of self-replication shows the strong potential of technology to contribute towards universal access.

5.6. Financing and user charges

The choice of technology, its capital cost and the need for operation and maintenance are directly linked with the financing. Understanding the financial needs on the ground is necessary to be able to incorporate such learning into policy. Where available, the teams looked into the capital cost of technologies, community contributions and user charges.

5.6.1. Capital costs and community contributions

In the Ethiopian context, projects are generally funded in the same way, according to the procedures set out in Annex 1. HCS secures funding from different programmes (e.g. the US Office of Foreign Disaster Assistance – OFDA, European Union – EU) and then grants this to selected sites based on government and HCS prioritisation and selection criteria. However, there are instances where the local community has also contributed to the initial costs of a system, for example in Goro Beyo, where community social services provided a Birr 1000 loan to start up an irrigation committee. Communities also contribute their labour in building schemes as their form of matched funding. The community contribution is an essential component to demonstrate community trust in a particular water system. It creates a sense of ownership and provides an important impetus to maintain the technology. However, often this is not considered important, as communities are poor and local governments expect to maintain systems for them rather than handover all responsibility. These linkages are extremely important research areas for further work in RiPPLE.

5.6.2. Cost recovery

Conventional technology assessments ensure that technologies deliver what they are expected to deliver. However, a broad assessment also takes into consideration issues such as how a community expands its economic opportunities with the use of a technology. In Kenchera, after an initial well improvement project increased farmers' productivity and therefore income, users could afford to pay for further improvements (a pump). This type of 'incremental' development could be considered for other areas, where using savings or own initiative to collect money and reinvest may not have been considered.

There were cost recovery mechanisms in place in all schemes studied in Ethiopia, as part of HCS policy. There are two main modes of user payment: a flat rate irrespective of usage or a fee each time water is collected, based on the running costs of the system. Motorised systems have much higher running costs, so are better suited to a fee charged at point of collection. In Ethiopia, where motorised systems are more prevalent, it was seen to be more manageable for users to pay daily for the amount they need, particularly as they lack meters to measure individual consumption. In these cases, if the price goes up, people reduce their consumption, using water only for drinking and cooking and returning to original unprotected sources for surplus needs. This could lead to a drop in overall revenue to keep the system financially viable, as well as leading to possible health risks for the community through use of unprotected water. Revenue collected on an ongoing basis covers maintenance, guards and caretakers and fuel costs, where applicable. Charges for water need to be in line with income and seasonal patterns. They also need to take into account the multiple livelihoods and seasonal migration patterns of a community.

In Ifa Jalela/Kufanzik, the WMC became corrupt and was eventually dissolved by local government (as mentioned earlier). This issue could have been avoided if the amount of income generated was clearly known about. In Welteha Bilisuma, the treasurer could neither read nor write, so accountability was poor: he was not aware of how much money he had. The amount of money in the bank reflected discrepancies with the figures provided by the community. Generally, managing a motorised system is more difficult and needs more support, not only because of the complexity of the system but also because of the high running costs, the potential for less financial transparency and accountability and the dependence on fuel.

In gravity-fed systems, water is generally more abundant and running and maintenance costs are minimal, so a flat rate can be implemented. It was observed that, at sites where a flat rate was payable irrespective of usage, there was more transparency and accountability, since each household paid the same amount and the number of households was known (so the level of income was known and the system was less open to fraud). Members of farmers' cooperatives who used gravity-fed systems also tended to pay a certain rate on an annual basis, irrespective of usage (e.g. in Goro Beyo scheme). Whilst not all members of the community have the same ability to pay, varying tariffs can help people better afford water. Ideally, a range of technologies must support more flexible systems of payment, but this is not always possible because of management difficulties.

Tariff and user fee collection is mandatory in any water system in Al-Fasher state and Sudan in general. For government-constructed water systems larger than hand-pumps, tariffs are always set by government, but tariffs on locally constructed water points such as hand-pumps are decided on by local communities. At the moment, the tariff for pond use is based on a tariff set by the DWC and fees are paid in advance. A ticket/pass is provided for households using the water service. Livestock owners are expected to register the number of livestock they own. The tariff rate for domestic use, for example, is SDG 0.5S whereas for livestock it varies according to size, i.e. SDG 0.3, 0.2 and 1.5 per head per year for sheep, goats and camels, respectively.

In villages around Shugra in Sudan, water points are managed not by committees but by an individual from the community. Individuals are invited on an annual basis to tender, and the winning bidder administers the water point and retains some income. By attaching a meter to the water yard, having one individual held accountable makes it possible to increase transparency and accountability.

The Al-Fasher privately owned borehole provides some useful insights into the processes of the private sector and governance. In this case, maintenance is conducted by the owner and his sons or, if an issue is beyond his capacity, the owner pays for maintenance services from the DWC. The operational costs go towards fuel expenses, maintenance and a supplementary income for the family. Users currently pay SDG 1 per horse cart (about 400 litres) during summer months, when there is less demand, owing to rains and recharged natural pools. During the drier months, just before the rainy season, when there are limited alternative water sources, the owner is able to charge SDG 3 per horse cart (April – 15 June). In addition, the owner is part of an organisation of private well owners, who agree on a set tariff between themselves, depending on the power supply. The income from the well is shared among the extended family, whereas income from his adjoining farm (about SDG 200 a week during harvest season) is just for the owner. The owner has used some of the water from the well to irrigate his land, but only a small area. Most of his cultivable land sits in an area fed by rains and does not need irrigation. The owner is registered with the local government but refuses to pay taxes because feels he does not receive any government support.

In Kabuku, the community-managed network has tariffs set by the community members. Some of the water is distributed through a home network and the rest through public tap-stands. Monthly billing, a progressive tariff and strict enforcement of payment rules have enabled the scheme to maintain high average collection rates over many years. This financial discipline, together with each group's authority to set its own tariffs and to set and approve annual budgets, ensures that income collected is enough to cover all operating and maintenance costs. Having a set number of members, rather covering than the entire community, allows for easier management as well, but this may create barriers to entry.

Metering is key in aiding cost recovery and financial sustainability in Kabuku.

In all, the field visits presented a range of fee recovery options, with variations depending on type of technology, system ownership (public/private/community) and impact on transparency and accountability as well as maintenance and rehabilitation.

5.7. Growth and productivity

Unsurprisingly, access to water means that productivity improves; this is important for all the sites. Impact on growth and productivity is heavily dependent on availability – amount of water available for multiple use (drinking, livestock, irrigation, etc.) – and accessibility (for example, farmers within the cooperative and those not). In sites where there is no irrigation, such as Welteha Bilisuma, productivity has also shown improvements owing to healthier livestock and time saving. Employment has increased, for example in Goro Beyo, where there is an irrigation scheme. There is now more year-round self-employment in farming activities. Members of the farmer cooperative in Goro Beyo have access to markets for their produce, hence the increased income, and are now looking to obtain assistance in order to remove the middlemen and access the market directly themselves. In Kenchera and Millennium Village, farmers can now earn an additional income from selling surplus vegetables. Kenchera has links with a women's processing project in Dire Dawa, to which it is planning to sell first harvests to generate capital quickly.

Introducing more environmentally-friendly ways to make bricks is one of the lessons that can be learnt between villages in the region.

There is also indirect employment in non-farm-related activities, for example mud brick construction. In Sudan, mud brick construction and livestock are the main sources of income, particularly for users with access to hafirs. Being able to partake in mud brick construction has provided another source of income in Millennium Village in Ethiopia also. Access to water ensures that these incomes can be derived from non-farm-related activities. In Fasher in Sudan, nurseries can generate an income for women farmer associations to add onto the income earned from livestock.

Overall, better access to safe water has saved time in the sites, and communities recognise improvements to their health and have seen an increase in income from both farm-related and non-farm-related activities.

5.8. Risk and vulnerability

Provision of water services was found to decrease vulnerability to shocks in various ways. In Kenchera, land tenure systems have allowed farmers to grow vegetables and create incomes where this was previously not possible. As we saw in the previous subsection, growth in farm-related and non-farm-related income generation can allow households to protect themselves from vulnerability. In Goro Beyo, grain was being saved and then sold at a higher price during times of scarcity to make a profit. In Millennium Village, more people have been building mud brick houses, thus investing in an asset that will give them greater security in times of hardship. In irrigation schemes such as Goro Beyo, there has been a direct increase in food security as the productivity of the land has been raised. Nevertheless, achieving sustainable livelihoods is a bigger issue than that suggested by these positive signs and water can contribute only to certain dimensions of this.

The increased availability of labour was noted in several cases. In most cases, women previously had the responsibility of collecting water but the scheme allowed them more time for other activities. In one case (Millennium Village), the water was previously collected by the strongest members of the household (men) since the source was very inaccessible and dangerous to reach. In this case, the labour of this group was freed up to allow men to participate in other income-generating activities, such as farming. In many cases, it was reported that children had more time to attend school.

Skills have also been developed in the communities. For example, in Millennium Village, residents can now maintain the system themselves. All sites have trained caretakers, who should be able to carry out minor maintenance, such as replacing taps. Motorised pumps have separately trained caretakers, for fuel loading and pressure checking.

The issue of asset inequality was brought up in the site report of Goro Beyo: increases in income inequality between beneficiaries of the irrigation scheme and others in the village could lead to conflict.

5.9. Sanitation

In Ethiopia, HCS interventions are accompanied by hygiene awareness programmes to improve sanitation alongside water schemes. As such, improvements in sanitation were reported in many sites in Ethiopia as a result of integrated programmes run by HCS. At Kufanzik, there is now 100% latrine coverage at household level, despite limited access to water. At Goro Beyo, there was improved latrine coverage, with water at the entrances of latrines to be used for hand washing. And at Millennium Village, the community has built latrine pits, with maintenance the responsibility of the females and construction the responsibility of the males. All of these improvements should lead to public health benefits and therefore improvements in quality of life. At Golo in Sudan, there was a keen interest in developing latrines and sanitation systems, as seen in camps for IDPs. Generally, in Sudan, Islamic religious practices consider hand washing an important component of ablution.

Whilst, sanitation at a household level was visible in most places we visited, there was little investigation into hygiene or maintenance of such facilities.

In this study, however, there was, yet again, evidence of a lack of attention and focus on sanitation, with a focus on water taking precedence. This reflects to some extent the attitudes of implementing agencies as there is not enough recognition of the benefits of good sanitation practices and, as such, sanitation is merely an afterthought.

6. Conclusions and the way forward

6.1. Phases of technological choice

Based on the learning and research exchange on technology choices in Ethiopia, Sudan and Kenya, this section summarises overall learning and proposes way forwards. A number of specific points and areas for further exploration were also included in the previous sections.

The process of technology choice can be broadly divided into three phases:

The **first phase** is the process of exploration and planning before the actual physical design and construction. This needs to be informed by a range of technical details and a thorough understanding of the social processes in place. Communities could take a leading role in some of the key decisions, such as location of the schemes, land ownership, operation and management of assets, charges and systems of conflict resolution. The community also needs to be informed of future requirements which they may not know about, such as need for spare parts, fuel consumption, protection against floods, etc. Ideally, governments should coordinate this process, working with an informed community but, in the absence of resources, capacity and sometimes commitment, NGOs often take this role. Careful assumptions need to be made about the capacity of local government and communities to operate and maintain the systems beyond the period of external project support. Interviews with staff at the Water Bureau in Ethiopia and the DWC in Sudan showed that, although policy is in place, there are limitations in terms of government capacity and resources. In Sudan, this has been exacerbated by the conflict. These processes are mentioned in the annexes covering the generic project description and site reports, but the quality of the process could not be assessed and commented on. Although this is one of the important phases with regard to technology choice, detailed investigation could not be carried out, as research would ideally occur during the planning process rather than post-installation. As most of the projects visited were already functioning, the visiting group could look into its current operation only and spoke only to those responsible for the schemes now.

Once the participatory plans are ready, the **second phase** is the actual technical design and construction of the scheme. Traditionally, engineers are responsible for this phase and they are trained to prepare designs and estimates, select contractors and make payments. They are responsible for the quality of construction and they validate the design for safety against any possible physical failure. Safe and quality designs need financing and sufficient resources to ensure that sound technological solutions can be implemented and maintained. In community-managed systems, there is a need to work in consultation with the community, to build local operators' capacity and to use and train local labourers or small contractors from the local area. Resources are often in short supply and needs are huge. Often, strict national/regional standards and regulations make the choice of technology fairly restricted, especially when it comes to reducing the cost and creating space for users to participate and benefit from services. Freedom of innovation becomes narrower as a result of licensed engineers signing off the design against any failure. In most of the schemes visited, the design was carried out by local government engineers and local contractors were hired, although community labourers were used in some cases. An important area for understanding and further investigation is the engineering design process and the ability to link the design with plans and operation and maintenance afterwards.

The **third phase** is the actual use of the technology and making sure that it sustains the operation, makes an impact and delivers outcomes. The success of this phase depends on the quality of the information and processes in Phases 1 and 2. Most of the failures in externally supported projects lie in this phase, when funding is over and there are not enough resources to reassess and understand the issues. As a result, local governments and community leaders start looking for new projects. Many assumptions about the capacity of the community, partnerships, user payments and government ability to serve the community may prove wrong at this stage. Consequently, despite the very positive intentions of NGOs, communities, government and donors, technologies fail to deliver the intended outcomes. This situation needs to change: a great deal of action research and learning needs to be carried out on this third phase. This was also one of the key recommendations arising from the Kampala Colloquium. A range of specific findings related to RiPPLE themes are discussed in the previous sections also.

In this small piece of research on technology choice, interaction with practitioners was very beneficial. However, the research process was potentially restricted by the choices of organisations to provide access to their own relatively 'successful' projects. In addition, projects in Ethiopia work under a framework set up by the government, which restricts NGO intervention to one organisation and, in some cases, limits innovation in technology choice and processes, despite very intelligent use of the available space by HCS. In Sudan, logistics restricted the range of organisations and the depth of investigation possible. In future, PAC is keen to look more into the capabilities of the community to participate in the process, to understand the constraints for the government and NGO engineers in using low-cost and innovative systems and to bring the dynamic processes of learning and research to the grassroots level. The Kenchera example of testing drip irrigation technology with farmers is an example of rapid and useful technologies that are easy to use and easily replicated and that increase the skills of the beneficiaries. At the same time, larger and more complex systems are needed for places where water is limited and access is difficult (for example in Kufanzik). Developing technology to improve the efficiency of water, as well as implementing natural resource management programmes integrated into water schemes, can improve the sustainability of water supplies. With growing concern over the impact of climate change on this limited precious resource, there is a need to share learning on using and adapting technology in a sustainable manner. Our offices in Sudan and Kenya will hopefully make such research and networking possible to make a wider impact in the Nile region.

6.2. Ways forward

There were two key advantages in carrying out this study. First, the research brought a multidisciplinary perspective to the understanding of social, economic and technical aspects of WSS. Second, the study gave primacy to both local issues at site level, which were vital to understanding the complexities of the various situations, as well as the wider policy issues. This approach underlined key lessons learned and highlighted room for improvement in every site, even those deemed 'successful'. Participants also learned from participation and sought to put behavioural changes into practice.

The real work on technology choice lies in approaching development as a dynamic and hard-to-control process as opposed to a linear process, constrained to sequential phases, with expected outcomes based on an approved strategy or business plan.

Technology choice needs to come to be understood as a complex interaction of technical and social processes, and policy on implementation should reflect this at every stage. All the players in this process are important, but the key decisions are often made by government officers/engineers, community leaders and NGO staff. These groups need information at the relevant time and in a format that they can understand and use. RiPPLE's flexible approach to learning alliances and networks could be important in this. Relatively more learning opportunities are available now because of the internet and other means of communication. However, there are still major barriers to overcome before this knowledge can be used for the benefit of poor people:

1. The support process to ensure that knowledge is available at the time of need and in the right format for the people who need it most is still missing.
2. The cost of delivering this knowledge is still high, mainly because there is a large mismatch between need and availability, even if knowledge centres are hosted nationally.
3. Policy on technology choice should aim to be as flexible as possible, because of the complexity surrounding technical and social processes.

Future research on technology choices must look in more depth into these processes and relatively less into physical design. It must focus more on simple outputs, with a great deal of collaboration with practitioners and local communities. This can be done over a long period of time, to lead to mutual exchange of information and experience. This will give equal importance to talking and discussion at local level, moving away from the current emphasis given to research and high-profile publications. Quality needs to be measured in terms of the process, not just the product.








Numerous discussions with a range of stakeholders in the field were conducted as this piece of collaborative study was conducted.

Annex 1: Methodology

Below are the checklists for focus group discussions, the framework for key informant interviews and the daily report templates that team members used for reporting, which were applied throughout the study. This annex also includes a list of the core team members.

Community focus group discussions

Planning

- How did this project come about?
- Were community members consulted from the project planning stage?
- How was the management committee selected?
- How much members of the community informed about the project stages?
- Were they involved in site selection?
- Who owned the land that the water point was installed on? Were there any issues related to land ownership?
- What financial contribution was the community asked to provide and how was this decision made?

Implementation

- How was implementation executed?
- Did the community meet its agreed contributory requirements? If not, why not?
- Which members of the community managed the implementation? How were they selected?
- Was any training given to the community as part of implementation? Was the training used?
- Were any local materials or human resources used in implementation?

