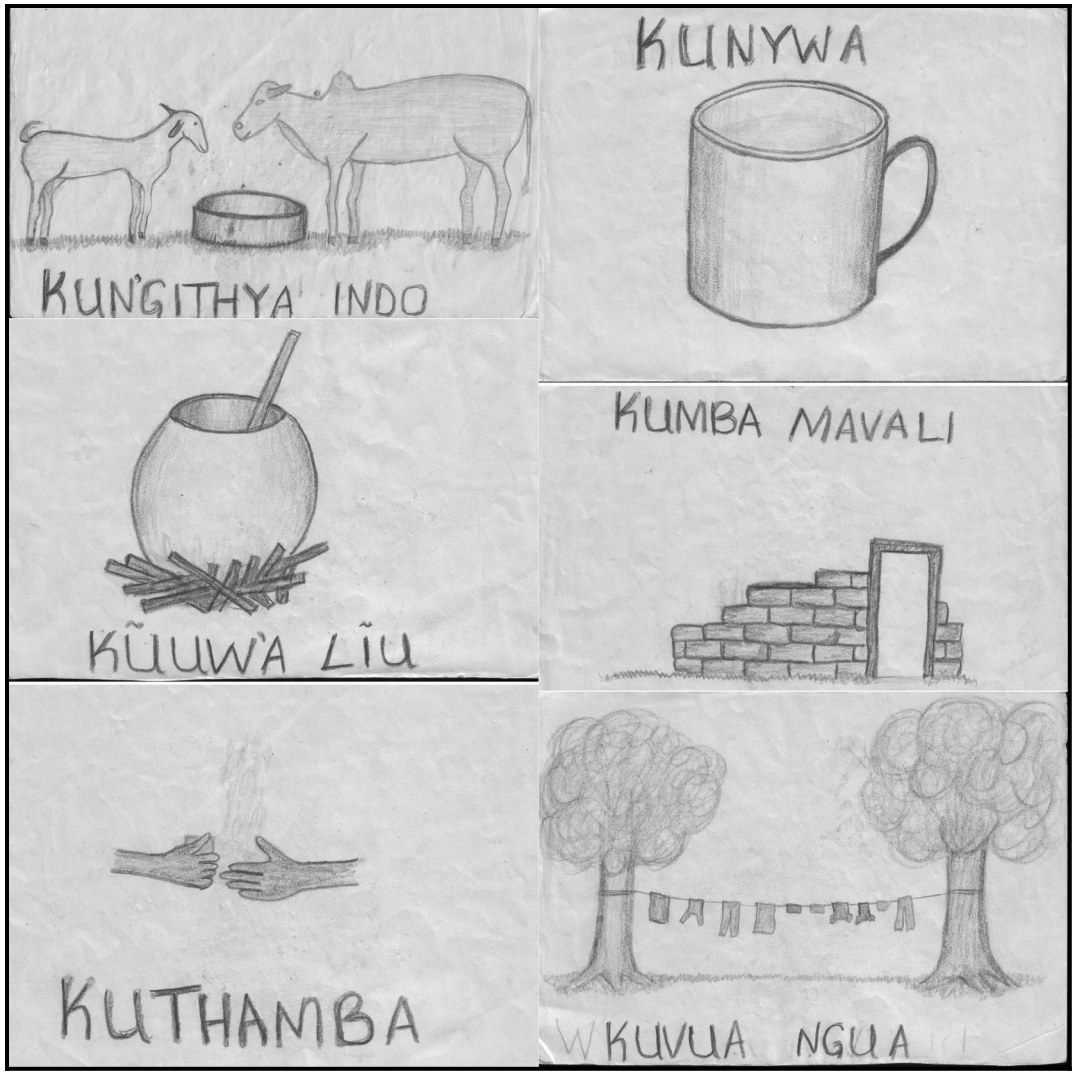
When There Is Water

a research about water use in relation to sand storage dams in Kitui District, Kenya



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Preface

This report is the outcome of a research done by two students from Delft University of Technology as part of their studies, respectively Civil Engineering and System Engineering & Policy Analysis. The research is part of the REAL project and will be used by partners in this project.

Our thanks go out to the members of the Ngunga-Kwoko, Kamunyuni, Katothya, Kyaki, Kwa Munyoki and Kwa Wambua dams for their cooperation, openness and wonderful care for us.
We thank Leonie Postma and Maurits Ertsen for introducing us in the world of sand-dams and MPA and Sam Mutiso from SASOL for making our research possible. Special thanks go out to the SASOL field team in Kebwea sublocation: James, Joseph, Julius, Moses and especially Ancent Kennedy Mumina. Without their help our research could not have been like this. We also thank Bernadette Mwende and Esther Kavinya Paul for the great time, while they were making us able to communicate with the people from Kitui. Last but not least we thank everybody at the AJYTI Nairobi for giving us a home in Kenya and Hessel, Sieger and Willem for their very enjoyable company.

Delft, 17 September, 2020

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Summary

Since 1995 the NGO SASOL has been building sand dams in Kitui district, one of the dryer parts of Kenya. Since one of major functions of these dams is re-hydrating the arid land, the sand-dam projects in Kenya became a part of the REAL project. Within a recently started part of this research project the management and use of dams is evaluated to give recommendations for future design and management of dams. This report is a part of this evaluation. It describes the handling of water from the moment it is drawn from the source until it is used for a certain goal in relation to the different stages of the dams. Goal of the research was to get detailed information on the water use patterns, in order to lead to other interesting aspects in related fields, which could be considered in a design manual for the next projects. The main research question was: “How did the water use patterns of different users change over time and especially as a result of the dam?”
The research was done in six dam-communities in Kitui district. Four of them were sited in the dryer and less dense populated southern part and the dams were still under construction or just finished. The other two dams were sited in Kitui Central and were already fully usable. In each community the dam-committee and two households were observed and interviewed.
Even though the data were the main objective of the research it was possible to give global answers to the research questions. Overall people start using more water when sources are nearer and availability is secured during the year. Extra water that is available due to the dams is mainly used for economic purposes, like irrigation, having cattle and making bricks. Building the dams causes, especially in South, that people have more water during year at places closer to their households. However this is not the case for all households and so some households will benefit less than others will.
The difference between the handling of water in different communities or different households is very small. The actual water use differs more. This is mainly a result of factors like available water sources and population density. Seasonal changes are likely to diminish when a dam is mature though the changes stay bigger in the South than in Central. Social and managerial changes are also causes for changing water use patterns.
In order to increase the total benefits and decrease the total costs of a dam it is time to shift the focus from the actual building of dams to other fields like research and planning. Preliminary investigations, training and guidance are possible steps to achieve this.

Contents

Glossary

Action Aid	Development agency from the UK
Artisan	SASOL employee who works together with the community on construction of a dam
(dam-)community	Group of households, that is involved in one dam.
Committee	Group of people that is bothered with administration and management of (the construction of) a dam
(dam-)member	Person who is allowed to use the water from a dam.
DANIDA	Danish International Development Agency
District	An administrative unit in a Province
Division	An administrative unit in a District
Domestic water use	Water used for drinking, cooking (including cleaning of utensils), bathing and washing
Economic water use	Water used for livestock, agriculture and making bricks
IRC	International Water and Sanitation Centre
Location	An administrative unit in a Division
MPA	Method for Participatory Assessment
NGO	Non-Governmental Organisation
REAL	REhydrating Arid Lands
SASOL	Sahelian Solutions Foundation.
Shamba	Garden
Sub-location	An administrative unit in a location
UNICEF	United Nations Children's Fund
Water use	The handling of water from the moment it is drawn from the source until it is used for a certain goal.

1 Introduction

1.1 Background

Kitui district is located in Kenya's eastern province. Though some higher parts can be relatively wet, this district can be considered as one of the driest parts of Kenya. The rainfall is very irregular through the years and the rain that falls most times runs off very fast. This makes water one of the major problems in this district. The insufficient availability of water has major impact on the daily life of the people and on the development of the area.
One way to conserve the water is building so-called sand-storage dams, also called sand dams. These are artificial barriers in the riverbed that, when they are gradually filled up with sand, can form a big reservoir which can store the water during the dry season in a relatively cheap way. Because the water is stored in the sand bed it can be regarded as groundwater, which can be bacteriological reliable for domestic use if the environment of the dam is used properly.
Since one of major functions of these dams is re-hydrating the arid land, the sand-dam projects in Kenya became a part of the REAL project. In this project several organisations work together. Among others SASOL, a Kenyan NGO founded in 1992, who started constructing the sand dams in 1995 in Kitui Central. After proven to be successful, the project was expanded to the West and the South of the district. One of the major characteristics of the project is the emphasis on participation of the local communities. In this bottom-up approach, SASOL gives communities the opportunity to identify their own problems and work out the solutions within the context of the sand dam project. In this way SASOL is the facilitator in community development and over 350 dams are build by now.
Research about the working of the dams and the impact of the dams on communities is partly done by the Technical University of Delft. IRC, International Water and Sanitation Centre developed one of the used methods for the research and is also a partner of the REAL project.

BOX 1 Local Hospital Kisayani

Kebwea sublocation, Mutomo division

According to a doctor from the hospital illnesses like amoebic dysentery, giardiasis and malaria are very common in this area. Also malnutrition is a major cause of poor health, especially for children and elderly people. To his opinion the major benefits of the dams will be:

- Better nutrition, due to increasing agricultural possibilities and raising incomes.
- Better hygiene in the dry period, due to increased availability of water for domestic use during this season.
- Reduced spreading of contagious diseases, because people are more likely to use just one water source being a dam member. This makes it easier to control diseases, like cholera and typhoid.

A disadvantage of the dams can be the stagnant water in front of the dams during few

1.2 Problem formulation

The initial goal of the dams was to increase the availability of water in the Kitui district for different uses.[1] However water use has many interfaces with other fields like e.g. the environment, social relations, and management. As a result of creating a higher availability of water these fields will also be affected and on their turn affect the possible benefits of the water. In other words 'there's more at stake than just installing sand dams'[2].

It is clear that creating a higher availability of water brings a lot of opportunities and threats. In order to increase the benefits in all fields it is necessary to have a look at the related issues. Which fields might be affected by the use of water and how can they affect the water (use)? Within a recently started research project, REAL, Work Package 2 in particular, the management and use of dams is evaluated to give recommendations for future design and management of dams. For this evaluation intensive fieldwork is crucial and this research covers part of it, namely the use of water on household level and the possibility to benefit from dams for households.

BOX 2 Local History

Kebwea sublocation, Mutomo division

According to some elderly people, more people are living in this area now comparing to the past, due to bigger families and increasing immigration to this part of the district.

