Rainwater Harvesting in Rural Kenya

Reliability in a Variable and Changing Climate

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Examensarbete avancerad nivå
Naturgeografi och kvartärgeologi, 45 hp

Master’s thesis
Physical Geography and Quaternary Geology, 45 HECs
Preface

This Master’s thesis is Nelly Aroka’s degree project in Physical Geography and Quaternary Geology, at the Department of Physical Geography and Quaternary Geology, Stockholm University. The Master’s thesis comprises 45 HECs (one and a half term of full-time studies).

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Stockholm, 01 October 2010

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Rainwater Harvesting in Rural Kenya

Abstract

In many parts of the tropics irregular and erratic rainfall has great national economic as well as socio-economic effects. In Kenya, where a large part of the population live in rural areas and rainfed agriculture is the main livelihood, droughts and floods have far-reaching impacts on communities. One form of mitigating the negative effects of drought is the implementation of simple, small-scale, low cost schemes called rainwater harvesting. This involves the capture, storing and redirection of rainfall, runoff, and groundwater. In Kenya, such schemes are being implemented in rural areas through different actors. Two Non-Governmental Organizations involved are the Kenya Rainwater Association and the German Agro Action that work in Tseikuru, a semi-arid area with water availability and sanitation issues. The main livelihood is agro-pastoralism and there is little experience with rainwater harvesting. Commonly, water is collected by digging shallow holes into dry river beds where groundwater tables are high. These areas are prone to contamination and could be situated many kilometres away, making water collection laborious. By implementing rainwater harvesting schemes water availability as well as water quality is expected to be improved. However, due to great rainfall variability and effects of climate change these schemes may fall short of their expectations. Also the potential change on water demand may affect communities’ response to prolonged dry spells. This study aims to examine whether the implemented rainwater harvesting schemes in rural Tseikuru are reliable in times of adverse rainfall and if increased water availability (and potentially also increased water demand) affects the communities’ vulnerability towards droughts. The study is based on interviews with local stakeholders and technicians during a Minor Field Study in Tseikuru, as well as statistical analysis on rainfall data over the area and literature studies. Results showed that rainwater harvesting schemes are generally successful in supplying readily available and safe water. However the rural population of Tseikuru have not completely abandoned their old habits of collecting water from dry riverbeds, choosing instead to treat the schemes as an alternative source to water, thereby avoiding dependency towards the schemes.
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1. Introduction
Lack of water of adequate quality and quantity is a major constraint to development in many areas of the world. It affects every aspect of human life: health, agricultural yields, food security, technical development, and the economy of states. Water scarcity and water quality problems are of particular concern in the tropical regions of the world where many countries are less developed. In these regions there is often a connection between poor water resources and poverty. Water balances (precipitation – evaporation) are often negative, and climatic oscillations, such as the monsoons and the El Niño Southern Oscillation, have far-reaching climatic, social and national effects (WHO 2010, McGregor and Nieuwolt 1998, Nordström 2000). Pollution of water resources is also common owing to high temperatures causing organic growth in water bodies, and to lack of societal infrastructure such as sanitation, garbage handling, adequate water pipes and treatment plants. A great number of people in the tropics rely on scarce and low-quality water sources, a problem that cascades from individual level to household and national scales and which inhibits development and affects human welfare.

The United Nations recognize the role of water as a key to development. The 7th UN Millennium Development Goal (insuring environmental sustainability) states that by the year 2015 nations must work progressively to halve the number of people without access to safe drinking water and acceptable sanitation (UN 2009a). Furthermore, chapter 18 of Agenda 21 highlights the protection of the quality and supply of freshwater resources for the benefit of the Earths ecosystem as well as human population through the following statement:

“The general objective is to make certain that adequate supplies of water of good quality are maintained for the entire population of this planet, while preserving the hydrological, biological and chemical functions of ecosystems, adapting human activities within the capacity limits of nature and combating vectors of water-related diseases.” (UN 2009b)

Water stressed regions are further threatened by climate change. For Africa there are predictions that climate change is a potential danger to future water and food security (IPCC 2007). However, it is imperative to recognize that the situations in many African countries are neither hopeless nor are they unmanageable.