Operation and maintenance

- In what ways is the water used?
- Does this meet the needs that the community identified? (if the needs were originally considered in planning)
- How is the system managed? By whom? Is this deemed successful?
- What is the cost recovery mechanism in place? Is this sufficient to maintain the system? Is it affordable for the community?
- Who maintains the system? Is there adequate support for maintenance from external sources? Has there been a change between previous maintenance models and the current maintenance model? Are there problems with sourcing replacement parts?

Impact

- What are the changes in income? Are these changes consistent throughout the community?
- What are the accessibility issues, both physical and social? (e.g. women's access/disabled access)
- Are there any changes in livelihood? If so, do these changes owe to improved water accessibility, or are they indirect? E.g. improved health owing to improved quality of water or time saving which leads to more productive activities.

- Have any conflicts arisen within the community or between the community and other surrounding communities owing to the technology? Are these being resolved? If so, how?
- Is there any change in the water discharge? What does this owe to?
- Have changes in productivity impacted on market access? Or has marketability been impacted on by other factors (such as complementary changes or transport access to markets)?

Sustainability

- Are they aware of environmental issues to do with water conservation?
- Is the technology implemented culturally appropriate and has the community adapted to it?
- Are they aware of the importance of natural resource management and water management? Are they implementing this?
- What problems have they faced/identified in any areas? Do they think they can resolve this internally within the community or do they need further support? Do they have the means to identify what kind of external support they may need?

Sanitation

- What proportion of the community is aware of sanitation?
- Was sanitation considered as a part of this project?
- How was it implemented?
- What sort of technology has been installed to tackle sanitation?
- Was it accompanied by hygiene awareness and maintenance campaigns?
- How is it managed?
- How is it maintained?
- What impact has it had on the community?
- How are pests controlled? (improved/traditional)

Key informant checklist for semi-structured interview

Information on key informant

- What is their level of responsibility (position)?
- Which sites are they involved in?

Policy

- What is your organisation's policy when implementing technological choice projects in communities?
- Are you aware of how this policy was decided?
- How well do you think these policies are implemented? Does your office have the capacity to deliver on these policies?
- Are there weak points that you recognise in implementation?

Site specific

Which site are they involved in?

Background

- What were the *specific* needs identified? Who identified these? When were they identified? How were they identified?
- What was the subsequent objective of the project?
- What was the overall planning procedure for the project? Who were the key people involved and at which stage (including interviewee)?

Planning

- What was the final design of the project?
- When designing the system, what factors did you consider? Why were these factors important? How did they feed into the final design of the system?
- Was environmental and social impact considered? Was indigenous knowledge assessed and incorporated?
- How much freedom did you have in selecting the appropriate technology?
- What was the budget? What was the source of funding breakdown – % from community, from government, NGO, etc.?

Implementation

- What is the implementation procedure? To what extent were you involved in the installation of the technology?
- Were changes made to the design upon installation? What were these changes and why?
- How was the installation managed? Were existing institutions considered/improved for management purposes?
- What role did the community play in the installation? How was this integrated?
- Were there any issues identified during implementation that had to be resolved? What mechanisms were used to respond to these issues?
- What role do you play in post-implementation support? Is this technical or management support?
- Was there a capacity-building component of this post-implementation support? Who was identified and trained? In what ways were they trained?

Operation and maintenance

- What in your opinion are the successes and failures of the system?
- How many current beneficiaries are recognised as using the system? Does this match the original plan?
- Who is managing the current system, and how are they being supported in management aspects? What is your role in follow-up support?
- How often does the community request support in resolving issues from your office?
- What was the phasing-out strategy for this project? Was it implemented? Was it sufficient to ensure the smooth running of the system? What kind of continuing support is provided/needed?

Impacts

- What do you recognise as the impacts of the system?
- Do you see these as being sustainable impacts? What would be the limitations on the sustainability of this project?
- What other follow-up actions are planned to continue/address these impacts?

Daily reporting template (site specific)

Your name: ………………………………………… Date: ……………….

Site name: …………………………………………

- Overall site descriptions (technologies, management, observations, etc.)
- What is your key role today? ……………………………………………………….
- What are your main observations about the various stages of this project? (split into planning, implementation, operation and maintenance)
- What are the main impacts of this project according to:
    - a) Different sections of the community
    - b) Water management institutions
    - c) Key informants
- What do you recognise as impacts on
    - a) Environment
    - b) Productivity
    - c) Health
    - d) Sustainability
- In your opinion, what are the key lessons learned from this project (good and bad)?
- What other observations can you make regarding this project that have not been mentioned above?
- Would you deem this project a success (yes/no/maybe)? Why?

Study core team

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Annex 2: Ethiopia generic project approach

In the Ethiopian case studies, there is a standard procedure for project planning and implementation based on Ethiopian government policy. This does not, however, preclude NGOs from adapting their own project cycle management approach which can innovate programme implementation strategies based on their past experiences.

Role of Ethiopian government

Background

The government works at fivelevels: kebele, woreda, zonal, regional and national. The country is split into nine regional states and two administrative towns, the former further broken down into zones and then woredas. Each woreda is made up of smaller administrative units called kebeles. There are government water offices at woreda, zonal, regional and national level. Any NGO intervention needs approval from the woreda, zonal and regional level prior to intervention and registration at national level with the federal Ministry of Justice. In an attempt to harmonise donor interventions at woreda or regional level, each NGO is assigned a geographic area in which it operates. The water sites visited were in Kersa and Meta woreda, in East Hararghe zone of Oromia region. HCS is the only NGO working on water and sanitation and other integrated rural development programs.

Procedure

Kebele communities officially request intervention through their kebele chairman or a project idea can be initiated from an NGO and fit within the wider woreda-evel plan. Sites are then prioritised jointly by the zone and woreda, based generally on population and severity of problems reported over a period of time from kebele level. Woreda-level water offices prepare a feasibility study in conjunction with NGOs and zonal offices. A feasibility study assesses types of source and possibilities for water access and also compiles baseline data (population, cattle, resource availability, etc.) The study is then kept for later prioritisation. If a project is beyond the scope of the woreda, it is passed on to the zone and the regional level office if need be. The woreda office takes on small schemes, such as hand-dug wells, shallow wells, spring capping, improving traditional wells and rainwater harvesting. Generally, wells deeper than 25m are considered beyond the capacity of the local woreda office and are passed on to the zonal office.

NGOs then approach the woreda or zone office once funding is secured from elsewhere or in order to bid for funds. Using the feasibility study, NGOs can apply for funding or see if untied funds are available to allocate to projects.

In all cases, the woreda water office is responsible for overall follow up and implementation of any water schemes. The offices see general limitations in terms of budget, manpower and logistics.

Once a project has funding, the woreda office and the NGO plan and mobilise the community to provide labour and local materials for the project. The NGO is fully engaged in construction and implementation according to standards set by the government on designing water structures (such as storage tanks, cattle troughs, etc.) The woreda office needs to intervene only when a design does not agree with one of the standard templates.

A WMC is often democratically elected by the general assembly (community) with seven members – also a government standard – to be trained. This WMC is made up of a chairman, treasurer, secretary, auditor, purchaser, storekeeper and elder. In addition to this, two caretakers are trained to maintain the system. For motorised systems, a guard is trained both to protect the pump and to maintain it and refill with fuel.

Upon completion, the NGO inaugurates and hands the project back to the government and the community. The community is meant to be audited annually by the woreda water office, with refresher training for the WMC every two years. In reality, the woreda water office does not have the funding to provide the refresher training.

HCS

HCS is the development wing of Hararghe Catholic Vicariate, officially established in 1987 and operational in the eastern region of Ethiopia. The agency is engaged in the implementation of emergency, rehabilitation and development programming based on community needs. The following are the basic approaches followed by the project cycle management of any programme/project.

Planning

Projects or programmes generally follow participatory approaches which involve a local community and the government at all levels when identifying, designing and appraising any project. In view of this, two types of water and sanitation project planning exercise are practised.

- On-the-shelf projects, for which all feasibility studies and designs are completed by the government and, after financing, are taken over from the government. Direct implementation is launched after the necessary agreement is signed with the Water Bureau at regional level.
- A planning team, from both zonal and woreda level, is organised and conducts community needs assessments and prioritises needs based on a feasibility study. The project is further appraised both by the donor and by the relevant government sector office to prepare it for implementation.

Finally, all projects are subjected to agreements, indicating the roles to be played during implementation and post-implementation, signed by stakeholders. HCS commits itself to funding and implementation (including capacity building of the user community and line department/government sector office staff). The relevant government department commits itself to providing technical support and periodic monitoring through to final handover to the community and following up with the project after NGO phase-out.

Implementation

HCS currently follows a multiple use strategy that allows economic use of water for domestic (sanitation and other domestic use), productive (agriculture) and livestock consumption. Moreover, community participation in terms of provision of 25% of the project in local materials or labour is mandatory for the implementation of the facilities. Prior to implementation, a general community meeting is conducted to organise a construction committee, which acts as an interface between the project and the community. The role of the construction committee is to mobilise the community in any action required during the implementation process and to receive any technical on-the-job training during the construction process. In addition to construction, the following activities are also conducted:

- Organising and training of water management and caretakers in partnership with the water office;
- Provision of the required maintenance kits to the water management and caretakers (kick-start funds and spare parts are also provide for motorised schemes);
- Training of government staff on the project cycle and database management;
- Establishment of accounting systems for collection of user fees and assistance to committees to open a bank account in a nearby bank;
- Preparation of a complete project report for handover;
- Organisation of a handover ceremony to pass scheme on to users and government for future operation and management.

Post-implementation management

Although post-implementation management and follow-up is the responsibility mainly of the government, HCS is sometimes involved in activities based on the availability of funding, because of the limited capacity of the government to carry out follow-up. The following are the major activities carried out during this phase:

- Provision of refresher training to water/irrigation management committee and caretakers of the phase-out/handed-over projects/activities;
- Provision of additional agricultural inputs for irrigation projects on revolving credit (the revolving fund is managed by the user communities);
- Provision of technical support and maintenance of the scheme as required.

HCS and government-specific relationship

HCS provides training to the government to build capacity in technical maintenance but also in training methods. As HCS is based in the region in the long term, it has built a relationship with government offices and this allows it to build some flexibility into its approach.

Annex 3: Sudan country background based on interviews

Interview with the general director of the DWC

The DWC is an umbrella or policy corporation for all water-related government initiatives: WESS; UWC; and RWC.

Water is accessed through deep boreholes, hand-dug wells, hand-pumps (groundwater), dams and hafirs (surface water ponds) within North Darfur. There are also water yards with five water points. These have a borehole and reservoir and water points are split into human and animal consumption.

Requests are made directly by communities to the Ministry of Physical Planning and Public Utilities, then to the DWC, which then goes to the three water administration bodies for discussion. They do a feasibility study and send it back to the ministry at national level for planning.

All implementation is funded by Khartoum centrally and actual implementation is done by the private sector, which is supervised only at regional level. The community contributes no finance or labour, although four members of the community are trained for the boreholes.

Water yards are managed by the DWC using fee recovery schemes with tariffs set nationally. WMCs elect from two local councils to represent the community, and these act as go-between. The DWC sends three people down to manage each system: one technical, one mechanical and one financial (fee collection). DWC staff on operation and maintenance receive a government salary, whereas community members are paid in bonds. The DWC used to allow communities to control water yards but they were poorly managed, so now standard policy is that water yards are managed by the DWC. The DWC is not funded centrally, but rather by fees collected on these tariffs.

Community management is generally only allowed for hand-pumps, which have a trained four-person management committee.

According to Sudanese government law, the DWC can reclaim any land with water, owing to its scarcity, and pay compensation to the landowner if necessary.

The private sector can apply for approval to set up water systems, and the DWC advises on this, from identification to implementation. On-the-job training is done by the DWC; other training is done by the WESS.

With regard to water treatment, the DWC holds the laboratory testing facilities, and the other water corporations have some facilities to treat water.

North Darfur has roughly 35% rural coverage and 40% urban coverage, although there is more during the rainy season, so there is high seasonality.

Interview with water engineer and general director, WESS (government department assisted/funded by UNICEF)

UNICEF and the government have a five-year masterplan in water, health, education and primary health care. WESS was started in three states of Darfur in 1992 as emergency cover, with a focus on delivery of safe drinking water. It focuses on:

- Drilling boreholes with hand-pumps;
- Water yards;
- Water quality tests and treatment;
- Coordinating rainwater harvesting as part of food for work schemes;
- Constructing pit latrines, household latrines and communal latrines;
- Conducting training on latrine construction;
- Raising community awareness in hygiene promotion;
- Training community leaders and influencing policy.

Structure outline

National level: National Water Corporation and UNICEF and Ministry of Health

State level: Ministry of Health and Ministry of Finance and Water Corporations

Mehaliya level (locality): Five members (two health workers, two female and one male)

Village level: 10 members (five female and five male) → operation and maintenance at village level and hygiene promotion

Training: WESS' mobilising sector is responsible for training the community. Generally, the number of days for training varies: technical four to five days, sanitation seven days and training of trainers seven to 15 days. Training includes hygiene education, monitoring for effectiveness, community management, water for sustainability, gender, hand-pump/mechanical training. Basic training is on hygiene education and mechanics.

Funding: WESS funding is sourced from government or NGOs at different levels. A revolving fund comes from national level to kick-start and import components required. Water corporations then manage installation and try to ensure sustainability through revolving funding to reduce dependency on external funding, particularly UNICEF.

Community management: Communities select their own committees, which is usually a village development committee made of five men and five women. WESS considers most of its projects community-based projects. Communities are meant to contribute in cash/labour (mainly cash) to promote and develop a sense of ownership. Community members are then trained by the community and the scheme is handed over. Since 1992, 1800 hand-pumps have been installed in North Darfur, all of which are meant to be functioning. The community decides the tariff for water and uses part of the income earned from fee collection to buy spare parts.

When implementing systems in communities, an attempt is made to use existing committees, such as the health committee or the village development committee, who are trained in water, sanitation and mobilisation. Using existing committees is based on past lessons learned regarding having too many committees and little coordination between them at community level. The community then decides how members of the committee are compensated.

Technology choices: Drinking water provision is priority, so single use is the focus, especially in areas of scarcity. However, where water is more abundant, multiuse systems are considered. WESS also has a role in coordinating with all partners in WSS (i.e. NGOs, community-based organisations, etc.), with solutions focusing on the simplest technologies in terms of operation and maintenance and user friendliness. The most commonly installed is a simple borehole with a submersible pump and pit latrines for sanitation. In addition, technology choice options are limited by the scarcity of water.

For hand-pumps they use the IndiaMach2 machine, based on extensive consultation over the years. Communities tend to be familiar with the technology, it is easy to install and maintain and some communities are even able to install the pump themselves.

For boreholes, four digging rigs are currently available in the area – two owned by WESS, one by Oxfam and one by Action Against Hunger. However, at the moment, one of the WESS rigs has been hijacked by rebels, and discussions are ongoing regarding its return. Every borehole needs approval, with various sectors such as health needing to sign off, with the DWC having the final say.

Currently, policy is to promote rainwater harvesting, especially in places where water is unavailable. This is a more expensive scheme but is often the only option in this region. WESS is also encouraging implementing partners to adopt rainwater harvesting and also improving rainwater harvesting technology incorporating water, sanitation and hygiene treatment. The interviewee expressed an interest in more information about how watershed management can help to raise the water table as well as improve the efficiency of RWH schemes. Natural resource management around schemes is conducted in conjunction with the Soil Enhancement Unit, in an attempt to improve the environmental sustainability of schemes.

Currently, UNICEF is working on setting standards and guidelines for implementing WSS systems, to be finalised in August 2008. It is hoped that the document will have clear and accurate descriptions and definitions to improve alignment within the water sector.

Sanitation: Overall, water and sanitation are considered separate, and national policy is now working on reducing the gap between the two. WESS works on both because of its mandate. Sanitation coverage is implemented with hygiene education (hygiene first, then building training). Some places have a sanitation centre.

Slabs are fabricated at village-level, after demonstration and training, and moulds and cement are provided to the community to complete latrine construction. Through this, communities can fabricate latrine slabs and generate an income as well as ensure sustainability from selling the slabs. In IDP camps, training has already been carried out, so implementation is fairly straightforward: those communities are already familiar with the technology.

Overall, there is less than 30% sanitation coverage in North Darfur, based on a household survey. In response to Year of Sanitation, WESS held a workshop in April 2008 to raise awareness about sanitation.

Partnerships: In Darfur, there is a learning forum within the water sector that meets every 15 days with active partners.

Annex 4: Ethiopia site descriptions

Goro Beyo project briefing

Name: Jojoh Faal Date: 26.2.08

Goro Beyo is one the sites selected for investigation as part of the technological choice study. The water source is a capped spring, with both water points for domestic use and an irrigation system for nearby farmland.

Background

Goro Beyo is one of the peasant associations located in Meta woreda, East Hararghe zone of Ethiopia's Oromia region, 93km from Dire Dawa city. The site is accessible through the main road from Dire Dawa to Chelenko, via 15km of dry-weather road constructed through the public work programme of the Employment Generating Scheme.

The landscape and topography consist of rugged terrain aggravated by frequent landslides along the dissected gully catchments. Surface water runoff from unprotected hillsides has contributed to the fast degradation of the top soil in the area.