History has also shown that the amount of water used per capita increased. Nowadays people wear more clothes that have to be washed and more water is also used for bathing, resulting in better hygiene and health. The change of climate causes less rainfall then in the past, though some elderly people blame it on disbelieve of the youth in rituals related to water. Rivers are flowing only short periods and clearing of the land makes the runoff fast.

All this factors together cause pressure on water sources, which makes projects like building the sand dams needed in this area. Increasing availability of water gives opportunities for new economic activities, like irrigation, making bricks and keeping more cattle. This will improve the living standards.

However, the availability of land can be a limiting factor for these economic

1 SASOL and Maji Na Ufanisi (MNU), 1999, Where there is no water. A story of community water development and sand dams in Kitui district, Kenya.

2 Ertsen M., Land and Water Management DUT. Delft, February 2003. Participation in design, management and construction of water structures. Position paper prepared for the REAL project, deliverable D2.

2 Research plan

2.1 Research objective and research questions

The main objective of this research was *to collect information about water use patterns from source to the actual use for a certain goal*. The different aspects of water use would be studied from the perspective of the water users themselves and had a focus on the differences in use as a result of the dam.
The findings about the water use were to lead to other interesting aspects in related fields like e.g. the environment and management, that could be considered in the design manual which is the intended product of the REAL project.

The main research question was:
I "How did the water use patterns of different users change over time and especially as a result of the dam?"

Which in turn was divided in different questions:
a) Is there a difference between the handling and use of water between different users from various different groups within the community? Why (not)?

b) Is there a difference between the handling and use of water between households from the different communities? Why (not)?

c) Is this pattern a dynamic process in time due to other changes (e.g. dry/wet season, social and/or management changes)? Why (not)?

A second major research question that was investigated was:
II "What are the implications on other fields, e.g. management, environment, need for training, laws, resulting from these patterns?"

2.2 Variables to be studied

Water use can be defined in many ways. In this research *water use* is defined as the handling of water from the moment it is drawn from the source until it is used for a certain goal.

In order to study the water use patterns the different aspects, which constitute and influence a water use pattern, were identified.

Water use patterns:
Different aspects were considered at several moments in time (i.e. dry and wet season, before and after the dam):
- Goals and volumes of the water use.
- The way the water is handled, like the way the user transports it, stores it and handles the water just before use.

Variables influencing the patterns:
Causes and reasons for differences in the patterns can be found in endogenous factors (the personal backgrounds) as well as in exogenous factors. Therefore the following aspects were studied:

- Physical community data about water sources, sanitation, land use and infrastructure.
- Social data like family size and composition, wealth, daily activities, health and access to water sources.
- The system quality, as well the physical facts as the users' opinion.
- Water quality, also the biological and physical features and the users' opinion.
- The present and needed knowledge.
- Environmental context, like erosion and pollution.
- The way of participation on community, household and individual level.
- Institutional context, like the committee and the by-laws.
- Perceptions of the user about the dam like the balance between cost and benefits.

An extended table of these variables can be found in appendix 1.

2.3 Used methods

This paragraph will describe the methods that were used including the reasons why. In the end it is also described how is dealt with strengths and weaknesses of these methods.

2.3.1 MPA influences

The used methods were influenced by the Methodology for Participatory Assessment (MPA). This method has been identified as a tool, which can contribute to a management approach that could result in better-sustained service and mainstreams gender and poverty perspectives[3]. Most of the MPA criteria to ensure quality data collection[4] were ensured. It was tried to mainstream gender and poverty aspects by making sure that all sections (male/female, rich/poor) in the community were able to participate in the research, by collecting disaggregated info per section as much as possible and by using tested indicators. Qualitative and quantitative data were gathered from stakeholders at many different levels and positions. Also information was cross-checked in several ways. Next to these criteria some tools[5,6] from the MPA were used, like the semi-structured interview, transect walk, ladder and 10 seeds. See BOX 3 and paragraph 2.3.3. community and household level.

3 L. Postma and M. Toot, IRC, Delft. 2003. REAL Project, Kenya and Tanzania. Proposal for a research methodology for Work Package 2 (WP2) on Performance.

4 Van Wijk, C. and Postma, L., IRC, Delft. 2003. MPA: A new methodology for participatory monitoring.

5 Bolt E. and Fonseca C., IRC, Delft. 2001.Keep it working. A field manual to support community management of rural water supplies.

6 Wijk-Sijbesma C. van, et al. IRC. Delft. 2003. Update of the original MPA Metguide published in March 2000.

BOX 3 MPA tools

In this box a short explanation is given about the used MPA tools stone scoring , ladder and 10 seeds. For more information see also IRC's publication "Keep it working. A field manual to support community management of rural water supplies".

Stone scoring *on community and household level*
Aim of this tool is getting insight in the division of the total amount of used water between the different purposes before and after the dam was built. The people were asked to mention the different purposes they use water for. Those purposes were portrayed by drawings with subscription. The total amount of used water was resembled by respectively 15 and 25 stones, before and after the dam is built. The people divided those stones between the purposes.

Ladder *on household level*
Aim of this tool is getting insight in the costs and benefits of the project and the priorities of the households. First people were asked to mention all the benefits they experienced personally (or their small children) from the dam. Those benefits were portrayed by drawings with subscription. The people were given some stones and asked to range the benefits by putting most stones on the biggest benefit and few on the smallest benefit. This was repeated for the costs.

10-Seeds *on household level*
Aim of this tool is getting insight in the balance between costs and benefits. The drawings from the mentioned costs and benefits from the ladder were used. All the costs were laid on one pile and all the benefits on another. People were given 10 stones and

Initially the intention was to investigate two communities and in each community two or more households. After arrival in Kitui south it seemed more practicable and interesting to have a look at six communities in three different stages: two dams under construction, two young dams (<1 year) and two mature dams (>4 years). On of the practical reasons was that the definition of community appeared to be very different from our original idea. For the research it was necessary to have a look at the group of members of one dam (hereafter referred to as community), which in turn formed a part of a bigger, official community. Due to this other definition two weeks seemed rather long to be busy with one dam-community. Another difficulty was that people lived very scattered and that parts of our original plan (like community mapping) would be very hard to carry out and not have any added value for the research. Next to all this it would just be more interesting to have a look at more dam-communities and the changes at different stages op the dam projects.
The research of the two mature dams has taken place in Kitui Central, Mulango Location, Kyambiti sub-location. The other four dams were sited in Kitui south, Mutomo Location, Kebwea sub-location. Next to the difference in age of the dams, the latter four are also situated in a dryer part of the district, which is less densely populated.

2.3.3 Three levels

Community level
Information on community level was gathered to assess differences between different communities and get insight into organisational structures. The research started with an introduction by SASOL and/or the headman. The committee interview formed the main way to get information on this level (see appendix 2).
In this interview one special MPA tool was used, in this report referred to as 'stone scoring'. Both women and men separately were asked to divide stones, see also BOX 3.
Information from the interview was cross-checked in several ways. First of all an environmental assessment was carried out by walking up- and downstream from the dam-site and visiting the different water sources together with interested community members. Next to that several semi-structured interviews were carried out if possible, among others with: a doctor, eighteen elderly community members and some SASOL field workers. Of course also the research on the other two levels that are described below gave possibilities to ensure the correctness of data.

Household level
On the first community day arrangements were made to visit two households in the community. It was tried to select two different households on the following criteria: distance to the dam-site, single or double parent and wealth. In Kitui south also a non-participating household was visited. The whole day was spent with the household with special interest for the ones who deal with the water and/or participated in the dam-project. Throughout the day many questions were posed, water was fetched and the daily water use was observed (see appendix 3). If necessary the 'stone scoring'-tool was used again. Also the 'ladder'-tool and '10 Seeds'-tool were used to assess the different cost and benefits of the dam, see BOX 3.

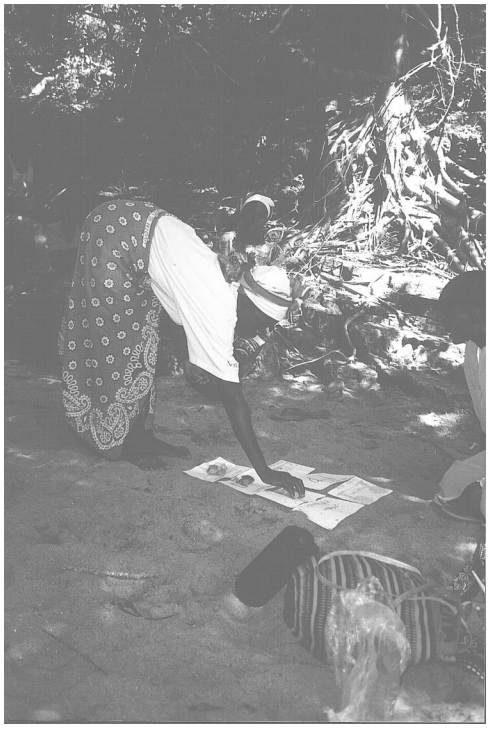
Individual level
To assess personal differences it was tried at the household visits to get information from several different persons. For example: man and wife, mother and daughter in law, one who participated in construction or not, one who is committee member or not.

2.3.4 Weaknesses and strengths

Of course every research method has its weaknesses and strengths. In order to know the right value of the data it is useful to have a look these weaknesses and strengths. Most things mentioned below are inherently linked to social research. During the research those facts were known and treated with care. The expected influence of the strengths and weaknesses is given below.

It might seem a weakness that the sample of data is not very big because this makes it impossible to analyse it statistically. However, this was known from the very beginning of the project and it has always been the objective to gather very detailed data on water use. This could only be gathered from a small sample.
Another fact is that people who are interviewed always relate the research to SASOL. This makes it difficult to make sure that people are very honest about their opinions, even

though they are told that all information will be kept anonymous. On the other hand is this also encouraging people to be open because they expect more benefits from co-operating.
Of course it has some disadvantages to do a research if you don't speak the language of the communities. Though our translators were very good, they were not trained in translating and it is never sure if they pose a question in the same form as it was formulated in English or if they translate everything that people answer. It was tried to avoid such things by making clear to the translators that every word from both sides was very important because the research was aimed at detailed information. Both translators grew up in the area, so it must not be forgotten that they were a great help for the logistics of the research.