In Kenya, after decades of implementing soil conservation schemes, the Non-Governmental Organizations (NGO) Kenya Rainwater Association and German Agro Action are among those who are now putting the spotlight on rainwater harvesting and water resource management, i.e. simple, low-cost techniques that involve the capture and storing of rainwater. Different types of rainwater harvesting management systems have been implemented throughout Kenya as a strategy to secure water resources in rural areas (Kenya Rainwater Association 2010). The selling point for rainwater harvesting is that the methods are simple enough to orchestrate and maintain at individual or community level with little training from specialists or technicians.

Many reports have been written on the potential benefits of rainwater harvesting for rural communities (Gould 1995, Mugerwa 2007, Enfors 2009, Relma 2009). But there are few studies describing the detailed effects of the schemes on water availability, demands, and vulnerability in the case of climatic variations – especially in the light of future climate change. Further studies are a vital part of reviewing the findings from
previously conducted water schemes as well as making future rainwater harvesting methods more efficient.

This study has three focuses: firstly, to investigate various rainwater harvesting schemes through observations, literature studies and field studies; secondly, to assess the potential and reliability of the investigated schemes; and thirdly, to document coping strategies of stakeholders during times of water scarcity, before and after the implementation of rainwater harvesting systems.

Within these focuses, the following topics have been documented:

1. Precipitation variations in focus areas in rural Kenya
2. Rainwater harvesting methods in the study areas, and their implementation procedures
3. Differences in yield given by implemented rainwater harvesting methods during dry spells and periods of good rains.
4. Strategies for coping with water scarcity before and after the implementation of rainwater harvesting schemes

To document precipitation variation climatic data was gathered and compiled at the Kenyan Metrological Department. Statistical analysis was then performed on the retrieved information. Rainwater harvesting methods and their implementation were documented through interviews with technicians, administrators and water users, and through field visits. Qualitative estimates on the potential yield from RWH during drier conditions were obtained from studies of the type of implemented installations and climatic and geological conditions at the site. Simplified quantitative yield estimates were obtained through simple modelling of precipitation and physical water capacity of the implemented structures. Coping strategies were explored through on site observation and information gathering in rural areas where interviews with stakeholders’ and well-informed technicians were held.

The study is based on a Minor Field Study conducted in Kenya for a period of two months.
2. Background

2.1 Kenya a climatic overview

Kenya is situated in East Africa at the equator and is consequently influenced by the Inter Tropical Convergence Zone (ITCZ) as well as the El Niño-Southern Oscillation (ENSO) phenomenon (Malesu et al. 2007). The ITCZ is a fluctuating low pressure zone characterised by thunderstorms and heavy rainfall. It is caused by the upward flow of hot air combined with the converging of the trade winds around the equator (Marshak 2005). The converging of winds causes hot air to congregate and condense, thus building clouds (McGregor and Nieuwolt 1998).

ENSO refers to an unusual warming (El Niño) and cooling (La Niña) of the waters of the Pacific Ocean which occurs in association with changes in atmospheric pressure known as the Southern Oscillation. ENSO occurs with a periodicity of approximately 5 years and is associated with seasonal rainfall anomalies in the Tropics, in the form of droughts in some regions and floods in other regions (Malesu et al. 2007).

ITCZ and ENSO affect precipitation in a wide belt in the tropics. The passage of ITCZ results for Kenya in two annual rain periods; one short in October-December and a longer one in the period of March-June. Average annual rainfall is relatively high, but rains are poorly distributed both spatially and temporally leaving some areas of the country experiencing dry spells while other areas have occurrences of floods during the same season. In addition high evaporation due to solar radiation generally leads to a negative water balance over time. This is evident in arid and semi-arid lands where many rivers only carry water during the rain periods (Falkenmark 1988). The effects of ENSO on East Africa include widespread flooding during El Niño events and droughts during La Niña events (Mason et al. 1999, WMO 1999). Figure 1 illustrates the fluctuation of the ITCZ over Africa and the resulting precipitation changes.