Prior to this programme, the community used to drink from the surrounding ponds and unprotected springs. As a result, there was high incidence of waterborne disease. The spring is located 2km from the main settlement and, prior to installation, it had a low discharge of 0.2 litres per second, as the majority of the water was dispersed in the soil. It was also used for irrigation for nearby farmland and served 13 farmers, with roughly 1/16 ha of landholdings.

The spring was also devastated by flooding, and community members appealed to their woreda officer for a water supply scheme. HCS, under the Development Activity Programme (DAP) scheme, was operating in the region; on sourcing funding as part of the Integrated Rural Development Programme (DAP II) from the US Agency for International Development, Catholic Relief Services and EC-SDCOH, planned to implement a project in two phases. The first phase targeted drinking supply and the second small-scale irrigation.

In Phase 1, the project was designed to generate a drinking water supply for humans and livestock. The retrieval mechanism applied is a spring capping, with a reservoir for storage of 15m^3, to stabilise water demand during peak hours. The water is then distributed to two four-tap water distribution points, with galvanised iron pipes of one and two inches in diameter connecting the system components. There is also a cattle trough and laundry facilities at the water points. The system is designed for 800 people and 400 cattle.

A year later, the second phase of the system was implemented, to achieve a multiple use system by improving the existing irrigation scheme for 6 ha of land, owned by 48 farm households (300 members). The irrigated land was meant for growing fruit and vegetables, and the farmers were organised as a cooperative.

As per the engineering design study, the following are the major infrastructure components of the small-scale irrigation scheme:

- Head work construction: The existing spring box is linked to the storage reservoir. Thus, the outlet pipe and the overflow pipe were joined together and led to the night storage pond with a new pipeline.
- Night storage pond: To utilise the available water fully, night flows of spring water were stored in a $36m^3$ capacity reservoir. The night storage pond has a masonry wall and a reinforced cement concrete bottom slab, with the inside portion of the wall plastered up to a fine finish with three coats to make it watertight. The exterior wall is cement mortar of rich mix. Surrounding the tank is a barbed wire fence, which extends to protect the open tank from children and animals.
- Lined canal construction: To reduce seepage loss in the earthen canal, there are three canals – a source canal and two primary canals:
    - Source canal: With a total length of 35m, this canal links the spring source to the storage pond, through galvanised iron pipes of two inches in diameter.
    - Primary canals: The 'right' and 'left' primary canals start from the night storage pond and run to the respective sides of the farmland. The right primary canal runs a total length of 338m, including 48m of galvanised iron pipe, 10m of closed concrete pipe and 280m of semi-circular open concrete pipe. The left primary canal is made up of 18m of galvanised iron pipe, followed by 12m of closed concrete pipe and then opening up to a semi-circular concrete pipe of 338m, bringing its total length to 368m. In addition to lining the canal, proper jointing of the concrete pipes was made of cement mortar and masonry anchorage was used to protect from sliding and to retain alignment. After lining the canals, the beneficiary farmers constructed an earthen canal up to their farms.
- Structure protection: The main canal on both the left and the right sides of the farmland crosses small gullies and flood paths in different places. During the rainy season, the flood flows through these small gullies and may cause damage to the main canal. Drainage culverts were constructed on both sides of the canals to safeguard against flood damage and silt accumulation. Moreover, in each gulley, gabion protection work was carried out downstream to protect the galvanised iron piping against flood.
- Turnouts: At various points along the canals, a total of 40 turnouts were constructed with masonry walls. Each turnout has a controlling gate, made of flat sheet metal, constructed so farmers can easily open and close them by sliding them up and down.

Project cycle

The project was prioritised through the usual channels of woreda and zonal government interaction, with HCS securing funding for implementation. According to HCS policy, existing systems were improved to enhance performance. This led to the choice of a focus on drinking water supply and upgrading existing irrigation structure.

On selection, the woreda officer conducted a survey with the community and HCS staff. HCS capacity building mobilised the community to contribute to construction in terms of labour, through site excavation, stone collection, carrying of pipes to the site and gathering of any local materials needed for system construction. All other materials not locally available were offered by HCS. All decisions regarding community contribution were made in consultation with the community.

On completion, a WMC was established and trained. HCS also organised the training of the WMC in collaboration with the government woreda-level Water Office. The WMC consists of seven members – chairman, secretary, treasurer, auditor, purchaser and two caretakers – who organise fee collection, introduced after two years of use (Birr 1 a month per household). Usually, gravity-fed systems are low in cost, but the WMC recognised the need to collect funds to cover maintenance costs. At the time of interview, the WMC had Birr 400 in the bank, saved over a year of fee collection implementation. Accountability and transparency within the WMC were better because the number of households was known, so the monthly income was fixed and clear.

A separate management committee was established for the cooperative to manage the irrigation water supply – the Water Irrigation Committee (WIC). This committee was made up of the original 13 farmers who used the pre-improved spring, managing the cooperative of 50 farmers. They have a slightly different structure – chairman, assistant chairman, secretary, treasurer, purchaser, three credit givers, three auditors, storekeeper and water distribution manager (Abamalaka). The committee has since expanded to include two members of the cooperative to provide support to the distribution manager. The committee members were trained by HCS and the government Cooperative and Irrigation Office on how to manage the system and to run the cooperative. On establishment, the cooperative borrowed Birr 1000 from the community's social services to go towards purchasing seals, documents and auditing and other administrative start-up equipment. Members contribute Birr 50 annually towards running the cooperative and maintaining the irrigation system, for example they have purchased seven quintiles of grain to store and sell when the price of grain increases.

The WIC highlighted as an issue the lack of a caretaker to address maintenance issues specific to the irrigation system, and said that maintenance tools were inadequate. The training given to the caretakers to maintain the system was also insufficient (just two days). They had seen irrigation channels improve, and requested support to develop the same technology for the tertiary channels supplying the farms, as these are not lined but are dug trenches.

The WIC meets regularly to resolve any issues and to plan and budget for future needs. Any water distribution issues and complaints from the wider cooperative are brought to these meetings and resolved. The cooperative has not met since its establishment, so all major decisions are conducted through the committee.

With regard to water distribution, each farmer within the cooperative is allocated a two-storage-pond-full allocation of water per week, regardless of land holding size. As such, farmers with spare water can sell some of their allocated water to other members of the cooperative. Farmers with an excess of land that they are unable to farm can rent it out to other community members, who pay a fee to rent the land and join the cooperative. The cooperative is at maximum capacity at the moment, with 50 farmers cultivating an estimated 3.5 ha of land.

The cooperative is productive, with annual earnings of up to Birr 7500 generated per 1/16 ha, through three harvests per year of fruit and vegetables, particularly potatoes. This is in comparison with the Birr 1500 generated by other landowners through the cultivation of sorghum and wheat. As a result, some farmers are able to plan to purchase high-capital items such as cars, and one particular farmer has generated enough capital to purchase a town house, which he hopes to rent out.

The cooperative has also been trained in marketing produce and working through a broker. They recognise the limitations of this latter and are now appealing to the woreda office for further support to access the market directly. Use of a worm-resistant strain of potatoes (main cash crop), sourced from HCS after a request from the cooperative, has led to an increase in productivity and sales.

Joint management

The management of the water supply scheme is handled by both water committees, on shift rotation. Between the hours of 6-10.30am and 5-6.30pm, the reservoir is filled for drinking water; during the rest of the time, the storage pond is filled for irrigation. These time allocations were decided on within the water committees, to meet peak demand for water for domestic use.

Land ownership

Access to the cattle trough and washing facilities has been prevented by the landowner. It was allowed in the first year of the scheme, but the landowner felt that there were too many people on his land, affecting his crops, without adequate compensation for the damage. He continues to allow access to the water point, and the accessibility issue is currently under negotiation.

Expandability

At present, drinking water is available for three villages, but the irrigation scheme is accessible only by one village. There have been informal requests for expansion of the system to surrounding villages but, owing to the limitations of the system, these requests have been informally declined.

Impacts

Within the community, clean drinking water has had significant health impacts. Children are less prone to stomach and skin problems. The increase in income is seen as another significant impact of a productive use water supply. Community members' understanding of the needs and some awareness of the limits of the system have allowed them to evolve their management institutions, as well as articulate further areas for external support.

In terms of sanitation, awareness campaigns were run by HCS and villagers tend to have good coverage at household level. The use of latrines is based on a pre-existing traditional system, used for fertilisation, with the use of water for hand washing at the entrance to latrines as common practice.

Sustainability

In general, the management of the water supply system is satisfactory and a good example of combining productive and domestic use for income generation. However, there are limitations to such a system in terms of coverage, as the existing water supply has now reached capacity, with little self-sufficiency to expand the system. Natural resource management was implemented under a previous DAP, and helped increase discharge from the spring. This programme has since been stopped owing to a shift in funding from DAP to the Productive Safety Net Programme (PSNP). As a result, natural resource management is no longer being practised by the community, and this has serious implications for the expansion of the system.

Lessons learned

- The WIC was based on an existing management institution, rather than one implemented at the installation of the system. The model provides an alternative and well-functioning management structure that seemingly does not require the same level of managerial support as other models seen in other sites.
- Productive uses of water have a greater impact on income generation, although in this case there are questions as to how to manage the growing inequality between farmers of the cooperative and the rest of community, or surrounding villages that share the water source.
- Gravity-fed systems are cheaper to run, which has an adverse effect on the cost recovery scheme. The income being generated through fee collection by this system is comparatively much smaller and, as such, good maintenance of water points is lacking.
- A good understanding of the technology and its clear impacts allows communities to identify ways in which the system can be expanded. Without this, there are difficulties in replicating or improving the technology within the community. The cost of project implementation makes expansion of the system difficult: it relies on external funding, which depends on the priorities of the region rather than those of the community.
- Land ownership is an issue in site selection, particularly where there is no clear agreement between the landowner and the community. Compensation and a formal agreement would be one way of resolving this issue. This is another point that should be closely managed.
- The most successful/sustainable components of this project are based on the improvement of existing systems – i.e. the WIC and hand-dug latrines – with which the community is already familiar.

Kenchera project briefing

Name: Mahmoud Abuelhassan Mahmoud Date: 26.2.08

Overall site description

At Kenchera, there is a range of water sources. The site visit focused on the drip irrigation technology being tested at the site. The water source is a hand-dug well, reinforced with gabion wiring. The water is pumped up into a water tank of 1m^3, and is then fed to the different technologies being tested, either directly or by collecting water from the tank and delivering it to the site. The types of irrigation being compared on the site are furrow irrigation and three types of drip irrigation (imported pipe, plastic bottles and tin cans).

Background

Kenchera is one of the 12 villages in Lede-oda Mirrga peasant association of Dire Dawa Administrative Council northwest of Dire Dawa town. The village has 73 households (average family size of five) whose livelihoods are dependent on rain-fed mixed farming. Land holdings range from 0.5 to 1 ha, but are unproductive owing to scanty and unreliable rainfall. The major crop is sorghum, as a result of its tolerance to moisture stress. The average temperature of the area is 30°c. Access to water and sanitation is lower than 15%, with even less access to proper sanitation (such as latrines).

There is a driver sand riverbed adjacent to the village, where residents access water for multiple uses, either from meagre protected sources or from largely unprotected traditional wells of 10-15m in depth. Water for livestock and domestic use from unprotected wells is drawn either in buckets by hand or in tins/buckets by hand exchange between a person on the top of the well and one inside. There is good-potential groundwater in the sand driver riverbed which is utilised by three other villages from the same peasant association and from other two associations adjacent to the source area. Villagers reported that over 8000 livestock were watered daily from the traditional wells.

Water is pumped from the protected hand-dug well by a diesel motor into a small water tank

The lift and drip irrigation technology is located in the centre of the driver sand riverbed, occupying an area of 2.5 ha of land owned by one household in Kenchera village. The owner used to harvest rain-fed sorghum on a small parcel of land, with a large portion of land either unutilised or used for open grazing by the owner or the villagers for a long period of time. The new chapter in the use of the full parcel of land began in 1998, when HCS carried out intensive watershed management activities, mobilising the local community to use more floodwater for irrigation by adopting spate irrigation together with crop land bunding. This called the attention of 15 interest groups from Kenchera village to work with the landowner to clear bush on 2.5 ha of land and dig a traditional well of 8x10m at a depth of 6m for lift irrigation purposes.

The lift irrigation practice adopted at this time involved hand lifting of buckets by a series of people at the different stages of the traditional well, eventually joining to the furrow flood irrigation canal designed and laid out by the residents themselves. The residents suffered from frequent landslides, which meant there was a constant need to remove soil deposits from the well. HCS project staff provided technical advice and gabion to construct the well wall to overcome such problems. HCS also gave support in institutional issues and provided other inputs, as a result of which the groups were able to produce harvests three times a year for three years (1998-2001) without any problem, using sole irrigation or supplementary irrigation from the well. Residents were able to gather Birr

300/person to buy a water pump to irrigate their crops, to improve on their traditional water lifting irrigation. This enabled increases in income and savings in labour.

However, the system failed to address issues of land ownership raised by the family of the landowner. As a result, looting started to occur on the land and eventually led to the disintegration of the group. The lift irrigation practices stopped for five years, during which the landowner continued to engage in the former rain-fed production of sorghum. As such, conflict over land use led to the initial failure of the previous phase of the project.

HCS staff, recognising the failure of the lift irrigation scheme, came up with a new partnership arrangement with the owner of the land and selected villagers with an interest in irrigation. In this second phase, the intervention was in the form of a drip irrigation system supported by HCS. The users are a group of 10 individuals, including two women, established in the past four months. In this new partnership, there is a legal tenure agreement between the land users and the landowner, recognised by the kebele administration. The tenure agreement entitles the users to use the land for five years with a Birr 1000 total annual payment for renting the land. The total rent is to be paid within the first two years of the tenure period. Moreover, to improve the relationship with the owner, the group has agreed to allocate him an equivalent piece of land to farm and support in cultivation, as he is getting old.

Since the start of the agreement, the group has begun cultivation on only 1 ha of the 2.5 ha of available land. The crops cultivated are tomatoes, chilli and pepper, with the 10 farmers dividing the land equally and sharing running costs. They are planning to market their produce to a women's processing group in nearby Dire Dawa, which should lead to quick returns on the investment.

The irrigation technologies under promotion and trial in collaboration with HCS and Haramaya University research units include four interrelated and mutually reinforcing approaches, as indicated below:

Improved drip irrigation

Drip technologies being tested: Imported, tin and plastic bottle (from left to right)

- **Imported drip irrigation technology:** A lined bag stores water which is fed into pipes, out of which smaller pipes lead to individual plants. As this is an imported technology, it is more expensive to implement and access; without HCS support this would be a challenge. However, there is the scope for replication using locally available materials, which should improve affordability. The water is controlled by a tap on the bag, which allows the amount of water to be increased or decreased.

- **Traditional drip irrigation with plastic bottle of 1-1.5 litre capacity:** The bottle is filled with water and buried around the root zone of the vegetable crops (tomatoes), with small holes made on its bottom edge. Water flows directly to the root zone because of pressure applied when opening and closing the bottle at the top. In this approach, there is reduced soil cracking and a reduction in vapour transpiration. Farmers observed that this method requires close monitoring for it to be as effective as other technologies being tested.

- **Traditional drip irrigation with 5 litres tins buried around the root zone of the plant:** The tin has two tiny openings on its bottom edge and water leaks into the root zone through osmosis. This allows the water to seep through as needed by the soil around the plant.

- **Furrow flood irrigation by water pump from well system:** This area traditionally used furrow irrigation, which is still being maintained in order to provide a comparison with the new technologies. The water is flooded along the plant bed; although this generates a greater yield, it is prone to soil compaction, cracking, weeds and inefficient use of the limited water resources available.

Main observations

- The farm provides an environment where farmers can participate in the testing and comparison of irrigation systems. As a result, there is a sense of understanding and ownership among the farmers. They are also able to pass on the learning to other farmers who, in the four short months the project has been running, have started replicating the system.

- Informal management of the test farm is in place. Although this is sufficient for the time being, it may not be adequate if the cooperative grows.

- The short five-year tenure may be a disincentive for farmers to properly invest in the scheme, particularly in terms of considerations of natural resource management and sustainability.

- Analysis even at this early stage of the project was done by the farmers during the focus group discussion and is highlighted below:

Technologies tested	Advantages	Disadvantages
Imported drip irrigation	• Saves water • Easy to manage • Less weed growth in field hence low labour use for weeding • No land cracking • No compaction of soil	• Vapour transpiration is high
Plastic bottle drip irrigation	• Saves water • Less weed growth in field hence low labour use for weeding • No land cracking • No compaction of soil	• Management not easy (opening and closing the bottle and refilling the bottle every two days) • Lack of availability of bottles
Tin can drip irrigation	• Better than other drip irrigation above + other advantages above	• No major disadvantage noticed (availability of tins)
Furrow flood irrigation	• Easy to irrigate	• More compaction of soil

		• Cracking is common • Weeds are widespread: more labour demand for weeding • Vapour transpiration is high: mulching of field needed • No water saving

- Alumiya University is conducting research to test water-to-plant requirements in order to improve management and provide farmers with information to improve efficiency of the system. The site will be provide useful information on researchers working directly with users to improve ownership.

Impact

The project was too young for a full assessment of impact and sustainability, but evidence of replication was already clear, demonstrating the transferability of the technology in this area prone to water scarcity. Intervention is still needed to assist with access to the water, however, so this type of technology relates to improved efficiency rather than solving the problem of access to water.