Stone scoring

Throughout the research some lacks and obscurities in the way that the MPA tools were used were noticed and as far as possible solved the next time. For example, the stone scoring to assess the division of water had the problem that some water-uses are not 'every day' uses (e.g. washing clothes or making bricks) so it is hard to know the division between daily and non-daily purposes. A weakness of the cost and benefit ladder is the fact that there are many classes of benefits. Growing crops is a benefit of having more water but this can cause better health or more money. More of these difficult interrelations exist but it was tried to have as clear as possible what was the real benefit.
Observing people also has some well-known weaknesses, because people are aware that someone is observing her/him. The same holds for some answers. Both weaknesses were met by cross-checking the data. Sometimes it seemed that people just told us what they thought we wanted to hear, for example on the question if they boiled the water one household answered 'yes' but it was observed that people drank from the normal jerrycan.Another fact that has to be mentioned is the fact that at the households mainly women were interviewed, because most time no men were present. If possible also a man was interviewed. At the interviews it was unavoidable that other people were around. Their influence on the outcomes is unclear.

There were also some circumstances, which have really benefited the project. Us being young women was one of those strengths. Dealing with water is most of the time the woman's task and it was clear that they were very open. Another positive circumstance was that we had to live in the areas for some time. This gave us the opportunity to really see the daily life and speak to many people. It also made us free to spend very much time with the households, which surely contributed to getting reliable information. During

lunch after one committee interview two women and they told that some given answers were not correct. Because of the presence of one man the committee told that their well was not used due to a bad quality of water. The real reason according to the women was that the man refused the access to the well.

3 Data summaries

This chapter will describe the data, which are gathered on the different levels in the six communities in two areas. Wherever differences are significant on one of those levels or between Kitui South and Central the data are presented separately. Also remarkable seasonal changes are presented. If not then the data are a summary of all findings. Most of the raw data i.e. the answers of all interviews and the observations are not included in this report for privacy reasons.
The data are divided in three parts. The first part describes the water use. How much and how is the water used? The second part deals with the variables that are related to water use. The last part describes other findings, which are related to the dam-projects but have no direct relation to the water use.

3.1 Water use

Most of the findings on water use will return in the next paragraph because they are related to the variables discussed there.

3.1.1 Quantity

Of course for the new dams people can only guess how their water use will be so the division of the water after the dam is more like a desired division. Here these desires are treated as the actual use. See appendixes 4 and 5 for stone scoring.
The main uses of water can be divided in domestic use, which is drinking, cooking (including cleaning of utensils), bathing and washing, and other use, which is livestock, agriculture and making bricks. These last three we will call economic uses although most of the time a big part of the products is for own use.

Community level
On this level it is very clear that people start using more water when the dam is finished. This happens from the moment that the dam has stagnant water. Main reason is that they will start or increase the economic uses. In general people start irrigating land, buy (more) livestock and make (more) bricks. In some occasions also the domestic use increases, mainly washing and bathing, because the dam is nearer than the previous water source. In some communities it is clear that when there is more water, new minimising factors occur. For example in the communities in Kitui Central people could not buy more livestock because there is not enough grazing land.

Household level
In general the outcomes on this level are the same as above. However, between households big differences might occur in how they benefit from the dam in quantities of water. Factors like total needed time of individual household to fetch water, wealth (if they have a donkey or not) and health status of the different family members have a big impact on the use of the extra available water. For example in a household of which the man cannot walk well less water is used because the woman is very busy on the shamba taking over her husbands tasks. In other cases the dam just didn't bring more water because the household already had a good water-source nearby. In table 1 are the quantities of used water for domestic purposes per person given. It is clearly that the

difference in used quantities between households is bigger in the South than in Central. The table shows on average people in the South use more water than in Central, 13.7 litres versus 13.3 litres. However, this does not match with the observations. Reason for this is probably that the quantities mentioned in South are the total amounts used per day, while people in Central fetch water whenever they need more (higher frequency), because the sources are nearer, and therefore do not mention these irregular amounts. This idea is supported by the much higher amount of time in South needed to fetch one litre of water compared with Central. Time needed to fetch water not only depends on distance to source, but also on queuing time and condition of the path to the sources.

Table 1; quantity of water for domestic use per person related to stage of dam, time needed to fetch water and availability during the year.

Community	House-hold	Persons (adult, child)	Total quantity [liters per day]	Quantity per person [liters per day]	Frequency of fetching per day	Total time spend, rainy season [hours per day]	Time spend [minutes per litre]	Change quantity in dry season
Dam under construction	I	5, 2	160	22.9	2	2	0.75	half amount
	II	2, 0	40	20	2	45 minutes	1.13	same
	III	3, 7	120	12	1	1	0.5	less
	IV	3, 3	40	6.7	2	1	1.5	same
Young dam (<1 year)	I	3, 3	120	20	6	3	1.5	more
	II	3, 7	50	5	2	3	3.6	less
	III	8, 7	170	11.3	2	1	0.35	less
	IV	4, 6	80	8	1	1	0.75	far less
Non-members	I	5, 4	160	17.8	4	2	0.75	less
Average Kitui South				***13.7***			***1.2***	
Mature dam (>4 years)	I	4, 2	80	13.3	4	40 minutes	0.5	same
	II	3, 3	100	16.7	3	30 minutes	0.3	less
	III	2, 2	60	15	3	30 minutes	0.5	less
	IV	3, 6	80	8.9	4	20 minutes	0.25	same
Average Kitui Central				***13.5***			***0.39***	

Individual level

On individual level the main differences are gender related. Roughly seen women use most of their water for domestic purposes and men for the economic purposes. If the economic uses increase the women also take part in these activities. The only time that men use more water for domestic use than other men is when they are bachelors. Between women differences sometimes occur due to the number of small children. For small children more water is used for washing and bathing.

Seasonal changes

The seasonal changes in water use differ greatly but in all cases the dam shortens the period in which there is not enough water for all purposes or people expect that the dam will shorten it.

In Kitui South in the dry period people use less water for all purposes, sometimes even for drinking, and sometimes they walk very far to get water. Between two communities there were also significant differences even though they only were 5 kilometres from

each other. One had during 5 months not enough water even for drinking. The other only used less water for bathing and washing during 3 months.
In Central people also use less water in the dry period but the sources are nearer and it is easier to find other solutions, like bringing the laundry to the dry-period source if this one is further away. So the seasonal change are smaller than in Kitui South.

BOX 4 Water Sources in Kitui District

This box describes the different water sources that were observed in this research.

Rock rainwater catchment (rock catchment): A rock rainwater catchment is an artificial basin on a high rock, where most of the rainwater that falls on that rock is caught. Several local or international groups built rock catchments in Kitui South. A few months after the last rains most rock catchments are dry.

Roof rainwater catchments (roof catchment): Almost all people with iron roofs catch rain, therefore most and best rainwater catchments can be found in Kitui Central where more people have iron roofs. The quality of the catchment ranges from a bucket under a down bent part of the rusty roof up to well contained roofs with gutter leading the water through a pipe to the closed reservoir with tap.

Springs or subsurface rivers (springs): Some people use sources of which the origin is not clear. They look like springs but could also be subsurface rivers. After this they will all be called springs. Some of the springs have water throughout the year. Two of those were visited on the mountains in Kitui South. Others are dry for some months. Two of the latter ones were found on the shamba of two households.

Surface river water (surface water): A few months per year some rivers in the district have some runoff. In the dryer southern part this period is shorter than in Central. In the years that the dam is filling up with sand there will be stagnant water in front of the dam. Both sorts of river water will be referred to as surface water.

River scoopholes (scoopholes): In all seasonal rivers in the district people dig (= scoop) holes to reach the groundwater level. Sometimes these holes can become very deep, more than 2 metres. Some of the scoopholes are fenced to prevent animals from getting near or to keep them private.

Shallow wells: During this research three types of wells were found in Kitui Central.
Simple well: One household in Kitui Central had dug their own well on their compound. It was just a shaft with brick walls.
Well with windlass: Measures are taken to protect the water quality, like a cover and lid, and en apron to prevent spilt water from leaking back. A windlass is installed to ease the abstraction of the water. No bucket and rope were present at the visited wells.

3.1.2 Handling from source to use

The handling of water from source to use is different from household to household but the differences are very small. There are no particular differences between Kitui South and Central. The source that is used is the main cause for differences.

Sources

The different sources in the district are: rock catchments, roof catchments, springs, surface river water, scoopholes and shallow wells. They are described in more detail in the BOX 4. Some people use different sources for different purposes, for example one can use a rock catchment because it is the nearest source but walk further to get cleaner water for drinking from a another source. Or they us two different scoopholes for watering cattle and fetching water for domestic use. Table 2 shows the purposes of the water fetched from the different sources.

*Table 2***; purposes of the water related to the sources.**

	Drinking	Cooking	Bathing	Washing	Livestock	Crops	Bricks
Rock catchment	x	x	xx	xx			
Roof catchment	xx			x			
Spring	xx	xx	xx	x	x	x	x
Surface water					xx	xx	xx
Scoophole	xx	xx	xx	x	xx		x
Shallow well	xx	xx	xx	xx	x	x	x

xx: used for this purpose by many people
x: used for this purpose by some people

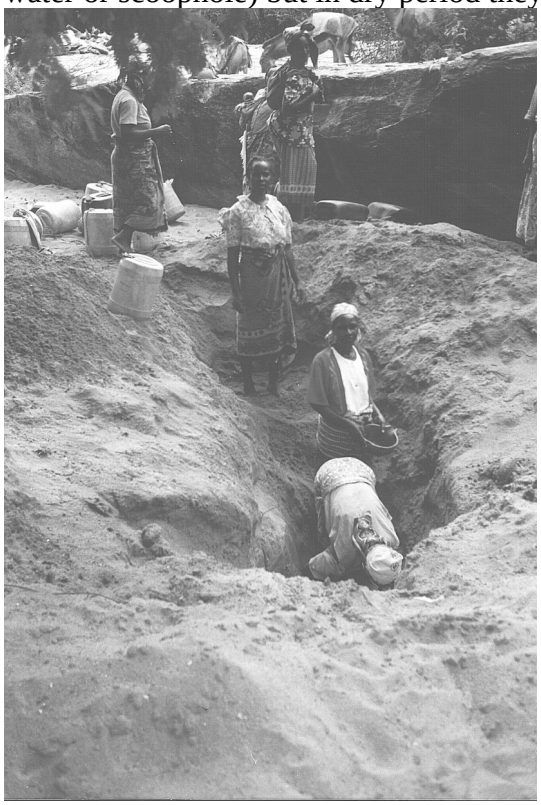
Way of fetching

From sources with surface water (rock catchments, springs and stagnant water) and scoopholes, people scoop the water with a calabash or can. People all bring their own calabash or can. Many times people also drink from this calabash or let the donkey drink from it. Sometimes it is cleaned after drinking from it. Sometimes the calabash is put on their head or the donkeys' head. When using a scoophole everybody scoops out the water that is in the hole at arrival. Some throw this water far from the scoophole, others throw it very near. When a scoophole is very deep often a line of women is formed through which the calabashes are passed from hand to hand.