Figure 1. ITCZ over Africa, July and January. Source: UNEP (2010a,b)
2.2 Environmental challenges

In 2009 the Long Rains (April-May) were in many parts of Kenya inadequate and erratic. North-eastern as well as south-eastern pastoral and marginal lands received a rainfall amount of between 10-50% of normal conditions and crop failure was widespread (Kenya Red Cross 2010).

Such undependable weather circumstances have negative national economic consequences and extensive socio-economic effects, such as loss of life and livestock, food shortages, and the destruction of infrastructure. These types of events are unfortunately not uncommon for the region. On top of this, Kenya has struggled for decades with issues concerning soil degradation. Part of this has been due to agricultural policy changes after independence in 1963, high population increase rates, increasing use of marginal lands, and substantial soil erosion (Lundgren 1993).

Figure 2 illustrates that not only is there a remarkable range in precipitation (225-2474 mm/year), but rain falls over the country in an unpredictable manner.
2.3 Kenya – a water-stressed nation

Out of Kenya’s population of approximately 38 million, a considerable portion (75%) is living in rural areas where rainfed farming and livestock keeping are the main livelihoods (UI 1999). Moreover, the population is increasing at a rate of 2.6%/year (Worldbank 2010). There is a high level of dependability on the seasonal rains. Kenya is classified as a water scarce country with annual water supplies below 1000 m³/person (UNEP 2002). The situation is predicted to worsen drastically within the near future. In semiarid regions temperatures are projected to increase and precipitation decline by 2030 due to climate change (Malesu et al. 2007). Some figures estimate annual available freshwater at around 250 m³ per capita in 2025 (Malesu et al 2007). This would be detrimental to the development of the affected countries.

2.4 Rainwater harvesting – methods of abating water shortages

Due to variability in rainfall a myriad of rainwater harvesting schemes have sprouted in recent years, both in Kenya and in other water-stressed nations, with the aim to abate drought and water shortages. Rainwater harvesting is simple, low-cost techniques that involve the capture and storing of rainwater and/or groundwater. Such systems have been used all over the world for long time periods and go under different names such as small-scale water system innovations and rainwater catchment systems. However, in this report the term rainwater harvesting will be used.

Rainwater harvesting involves the diversion, collecting, storage, usage, and management of runoff through various schemes and as sustainably as possible, in order for the water to be used for domestic, livestock, irrigation and/or commercial purposes. In practice this would include for example managing water in dams, shielding soils to prevent extensive evaporation, storing rainwater in tanks, or collecting rainwater from roof-tops. Schemes are specialised to fit different locations and target groups and should be used alongside sustainable land management systems such as micro irrigation, agroforestry or simple terraces and trenches to avoid extensive soil erosion and dangerous landslides during flash floods. In figure 3 two types of rainwater harvesting schemes are presented; a roof tank that is sustaining a school with water and a sand dam that retains water upstream.

Rainwater harvesting systems can be classified by the runoff generating process, the size of a catchment and the type of storage. Runoff generating processes are rivers, lakes and rainfall. The storage type could be storage within a soil profile, a tank or a reservoir and the size or scale of the system determines whether it is regarded a micro or macro scheme (Greater Horn of Africa Rainwater Partnership 2010).

The benefits of rainwater harvesting include access to relatively safe, clean water at local points, and sustained water demands in times of precipitation failures. Rainwater harvesting reduces pressure on surface- and groundwater and also contributes to the replenishment of groundwater. In addition it promotes gender equity and female empowerment as it relieves the chore of collecting water from afar for many rural women. Rainwater harvesting can be done in single households or as a joint community venture. The selling point is the systems simplicity in terms of construction, usage and maintenance coupled with a reasonable price (Malesu et al. 2007).
Already during colonial times, soil conservation was practiced in Kenya. After independence, these efforts were generally discontinued, because of the oppressive nature of their implementation. However, since the 1970s and onwards, soil conservation, from the late 1980s in the form of land husbandry, has been on the agenda (Lundgren 1993). Land husbandry includes the sustainable care and management of land to provide valuable output to individuals and society interweaving agro-ecologic and socio-economic principles (Hillel et al 2005). Rainwater harvesting plays part in this, and in fact land husbandry and land management systems in many ways incorporate water management even if this is not always an obvious focus upon implementation. Over the past few decades, rainwater harvesting systems have started to take off as a means of securing one of human beings basic needs; access to good quality water. Through nongovernmental organizations such as the poverty and hunger mitigating German Agro Action and the Kenya Rainwater Association, these systems are reaching out to rural populations with the aim to abate drought and instigate rural development. Kenya Rainwater Association is in addition part of the Greater Horn of Africa Rainwater Partnership (GHARP), a rainwater harvesting promoting umbrella institution with branch-organisations in Uganda, Ethiopia, Somalia and Tanzania.