Technology replicated on nearby farmland

Millennium Village, formerly known as Olan-Oulla

Name: Zelalem Lema

Site: Olan-Oulla/Millennium Village

Project implemented: Multiple use system

Project implementer: EC-SDCOH/HCS

Background information

Olan-Oulla lies in Dire Dawa and is one of areas most prone to water scarcity in Ethiopia. Dire Dawa has nine urban kebeles and 32 rural kebeles. Its urban water supply is based entirely on a ground source; rural communities depend on ponds, small springs, rainwater and shallow and deep wells. Quality, availability and access to these sources vary greatly from village to village in rural areas. Long distances, inaccessibility, inadequacy and poor quality are major problems that the poor have encountered. As a result, poor families tend to spend more time in search of water, and suffer from water-related health problems, leading to frequent visits to health centre. There is also a higher incidence of social conflict and higher mortality rates in women and children.

Olan-Oulla is Amharic for leeches, found near the spring supplying the village

Regardless of all the challenges faced and of whether a water source is protected or not, rural people naturally make multiple uses of available water sources.

The community suffered from problems found throughout rural kebeles in Dire Dawa. It was one of the most inaccessible and forgotten rural villages, located 21km southwest of the capital Dire Dawa. Before the Ethiopian millennium, the village had only one water source, which was unprotected, inaccessible, contaminated and full of leeches. The spring was located 3km from the village in slopped stone boulders and flood gorges.

Before the project, the village collected water in this way

In most cases, women and children are responsible for water collecting, but in Olan-Oulla it was different: only physically strong family members could collect water for the household's daily needs. This greatly affected the household economy, by taking up the time of the most productive labour – men. The elderly, pregnant women and children found it difficult to access the source. In 2006, 11 out of 16 pregnant women were forced to have abortions at the nearest hospital (221km away) after falls on the rocky path to the spring source, with one death. The inaccessibility led to issues in other areas too. In one discussion with the village community, an old man said: 'I wash my body in the open field on the rainy days of the year'.

Project cycle

Water scheme development for the village had two phases.

Phase 1

Planning: The first intervention was 10 years ago during the government-implemented PSNP. This involved promoting soil and water conservation, by mobilising the community to build terraces upstream with HCS assistance. The community was consulted, and members highlighted the need for the spring to be capped and identified the sites for water points and reservoir. The land for the reservoir and the water point belonged to individual farmers, who were happy to hand it over since the water issue affected them and their community.

Before implementation, HCS and the community agreed on the contribution from both sides: the community contributed in terms of labour and local materials (such as stone) whereas HCS developed the scheme and provided technical knowledge and non-local materials.

Implementation: The community contributed through excavation, stone collection and access road and terrace construction. During construction of the water scheme, the pipe was laid to the reservoir. Only one water point was built, with a washing basin and a cattle trough.

Operation and maintenance: The overflow from the reservoir was used by the farmers who owned the land around the reservoir. Before the scheme started to deliver water to the community, HCS provided training on water management to a WMC of three men selected by the community. The WMC held discussions with the community to decide how much to collect in user fees to cover operation and maintenance. The community agreed to pay Birr 1 per household per month, irrespective of size of the family and amount of livestock. The total number of beneficiaries at that time was 125 households. The WMC received support from HCS to open an account at Dire Dawa Bank and to deposit the fees collected from users. After nine years of service, the WMC had deposited almost Birr 8000. Concerning operation and maintenance expenses, there were few running costs. Since WMC members were not trained as caretakers, they receive technical support from HCS: there is a good relationship between the community and the HCS field representative working in the area.

Phase 2

A disaster occurred three years ago when heavy rain was followed by heavy flooding in the area, which washed away the water system structures. The flood destroyed the pipe laid to carry water from the spring to the reservoir and from the reservoir to the water points. It was beyond the community's capacity to repair the damaged scheme. As a result, the community was forced to return to practices used prior to initial implementation. They continued doing this for two years, at the same time appealing to their local woreda office for support to repair the system. Eventually, HCS came to the community with a new project focused on a number of interventions set in response to the Millennium Development Goals (MDGs). This involved taking an integrated, multiple-use approach to water development and management as an opportunity to advance progress on five of the eight MDGs: to eradicate extreme poverty and hunger; to achieve universal primary education; to promote gender equality and empower women; to reduce child mortality; and to ensure environmental sustainability.

Implementation: Accordingly, EC-SDCOH redeveloped the source spring in the flood gorge and added another spring, protected the sources from flood hazards, installed and extended a pipeline of 3.2km and constructed 25m^3 of night storage, two distribution points, two cattle troughs, two washing basins, two showers (two rooms each) and a 500m long pipe line to distribute leftover water for small-scale irrigation to develop local enterprise. There was a strong participatory relationship in project implementation.

The scheme was developed for 170 households and 1157 livestock and to encourage small-scale farm enterprise on 8 ha of land. It has met multiple needs from the outset. The improved discharge of 1.2 litres per second, resulting from the increase in the number of springs capped, provides enough water for domestic needs and micro-scale irrigation. This gives small-scale farmers the opportunity to start vegetable gardens and enables them to sell their produce. The pipes were laid outside the flood riverbed so they would not be affected by flooding again.

The community decided on the location and setup of an extra water point after seeing the improved discharge of the spring. The farm around the water point was irrigated for cultivation by using a plastic hosepipe leading from the tap on the water point. Although the farm around the water point land belonged to three individuals, they freely divided it up and gave it to another 34 farmers to cultivate. The same is true for the farm around the reservoir, which is irrigated by the overflow: this belonged to one individual but is freely cultivated by another 13 farmers. As a result, there is now a cooperative of 47 farmers, who sell their surplus produce in nearby markets.

Current multiple-use facilities for Millennium Village communities

Operation and maintenance: Four farmers (two men and two women) were selected by the community as a new WMC and they received training on how to manage the water system. The responsibilities assigned to the members of the WMC are as follows: one woman collects the user fee (Birr 1 per household per month) (she earns a Birr 25 salary); one woman stores the collected money; one man does the auditing; and one man takes the money to the bank. There used to be 100 beneficiary households in the village and 25 in the neighbouring village, so a total of 125 beneficiary households. This month, though, the number of beneficiaries increased to 195 households. The extra 70 households come from the neighbouring village, whose own hand-pump system had broken. They also pay the user fee.

Phase-out strategy

The HCS strategy followed after the end of the project was as follows:

- To create awareness on water management issues among the community;
- To give training to the WMC on how to collect, deposit and use fees for maintenance;

- To pass over the system for the community to manage by itself (if something was beyond their capacity, HCS and the government Water Bureau would support the system);
- To remain in support of the community on different projects still being implemented, even after project phase-out.

Impact

The impact of this project is of different from those previously discussed, as it deals with an integrated approach. As a result of multiple-use system developments, the village community has been able to build social capital, using communal assets, change its traditional village name and gain respect from nearby village communities.

Moreover, health, nutrition, sanitation and income status have improved significantly. The farms grow tomatoes and green chillies, with the surplus sold in Dire Dawa to generate income. Families unable to do this are given some from the supply free of charge. A home management scheme has also been implemented, promoting the use of improved stoves, shelving and divisions inside the home.

Water goes with hygiene, so now everyone has a latrine, or is about to get one. People also wash clothes and have showers regularly. Houses have been constructed from mud bricks now there is access to water (13 over the past eight months).

Children now go to school regularly because of the time saved. Before, four out of six male children dropped out; currently, 65 children are attending school (three female).

The community has developed bylaws for the supply scheme. When an issue arises, traditional conflict resolution mechanisms are used. Those involved appear before the elders and plead their case. The elders deliver judgement and parties adhere to this out of respect for the elders.

As a result of the implementation of parallel natural resource management programmes, the community is aware of the benefits of terracing to hold the soil better and of recreating natural forest in order to improve the water discharge of the spring and to reduce flooding, etc.

There are still irrigation constraints, and community members want to extend the system by capping more springs and also by channelling the overflow from the reservoir to feed irrigation systems.

Lessons learned

- Integrated water scheme development has brought many changes in Millennium Village.
- Being able to implement a multiple use system depends on availability of water. Although it is ideal, it is not always possible.
- Little is being done to reinvest fee money saved by the community. This suggests an overdependence on external support, owing to a lack of true understanding of the system in place. There is some familiarity with the system, but ability to repair major components seems beyond the capacity of the community.

Welteha Bilisuma

Name: Samuel Chaka

Project name: Welteha Bilisuma Water Supply Expansion

Source: Machine-drilled shallow well

System: Motorised fitted with submersible pump and driving generator

Funding: US Office of Foreign Disaster Assistance through Catholic Relief Services Ethiopia

Overall description

This project briefing was compiled from HCS project documentation, community focus group discussions and key informant interviews with government officials.

Background

Welteha Bilisuma is located in Kersa woreda, East Hararghe zone, Oromia region, about 51km from the zonal town of Harar. Geographically, it lies at $09^{0}21$'E and $041^{0}49$'N latitudes and at an elevation of 1948m above sea level.

The village is 10km from the nearest asphalt road, which runs between Harar and Addis Ababa. This road turns onto an all-weather gravel road for 20km, and then north to Welteha Bilisuma for about 10km on a rough, dry-weather road. During the time of the feasibility study, the population was placed at 3500.

The area is hilly in one part, with exposed limestone and plains, and swampy in the other, recharged from the Woter area, which now serves as main reservoir for the groundwater.

At the time of installation, the total system cost was Birr 1.2 million, with OFDA the source of funding, through CRS Ethiopia. The entire system was constructed in line with government standards.

In 2003, wells were drilled to give service at a depth of 53.3m and 55.75m, fitted with Indian mark II hand-pumps. Owing to drought risk, HCS sourced funding to create distribution points for the system. The discharge of the wells, tested at drilling time, was 241.98m^3 per day and 282.62m^3 per day, respectively.

As it stands, the system has the following facilities:

- 6x4m corrugated generator house fitted with Duetz generator;
- Submersible pump with capacity to pump 4 litres per second to an elevation of 300m;
- Pressure line of 2162m GI pipe by 2.5 inch;
- 50m^3 masonry reservoir;
- 4030m distribution pipe line of 2.5 inch to 1inch GI pipe;
- Five water points with six taps each;

- Four cattle troughs;
- Four washing basins; and
- Four shower rooms.

The above distributing system is used mainly for Ganda Nole, Ganda Uriyo, Ganda Gara Biluu, Ganda Kura, Ganda Qalayaa and the community around the well. A water quality test was conducted and a water committee has been established.

Project cycle

The project arose from a request from the community after a drought and because of the high incidence of skin disease and waterborne disease in the area. Baseline information found at the zonal water office, the woreda office, the kebele administration and the HCS office was used to study the site. A project can not be appraised without the involvement of government and community representatives, so experts from the respective governmental offices and hydro-geologists from CRS and HCS were involved in selecting the well site.

In this case, the community participated in planning and was involved in preparing access to the site. Prior to installation, a construction committee selected by the community had the role of mobilising the community to participate in a range of activities, such as pipeline excavation, local material collection and, to some extent, provision of skilled manpower with some small incentives (chat and coffee). During design, members of the construction committee were responsible for assigning sites for construction and negotiating terms with private landowners.

HCS makes it mandatory for development work to be participatory. Community members explained their participation during implementation, mentioning that they had been involved in digging trenches, collecting stones, constructing the 10km access road and collecting money for system start-up. In total, '11,000 people' participated. In this regard, the construction committee was responsible for facilitating installation. However, no extra training was given for construction.

According to HCS procedure for implementing water systems, the organisation trained a standard WMC with seven members: chairman; assistant chairman; secretary; treasurer; material controller; and two caretakers. WMC members were elected by the community, although there are no women. As the scheme progressed, the committee added members to improve management, with additional fee collectors and an elder as a mediator. Eventually, after providing their services for free initially, the guards and the caretakers were paid a salary of Birr 150 and Birr 100 a month, respectively.

The WMC originally charged users 10 Ethiopian cents per 20 litres but, owing to increases in fuel prices, the fee increased first to 15 cents and then again to 20 cents per 20 litres. Consequently, some users have complained about the price increase, and now purchase water only for drinking or cooking and are looking to original unprotected sources. Currently, the community has Birr 17,180 in the bank and some Birr 3000 on hand after conducing operation and maintenance for four years. The treasurer of the WMC is entrusted with money collected by the fee collectors, but he is unable to read or write and confessed to being unaware of the amounts handed to him, demonstrating weakness in auditing. The motor was maintained last year using some of the savings (about Birr 3000). The monthly income of the system per water point is about Birr 500. There is a problem with accessing spare parts. The purchaser is paid a per diem of Birr 25, with reimbursable expenses on receipt, when it is necessary to visit the nearest town. Spare parts for the machine are only available in Addis Ababa, over 500km away.

Water points are accessible most of the time, with fee collectors locking the system during periods of low demand. Owing to the absence of a controlling mechanism and increases in the price of fuel, the WMC has decided to close the washing basins and cattle troughs. In this village, married women do not use the central shower facilities and, in general, use showers when men are not around.

Impacts

Prior to installation, water was accessed in the nearby swampy area, 2km away from the village. Accessibility to water has now been improved, with improved quality of water leading to improved health in the village. Women now have more time for other activities and children are freed up to attend school. Productivity and production have shown improvements since implementation.

Lessons learned

- Even though they have improved the management structure to include fee collectors external to the WMC, it is not recommended to have a treasurer who is unable to read and write. This weakens management auditing processes.
- The WMC training manual has been remade to be context specific.
- Construction of a shower room has to consider equal accessibility for both male and females.
- In comparison with other motorised systems the team visited, this scheme has strong management, which has been improved upon by the community.
- Implementing motorised system structures like washing basins and cattle troughs need to take land issue and fees into careful consideration in order to be able to give a service.
- Regarding problems with accessing spare parts, it would be useful to be aware of which items break repeatedly and open a store in the region or woreda that can supply parts to local WMCs.

Ifa-Jalela and Kufanzik

Name: Musa Ibrahim Musa and Zegeye Tesfaye

Summary

Ifa-Jalela and Kufanzik are two adjacent kebeles that share the same water source, using a relay system. The water source is located in Ifa-Jalela; owing to the inaccessibility of water at Kufanzik, the only solution was to extend the system in place in Ifa-Jalela to Kufanzik by building a collecting chamber at one of the installed water points in Ifa-Jalela, which would then be pumped to a reservoir in Kufanzik, supplied with a further four water points. The project was installed just under a year ago. It has been plagued with managerial problems, and Kufanzik is still unable to access water.

The study visited both sites and communities to discuss the project and identify problems and potential solutions. At the time of visit, the Ifa-Jalela WMC had been dissolved by woreda officials on charges of corruption, and discussions were ongoing as to how to manage the shared resource.

Background

Phase 1: Ifa-Jalela

Ifa Jalela is located 45km from Dire Dawa town on the road to Addis. It is accessible by an all-weather asphalt road of 42km and a 3km rural gravel road. The beneficiaries of the Ifa Jalela scheme are those communities living in the surrounding area. The scheme also benefits the school located inside the beneficiary village. The total number of beneficiaries is 1032 households and the local school (5835 people). More than 3000 livestock also benefit from the scheme.

Prior to construction, communities suffered from a lack of safe drinking water. They used an open earthen pond for drinking water, located near the village. The pond, still in existence and use, is highly contaminated and full of suspended soil particles and other foreign materials. Since the communities had insufficient knowledge on hygiene and sanitation, they did not use any purification methods, like settling and boiling of pond water. There was also open defecation around the pond, with faeces entering the pond during floods. The pond water was available only for three months before drying up, when villagers had to go further to access water. Some community members fetched water from a stream more than 3km away. This stream is not protected and was susceptible to contamination; as it was intermittent, it did not have the capacity to serve the population throughout the year. The nearest safe drinking water locations were in Woter and Lange towns, located 12 and 15km from the village, respectively. As a result of all this, villagers spent a great deal of time searching for drinking water.

After the villagers requested intervention through their woreda office, Ifa-Jalela was prioritised and HCS received funding to construct a water supply scheme. According to HCS policy, the community was engaged in site selection and construction-related activities, such as gathering local materials, trench digging and excavation. The following system was designed for Ifa-Jalela:

- 68m deep borehole with 6 l/s discharge;
- One motor house;
- Provision and supply of 40 KVA diesel-driven generating set;
- Provision and supply of 21KW submersible water pump;
- 6.7km GI pipe of different sizes;
- 50,000 litre capacity masonry water reservoir;
- Six water distribution points;
- Six clothes washing basins;
- Three cattle troughs;
- Two shower houses.

Post-implementation, the standard WMC was put in place, with training provided by HCS. The landowners of the borehole site were employed as guards for the motor house. The water was charged out at a rate of 20 cents for 20 litres, collected in rotation by various members of the WMC. However, members of the WMC tended to keep funds collected and then avoid water points. As a result, there was inconsistent water supply, with the longest period without water being three months. There were also indications of intentional damage to pipes, which affected the efficiency of the system. Members of the WMC changed constantly and refresher training was not given to new members; the legacy of corruption continued.

After the first two years, Kufanzik requested a water system too. After initial feasibility studies, it was recognised that no water in the kebele could be accessed easily. The only solution proved to be extending the relay system from Ifa-Jalela to supply Kufanzik.