Fetching water from the wells differs greatly. One well had a pump, which is easily operated. The three SASOL wells that were visited have a windlass on which people could hang their own bucket and rope. However, none of the windlasses is in use. People bring a jerrycan, which is cut open on top. By using their own, often dirty, sisal rope, they lower and lift the jerrycan, just using their arms. From another, self-made well water is fetched with one bucket and stick that is used by all members

Sometimes people don't fetch the water to bring it to their homes but use it near the source. It is not observed how near this is. Many people do this when they wash their clothes in the dry season. Some even bring their utensils to clean them near the source because the source is too far, so transport of water takes too long and is too heavy.. With

livestock it is sometimes the other way; normally they are taken to the source (stagnant water or scoophole) but in dry period they are watered at home



Deep scoophole

Transport

Water is transported in jerrycans (most of 20 litres) either carried by a donkey (two to four jerrycans) or by a woman carrying one jerrycan on her back supported by a strap around the head. The jerrycans are closed with a small lid, piece of wood or with an empty maize cob. To prevent the plug from leaking many women use a piece of plastic between the plug and the can. Most of the time this piece of plastic was just lying somewhere on the ground (between dirt) and not all women washed it before putting it on the jerrycan..

Storage

Most of the time water for domestic use is not stored for a long time (maximal one day). Some people store it longer to let sediment settle down. In the dry period water often is stored for a longer time because it takes longer to fetch water, so people use less water during this period. About half of the households stores water in the same jerrycan as which they fetch water with. Others have different storage cans, most of the times for all domestic uses together. Almost.

all storage cans and buckets are closed. All households clean their jerrycans from inside but there is a great difference in frequency and thoroughness of the cleansing. This difference is very obvious when the jerrycans are observed, some look clean others are covered with fungus. Some women clean the can each time they fetch water, others clean them once in two weeks. Most of them use water, soap and sand and shake the jerrycan. The sand that is used is not always clean and sometimes animal dropping get into the jerrycan. Some also use a brush or a stick with some plastic rope to clean the can from inside.

Water for economic purposes is used directly after fetching.

Treatment before use

From the thirteen households that were visited only four boil their water before drinking. Two of them only boil water from specific sources because they got digestive problems of drinking that water untreated. The other two learned from the school and hospital that boiling water prevents them from getting sick. None of the households boils rainwater. Reasons given for not boiling the water are: it takes too much time, they don't get sick of drinking the water (or don't know it), they have no can to store it and they don't know why they should boil it.

Some people boil water for washing their clothes because the water otherwise is too brown or too salty to make soap.

3.2 Variables in relation to water use

The variables that are described below are all related to water use. Some of them might be the reason for a certain water use pattern. Others on their turn are influenced by the water use. Regardless of the direction of this relation all of these variables are important for how and how much a community or household will benefit from a dam.

3.2.1 Physical community data

These data mainly differ between the South and Central, due to differences in population density. Within a sub-location differences are not very significant.

Water sources See also BOX 4.
In Kitui South people now mainly use rock catchment, springs, scoopholes and the stagnant water behind the new dams. Rainwater catchment from roofs is not very significant. Most sources are used for all purposes. However some households use different sources for different purposes. Main reasons for that are distance and quality of the water. For example, if a source is further away, but has a better quality, this source is only used for drinking.
On community level most people expect that they will use the dam for all purposes once it is mature. On household level this is different. For some people it is rather impossible or inconvenient to use the dam for all purposes, e.g. because the dam is much further than their present source.

Data in this table are from the seven households in Kitui South. The aspects of a source are only presented for households that use the source!

Table 3; distance to dam, accessibility and availability of water per type of source in Kitui South..

SOUTH	**Time to fetch (min-max)** [7]	**Accessibility (physical)**	**Availability of water**
Rock catchments	30 minutes 5 hours	Steep rocky path to climb to the catchments	Some only have water just after the wet season. Others always have water but are very far, thus are only used in dry season when nearer sources are dry.
Springs	45 minutes 1hr 15min	Steep rocky paths	Some are mainly used in dry season when other sources have

7 It is chosen to use time to fetch the water instead of distance to source. Some sources are quite near but the path is so bad that it takes much time. Also the time to fill a jerrycan can differ greatly between the different seasons.

			little water, others are just the nearest source throughout the year.
Stagnant dam water	5 min 2 hours	Small paths or from gravel road through river	After rains.
Scoopholes	30 min 1 hour 30min	Small paths or from gravel road through river	Some only can be used in wet season. Others are used always but discharge can be very low, the queue long and the water level very deep.

In Kitui Central people use all sorts of sources from BOX 4 except rock catchments. However none of the households that were visited had a spring or functioning roof catchment. The amount of rainwater caught was not very significant. Therefore these are not included in the table.
It has to be mentioned that many participants in the visited communities mostly don't use the dam because they have nearer sources.

Table 4; distance to dam, accessibility and availability of water per type of source in Kitui Central.

CENTRAL	**Time to fetch (min-max)[8]**	**Accessibility (physical)**	**Availability of water**
Stagnant dam water	5 min 50 min	Small paths or from gravel road through river	After the rains
Scoopholes *Main river* *Tributary with dam*	 1 - 2 hours 10 min 50 min	 Small paths or from gravel road through river	Main river always has water. Scoopholes in front of dam dry up but for less months than before dam.
Wells *Private* *SASOL* *Pump well*	 5 min 10 min 10 min	 On compound Gravel road or small path Gravel road	 Always 11 months a year Always

Sanitation
In Kitui South only two out of nine visited households had a latrine (under construction). All others defecated in the bushes around their compound. In Kitui Central most compounds lay directly next to each other and all households that were visited had a latrine or were building one. Some were made by NGO's, others made them themselves.

8

Land use
The way land is used differs very much between Kitui Central and South. In South there is much land which is not yet used. Population density in Central is much higher and almost every piece of land is used for agriculture.
Very near to both dams that were visited in Central there were shambas. In South less shambas were found next to a dam. At one dam in Kitui South each dam-member would get a piece of land near the dam, to be able to use the water for irrigation.

Infrastructure
In the rural areas of Kitui district the main roads are gravel, car tracks. Most people reach their houses and water sources via small footpaths. The road network in Kitui South is even less developed. Most people live further from a gravel road than in Central. In Kebwea sublocation there are some high hills that only have narrow rocky paths. None of the visited communities had any other form of infrastructure like electricity, water or communications.

3.2.2 Social data

Composition of household
There were no significant differences between the communities on this social aspect. In both areas size of the household could vary from two persons up to ten (excluding the people who work of study elsewhere). Almost every household consisted of three or four generations.
Circa 25% of the households in the majority of the communities is single-parent according to information from the committee interviews. Reasons are: one of the parents died, works in town, polygamy or divorces.

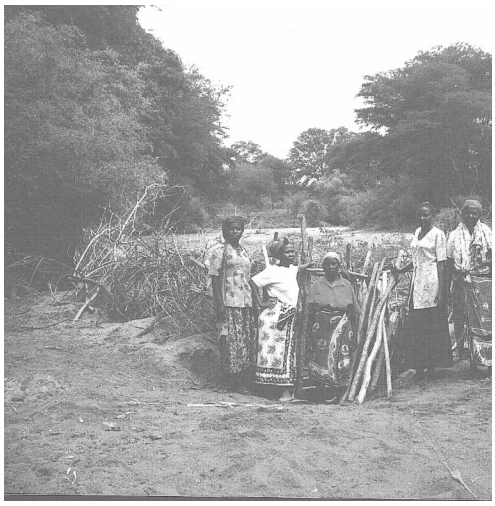
Wealth
Many of the indicators of wealth are the same in both areas of subject. All households mentioned money, many cattle and good houses as indicators but the description of a good house varied between South and Central. In South people are rich if they have a brick house with iron roof and enough space for the children. In Central almost everybody had brick houses and wealth determined the size and quality of the house and if it has windows. Some people in South also mentioned a water tank, car, many children, modern equipment, improved cultivation methods, large piece of land, much food and satisfaction in daily life. People in Central mentioned people who work for them on the shamba as another indicator.
According to these factors differences in wealth between communities in the two areas were visible but conclusions were hard to make. Although it is generally known that the South is less wealthy, the score on the indicators sometimes more seemed a matter of competing factors and priorities, than a very obvious result of wealth. For example in South people in general had more cattle but simpler, mud houses with thatched roof.
In the South five of the nine households described themselves as poor and in Central none of the households described themselves as poor. In both areas none of the households described themselves as rich.
People in the South claimed that there are many poor people in the area. They expect this to change because of the dams. In Central the dams increased wealth for some people

because they could start or increase economic activities like brick making. Others didn't benefit much of the dams because agriculture has never been their major source of income or because they already had another good water source.
Also between households from the same community difference in wealth was visible but not very conclusive. The only clear difference was that richer people, who often have donkeys, have the possibility to fetch more water per day.

Daily activities
In both areas in half of all visited households the husband was a farmer, they worked on the shamba or looked after the cattle. In South the other men most times worked in a big city as casual worker, in Central the men had other jobs in the area like teacher. None of the men dealt with the daily water use. As well in South as in Central most men had some time per day to relax.
All women managed the household and most of them also worked on the shamba. Very few women took care of the cattle, except for milking which is often a women's task. Big difference between the two areas was that in Kitui Central all women said to have some hours to relax because it takes less time to fetch water, while the women in the South claimed being busy from morning until sleep.

Health
A problem with this variable is that some people don't have knowledge about diseases and therefore cannot tell which diseases occur and when.
People in both areas mentioned diseases like bilharzia, amoebic dysentery, giardiasis, typhoid, cholera and malaria. According to the communities in Kitui Central al those diseases are not so common anymore since the dam. It is not clear if this really is a result of the dam.
At the households few people mentioned stomach problems and malaria. Most people considered their family as pretty healthy apart from some not water-related diseases. From observation it was clear that some people have open wounds and especially in the South children have oedematous bellies. In one household all members suffered from tuberculoses.
According to most communities in the South most people are sick in the wet season. In a community in Kitui Central more people are sick in the dry season, probably because in the wet season they drink rainwater.