2.5 Specific rainwater harvesting schemes in rural Kenya

Different types of rainwater harvesting schemes have been implemented in Kenya. Here follows a short description of the more common ones implemented by the Kenya Rainwater Association and German Agro Action:

Subsurface dams/Sand dams with off-take wells

These are rather hefty constructions stretching across the course of a dry riverbed and down towards the impermeable floor of the riverbed. They can either be partly visible in the landscape or totally submerged into the ground, hence the distinction between sand dams and subsurface dams. Location is important, and the best potential riverbeds are those of hilly and stony catchments with coarse sand where water may be easily extracted. Catchments with flat farmland usually have more fine-textured soil, which reduces the yield potential, whereas stony riverbeds have the poorest potential due to extensive seepage through the fractured rocks (Nissen-Petersen 2006). The purpose of these constructions is to raise groundwater tables and increase the storage capacity for water withdrawals.
Roof catchment tanks
These are tanks built in connection to tin-roofed buildings (mainly public buildings such as schools) with rainwater flowing in via gutters. They have a capacity of 50 000 litres when full, and keeps water cool and relatively contaminant-free.

Tanks are one of the most typical means of collecting rainwater and have a long global history (Nissen-Petersen 2007). They come in different shapes and materials, for instance cement, brick, iron sheet, and polyethylene (Figure 4).

Shallow wells
Shallow wells are commonly situated adjacent to a subsurface dams/sand dams or riverbeds with high groundwater tables. Their low depths of a couple of meters allow for manual excavation with a relatively short implementation period. The sides are typically lined with rocks or bricks and the top is concealed but for a simple hand pump which is installed to facilitate water withdrawal and to minimize contamination.

Rock catchments
This system constitutes leading runoff from rock surfaces into a reservoir using walls. The reservoir could be a tank, an earth dam, or a rock catchment dam (Figure 5). A rock surface is good supplier of water due to its impermeability. However, as common with reservoirs some water loss is expected due to evaporation. If properly maintained it is a good alternative to wells in areas with saline groundwater.
2.6 KRA and GAA – implementing rainwater harvesting in rural Kenya

Kenya Rainwater Association (KRA) is a non-governmental, non-profitable, non-partisan association that specializes in rural water managing. It was founded in 1994 with a vision to work for the right of all people to have access to safe and reliable water supply, and a mission to promote Rainwater Harvesting and Management (RHM) systems. It also supports technological approaches to improve water supply, food security and sanitation, in order to reduce poverty through sustainable management of natural resources (Kenya Rainwater Association 2010). The association is made up of a diverse base of multi-disciplinary professionals such as technicians, hydrologists, consultants and private supporting members. Although it is a non-profit organization there is still a small membership fee; however, the bulk of the KRAs financial resources are linked to the rainwater harvesting projects being implemented. These projects are mainly funded through donor aid with some contributions from the recipient community.

The Deutsche Welthungerhilfe/German Agro Action (GAA) was established in 1962 as part of the global Freedom from Hunger campaign, with the view to halt world hunger and poverty. It works with project partners in Asia, Latin America and Africa, and has been active in Kenya since the 1970s (German Agro Action 2010). There are currently 8 projects in Kenya concerning rural development, expansion of water and sanitation services, HIV/AIDS awareness and the endorsement of children and youth. The projects are donor funded and valued at about 9 million Euros (German Agro Action 2010).
KRA and GAA play the role of helping communities to understand their potential to harvest water and gain the benefits from this. Water is a key point in rural development; when a village can secure their water resources through sound management, there is more water for agriculture, livestock and domestic use. KRA have locations in various districts in Kenya, and in some areas works for development alongside GAA and ActNow (an NGO focusing on public health, HIV/AIDS awareness, sanitation and hygiene).