Phase 2: Kufanzik

Kufanzik village is one of the kebeles in Kersa woreda. It lies 14km from the woreda town of Kersa on the way from Dire Dawa to Kulibi. The population is 5640, according to information from the woreda. All villagers are said to depend on farming, with some supplementing this with small trading activities. The main crops are maize, sorghum and potatoes, but many harvest the cash crop chat for additional income. The community is concentrated in hilly and rocky areas. There is an elementary school, but people are forced to travel long distances to access health services and water. Waterborne and water-related diseases are the main problem of the area – the number one registered sickness according to the woreda Health Office. To solve these problems, based on the community's request, HCS formulated water supply development interventions together with line departments and the community itself.

Project objectives identified from project documentation:

- To expand the water supply system of Ifa-Jalela to four villages of Kufanzik for a total of 440 households.
- To alleviate waterborne and related-diseases in the area, which highly influence children's and mothers' health.
- To decrease time spent fetching water and thus reduce the workload of women and children.

Prior to implementation, the closest access points were in Ifa-Jalela, about 2.4km away from Kufanzik, or unprotected, exposed ponds, which were high in bacteria. Water was insufficient to meet needs all year round. Accordingly, a system with the following criteria was designed:

1. Lifespan of 20 years, considering durability;
2. For a population of 2640 from the village and about 3000 expected neighbouring users;
3. With no recorded information on patterns of water use in the region, per capita demand assumed as 15 litres/day/head throughout the design period.

The system had the following components, with a cost breakdown:

Description	Cost in Birr
5800m of pipe line	
Generator house with installed generator	**18,772.10**
70m^3 collecting chamber with submersible pump installed	**34,513.17**

20m^3 distributing reservoir	**33,025**
Water points	**4872.3**

As per standard, a WMC was established to manage the water supply in Kufanzik. The WMC would have to work with the WMC of Ifa-Jalela, so a Board made up of community members of each village across both kebeles was established to monitor both WMCs. However, since implementation, there has been little water supplied to Kufanziq, and this has been blamed on technical and managerial issues at Ifa-Jalela.

The problems

A few issues were identified in the cross-kebele system.

Managerial: Management of the water system in Ifa-Jalela was already poor: management was prone to corruption and poor service delivery was the result. WMC members changed from those originally trained and so were unaware of the correct procedure and were subject to corruption themselves. The WMCs did not work well together, and the Board had little power to control them. In a system of this size, there was inadequate management support available to the communities from woreda level. The complexity and size of the system meant that it was beyond the capacity of the communities to manage it properly: the system requires constant external support, which is currently unavailable. Kufanzik community members suggested the employment of a government official to manage the system, whose salary would be paid through the cost recovery system, to ensure smooth running.

Sabotage: In order to cover up some of the inefficiencies in the system, pipes were deliberately broken to impede proper water supply. This enabled a demand for extra fuel money and the broken pipes could be blamed for the lack of water being delivered to Kufanzik. Maintenance tools are now easily accessible, so anyone can open and close the gate valves that control where the water is pumped to.

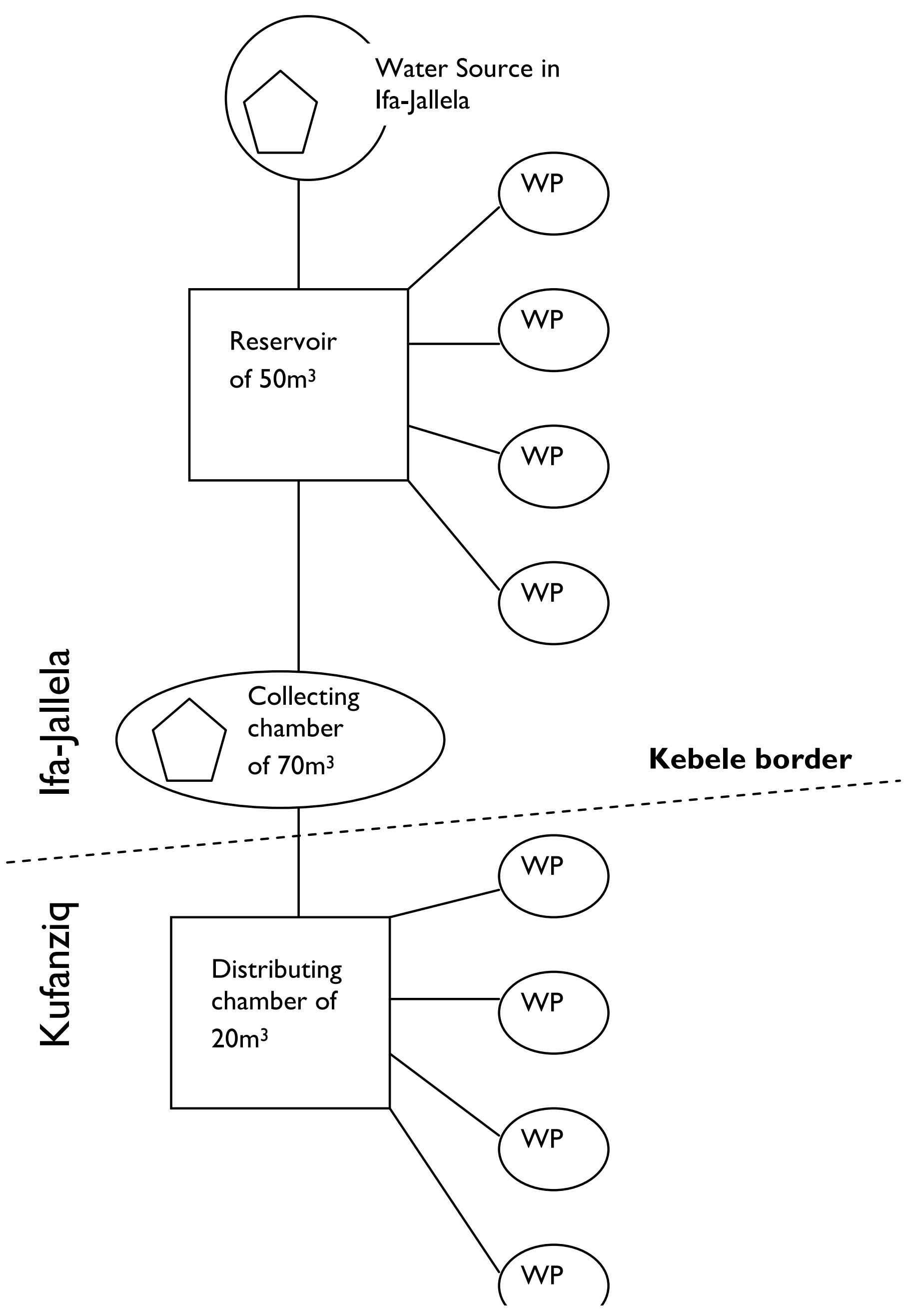
Ownership: As the water source and collecting chambers are on Ifa-Jalela land, both kebeles refer to the water as Ifa-Jalela water. Kufanzik community members resent having to rely on the other kebele for water, and Ifa-Jalela controlled the water source because of its sense of ownership. This also gives Ifa-Jalela power to demand bribes from Kufanzik caretakers for access to the pump house, gate valves and reservoirs. Kufanzik was already subject to higher costs to operate the two pumps, and then had to pay further unofficial costs to allow water to be pumped to its collecting chamber. These high fees have acted as a disincentive to invest further in water that community members can not access.

Lessons learned

- Land ownership issues generally feature in water supply systems, and these need to be resolved in a more formal way. In this circumstance, land issues were more pronounced because the system extended across two kebeles, as well as being on private land.

- The more complex a system, the more managerial and often technical support required. With a cross-kebele system such as this one is, there is potential to implement external managerial support to run the system. A motorised system has higher costs and a greater need for transparency and accountability mechanisms to ensure sustainable fee recovery schemes.

Schematic of the water relay system of Ifa-Jalela and Kufanzik



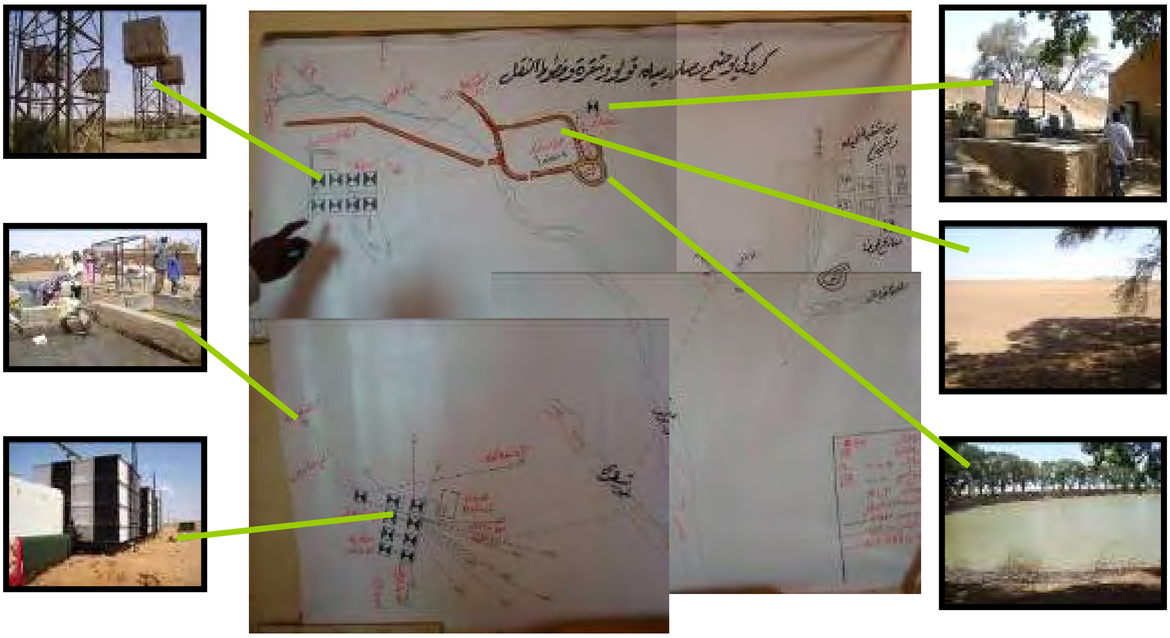
Annex 5: Sudan site descriptions

Golo dam and Shugra boreholes: Al-Fasher town supply

Background/introduction

Al-Fasher town gets its water supply from Golo dam and Shugra boreholes, located 8 and 12km away west, respectively. Golo dam is a surface water dam with three reservoirs, whereas the Shugra boreholes are supplied by groundwater (20 boreholes – 13 in Shugra Goz and seven in Shugra Waadi). The system as a whole answers to some of the water demand for Al-Fasher town, which has a population of about 300,000, and for residents in the two villages close to the water source sites. The major livelihoods of the residents of the two villages are in mixed farming, whereas those in the town rely on service and trading. The two water systems provide water to Al-Fasher in shifts throughout the year. During the rainy season (July to September), the water supply comes mainly from Golo dam, with Shugra boreholes the main source for the rest of the year.

Golo dam and Shugra boreholes



Map of Golo dam and Shugra Goz and Waadi boreholes, linking to Al-Fasher water treatment plant

Golo surface dam has three reservoirs of 7m depth – one with a design capacity[4] of 4,000,000 m^3 (2,000,000 m^3 at the moment) and twin reservoir ponds of 350,000 m^3 and 450,000 m^3. The main reservoir and smaller reservoir were constructed in 1947, and the second reservoir was constructed in 1967. The dam is fed by three major valleys, called Behaire, Cutteme and Huttume, and four

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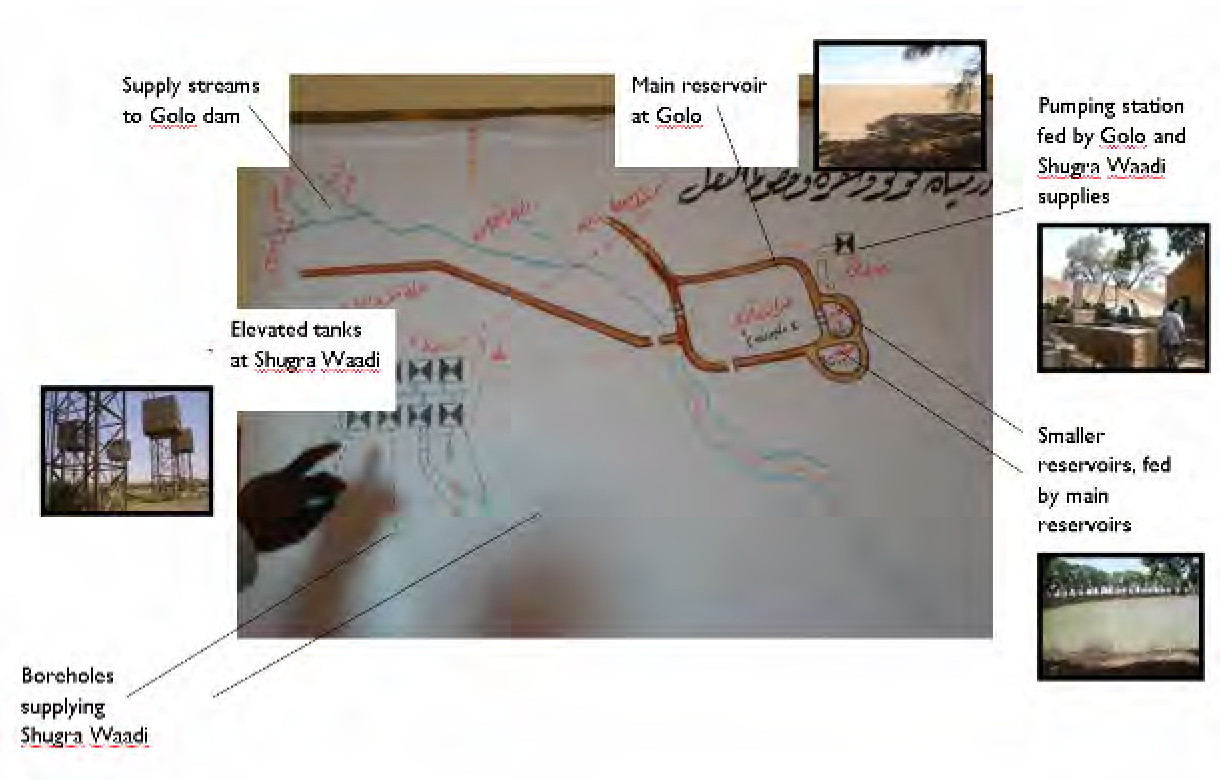
[4] This capacity is not the annual yield, but rather the storage capacity of the reservoir. So the amount of water that flows through Golo and Shugra would depend on measurements at the water treatment plant and water points. As a result, it is difficult to estimate the efficiency of the system.

seasonal rivers. The construction and lining of the dam and the former pond took one year to complete, carried out by the DWC using heavy machinery. The reservoirs provide water when the larger reservoir is dry, usually just before the rainy season, between April and July. The main reservoir and smaller reservoirs are connected by underground pipes with a valve.

Shugra Waadi has seven boreholes, of which only three are functioning, and these are pumped into seven elevated tanks (originally nine, but one fell off and the other is not functioning) of 50m³ capacity. The water from the tanks then flows by gravity to the pumping station at Golo, and is pumped to Al-Fasher.

Supply from Golo dam and Shugra Waadi are linked to storage wells adjacent to the Golo dam reservoirs. The water is then pumped via three pipelines – two of 8" and one of 12" diameter pipes – to Al-Fasher treatment plant and monitored by a water meter. Two diesel generators are used for pumping at a rate of 25m³/hour from the storage well to Al-Fasher. Villages around Golo and Shugra also access water from these water points. Golo and Shugra Waadi are untreated water supplies. Surface water needs treatment prior to drinking; groundwater tends to require less treatment. However, water is mixed at Golo before being pumped to Golo villages, which means villagers are supplied with untreated water. Golo villages have a population of 1560, spread across 246 households, with 80 households having piped water to their homes.

Golo dam and Shugra Waadi borehole components



Shugra Goz has 13 boreholes connected to five tanks with a combined designed capacity of 115,000m³ and then directly to Al-Fasher town through gravity. It was constructed in 1982, and water is pumped into water tanks through a pump, powered by mains electricity, via a 12km pipe of about 90cm diameter directly to Al-Fasher town. One of the tanks supplies the surrounding Shugra villages distributed to three water points – Hillah Mirrah, Hillah AbuBakr and Hillah Mosa –a population of over 8000 people.

Overall, three water pipes from Golo and one water pipe from Shugra Goz deliver water to Al-Fasher town, with a service provided to surrounding villages.

Shugra Goz borehole system

Planning, implementation, operation and maintenance

Both water systems were designed and constructed by the DWC with the main objective of making water available to Al Fasher town. In the course of implementation, however, local paid labour was sourced, with some local villagers still being employees of the water corporation. The village of Golo was created to provide a labour source for the construction of the dam and has since grown. Service provision is entirely under the control of the UWC.