Access to water sources
The rock catchments that were used by the communities in Kitui South are all for public use. So are the springs in the mountains and most of the scoopholes. Some of those sources have unwritten rules about how to use them. It depends on the enforcement (see 'management') if this influences the accessibility. Some scoopholes are fenced and are only to be used by the people who dug them. Also some springs are for use of one family and their relatives because they are on someone's compound. Only the dam members can use stagnant water and



Fenced scoophole

scoopholes near the young dams in Kitui South. All roof catchments that were seen are private.
Surface river water and scoopholes in Kitui Central are generally for public use. Even the water in scoopholes near a dam and the stagnant water from a dam in many cases are for public use. Probably this is because nobody is bothered with keeping away non-members. Some people have a scoophole on their compound, which is only used by relatives. The wells are also not for public use. The simple well was found on a compound and was only used by relatives. The SASOL wells are only to be used by people who participated in construction. Some families are not allowed to use the well from their dam because they only participated in the dam and not in building the well. The well with pump can only be used by people who participated in building that well. One has to fetch the key from the key-holder.

BOX 5 Social Accessibility

SASOL located a well on the shamba of a participant after considering the accessibility for the rest of the community with the man. Two weeks after the well was finished the man refused the other members to enter his compounds. Talks with the headman didn't solve the problem and the dam was not used for more than two years. The water in the well became dirty as stagnant water.
The community is too scared to take others steps, like informing the chief of the sub-location about it or asking SASOL to intervene. The benefits from this project decreased till almost zero for this community and will be like that till the source is

3.2.3 Physical dam aspects (system quality)

Location
Representatives of the communities and SASOL together chose dam locations. Most dams are located near rocky areas and most people used scoopholes near this places already. In some cases the dams have not very big reservoirs (because of the rocks and/or steep slope of the riverbed) and other observed locations along the river looked more suitable for this reason. For most people it is not clear why a certain location is chosen.

In Kitui South some people live far from the dam location, up to five kilometres, but the majority lives closer to the dam. In one community the majority lived far from the dam and they planned to build a dam closer to their households next year, but SASOL convinced the community to build the biggest dam first for participatory reasons. In Kitui Central most people live near to their dam.
Reasons behind a certain well location were not always clear to the members. One was dug less than one meter from the dam and located higher on the bank than the wing reached, so water could flow away. Another one was located downstream from salt containing rocks, which caused that the water was not used.

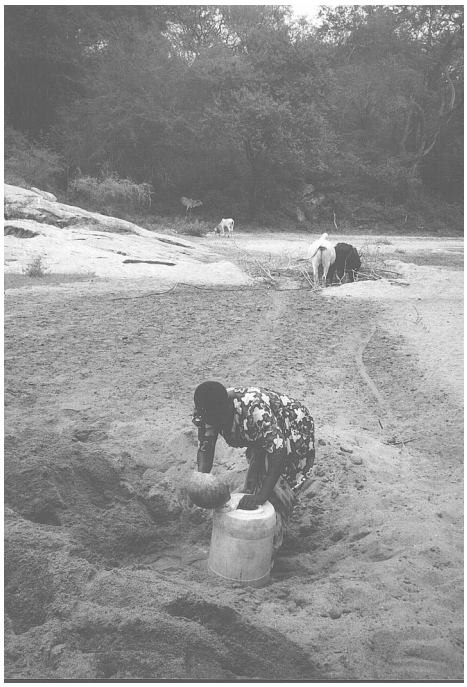
Current state
The dams visited in the South are still under construction or just finished, so the dams are still in good condition. In Central most dams are in good condition, although one of them was leaking. Most stilling basin seem very short and scouring holes are visible behind the dams. Some wings constructed in the bank are too short and without good bank protection, e.g. Napier grass. This could cause problems in the future.
The quality of the sediment in Central was variable. In behind one of the dams the sediment consisted mainly of silt due to erosion of the roads during rains. In others places the upper layer was mainly silt with more coarse sand beneath it. The presence of silt has a negative influence on the storage capacity of the dam and makes the water brownish.
In the South no well is built yet, but those in Central have some physical problems. The lids are too heavy to lift by one person, so the wells are open most of the time. The windlasses are not used at all and one of the aprons and protection walls showed fractures.

Users opinion
Most people in both areas said to be satisfied with the design of the dam and the current state. In Central some people preferred the dam to be higher to store more water.
People were less satisfied with the ease of use of the wells. The heavy lid and the absence of a pump were the main reasons.

3.2.4 Water quality

The quality of rainwater is not discussed because the amount of rainwater used is not significant. Overall people consider this water to be very clean. See also ‘treatment of water before use’.

Biological
According to the amount of organisms all surface waters contain plenty of nutrients. In most cases the answers and observations showed that rock catchments contain a lot of organisms, as well animals like turtles and frogs as smaller organisms like larvae. Especially after storage
this water shows a lot of small organisms. Rock catchments are not protected from wild animals and bird droppings getting to the water.
This last remark also holds for the springs that were observed in Kitui South, the stagnant river water behind the dam and small pools in both areas. All those sources also have lots of insects and algae.



Scoophole with animals near

Also the deeper scoopholes most of the time attract a lot of insects. The majority of the scoopholes doesn't have a fence to protect it from animals getting near. Near almost all unfenced scoopholes animal droppings were found. There were no signs of human excreta.
The private well in Kitui Central was not covered and there were fish in the water. The SASOL wells all have a lid but often this was not closed so that animals (droppings) could get in the water. In the riverbed near the well, as well as near most other dams, animal droppings were found. Only the water from the well with pump was completely screened from direct pollution by animals.

Physical
The water from the rock catchment begins to smell bad some time after the last rain. For the other sources this was not mentioned. The water from most sources looked pretty clear. Only in rainy season water from scoopholes can be more brownish. As well in South as in Central the water from the rivers is often salty. The same holds for the water from wells near the rivers.

Users opinion:
According to most users in Kitui South the water from the rock catchments is of bad quality or at least not as good as from scoopholes. However quality of the water from the rock catchments is better than of the surface water behind the dams. Both springs that were discussed are considered to be very clean. People in the South generally expect the water quality from the dams to be better than their present water source.
In Kitui Central people are not satisfied with the quality of the water in most scoopholes. The same holds for the water from the wells near the dams. The private well and well with pump are considered to be of good quality.

3.2.5 Knowledge

Present knowledge
Community level*:* In both areas one person per community is trained by SASOL as Community Resource Person (CRP). The community appointed those persons and those were trained for one week. They all received a book with the learned information to spread the knowledge through the community, the aim of this method. In Kitui Central those persons are trained a few years ago and received a course to refresh the knowledge, but still it was not spread within the community. One CRP explained that she doesn't have time next to her daily activities to train people. Another one told that it is too hard to organise a meeting with people from the community.
Besides explanation about the working of the dam given by SASOL at the start of each project, all communities in the South appointed a few people to visit mature dams in

Kitui Central to see the benefits. During the construction of the dams the artisans gave training, but the way that they do this differs per artisan. One told people to boil water before drinking and only gave the explanation after people asked for it.
In both areas the division between men and women who received training was almost equal, but this differs between communities. In one community much more men received training.
In the South some people are trained by SASOL and other NGO's operating in the area about resource management, health and sanitation and improving the strength of the community.
In Central in general more people are trained than in the South, mainly in the conservation of soil, building of latrines, agriculture and health and sanitation. Those trainings were given a few years ago by other organisations than SASOL.

Individual level: Even when people received training it was sometimes clear that they didn't understand it all. Spreading of diseases related to water was one of those subjects. Because this lack of understanding some people still don't practice things learned, like boiling water and building latrines.

Needed knowledge
All interviewed people preferred to have more training in general. Almost all respondents mentioned subjects like health and hygiene. In South people also mentioned they need training about water management (division of water between different purposes), agriculture and business to increase the benefits of the dam. In Central the people are interested in more knowledge about the conservation of soil.

3.3 Other information gathered

The data below is not directly related to the water use. Indirect relations do exist and in one way or another they (might) influence the water use. Therefore these data are important to get knowledge about ways to increase benefits from the dams.

3.3.1 Environment

Erosion
In the whole area soils can easily erode due to the type of soil (fine sand/silt) in combination with the dry climate. After the rains most of the roads are heavily mutated, much silt flushes away to the river.
In Kitui South less erosion was seen. Now the banks still have much vegetation and the land is not yet cultivated all over. However, at some sites the banks are very steep and people might start cultivating the land around the dams, which might cause erosion in the future. Very few farmers have terraces on their land.
In Central both damsites were protected with Napier grass but it didn't function properly. One of them had signs of erosion due to heavy run off from the steep bank. At the other dam the Napier grass was absent right next to the dam because the people fetched there the stagnant water for their shamba. This might form a problem when the river has a large discharge. Many farmers have tried to make terraces on their land but many of them still have problems with erosion.

Pollution
In Central some indicators for pollution of the river water were noted. The bigger river contained some domestic refusals and cars were washed on a bridge upstream of many scoopholes.
Near most of the sources there were no signs of washing and bathing, but due to cleaning of jerrycans, clothes or utensils in dry period near some sources some pollution through soap can be expected.

BOX 6 Projects in the past.

In Kitui District other NGO's have been active in the past and are still active.
In Kitui Central Unicef helped individual households build latrines and Danida helped, next to other projects, better off households building their own roof catchment. However, most people have little knowledge about the catchment and many of the catchments are now idle because of a problem.
A rock catchment that was visited in Kebwea sub-location was built in a participatory project by Action Aid in 1980. The taps don't function anymore because he pipes were stolen but the basin is still used. Elderly people explained that they didn't know the working of the taps and the reason why they should use them (to keep the water clean). Although the project used a participatory approach like SASOL does, it was not very successful due to a lack of knowledge.

3.3.2 Participation

Community Level
SASOL choose to work with a participatory approach of the communities. As start of the project they call the community for a meeting through the headman. Explanation about the working of the dam and the costs and benefits are given. In most cases the community elected a committee during this meeting or short after it. In some interviewed communities people ignored this meeting, because they were busy with other things and/or didn't see the importance of the meeting. Some headmen and committees tried to convince those people in a later stage. In one case SASOL only contacted the headman of a village on one side of the river, while on the other side another community lived closed to the proposed dam location. This resulted in only one household of the latest community participating in the construction.
In a second meeting a location for the dam was chosen by walking along the river with representatives of community and specialists from SASOL. However in some communities the representatives did not really represent the community, for example only men chose the location with SASOL. For the communities it was not clear who chose those representatives. Most interviewed people didn't know why a certain location was chosen, but most of them were satisfied with it. In some cases problems arose during construction due to a lack of water near the dam for making cement.
All communities contributed in kind and money. The contribution in kind consisted of labour, tools and food. Labour was mainly digging and collecting stones. It differed per community how many people participated per household. The money was paid for fines (see also by-laws in paragraph 3.3.3) or the living of the artisan. According to one person this can cause stress between the community and the artisan, because it is not a fixed

amount and depends on the wealth of the community. One community also had to pay for the transport of rocks an another community had to hire tools to make an access road to the location of the dam. In only one community it depended on the size of a household how many people had to participate, in all other communities households contribute equally in money and kind. In some cases special arrangements were made, for example for old people who were not able to work.
Except for one, the building of a dam took two to three months. One dam was still under construction when the research was finished, while they were already working for more than four months.
There is no certain period during the year when building of the dams is planned. Most communities start digging soon after the first meeting. Reason mentioned for this is that they fear that SASOL will not come back if they postpone the start. This caused some stress during construction like a high water level in the trench during the rainy season and fewer people who attend work during some periods due to needed work on their shamba. In one community people could not even harvest, because they had to work at the dam site.