In Golo, discussions with community reflected little involvement in the planning, design and maintenance of the system, as the water supply is managed by the DWC. A significant proportion of Golo villagers work at the Golo pumping station and the village itself is within easy access of the water point. A trip to the water points is on average 15 minutes one way, with the longest journey taking 30 minutes. The women questioned reflected that there were hardly any queues, and fetching water was a relatively smooth process, unless there was a problem at the pumping station. Water is used solely for drinking and watering livestock, with some cultivation on the periphery of the reservoirs, fed by the overspill from the reservoirs and pipes. However, because water from Golo is untreated, access is to untreated water only, with a high incidence of waterborne disease.

Up to 2000, the village had a water point in the village, supplied through an elevated tank. Now there is a network directly connecting homes of the labourers at the station (80 households), with other villagers accessing their water from the water point or, in some cases, from their neighbour's tap. Rebels currently present in the area access water for free, with other villagers paying a tariff of 2 jerry cans (40 litres) for SDG 1. Sanitation cover in Golo village is based on traditional latrines, with little or no contribution or support from external sources. There is a keen interest within the community in developing latrines have sanitation programmes, as seen in IDP camps.

Water points in Shugra surrounding villages are managed by individuals within the community. Annually, individuals from the community are invited to tender for the management of the water point. Winners of the bid administer the water point through commission, and apply a set tariff of SDG 0.5 per pair of jerry cans (40 litres). The bid winner retains an income from the supply.

The villagers in Shugra get have three water points for their entire seven village communities. A declaration was signed in October 1990 by the government of Sudan to provide free water via the network and a free electrical supply to villagers in return for their cooperation on their underground water. Since signing the agreement, the village development council has bought pumps to strengthen the water network, which are still in storage, not in use. Allegations of corruption have also been thrown on the table of two households receiving water via the network.

We visited a water point in one of the villages served by Shugra Waadi. A member of the community had won the bid to maintain the water yard for the year and charged villagers according to national tariffs. The water is dispensed into a mercenary open pond, with algae and silt deposits, then, using makeshift jerry cans, water is fetched by hand. Cattle troughs are right next to the water point, with easy cross-contamination because of the closeness of drinking water and cattle. Both open tanks have algae and silt, even though the water from the pipes comes directly from the groundwater boreholes of Shugra Waadi, which generally does not require treatment. The water yard, which is muddy and has a lot of stagnant water, is used by young children fetching water. Donkeys are loaded with only two jerry cans each, with some light extra load in some cases. The cattle trough is too deep for animals to drink easily and for smaller animals to obtain access without having to get into the drinking water. There could or should be some basic maintenance and hygiene awareness training for those who bid to manage the water points.

Water point at one of the villages supplied by Shugra Goz

Water treatment

To improve the quality of water, particularly that from Golo Dam, a treatment plant has been constructed in Al-Fasher town. However, the water supplied to local consumers in Golo is not treated; people are drinking direct from the pipe and are complaining about its quality. Mahogany trees are planted on the reservoir borders: their leaves are known to reduce turbidity.[5].

Observations

It is good to note that Golo dam and Shugra groundwater have been in service for 60 and 26 years, respectively. Together, they are able to provide about 30% of Al-Fasher's current needs. However, with the growing population in the area, owing particularly to the increased number of IDP camps, demand is growing. The ability to meet these growing needs is severely hampered by the reduced capacity of Golo's main reservoir by half owing to silting, frequent pipe breakages and lack of capacity or resources from government for maintenance. At Golo dam, for example, part of the main reservoir is damaged; efforts and available resources are focused on minimising damage to this section of the reservoir. Engineers interviewed estimated that properly rehabilitating the reservoirs could make a significant impact on meeting water needs in Al-Fasher town.

Most components of this system have been affected to some extent by the conflict, and are managed or overseen by the government. Generally, the area outside of Al-Fasher town centre is under the control of rebel factions, so maintenance and rehabilitation, when there is capacity to do so, has to be done through negotiation with rebels, to ensure the safety of staff and equipment. Examples of this were seen when visits to Shugra Goz coincided with maintenance of one of the borehole pumps – the maintenance team and equipment were safeguarded by armed members of rebel factions in the area. Rehabilitating reservoirs requires heavy machinery to remove silt deposits and reline certain parts, which is beyond the capacity of local government and difficult given current security issues. Villagers rely on external support to dig wells and install hand-pumps.

Overall, given the size of the system and the service population, it is difficult to ascertain impacts on the service population as a whole. The team was also unable to access project documents from government offices, which hindered investigation of the system.

Al-Fasher privately owned borehole

Background

In Al-Fasher town, drinking water is a scarce resource. Many of the water points visited had queues of horse and donkey carts. The privately owned well is one of the 14 privately owned motorised wells located in Al-Fasher town. The system provides drinking water to the nearby residents of Al-Fasher town who are not connected to the main water supply network.

[5] Turbidity is the cloudiness or haziness of a fluid, or of air, caused by individual particles (suspended solids) that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a key test of water quality. Fluids can contain suspended solid matter consisting of particles of many different sizes. The higher the turbidity level, the higher the risk that people may develop gastrointestinal diseases.

Planning and implementation

The well was originally dug for irrigation purposes for the owner's adjacent farmland. Construction started in 1947, with the well dug manually on the rocky terrain using a chisel and mallet over 20 years. The well runs to a depth of 47m (previously 39m but it has since been deepened). The well has been in operation since 1959. From 1959 to 1980, a manual pulley system was used to lift water out of the well; now the owner uses a motorised pump powered by a mains supply, with a diesel generator when there are power cuts. The water is then pumped into storage tanks – an elevated closed tank and an open ground tank. From the open water tank, horse-drawn carts are filled by water purchaser. The elevated tank was built with funding and support from a German NGO, Vita in 1993 (including the generator).

Water is pulled up by motor and pumped to storage tanks before being passed on to purchasers

Operation and maintenance

As the well is privately owned, the owner receives no support from the DWC, despite being a registered company. In 2005, owing to a lack of spare parts, the well was not functional. The owner sought support from government to no avail, and ended up sourcing spare parts himself, which took a year and a half to replace because of limited availability. The elevated tank was initially sponsored by an NGO, which then ran out funds, so the owner completed construction. Maintenance is conducted by the owner and his sons. If it is beyond his capacity, the owner pays for maintenance services from the DWC.

The operational costs go towards fuel expenses, maintenance and a supplementary income for the family. Users currently pay SDG 1 per horse cart (about 400 litres) during the summer months, when there is less demand (rains and recharged natural pools). During the drier months, just before the rainy season, when there are limited alternative water sources, the owner is able to charge SDG 3 per horse cart (April – 15 June). The owner is part of an organisation of private well owners, who agree on a set tariff between themselves, depending on the power supply.

The owner estimated an overall investment of SDG 20,000 over time, with daily returns ranging from SDG 160-200 a day during peak seasons to less than SDG 20 a day in low season. The income from the well is shared among the extended family, whereas income from his adjoining farm (about SDG 200 a week during harvest season) is just for the owner. He uses some of the water from the well to irrigate his land, but only a small area. Most of his cultivable land sits in an area fed by rains and does not need irrigation.

The owner is registered with the local government but refuses to pay taxes because feels he does not receive any government support.

Observations/lessons learned

- A privatised water supply system, although capital intensive, is self-sufficient, with maintenance a priority, with or without external support.
- Water being poured into an open tank and then used to fill horse carts creates contamination concerns.

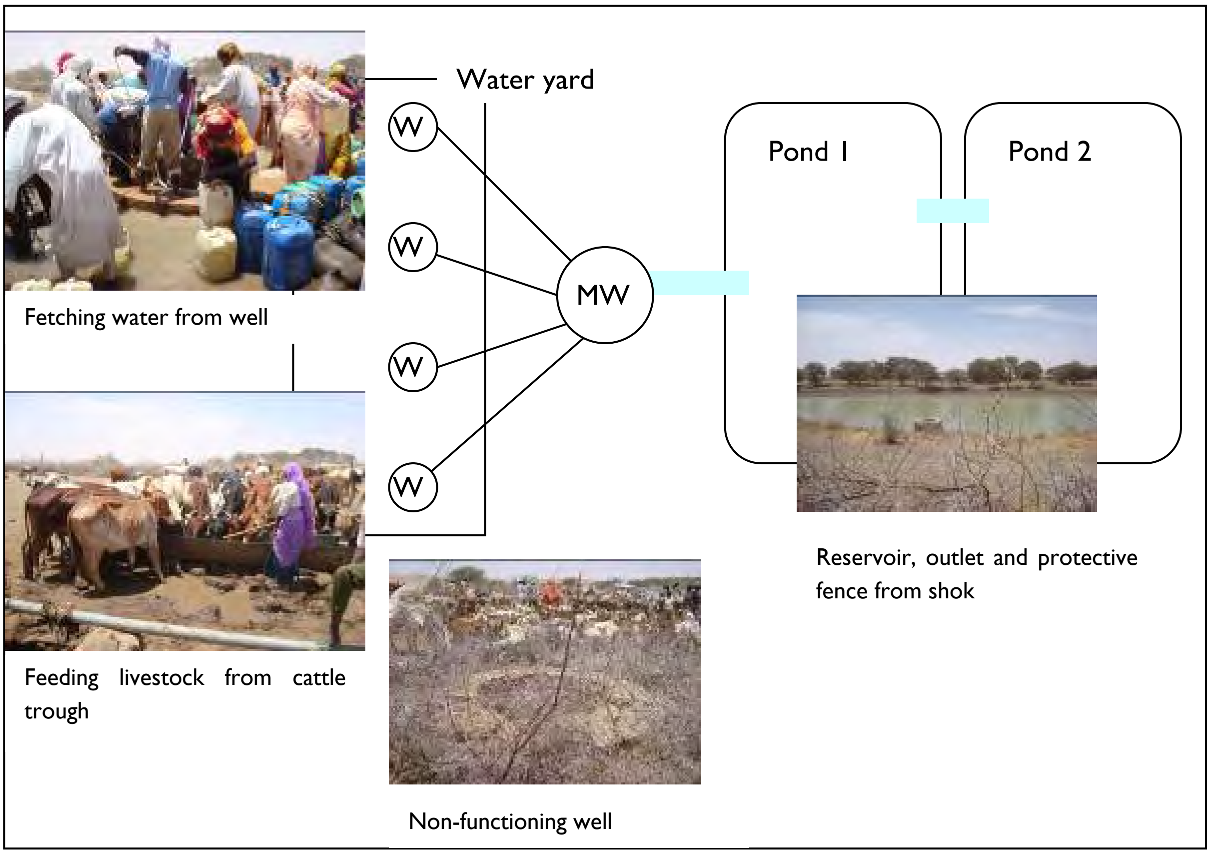
Fasher hafirs – twin ponds

Background/introduction

Fasher's ponds are located 11km east of Al-Fasher town. It is used by about 60,000 people and over 500,000 livestock, scattered over 21 villages. For administrative purposes, the villages are grouped under three localities – Fasher A hosts the council for 14 villages and was visited by the team. The major source of water for any use in this area is surface water. Groundwater is sometimes available, with 11 hand-dug wells, of which eight are functional. The climate of the area is hot, dry and arid, and livestock and mixed farming are the main livelihoods.

Description of water system

The twin ponds were constructed by the RWC, based in Al-Fasher state. The ponds are adjacent to each other and are connected by underground pipes linking the two together. Altogether there are three reservoirs, with capacities of 300,000m^3, 200,000m^3 and 100,000m^3, the smallest is under rehabilitation and not currently in use. The reservoirs are made of compacted soil, are lined and are protected and fenced by local shok (thorny) plants. There is a masonry outlet structure constructed to the second pond, which leads the water to the user communities on the lower side. Connected to the outlet structure is the main well, which stores the water coming from the outlet structure of the pond and distributes to four wells located about 15m away. All of these are connected to one another by means of underground pipes. Besides the main storage pond, there is a generator house, constructed to pump water to an elevated tank located some 150m from the water station. It was intended that users would be able to get water from the elevated tank, but this has not been functional over the past seven years owing to the conflict in the area. Connected to some of the distribution wells are cattle troughs, through which water is rationed for livestock. These are made from either masonry or movable metal sheets. People now collect water from the distribution wells by hand, pulling buckets from a 25m deep well.



Planning and implementation of the twin water ponds

The system was planned and constructed by the government using machines. During the construction process, the community contributed local labour paid for by the government. The supplementary hand-pumps (11, of which eight are functioning) in the area were constructed by WESS and PAC, both of which are active in the area. With the implementation of the hand-pumps, both implementers have followed a community-based approach, allowing the community to contribute local labour and resources. PAC and WESS are also engaged in the promotion of sanitation facilities, both at household and school level (pit latrines), among other diverse activities.

Management

The management of Fasher ponds used to be under the full control of the RWC, prior to the start of the conflict eight years ago. During this time, one person was hired by the RWC to administer the water supply system to the community. The water was rationed from the elevated tank to the water points using a tap. However, since the conflict, access to water has been free and unmanaged, and communities have started to access water directly from the wells, as the pump used to feed to the elevated tank has fallen into disuse.

Only in 2008 did the community establish its own management committees to mitigate the ongoing damage to the water system. Consequently, an 11-member committee was democratically elected from the three major villages of the 21 villages, with the elected committee responsible for administering the water system and collecting tariffs from the users.

Tariff and user fee collection is mandatory in any water system in Al-Fasher state and Sudan in general. Government-constructed water system tariffs are always decided by government, but tariffs at locally constructed water points, such as hand-pumps, are decided by local communities. At the moment, the tariff for pond use is based on a tariff set by the RWC and fees are paid in advance. A ticket/pass is provided for households when using the water service. Livestock owners are expected to register the number of livestock they own. The tariff rate for domestic use is SDG 0.5; the tariff varies depending on the size of the livestock, i.e. SDG 0.3, 0.2 and 1.5 per head per year of sheep, goats and camels, respectively.

When the system was managed by the RWC, the community indicated that about SDG 12,000 was collected per year on average and shared between the local village government and the RWC. All maintenance during this time was undertaken by the government. After the conflict started, there was no user fee payment; fee collection started on the establishment of the new community management committee in 2008. The committee budgeted to collect SDG 6000 to cover maintenance, with the surplus going towards further development. Four members of the committee are responsible for fee collection – one member actually collects the fee and the other three audit and sign off on fees collected.

Management of the hand-pumps generally follows the WESS established system. A 10-member health committee is selected to manage the water system, as well as performing other activities. Committees are trained for seven to 10 days on water mechanics, environmental sanitation, water management (fee accounting), etc. and provided with toolkits to carry out maintenance on the pumps.

The tariff for the water pump is decided by the community: people pay SDG 0.1 for a pair of jerry cans (20 litres) collected per unit time for domestic use. The water from this source is generally used for domestic purposes only.

Observations and lesson learned

The twin water ponds are the major source of water for both livestock and human consumption. Over 50,000 local populations and their livestock (approx 2 million) use the water from this source. The community reflected on the constant crowds around the water points. Owing to the conflict in the region, improving the available water source is difficult. This situation is predicted to continue for some time to come, until the conflict is resolved. In general, the following are the major lessons learned:

- Surface water harvesting technologies used in the area are suitable and are able to provide water for the needs of the population all year round. However, the non-treatment of the water poses a significant health threat
- Silting in the water ponds represents a major maintenance cost, and needs to be considered during design. This is a challenge in an area where desertification is a serious threat.
- Metal cattle troughs, though expensive compared with masonry troughs, are more durable and portable. They would be useful to reducing overcrowding, if properly distributed.

- Circular masonry around the distribution well has improved the sanitation of the environment in comparison with water points in Shugra Goz. However, open wells compound the contamination issues.
- There is a need to provide an alternative pond or build an outlet in another area to reduce the concentration of livestock traffic and queues to get water – environmental degradation around the water point because of the daily watering of a large number of livestock is evident.
- There is a strong need to introduce water treatment in the area. Owing to the limited access to groundwater, there is no doubt that some of the untreated water sourced from the ponds is used for drinking by humans as well as livestock.
- Access to water for domestic purposes and for livestock in close proximity could address the multiple use needs of the community. However, in designing the system there needs to be special consideration given to taking precautions against contamination.

Azagarfa, North Darfur: Water harvesting dam

Site name and description

1. Incomplete construction of dam for irrigation planned to cultivate 400ha of land
2. Hand-pumps
3. Protected hafir constructed for drinking water, not in use
4. Unprotected hafir for both animal and human drinking water

Background/introduction

The Azagarfa water harvesting project is located 33km north of Al-Fasher town, the capital of North Darfur. The water system, which is mainly surface water, is used by over 2300 people and their livestock, scattered in six settlements. Bordering communities from Chad also uses this surface water when cross Azagarfa village to Al-Fasher town market their livestock. The surface water includes one big diversion dam and four ponds (two big and two small). In the region, there are also meagre shallow ponds and a non-functioning hafir, as well as seven hand-pumps, of which three are working. The non-functioning pumps have dried up and/or need spare parts – the reinstallation of pipes costs about the same as a new installation. Owing to the conflict, the fee recovery schemes in the area have failed to provide savings for maintenance: collection fees are looted by fighters. The livelihoods of the communities in the area are based on mixed farming, with annual rain occurring in August to October. The area is wide and flat for the most part, with a few hills surrounding the village.

Description of water system

Water systems in the area include a **water diversion dam**, hafirs and hand-dug wells. The diversion dam was designed and constructed in 2001-2002 by Dr Adil, University of Khartoum, with PAC for irrigation purposes, diverting flood water into a 400 ha command area owned by about 400 households. The big dam was constructed using labour from village residents to divert flood water through a side canal, linked with six masonry outlets at different distances. In addition, there is one spillway before the six masonry outlets to reduce the pressure on the outlets. Beneath the side canal, another sideways canal was constructed to retain the water flowing from the spillway to enable irrigation of another smaller command area. The side canals are constructed of earth compacted with stones on top. However, the dam was not completed owing to the conflict in 2002. As a result, only five families are able to use the dam for cultivation.

Original designs from Azagarfa dam, dam in use, dam post-construction and dam now, silted up (planned by village development council and designed by PAC)

Pond water is the major source for domestic use, livestock and brick production. There are four ponds around Azagarfa village, two small and two large. The smaller ponds are much older. One was constructed in 1955 by the Anglo-Egyptian administration and the other by the DWC of North Darfur state in 1979. The two larger ponds were constructed in 1998-1999 – one with PAC and the other with the Red Crescent. The PAC pond was funded through the Food for Work programme of the World Food Programme (WFP) and was meant for domestic uses. However, after one year of use, the channel leading water to the hafir became silted up and was not rehabilitated and it is not providing a service at the moment (silting seems to be a common problem). Consequently, the community relies on the two small older ponds and the hand-dug wells in the village. The older ponds are now the major source of water for domestic use. Livestock watering and brick production are also carried out using these unprotected ponds. Villagers reported that waterborne disease was a critical problem in the villages, as they along with the animals drink untreated water.

Open access to the hafir; mud construction; one of functioning hand-pumps in the area

Since 2001, training of trainers has been conducted by WESS on how to construct and use household and public latrines, including hygiene promotion. Most communities own their sanitation structures, which either have been constructed or are about to be constructed, as they have movable slabs at their disposal. This has been well promoted, as it aligns with the promotion of hygiene in the religion practised by the community.

Planning and implementation of system

The planning of the project came into being when the villagers appealed to the local government for the installation of domestic water supply. The application was then forwarded to the Rural and Agricultural Development Department of Al-Fasher state and PAC. Consequently, PAC in collaboration with the community conducted feasibility studies and came up with the plan to construct the diversion dam and hafir, the former to be used for irrigation and the latter for domestic use. Utilising surface water was the only option, with the irrigation plan put in place using a different form of damming than that used in the region.

In the implementation phase, the WFP provided PAC with food commodities and the community contributed to construction through the Food for Work programme.

Water management and sustainability

Management of the hand-dug well is carried out by 12 villagers from the six villages, two from each village, selected and trained in water management and maintenance. User fees were set by the community – SDG 1 per household per month, with non-residential users charged SDG 0.2 per donkey (each donkey carries two to three jerry cans, each roughly 20 litres). One member of the water committee from each village was selected as fee collector and guard and is paid a salary of SDG 150/month. The fees collected so far have been used only to meet this salary and minor maintenance; there are no savings. The 12 committee members include a president, vice president, secretary, cashier and storekeeper; the others are committee members. Aside from this committee, there is also a 'popular committee', whose role is to represent community members in processing community requests to the government, to coordinate community members in construction and maintenance of water points and to monitor the water committee. All assets are public goods.

There is an umbrella body containing the community administration, the community council, the development committee and the women's development committee.

The hafir answers much of the community needs, but it is without a management committee because of the conflict and is used free of charge. In 2006, the popular defence force patrolled the region, but the conflict has meant their redeployment into national service to control checkpoints and to patrol the region and borders. Normally, tariff charges go towards source rehabilitation and maintenance, salaries for guards and pump installation. A surplus funds public goods and assets for new water sources.

Conclusion and lessons learned (benefits and impacts)

The community reported that system impacts are not clear as construction stopped as a result of the conflict in the area in 2002. Only five households out of 400 benefit from the diversion dam. However, these have been able to plant vegetables and fruits that were not common in the area. As the agricultural potential in the area is very high, they are hoping to benefit more in the future.

The major lessons learnt from the water harvesting system include but are not limited to the following:

- Water harvesting systems have great potential to alleviate water scarcity, if done properly. They allow for water tables to be recharged and for storage of water that would usually be lost in runoff.
- Having a popular committee under which the WMC works helps provide greater accountability and transparency, as well as better integration of village-level development programmes.
- Treatment through improved watershed management and prevention of soil erosion within the catchment area is crucial to reducing silt deposits along the diversion canal in both the ponds and the diversion dam. Introducing better natural resource management and terrace construction could reduce silt deposits along the water harvesting structures, as well as creating cultivatable land.
- Lack of a management committee, tariff setting and fee collection at the hafir has significantly affected sustainable use, as well as quality use of available water. Introducing a management system could provide funding for rehabilitation and even for treatment of the surface water in the hafir.
- Limited availability of water has not restricted the use of latrines, although it was difficult to observe practice within the scope of the study.
- Within the west region of Azagarfa, an overground 30,000 gallon tanker will soon be constructed, using local funds. Further funding will be needed to increase capacity in the region, as there is a great deal of demand for the underground supply.

Annex 6: Case studies on water and sanitation in Kenya

Prepared by Paul Chege

PAC East Africa, April 2008

Background information on Kenyan water sector reforms

The Kenyan water sector has witnessed major reforms since independence. The first Sessional Paper No. 10 of 1965 on African socialism and economic development, which defined the country's development path, identified the need to provide water for all. By the 1980s, the county objective was to provide water to all households by the year 2000.

To realise this ambitious plan, the government brought on board community-based organisations to develop community-based decentralised water supply systems to supplement government efforts. By the 1970s, most of these schemes had been taken over by the Ministry of Water, putting a great deal of pressure on public funds. The current reforms promote the decentralisation of participatory management of water systems to users and other stakeholders.

The Water Act of 2002 defines the fundamental objectives for managing Kenya's water resources. Sections 11(1) and 11(2) define the National Water Resources Management Strategy, according to which the country's water resources are to be managed, protected, utilised, developed, conserved and controlled. The strategy prescribes the principles, objectives, procedures and institutional arrangements for the conservation and control of water resources, including: classification of water resources, determination of the requirements of the reserve for each water resource and identification of areas designated as protected and groundwater conservation areas.

Sessional Paper No. 1 of 1999 on National Water Policy on Water Resources Management and Development provides the policy direction to address the abovementioned challenges. The policy directions include the following:

- Treating water as a social and economic good, preservation, conservation and protection of available water resources and sustainable, rational and economical allocation of water resources;
- Supplying adequate amounts of water of acceptable standards for the various needs and ensuring safe wastewater disposal for environmental protection;
- Developing a sound and sustainable financial system for effective and efficient water resources management, water supply and waterborne sewage collection, treatment and disposal.

The Kenya Economic Recovery for Wealth and Employment Creation Strategy (2003-2007) recognised that the then existing institutional arrangements were inappropriate and formed a programme approach for the water sector, putting a strong emphasis on providing services to the poor while ensuring adequate water for the various competing demands. It laid the ground for comprehensive institutional reform to facilitate 'pro-poor water and sanitation programmes'. Similarly, the poverty reduction strategy paper recognised that water is a basic need and an important catalyst for both economic and social development. It states that 'access to water for human consumption, agriculture, and livestock use is a major problem in rural areas as well as urban informal settlements'.

Proper access to water and sanitation provides dignity, convenience and social status, along with health benefits. The provision of adequate water and sanitation is vital to the improvement of living conditions. It ensures improved health and creates a conducive environment for education, gender equality, social inclusion and environmental sustainability. As such, the government recognises the need for more financial support for water and sanitation programmes in the national budget as well as from development partners. Water and sanitation have to be prioritised in poverty reduction strategies and development programmes in tandem with efficiency and performance gains.

National Water Resources Management Strategy formulation

The overall principles adopted in the National Water Resource Management Strategy are:

- To achieve equitable access to water, that is, equity of access to water services, to the use of water resources and to the benefits from the use of water resources;
- To achieve sustainable use of water by making progressive adjustments to water use with the objective of striking a balance between water availability and legitimate water requirements, and by implementing measures to protect water resources;
- To achieve efficient and effective water use for optimum social and economic benefit.

Specific principles adopted are:

- Water is as an indivisible national asset. The national government will act as the custodian of the nation's water resources and its powers in this regard will be exercised as public trust;
- Water to meet basic human needs and to maintain environmental sustainability will be guaranteed as a right, while water for all other purposes will be subject to a system of administrative authorisations;
- Responsibility and authority for water resource management will be progressively decentralised through the establishment of suitable regional and local institutions. These will have appropriate community, racial and gender representation;
- Productive use of water resources so as to improve the living standard of beneficiaries and the economy as a whole;
- Adopting the principles of 'water user pays' and 'polluter pays'.

Goals and objectives

The overall goal of the National Water Resources Management Strategy is to eradicate poverty through the provision of potable water for human consumption and water for productive use. The fundamental objectives in managing Kenya's water resources are to achieve equitable access to water resources, sustainability and efficient use of water.

The specific objectives are:

- To improve water resources assessment so as to obtain more accurate figures of the annual freshwater safe yield of surface and groundwater resources;
- To put in place mechanisms that promote equal access to water for all Kenyans;
- To enhance and strengthen roles of gender in water resources management;
- To create mechanisms for an integrated approach to land and water resources planning and management on a catchment basis;
- To put in place measures that enhance the availability of water resources to meet both quality and quantity needs;
- To put in place strategies that will provide accurate data on water use and demand for both surface water and groundwater resources;
- To provide guidelines for private sector water financing while enhancing opportunities for self-financing aimed at augmenting public sector financing;
- To develop water pricing policies and mechanisms which recognise water as an economic good;
- To develop policies and mechanisms on disaster management;
- To promote integration of sector and regional water policies.

Institutional framework

As discussed above, increasing access to sustainable and affordable water services is a priority of the Kenyan government within the overall policy framework of the Economic Recovery Strategy for Wealth and Employment Creation.

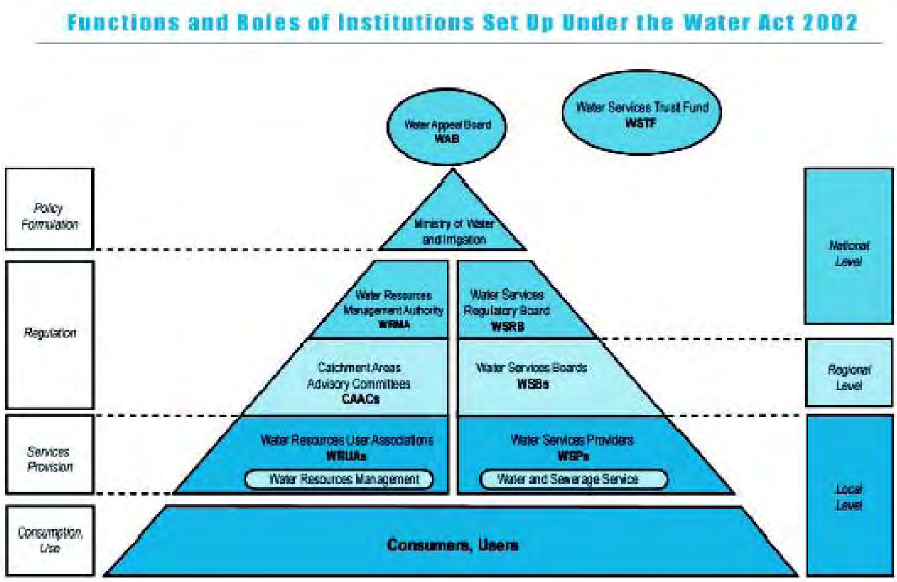
In order to address the problems associated with access and provision of water and sanitation services, the government has embarked on reforms in the water sector under the framework of the Water Act 2002. The Act aims at providing for harmonised and streamlined management of water resources and its supply. The Ministry of Water supported by WSBs is spearheading the implementation process. These reforms were mainly occasioned by the inability of the existing arrangements for provision of water services to deliver and maintain basic water supply infrastructure for the growing population. The reforms also aimed at coordinating the various actors involved in the water sector.

The Act aims at ensuring that policy formulation, regulation and service delivery roles are clearly delineated, with each role being carried out by a separate entity. The Ministry of Water is no longer involved directly in management of water services. Its key responsibility is to undertake policy formulation, sector strategy development, research and training, sector coordination, planning and financing.

The WSRB is responsible for the regulation of water and sewerage services, including development and maintenance of quality standards and issuance of licenses for service provision.

WSBs have the legal responsibility for provision of water and sewerage services within their prescribed areas of jurisdiction under license from the WSRB. Their responsibilities include holding or leasing and developing water assets, contracting WSPs that shall be their main agents in provision of water services and preparing plans for improvement of services, including expanding service coverage and reviewing tariffs. WSPs are the entities through which the WSBs will provide water and sewerage services under appropriate agreements entered into between them with approval of the WSRB. The WSPs may be community groups, NGOs or private companies, including those set up by local authorities for the specific purpose of operating water services.

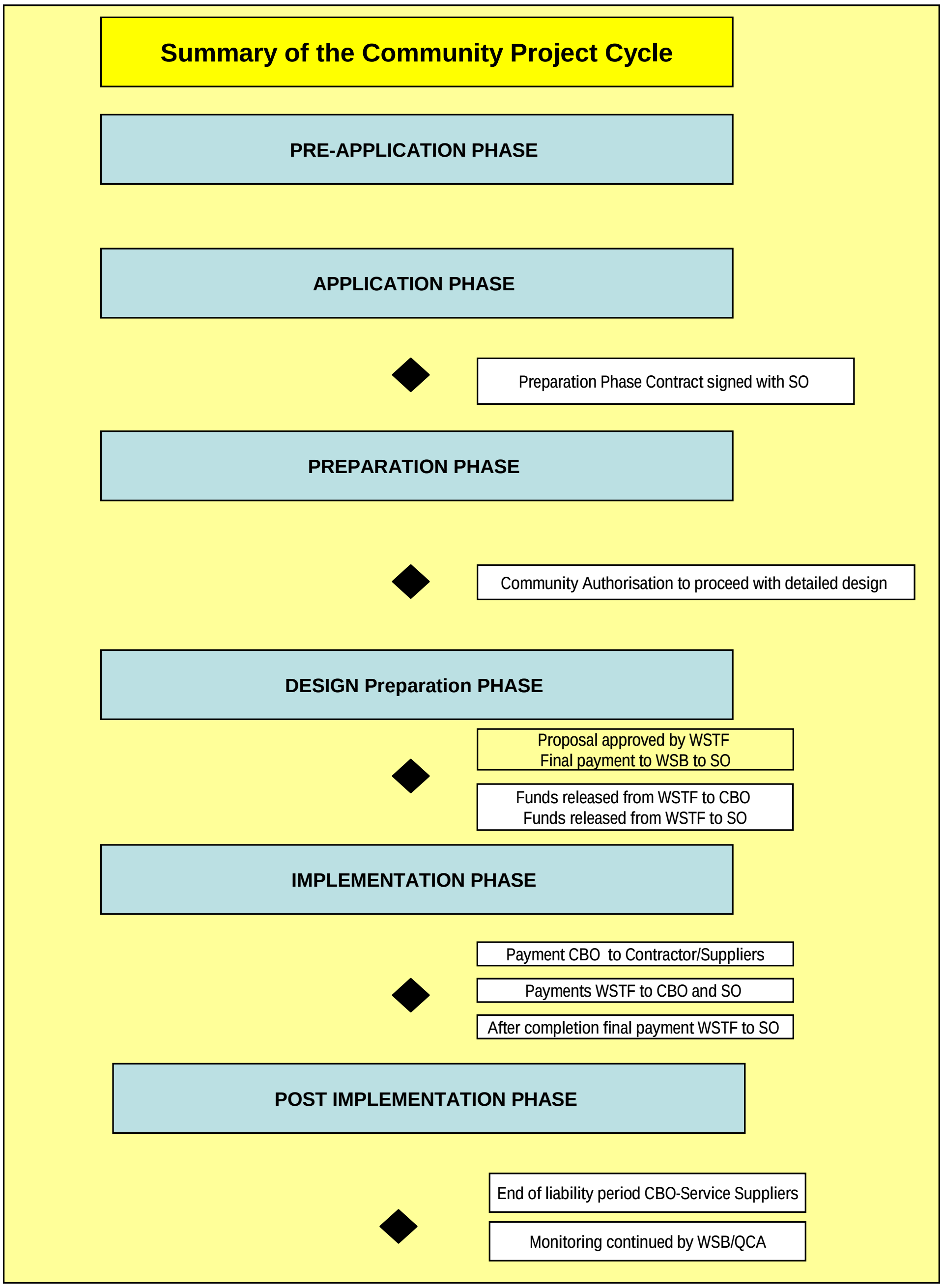
Institutional framework on water in Kenya



Framework for financing water and sanitation projects in Kenya

In recognition of the challenges facing the country in meeting the MDGs in relation to water supply and sanitation, and in line with water sector reforms, the government set up the Water Services Trust Fund to provide a basket fund of support from public funds and development partners. This was further supported by developing the community project cycle (CPC) document, a tool to inform the framework through which communities can form water user associations and develop proposals for funding of water and sanitation projects. The CPC provides the basis on which the trust fund can secure funds for improving water and sanitation services in underserved communities across Kenya. The diagram below shows the CPC phases.