Household level
In the South less households participated per dam. A lower population density in this area might be the main reason for this. Here most of the households decided to participate because they know the benefits of the dam and they wanted to increase the economic activities in the area. In Central all households mentioned as most important reason for participating the social part of the project, being a member of the community. Some of them don't use the water of the dam at all but consider it as security for future needs. Ignorance was the most mentioned reason why other households didn't participate. Also laziness and not being involved in the community were mentioned. Most communities tried to convince those households and some of them joined later. A lack of time, due to work on shamba and/or private reasons, was mentioned by some people and also was the main reason for the interviewed non-member household. If the dam was build in another period of the year they would have participated, now they have to save money to pay to become a dam member.

Individual level
The pressure on the household depends partly on the composition of the household and who and how many of them have to contribute. In the South in most cases the pressure was high, especially on the participating women when nobody took over their household duties. Most women woke up earlier to do their duties. One woman mentioned the by-laws were the only reason for her still participating. The pressure on her was very high, because she has no children and her husband is ill. In other cases there were persons (young children, grandmother, and pregnant daughter) who took over some duties but this caused extra pressure for those people. In none of the cases men took over duties from the women. Only when the men participated in building the dam, the pressure on the other household members was less.
Working on the shamba often received less attention during construction of the dams, which sometimes caused stress due to a lack of food. A final cause of pressure was that some communities build more dams directly after each other. Some mentioned as reason that they were afraid that SASOL would not come back if they waited longer with building the next dam.

In some communities people could ask the committee permission to be free of the duty to work for some time.

3.3.3 Management

Committee

Following the guidelines of SASOL most committees consist of circa 13 persons. One of the committees of which the dam was still under construction consisted of two subcommittees of eight persons which represented the two working-shifts. After completion of the dam the total number of persons in the committee would reduce. In all other cases the composition would or had not change(d) if possible. Most committees had more male than female members. This was also the case for the persons who had a special function like chairman, secretary and treasurer. In one case where women were few the given reason for this fact was that the women couldn't leave their households alone on the election day, while their husbands did attend the meeting. In the case where men were few given reasons were that the majority of the community consists of women and that women know more about water. One reason for the lack of women in special functions is that they are too busy.

Table 5; composition of committee and division between male and female.

Committee	Number of persons (m/f)	Male	Female	Women in special functions
A	20 (12/8)	60%	40%	37.5% = 3/8
B	13 (7/6)	54%	46%	0% = 0/3
C	11 (9/2)	82%	18%	0% = 0/3
D	13 (3/10)	23%	77%	80% = 4/5
E	13 (10/3)	77%	23%	50% = 2/4
F	12 (8/4)	67%	33%	25% = ¼

In all cases people were positive about the functioning of the committee although in some cases the committee has very little power to deal with abuse. In the communities with mature dams the committees didn't function any more at this moment. The reason given for this was that there were no problems. However this seemed not the case and arisen problems were not solved. For example nothing is done about the wells build by SASOL that are not used anymore.
In most cases the respondents are satisfied with the representation of the community. Some would have preferred more women and/or younger people in the committee.

By-laws

Most committees make the by-laws following the guidelines of SASOL. Most of the time these by-laws are approved by the dam-communities. Globally all committees use by-laws about the following subjects: way of participating (who, how, when), fines (for not working, for misuse of the dam or of the water) and prices to become a member after completion of the dam (often different prices for residents and immigrants, the latter pay less). One community had the by-law that all participants would get a piece of land for

agriculture near the dam. Another community with a completed dam only had the by-law that non-members were not allowed to use the water of the dam. In most communities serious offenders of the by-laws are taken to the headman.
Money that is collected from the by-laws is used for things like the daily life of the artisan (food and housing), a feast after completion of the dam, reparations on the dam and in one case for seeds for all members.
Most people said to be satisfied with the functioning of the by-laws, although very few signs of enforcement of the laws were seen at the completed dam-sites. Some respondents thought that more by-laws would be necessary. For example about someone who has to look after the dam (a sort of guard), about the protection of the land near the dam or about the interaction between the different dams (in many cases households were member of more than one dam).

BOX 7 By-Laws

By-laws that were specifically mentioned in more than one community are:
- working hours
- prices for non-participants and immigrants to become a member
- fines for bathing or bringing cattle to the dam.
- fines for fighting and misbehave at the construction site
- the fines that members have to pay if they don't work
- non-members are not allowed to use the water, some communities also have fines for non-members who use the dam
- contribution in money for members who stop working but want to stay a member
- how many people per household have to participate

By-laws that were mentioned in only one community (this does not mean that they are not used in more communities):
- destination of the money collected from the by-laws
- members will always stay one society
- all members get a piece of land near dam,
- contribution in money for members who have to work in the city during the

3.3.4 Perception of project

The benefits, costs and balance of those two are an indication for the perception of the project.
Main differences on this subject can be seen between the communities in South and Central. In the first area the benefits of a dam are not yet visible so the benefits that are mentioned are expectations (or desires) of the users. Costs are known in both areas, except for communities that are still building a dam. They don't know all the cots yet.

Stone scoring at a household

related to the dam project. In table 6 the mentioned benefits and costs are presented. In the South two benefits were expected that were not mentioned in Central: time gain and improved health. People expect to spend less time on fetching water. Most people want to use this time to work on their shamba, others want to use it to make charcoal for sale or visit friends. The improved health that is expected would be an effect of cleaner water and better nutrition. Both in the South and in Central people grow more and/or other types of crops, especially fruits, and make (more) bricks for own use as well as for sale. The difference is that in the South most people don't make bricks at all before they have more water. The benefit of having more water throughout the year is related to the months in which people used to not have enough water for all purposes. The dams will make sure that there is always enough water near also in drier years. The benefit of having more water for cattle will result in buying more cattle in the South, while in Central the cattle will just get more water per animal.

During the interview people were asked to mention all the benefits and costs for them

Table 6; Ranking of the costs and benefits

(Remark: this ranking is from a very small sample, South 10 persons, Central 5 persons)

	Kitui South	Kitui Central
Benefits	1. Time gain 2. Growing more/other crops 3. Making (more) bricks 4. Having enough water throughout the year 5. Having more water for cattle 6. Improved health	1. Making more bricks 2. Having more water for cattle 3. Growing more/other crops 4. Having enough water throughout the year
Costs	1. Labour 2. Food 3. Money, Tools (Time)	1. Money 2. Food 3. Labour 4. Tools (Time)

The costs that people experience are much broader than only their money. The costs that were mentioned are the same in the South as in Central. Only the big difference is that most people in South first mentioned their labour on the dam (digging, carrying and cleaning stones, making cement etc.) and people in Kitui Central most mentioned money. The food that is mentioned is food for all members during construction including the SASOL artisan. Some people also brought their own tools. The cost 'time' was considered separately from the time spent on labour. Some people spent time on the

committee or on extra tasks in the household while other members worked at the dam. Because for the latter group time is the only cost time seems an unrealistic high cost and therefore is not included in the ranking.
Almost all households considered the benefits of the dam worth the costs. Most people balanced them 6-4 and some 7-3. One household in central balanced the benefits and costs as 0-10; they didn't use the dam at all because they already had made their own well on their shamba.

BOX 8 Opportunities to Benefit

Increasing the availability of water will benefit households, but it depends on the circumstances of the households how big those benefits will be. In one household all members suffered from tuberculoses and their shamba is about 3 kilometres from the dam. It is very difficult to start for them irrigate crops. Another woman lives on top of a steep hill. She has no children and a sick husband, her participation in a dam will not change these problems so she might not be able to benefit much.
Benefits for those households can be increased by strengthening the co-operation within the communities. One interviewed community planned to give all members a piece of land near the dam to use as shamba. Another uses the money from fines to invest communal interests, like tools and seeds. With informing communities about their own possibilities and giving training to a broad range of people this can be

3.3.5 Desired projects

Community Level
During the interviews several different desired projects were mentioned but on community level many mentioned water closer to their households and shamba's, especially in Kitui South. Two communities, one in Central and the South, mentioned a better quality of the water. For this reason the community in Central prefers to have a lock on the lid of the well so they have control who can use the water. Many communities would prefer a well with pump, for sake of quality and ease of use. In Central communities also desire to have better roads to their water source.
The development of the communities without the help of other organisations differs greatly per community. Some communities are aware of their own opportunities and they invest the money generated by the by-laws in seeds for communal use and they also want to buy communal tools in the future, while others wait for help from outside to buy a pump.

Household Level
In Kitui South not all people could mentioned desired projects, but all who did, mentioned the well that is part of the SASOL project. Also more training projects were mentioned. Other marked desired projects as private tanks for water storage, piped water for irrigation and regular contact with SASOL about the project, also after finishing dam.
In Kitui Central it was clear people desire other kind of projects than in the South. Here people mentioned projects like soil conservation works, latrines and good roads. One man mentioned capital, because due to a lack of this people could not develop themselves.

In both areas more training was mentioned as a future project, only the subjects varied, see paragraph 3.2.5.

4 Findings and Recommendations

4.1 Findings

In this paragraph it is tried to give the answers on the research questions posed in paragraph 2.1, based on the gathered data. The answers on the research question II are very broad and therefore are given as recommendations in the next paragraph.

4.1.1 Main research question I

How did the water use patterns of different users change over time and especially as a result of the dam?

Globally it can be said that water use patterns are continuously changing over time. Partly this is a direct result of the dam but the dam also influences other factors that in turn can change the water use pattern in future (see also next paragraph 4.2). Those factors were also in the past causing changes in those patterns. For example growth of wealth (e.g. buying a donkey or an iron roof to catch water) can change the amount of water used. This wealth can be caused by the higher availability of water due to a dam or can have another cause.