CPC process



Rural community water projects in Kenya

The case of Kabuku

Kenya has a strong culture of self-help, which has been harnessed for many development activities, especially in rural areas. Looking specifically at water, of the eight million Kenyans who have access to improved water in rural areas, 30% are served by community-managed water supply schemes. Most of these schemes were developed by self-help groups. Many of them were constructed during the 1970s and 1980s and are still functional.

The Kabuku water supply is a pumped system. Water from a spring is pumped 2km up to a reservoir tank; from there, it flows by gravity through a 15-km distribution network to 300 yard and house connections, serving about 1800 people, and three public tap-stands, serving 700 people. The household connections supply over 50 litres per person per day.

Kabuku is a self-help project, completed in 1979. It provided some water for nine years thereafter, before failing in 1988. Later, the group members obtained support from Sida for redesign, rehabilitation, development of management systems and training. By 1993, the project was fully operational.

Kabuku now provides an example of strong financial management. Through metering, effective pricing and collection, the income is reliable. The reliable income enables the system to work well, supplying water for everybody. Its annual income averages US$11,000 and annual operation and maintenance expenditure averages US$9000. This surplus goes towards replacement and extension of infrastructure: for example, it was recently used to enlarge the reservoir tank.

Description and project implementation

The project was designed to provide water for both domestic consumption and for small-scale agricultural production and thus has an important economic role for its consumers. The group members set the contribution that each household is required to make in order to receive the service. They also decide how much water to make available to other people through public tap-stands.

Institutional arrangements and operations

The Kabuku group members own the water supply collectively. Each member has contributed in cash US$50 plus labour as a capital cost. The group is registered as a society and has rules on membership, governance and ownership of assets and how to regulate finance, operation and maintenance.

The members elect a management committee and hold it and the staff accountable through approval of the annual budget. The members set the water tariffs and penalties annually on the basis of projected expenditure for the following year. The staff usually comprise a manager (who is responsible for all the finances and serves as secretary to the committee) and a number of technicians who maintain the pumps, read and service meters, repair leaks and operate the pipe network.

The members, management committee members and staff all receive detailed and extensive training covering management, bylaws, key features of water supplies, finance and accounting, budget preparation and record keeping, staff supervision and operation and maintenance work.

Cost recovery

To improve on management and use of water, each member of Kabuku is fitted with a meter that is regularly serviced, and readings are taken on a monthly basis. Monthly billing, a progressive tariff (typically ranging from US$0.07 to 0.64/m3) and strict enforcement of payment rules have enabled the scheme to maintain high average collection rates over many years. Non-members also pay a set tariff for water from the public tap-stands. This financial discipline, together with each group's authority to set its own tariffs and to set and approve annual budgets, enables income to cover all the operating and maintenance costs.

Sustainability

From the point of view of the group members, this scheme is successful. There is cohesion within the group, they pay their bills and they receive a good service. The groups' financial sustainability is helped by their ability to set their own tariffs. Accurate, clear financial accounts are important to maintain trust among members. Technical sustainability depends on the members maintaining their level of interest from the construction stage through to the operation and maintenance stage. In this project, members have established basic maintenance systems and have agreed on tariffs and mechanisms for collecting water user fees.

Lessons learned

Community management works well in cohesive communities

- Self-help schemes serve a slightly different type of community group as compared with government water programmes. Self-help projects serve the registered and not necessarily everybody living in a particular area.
- Social cohesion is key, enhancing clarity of purpose and a sense of ownership, which in turn improve the sustainability of the system. The cohesion of the community is an important factor in the long-term functioning of these large piped water supplies.
- A well-trained community on all aspects of project management, technical, administrative and financial, will ensure a well-maintained public good. Schemes also need good, reliable workers.
- Sound financial management, including the authority to set tariffs, is vital. In Kenya, the schemes have proportionately more household connections and higher user charges, which the users can afford because the water is used for agriculture as well as domestic consumption. The users also set their own tariffs annually, based on their knowledge of the system's financial position. Provided they are well managed, schemes of this type are more likely to achieve financial sustainability. In addition to tariff setting, this sound financial management is exemplified by the use of metering and sanctions against consumers who do not pay.

Sanitation technologies in urban areas – Kibera slums in Nairobi

Sanitation in informal settlements in Nairobi is very poor, with pit latrines being the most common facilities. Flying toilets, i.e. where polythene and other types of bags are used as faecal containers, mainly at night, then wrapped and thrown anywhere outside the houses or on the roofs, are also a common phenomenon. Tenants without toilets use those of their neighbours at a fee or use the bush, especially along the river. This compromises the security of the women and children, who are susceptible to sexual abuse; the rest of the community is vulnerable to mugging.

To empty the toilets, residents break a hole and dig a drain to rivers, thereby letting continuous sewage out. In other cases, filled toilets are drained using exhausters (if accessible) or are manually emptied into Nairobi Water and Sewerage Company sewer lines, compromising their efficient operation. Poor disposal methods lead to increases in the incidence of waterborne disease, unpleasant odours and threats to the environment.

A few ablution blocks (including water supply, sanitation and hygiene facilities) have been successfully developed in some informal settlements and community management has been introduced, resulting in informal settlers having improved access to WSS at affordable rates.

A report by the Water and Sanitation Programme (1999) illustrates that, of the 2300 pit latrines constructed in Kibera, 1500 (65%) were not in use. The report reveals that, on average, 150 people shared one facility (the optimum is 10-20 persons per unit). Between 50% and 90% of the households do not have access to adequate sanitation. This is not because they cannot afford toilets but because there is a problem of space to construct new toilets or empty pit latrines that get full. The same applies to garbage disposal and drainage infrastructure. Subsequent assessments have not provided sufficient indicators of progressive improvement.

A few toilets and ablution blocks (in Laini Saba, Makina and Mashimoni) are connected to a sewerage facility (the Otiende Trunk Sewer). Pit latrines remain the primary sanitary facility. They also double up as showers. Given this 'sanitation stress', many residents defecate in open spaces near the river and the railway line. Because of insecurity and fear of mugging, the latrines are often not used at night. The open grounds and alleys become (particularly for children) the logical options for disposing of human waste.

Why sanitation?

Provision in informal settlements is a human rights obligation of the government and its agents to its citizens as part of its mandate to ensure that they enjoy a dignified life. The rapid urbanisation process has put undue pressure on governments to provide infrastructure services to meet the needs of a rising population. Provision of improved sanitation services contributes to the following:

- Better health as a result of improved hygiene through better sanitation facilities – studies have shown that a good percentage of infant mortality in informal settlements owes to waterborne and other water-based vector-borne diseases;
- Reduction of poverty as less time is wasted owing to morbidity as a result of waterborne ailments; the saved human hours can be spent in more worthwhile activities. Further, resources that would have been used to meet health care needs can be directed elsewhere to meet other needs and foster economic growth;
- More dignified living for the residents of informal settlements – most residents of informal settlements agree that improved sanitation facilities that are socio-culturally, religiously and technically appropriate for the unique local context can go a long way to ensuring more dignified life, especially for women and children. This is especially insofar as they contribute to the comfort and safety of the users;

- Improved environmental management through ecological sanitation – proper disposal of human waste will go a long way to solving the challenges of environmental degradation and the attendant problems of climate change and unsustainable livelihoods on a global scale. Poor management and disposal of human waste are key contributors to ecosystem imbalances and general environmental decay and deterioration in the quality of life.

Although the government clearly has good policy intentions that will eventually bring positive dividends in the long run, there seems to be some problems with the capacity of the newly formed institutions to address issues of basic services in Kibera.

The Nairobi Water and Sewerage Company, which is the main water service provider, is undergoing institutional restructuring. The rationale has been the strong need to improve operational and financial efficiency of the institution and the parent WSRB. Institutional strengthening aims at supporting improvements in management and maintenance to bring about visible improvements as a means of breaking the cycle of deterioration in service provision.

In response to the unfulfilled demand for water and sanitation services, private small-scale providers have seized a business opportunity and stepped in to fill the gap. Their operations are so extensive, and alternatives so limited, that at the present time they are the primary supply for most people in Kibera. The predominant type of small-scale provider in Kibera is the water kiosk. There are some 650 water kiosks in operation, of which 98% are run by private entrepreneurs and a few are run by community-based organisations or NGOs.

As the Water Act of 2002 clearly envisages a partnership with other stakeholders in service provision, community-based organisations and NGOs have a great role to play, not only in service provision but also in advocating for improved access to information, resolving conflicts, consumer protection and access to potable and affordable water and sanitation services, as some organisations are already doing in Kibera.

Technology choice process – community-based options

In response to the challenges faced in addressing sanitation challenges in informal settlements, development agencies have been leading in piloting various community-led technologies that have continued to improve over time to meet changing scenarios. PAC has taken a leading role in this technology development process. Factors that have informed the development of these technologies include: efficiency; affordability; ability to operate without need for water; ease of operation and maintenance; environmental sensitivity; etc. Sanitation technology has developed over time; ordinary pit latrines gave way to VIP latrines which had improved ventilation and fly control to enhance hygiene.

Methods for technology selection

Below is a description of three of the most used methods applied in technology selection:

1. Decision tree: This has traditionally been used for technology selection. The limitation is the tendency to emphasise technology and economic factors in the selection process and overlook other attendant sustainability factors, such as socio-cultural or institutional issues.

2. Computer models for technology selection, for example the SANEX model, take into some account the sustainability factors not considered by the decision tree approach. Being a computer model, it limits flexibility in the solutions offered, e.g. urine diversion toilets.

3. Integrated sustainable waste management (ISWM) approach, developed by WASTE for sustainable waste management (WASTE, 2004). Separation of solid waste into separate categories for reuse is analogous to the separation of household waste streams for reuse, which makes this method appropriate for use in sanitation. ISWM takes into account other factors such as socio-cultural and institutional issues, which all play a role in determining the sustainability of selected choice factors, rather than considering only technological and economic reasons. It recognises that there is an interrelation between the aspects, elements and stakeholders.

The ISWM model

Selection is done based on already established sustainable planning criteria, which are divided into broad categories that cover the areas addressed by a sanitation system and relate easily to the sustainability aspects of the ISWM approach, namely environmental, economic and technological viability.

1. *Health and environment*

   The objective of sanitation is to protect and promote human health and the quality of the treatment products should be such that harmful emissions to the environment (water, soil and air) are minimised or eliminated. The concept of reuse of treated waste streams should be accommodated. These objectives can be achieved by:

- Waste products should be collected and disposed of in a hygienically safe manner;
- Excreta must not be stored or disposed of so that there is a risk of leachate of nutrients or pathogens into the groundwater or poisoning of soils
- Surface waters (ditches, ponds, rivers, lakes) should be protected from nutrients and organic matter originating from toilets and grey water/wastewater;
- Virtually all nutrients could be recycled to productive uses and so minimise pollution, nitrogen losses within the system, etc.;
- The system (toilet /washing area, etc.) should be constructed so there is minimum water use, high hygienic standards and easy collection and recycling of water.

2. *Economy*

   The capacity to pay for sanitation among users is an important criterion for sustainability. Households should be able willingly to pay the investment and user costs, as well as to carry out minor operation and maintenance. Water consumption is one factor that has a significant impact on system performance.

3. *Socio-culture*

   A good sanitary system must meet basic user requirements concerning affordability, user friendliness, maintenance, reliability, comfort, privacy and status. The system should accommodate existing household habits and routines rather than making daily tasks more demanding. In sanitation, gender aspects can play an important role concerning the allocation of daily tasks. Consideration for people's views about human waste, its handling and disposal can vary greatly. People may be disgusted when seeing excreta in, for example, a toilet, but on the other hand have no objections to using excreta for medical practices when sick (Drangert, 2004).

4. *Technical function*

   The system should allow for management of operational problems without negatively affecting users, property or the environment. Selecting technologies that are robust and that can cope with extreme weather conditions can avoid operational problems. It must not be seen to be too complicated to use but rather to be quick and easy to maintain and able to sanitise waste efficiently and effectively. Additionally, the expertise to run and maintain equipment should be available locally and it should be possible to adapt the technology to varying household sizes. The technology must be easy for children and the elderly to use.

5. *Institutional responsibility*

   Responsibilities of households and authorities should have an institutional and legal framework that supports all aspects of the sanitation process in use.

Bio-centres developed through a community consultation process

First, there was a critical analysis of the existing challenges and opportunities as far as sanitation was concerned. Some of the key issues that arose that were to serve as the guide for the technology selection process included:

- Inadequate and unaffordable water supply that limited the amount of water available for flushing away waste;
- Lack of a sewer system;
- Unplanned settlement layout that is not amenable to laying of sewer networks;
- Insecure land tenure;
- Lack of space for construction of household-based toilets;
- Environmental concerns resulting from release of human waste direct into the river;
- Lack of income-generating activities, etc.

This was then followed by a sharing and participatory analysis of the different technology options that existed either locally or abroad that could be used to meet the sanitation challenges based on the existing opportunities. The typical process was as follows:

1. The facilitating agencies worked with community members to generate some of the options they felt would work in informal settlements. In this process, community consultations played a key role in allowing community members to share their dreams with others as far as water

and sanitation options were concerned. Some community members who had travelled to other parts of the country/world and seen some exciting options shared their experiences.

2. There were also some experts with photographs and images of technology options that have worked elsewhere in the developing world, such as India. These took time to explain exhaustively how each technology worked. Salient issues such as cultural considerations were raised and addressed.

3. Exchange visits to some areas where bio-sanitation had been successfully applied, such as Nakuru, were arranged for community leaders and members, so that they could see for themselves and hear user testimonies from members of other communities.

It is during this process that options such as pit latrines, ablution blocks, VIP toilets and flush toilets, among others, were examined and critically analysed. As a result, bio-sanitation was settled on as one option meeting most of the criteria set after the situational analysis.

Background to bio-centres

Results of most recent studies carried out by the International Hydrology Programme (IHP) of the UN Educational, Scientific and Cultural Organization (UNESCO) funded by GTZ have identified ecological sanitation (ecosan) as the most sustainable way of handling waste. Ecosan is premised on the need to close the loop in the waste management process and thus **turn waste into a resource**. According to what is referred to as the **Bellagio Principles**, it has become clear that, in order to achieve sustainability in the field of wastewater management and sanitation so as to achieve the MDGs, a paradigm shift is required.

The following Bellagio Principles are now widely regarded as the framework within which sanitation issues need to be handled. This is especially the case in people's settlements, where the need for cost effectiveness and sustainability in the long run needs to get more than just a passing glance.

- Human dignity, quality of life and environmental security at the household level should be at the centre of the new approach, which should be responsive and accountable to the needs and demands in the local and national setting. This implies that solutions should be tailored to the full spectrum of socioeconomic, health and environmental concerns; the household and community environment should be protected; and the economic opportunities of waste recovery and use should be harnessed.

- In line with good governance principles, decision making should involve participation of all stakeholders, especially the consumers and providers of the services, which points to the need for decision making at all levels to be based on informed choices; incentives for provision and consumption of services and facilities should be consistent with the overall goal and objective; and rights of consumers and providers should be balanced by responsibilities to the wider human community and environment.

- Waste should be considered as a resource, and its management should be holistic and form part of integrated water resources, nutrient flow and sanitation. This means that inputs should be reduced so as to promote efficiency and water and environmental security; exports of waste should be minimised to promote efficiency and reduce the spread of pollution; and waste water should be recycled and added to the water budget.

- The domain in which environmental sanitation problems are solved should be kept to the minimum practical size (household, community, town, district, catchment and city) and waste diluted as little as possible. This implies that waste should be managed as close as possible to the source; water should be minimally used to transport waste; and additional technologies for waste sanitation and reuse should be developed.

Based on the above principles, which were endorsed by the Water Supply and Sanitation Collaborative Council during its 5th Global Forum in November 2000 in Igram, Brazil, many agencies have developed and continue to successfully implement a number of bio-centres in partnership with communities living in informal areas. Bio-centres are improved ablution blocks that apply the above ecological sanitation principles to ensure that waste is turned into wealth by producing gas through bio-digester systems and producing fertiliser as a by-product.

Bio-centres vary from the ordinary ablution blocks in that:

- They do not utilise water for flushing away faecal waste, thus saving on water compared with a normal ablution block.
- The waste is fed into a bio-digester to produce biogas for cooking and/or lighting.
- The bio-product can be used as a fertiliser, thus generating income and reducing the pressure on sewer lines.
- The bio-centres are more than just toilets, providing other enterprises around the project.

Challenges offered by bio-latrines:

- They are more costly to construct.
- They can only be constructed to serve a sizeable population of around 200 people for them to make economic sense.
- They require more careful construction and post-construction management.
- The need for post-treatment calls for a space of at least 15x15m; this kind of space is not readily available in our crowded informal settlements.
- In areas where there is individual ownership of plots, they may not be easily applicable, e.g. Kisumu and Nakuru.
- Being community toilets, in the strict sense they do not necessarily contribute to the attainment of the MDG in relation to access to sanitation.
- Community asset management challenges face these facilities and, if care is not taken, they may just become white elephants.

Way forward for sanitation

Bio-sanitation is a step in the right direction in the search for sustainable solutions to the challenges of sanitation services provision in informal settlements but it is not an end in itself. There is need for continuous innovation in technology. We need to think about supplying simple portable household toilets that can then be emptied into the bio-centre, thus turning it into a decentralised treatment plant. This would ensure more efficient use of space and also efficient production of gas. Technology options need to be matched with innovative management, business and financing options. Finally, the rallying call here should be for innovation and partnerships for further innovation.

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