All people use more water when sources are nearer and availability is secured during the whole year. Building the dams causes, especially in the dryer South, that people have more water throughout the year at places closer to their households. In Kitui Central this extra water is mainly used for economic purposes. In the dryer South people can use more water for domestic purposes, even for drinking, which was not always possible in dry periods before the dam. Here people also start using (more) water for economic purposes.

However this is not the case for all households. Some households will change their water use less than others due to other factors that minimise their possibilities to benefit from the dam, like wealth, distance to source and health status of the different family members. On individual level the main differences are gender related. Roughly seen women use most of their water for domestic purposes and men for the economic purposes. This can change due to the dam. If the economic uses increase the women also take part in these activities.

4.1.2 Sub-question a

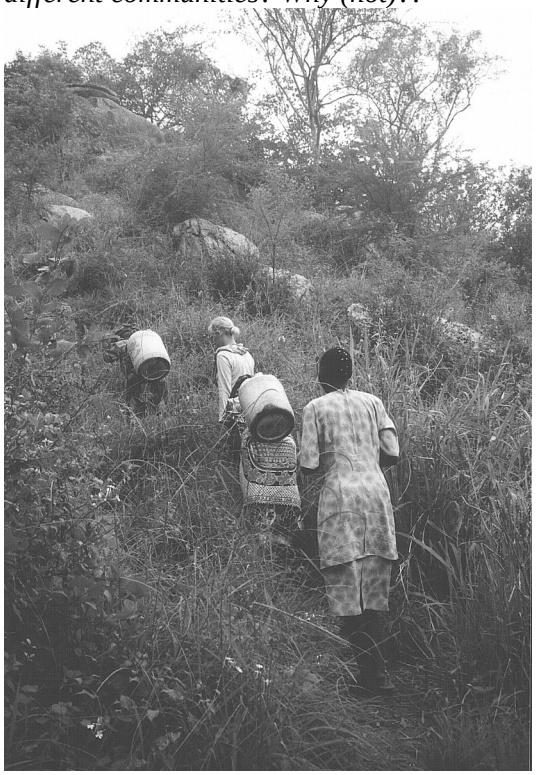
Is there a difference between the handling and use of water between different users from various different groups within the community? Why (not)?

The differences in handling of water between households within a community are very small. It depends on the source used how people fetch the water, not on social group. In all communities mainly women fetch the water. Women from one community most of the time use the same kind of sources. In Central this differs more within the communities due to less public sources. The way of transporting the water differs within the community. It depends on the wealth of the household, namely if they have a donkey. Storage and treatment before use depends mainly on the knowledge of the household and this varies a little within the communities The use of water within the communities varies more. Variations in time needed to fetch water, health, wealth and knowledge are the main causes for the difference in used quantities between households. Also the purposes for which water is used differ. As a result the economic activities which a certain household can develop are determined by those variables. Especially in Kitui South this

difference might increase after the dams are mature. This is due to a bigger difference in opportunities to benefit from the dam. The distances between households and dams varies more, but also is there more difference on social aspects in South compared to Central. As mentioned above women use more water for domestic uses and men more water for the economic uses. Differences in the amount of water between women are influenced by the number of small children they have. Men use more water for domestic purposes when they are bachelor

4.1.3 Sub-question b

Is there a difference between the handling and use of water between households from the different communities? Why (not)?.



Carrying water on a steep slope

The difference in handling of water between communities is small. The existing difference in fetching water is due to a difference in available sources, mainly between the communities in Kitui Central and South. For example, in Central some people fetch water from a well with a pump, while in South people scoop water from a rock rainwater catchment. Transport, storage and treatment don't vary between communities. All communities have people with and without donkey's, only the distance to the sources is longer in the South. In all communities the majority of the people store the water for a short time in the same jerrycan as they fetch it with and almost nobody treats it before use.
The use of water varies greatly between communities in Kitui Central and the South of the district. In Central people use more water for economic purposes and in general also for domestic use, as a result of nearer sources. In Central no household uses less water for drinking in the dry season, while in the South the majority does so.
Also between communities in the South there are some differences, like one community use far less water in the dry season than another community five kilometres upstream. Even though most circumstances seem similar.

4.1.4 Sub-question c

Is this pattern a dynamic process in time due to other changes (e.g. dry/wet season, social and/or management changes)? Why (not)?

The water use showed to be a dynamic process is time. This is especially clear at the different stages of the examined dams. People expect to change their water use pattern after a dam is mature and data collected in Kitui Central showed that it did change after a few years. An increase of water used for economic purposes is the main reason for this change. If the water use will also change this much in Kitui South is uncertain, because a

lot of households still live far from the new water source as a result of the lower population density.
Also the difference in climate during the year causes a dynamic process of the water use patterns. When the dams are mature the availability of water is more reliable during the year and data gathered in Central showed less variation in water use during the year.
Social changes can have a big impact on the patterns of water use. Causes for those changes are less clear and therefore also the time span can differ very much. For example there is a well in Central that people don't use anymore, because they are not allowed to enter the shamba on which the well is build. This change is very sudden but there are also very slow social changes, like that people nowadays have more clothes than in the past.
Management can have impact on the pattern in the future. Information gathered in Central showed that committees don't always function anymore. When problems arise, like physical problems with the dam and/ or well, they are not addressed properly so they are not solved. For example a well that has become salty is just not used anymore instead of solving the problem. Due to a low enforcement of by-laws it might be difficult to protect the environment against contamination through abuse, which on its turn could influence the water use patterns in the future. Those changes take some years to develop.

4.2 Recommendations

4.2.1 Main research question II

What are the implications for other fields, e.g. management, environment, need for training, laws, resulting from these patterns?
The (change in) patterns show that people can benefit from the dams and in most cases the costs are worth it. However for most people these benefits just outweigh the costs of building a dam. To increase the success of the dams this balance has to change: benefits have to increase and costs have to decrease. It must be said that this research focus mainly on the view of the communities on the project and the interpretation of the researchers. However, the time seems right to shift the focus from the actual building of the dam to the other fields than and an integral approach is needed.
Points of attention in these fields are given below. Many of those points are findings from fieldwork, which could be subject of future research. Roughly they can be divided in four categories: overall points of attention, before the start of construction of the dam, during the construction and after completion of the dam.

4.2.2 Overall points of attention

- In all phases of the *project choices* are made that are based on a cost estimate. However in many cases the only costs that are considered seem to be financial costs. As participants mention many other costs than only money, the view on costs has to be broadened. Costs like pressure on people or contribution in food have to be considered at all stages in the project and will probably influence the planning of the project greatly. In the following paragraphs some important moments for this consideration are explained more thorough.
- More attention should be paid to the *opinion of the users*. As the main goal of the whole project is development of the communities it is important to know their experiences, needs and desires. By only knowing more about this SASOL probably easier can solve some problems or anticipate in next projects. For example, the iron

windlasses constructed on the wells in Central are not used at all so those costs can be saved or more costs have to be made to create the desired effect. For example pumps are desired by the communities, because they are easier to operate and secure the quality of the water, which maybe worth the extra costs.

- The collected data showed a big difference in *opportunity to benefit* from the project for individual households. Distance from the household to the dam plays a role in this and also the wealth of the household (having a donkey, having a big piece of land). It is not clear if wealthier households within the communities have more influence on the decision of the location. Research should be done about this so opportunities can be more balanced and avoid a growing gap between rich in poor in the future. Also the possible role of knowledge in benefiting from the extra water might be interesting to be studied.
- More attention should be paid to *the environment around the dam* to increase the sustainability of the dam itself, but also to protect the quality of the water stored by the dam. Due to erosion near the dam which is not properly recognised by the committee problems can occur, like sagging or even collapsing of the dam. Safe water for drinking is still not secured in the district. Although it was not the aim of SASOL to secure safe drinking water the stored water can be used for that purpose if the area around the dam/ well is protected from contamination. Protecting the surrounding of the dam includes looking at which activities, like growing crops and washing clothes and cars, take place close to the dam and regulate them,.
- Due to the *stagnant water* of the dam there is possible an increase of water related diseases (insect vectors). It is recommended to monitor this in order to know this negative effect.

4.2.3 Before the start of construction of the dam

- It might be useful to give more attention to the *first involvement of communities*. When it is possible to involve more households from the start of the project more people can benefit and the costs per household might drop. Reasons for not participating like ignorance or the personal situation of a household might disappear when they are given more attention.
- To avoid to high initial costs the methods to *choose a location* are not always very scientific and there is a certain risk. A result of this is that some dams become to be very expensive in terms of costs for households. Pressure on households can increase very much when the construction is extreme heavy, the building period is much longer than expected etc. In order to determine if thorough research before choosing a location is profitable also these costs for participants have to be considered.
- In many cases the *period in which a dam* is built influences the costs greatly. This is the case for personal costs (e.g. building during harvest time) but also for communal costs (e.g. high water table which makes digging very hard). At this moment there appears to be a misunderstanding between SASOL and the communities about the starting time of the project. SASOL wants to start as soon as possible after the first contact with a community in order to keep the interest of the communities in the project. On the other hand the communities want to start soon because they fear that

SASOL will not come back on a later time. In order have the lowest total costs the best period has to be determined together with the community.

4.2.4 During the construction

- During the construction the artisan gives a small *training* to all members about health and sanitation. Because the artisans most of the time have a very good relation with the dam-members and know the area and its habits, this is a very good way to reach people. However, not every artisan is born to be a good trainer. Therefore it could be useful to educate artisans about ways to give training.
- *Spreading and use of knowledge* within the community is very limited at this moment. Even if people have the knowledge they do no always change their behaviour. For such a change a change in attitude is necessary next to some enabling factors, like time and skills (BASNEF model)[8]. Another approach of training the community and attention for the enabling factors might change this. Hereby it is necessary to reach all sorts of social groups. The data showed a difference in the level of emancipation between communities. Among other factors, the emancipation of a community and/ or a household seems to determine if women were trained and the kind of subjects they receive training in. Policy on how to intervene in communities with a low emancipation level might increase the spreading and use of the knowledge in those communities.
- Some *investments*, like buying good tools or hiring machines, cost money and at this moment it is often chosen to avoid this costs and use other method and/or tools. However sometimes this causes a lot of other costs for the members, which are higher than the avoided options. Therefore also during construction the costs have to be considered with a broad view which sometimes means that extra investments have to be taken by SASOL or communities.

4.2.5 After completion of the dam

- The *sales potential of the area* might form a minimising factor for the way people benefit from the dams. Now some crops are still imported from other areas in Kenya, while local people can not sell the crops that they produce with water from the dam. Something similar holds for bricks; it is not clear for how long there will be sales potential in the area for the single household that makes bricks. Especially in the South this could cause limitations because that part does not have cities or good transport networks. Training people with courses like business and creating co-operations might be solutions to these problems.
- Most communities are not aware of their *own opportunities to develop* their communities instead of depending on the outside world for development. Giving information about future steps, support of initiatives and guidance in administration and management (e.g. suggesting options for spending communal money from fines) could improve this.
- At this moment *enforcement of by-laws after completion* of the dam appears to be very minimal. This causes problems now and might even become a bigger problem in future. For example how rights of usage of the dam will pass on to next generations

[8] Van Wijk, C. and Murre, T., IRC, The Hague. Motivating better hygiene behaviour: Importance for public health mechanisms of change

and how many new people can become a member. One of the reasons for this fact seems to be that the committees are not aware at this moment that their responsibilities and tasks are broader than only keeping an eye on the participation during construction time. Therefore it has to be more clear for committees what they can and have to do after completion of the dam and that their responsibility also encloses the surroundings of the dam, not only the dam itself.

- Communities indicated that they would prefer to have more contact with SASOL after the construction. Therefore it would be useful for both parties that SASOL *comes back to the community* on regular basis. This would also give opportunities to give people extra training because a lot of people don't see the use of training before they actually use the dam and therefore don't attend education in an earlier phase. During those visits SASOL can also collect data about the experiences of the communities.
- It is not clear how the area of *Kitui South* will develop in *future* as a result of the dams. Attention has to be paid to possible developments like immigration and the occurrence of other minimising factors for development than water (e.g. the availability of grazing land for more cattle). When they are recognised early problems due to these sorts of developments can be avoided.

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Appendix 1 Table of variables

Variable	Aspects	Attributes
Water use	Quantity per purpose	Total volume (volume per visit, frequency of visit), division of water between purposes, seasonal changes.
	Handling	Source per purpose, way of drawing the water, transport, storage in house, treatment before use.

Background/ interrelation research data

Variable	Aspects	Attributes
Physical community data	Water sources	Kind, location, physical accessibility of source, availability of water, …
	Sanitation	Kind, location, way of use.
	Land use	Population density, economic activities
	Infrastructure	Roads, electricity etc.
Social data	Composition household	Size, ages, men/ female headed
	Wealth	Housing, Profession, cattle, properties.
	Daily activities	Profession, task equity, during/after construction
	Health	Water related diseases, other diseases, frequency, knowledge about diseases
	Access to water sources	Rights of usage, payments, ownership of sources and access roads.
System quality	Location	Choice, place, …
	Current state	Fractures, erosion, sedimentation quality, … (observation)
	Users opinion	Ease of use, satisfaction
Water quality	Biological	Nutrients, organisms, pollution (dirt, excreta from humans and animals, source protected by fence or lid), …
	Physical	Color, clearness, taste, distinction, temperature.
	Users opinion	Satisfaction, treatment before use…
Knowledge	Present knowledge	Who, subjects, how, spreading
	Needed	Who, subjects, how, spreading
Environment	Erosion (protection)	Vegetation on banks, steepness, soil conservation works, deforestation.
	Pollution (protection)	Erratic dirt, excreta,...
Participation	Community	Start of project, contribution for project, time span, period, problems during construction.
	Household and individual level	Reasons for (not) participating, pressure on household, equity.
Management	Committee	Composition, functioning, acceptance by user group, representation, , …

	By-laws	Which, made by, functioning, …
Perception of water project	Cost and benefits	Availability of water, gain of time, new economic activities, increase of health, costs in money or kind, social changes,…
Desired projects		Wishes, expectations, own possibilities.

Appendix 2 Committee interview

The committee interview starts with an introduction of the researchers and the project.

General outline and questions:

A. *General community data*
   1. Number of households in the community
   2. Number of single parent households in the community
   3. Number of participating households (be keen on changes in this number over time)
   4. Number of committee members and division of functions (male/female)
   5. Did this composition change over time? Will it change in future?

B. *Quantity of water use*

   Each question is asked for the use before (a) and after (b) the dam is/was finished.
   1. Which sources are used in this community?
   2. What is the water used for? Per source.
   3. How is the water divided between the different purposes? MPA method stone scoring
   4. Are there months during the year in which there is not enough water? Which months?
   5. How does the water us change in the dry period?

C. *Quality of the water*

   Each question is asked for the use before (a) and after (b) the dam is finished.
   1. Are you satisfied with the quality of the water? Why (not)? Per source.
   2. Do you treat it before use? Why (not)?
   3. Does the quality change during the year? When are most people ill?

D. *Dam construction and participation*
   1. How was the project started?
   2. What is your opinion of the location?
   3. - Dam under construction: How is the progress in the construction?
      - Dam finished: How did the construction go? What is your opinion on the design and materials used in the dam?
   4. How did participants manage their normal daily activities during the construction period? Was the pressure on households high?
   5. Could you mention reasons why some households (initially) didn't participate? What was done to convince them?

E. *Management and training*
   1. a) Do you have by-laws for the use of the dam and the surroundings? Which?
      b) Are they followed? What happens if not?
      c) Who made the by-laws?
   2. Will more by-laws be necessary in future? Which?
   3. How often does the committee meet?
   4. How was the dam financed?
   5. How did the members contribute? Did they all contribute equally?
   6. Did the community receive training in relation to (the use of) the dam?
   7. Is other or more training necessary?

F. Discussion

1. What is the most important next step to be taken in this project?
2. Are there other things related to water use or the dam that you would like to mention?

The interview is concluded by an explanation of our next research steps and the way that this information will be used.

Appendix 3 Approach on Household Level

Introduction of the project and ourselves.

Part 1: semi-structured interview

This interview was held in the morning to get insight in the household and their opinion about the sand storage dam project.

A. Personal Data

1. Composition of household
2. House sketch
3. Profession and daily activities
4. Livestock
5. Health
6. Wealth indicators and ranking

B. Participation

1. Start of the project
2. Participation
    A. Reasons why they participate in building dam
    B. Possible reasons for non-participants.
3. Member(s) of household which participate
4. Way of participating
5. Pressure on household during construction

C. Dam data

1. Opinion about location
2. Opinion about construction
3. Composition of committee and opinion about that
4. Opinion about By-laws

Part 2: Stone scoring

This part is done with the stone-scoring tool; pictures were made of different water purposes and the people were asked to divide the stones between those pictures to estimate the dividing of the water.

Quantity

1. Total volume water used per day
2. Purposes of water
    a. Division before dam was finished (15 stones)
    b. Division after dam was finished (25 stones)
3. Seasonal changes in the quantity of used water.

Part 3: Observation

In this part how the water is handled was observed and in a semi-structured interview more detailed questions were asked about the sources and quality.

A. Sources

1. Sort(s) of source(s) used by the household
2. Distance/ time spend on fetching water
3. Purpose(s) of water per source(s)
4. Accessibility for other people to source(s)
5. Seasonal changes in used water source(s)
6. Changes in used water source(s) before/after finishing dam

B. Handling of water

1. Way of fetching (observation)
2. Transport (observation)
3. Storage (observation)
4. Treatment before use

C. Quality of the water

1. Opinion of the quality of water per source
2. Indicators of water quality (observation)
3. Frequencies of diseases related to water use.
4. Seasonal changes in the water quality

Part 4: Ladder and Future perspective

In this part the people were asked to rank the cost and benefits with stones and pictures. After that they were asked to compare the costs and benefits and balance them. Also they were asked about their priorities in training and next projects.

A. Cost and Benefits

1. Benefit ladder
2. Cost ladder
3. Balance between cost and benefits

B. Priorities

1. Training.
2. Next projects.

Appendix 4 stone scoring on community level

Committee		%	drinking	cooking	bathing	washing	livestock	crops
Dam under Construction	Women	Before	15	15	40	20	0	0
		After	10	5	10	10	20	25
	Men	Before	20	10	15	20	30	0
		After	5	5	5	15	25	25
II	Women	Before	7	27	27	40	0	0
		After	8	12	12	12	16	24
	Men	Before	13	7	20	13	27	0
		After	4	4	12	8	16	32
Young dam I (<1 year)	Women	Before	13	13	13	13	27	0
		After	12	16	12	12	16	24
	Men	Before	20	0	27	13	27	0
		After	12	0	16	16	20	20
II	Women	Before	13	20	13	33	13	0
		After	12	16	12	16	12	20
	Men	Before	20	13	13	13	27	0
		After	12	12	8	8	12	28
Mature dam I (>4 years)	Women	Before	7	20	20	27	27	0
		After	12	12	12	16	20	24
	Men	Before	13	13	20	33	20	0
		After	4	12	8	12	24	20
II	Women	Before	7	13	13	20	13	20
		After	4	12	8	24	16	20
	Men*	Before	20	0	27	0	40	0
		After	12	0	36	0	40	0

* only one man was presented at the meeting. The total quantity of water he
probably less then the women.

For all communities: Before dam they only have rainfed crops, unless mentioned otherwise.

Appendix 5 stone scoring on household level

Households			%	drinking	cooking	bathing	washing	livestock	crops
Dam under Construction	**I**	Mother	Before	13	13	13	33	27	0
			After	12	4	16	12	12	28
		Daughter in law	Before	13	20	13	33	20	0
			After	4	8	4	20	16	32
	II	Woman	Before	13	20	27	40	0	0
			After	4	12	8	20	12	28
	III	Mother	Before	20	27	13	20	13	0
			After	16	16	16	12	12	24
		Daughter	Before	20	27	13	20	13	0
			After	16	16	16	12	12	24
	IV	Mother	Before	13	20	27	27	13	0
			After	8	12	8	16	16	20
Young dam (<1 year)	**I**	Mother	Before	20	27	13	20	13	0
			After	16	16	16	12	12	24
	II	Mother	Before	13	13	13	27	20	0
			After	12	12	12	16	16	24
	III	Mother	Before	13	20	20	27	13	0
			After	8	16	12	16	12	20
		Daughter in law	Before	13	20	27	40	0	0
			After	4	12	8	20	12	28
Mature dam (>4 years)	**I**	Mother	Before	7	20	20	27	27	0
			After	12	12	12	16	20	24
	II	Mother	Before**						
			After	4	8	12	24	16	16
	III	Mother	Before	13	27	27	33	0	0
			After	8	16	12	24	16	0
	IV	Mother	Before	7	13	13	20	13	20
			After	4	12	8	24	16	20
Non-members		Daughter in law 1	Before	13	20	13	20	33	0
		Daughter in law 2	Before	13	20	13	27	27	0
		Son	Before	7	0	13	7	33	40

* From one household the data were unreliable because the tool could not be explained properly.
** They only use the dam water for making bricks, so the division before the dam was almost the same.