2.7 The road to implementation
The road to implementing a rainwater harvesting scheme is long and requires a multitude of steps. In the beginning an appropriate implementation site/area is investigated. In the case of Mwingi there were true problems with water supply, and poverty levels were high. In other words this was an area where small efforts could have a considerable impact on the rural community. At this point of the process, extensive information gathering of the physical nature of the site (geology, hydrology, vegetation type, etc.) and stakeholder analysis (population, land use etc.) are performed. Proposals are written and funding is sought. The following phase involves the assembling and organization of the local community as well as gaining support from local leaders. Meetings are launched to inform communities on rainwater harvesting and community participation. Also operation and maintenance trainings are held. The mobilization process necessitates the registration of members in a community based organization like structure, in order to increase transparency and accountability. Construction of schemes, such as boreholes, sand dams, and tanks, are performed by local unskilled labor with support from technicians and local artisans. Materials for the structures are mainly supplied by the community in order to strengthen the sense of local ownership. Supervision and further training is conducted throughout the implementation phase as part of the GAA/KRA aims to work closely with stakeholders in all stages.

2.8 Implementation area – Tseikuru, Mwingi districts, introduction
Mwingi district covers an area of approximately 10 000 km², and has a population of around 350 000 (German Agro Action 2006). Agriculture is based mainly on millet and livestock-keeping. Water accessibility is problematic and during dry seasons many are forced to gather water from holes in dry river beds, situated sometimes kilometers away.
from home. This is especially common in the drier eastern and northern divisions of Tseikuru, Ngomeni, Nguni, and Nuu where agro-pastoralism is the common livelihood. Tseikuru is a particularly poor divisions in Mwingi, with prevalent difficulties in terms of access to drinking water and sanitation.

Figure 7. Kenya with Mwingi District. Green represents the area where agriculture is the dominant livelihood. Yellow represents the area where agro-pastoralism is the main livelihood. After German Agro Action (2006) and UN (2010).

In Tseikuru the projects implemented by KRA and its associate organizations involve maintenance of springs, water pipeline extensions, and the constructions of a number of rainwater harvesting schemes, for example subsurface dams, shallow wells, rock catchments, and school roof catchments. In addition sanitary hygiene services such as ventilated improved pit (VIP) latrines are established and sanitation and public health training are carried out. Communities are closely involved with implemented schemes.

2.9 Purpose of research and hypothesis
Rainwater harvesting is being implemented and accepted as a means of combating climate change as well as relieving detrimental effects of dry spells in arid regions of Kenya. The set goal is to supply rural populations with sufficient water of good quality throughout the seasons. However, there are two issues that influence the path to achieving this goal: precipitation irregularity and public water demand in the region. The first issue is climatic and there is little to be done except developing current monitoring systems further in order to make accurate predictions of heavy rains and
droughts and thereafter responding accordingly. Rainfall predictions should be done on institutional levels such as the Kenya Meteorological Department or the Ministry of Water and Irrigation. With appropriate forecasts it is easier to design and implement suitable rainwater harvesting schemes that retains water during dry spells.

The other issue is more complex since it involves the water demand and habits of the rural communities. It is a fair estimate that availability of such an essential natural resource as water would lead to an increase in water demands. Conversely, when people have adjusted to increased water supplies, how do they then respond to climatic variability such as natural droughts? In other words, can increased water availability and a potentially ensuing increase in water demands hamper resilience and create vulnerability towards dry spells?

Although both KRA and GAA have been around for quite some time rainwater harvesting is a relatively new phenomena in rural areas. The activities that are being carried out by GAA and KRA, for example in Tseikuru and Nuu, are younger than 5 years and some schemes are still in the process of implementation. Hence, drawing conclusions as to whether rainwater harvesting is an adequate insurance for rural communities during times of drought is problematic.

Regardless, this paper aims to look into the questions of whether rainwater harvesting is a reliable insurance in times of drought and if it affects the way rural communities deal with drought. This will be done through literature studies, precipitation quantification, yield assessment of implemented rainwater harvesting methods, and research on water demand via a field study in association with the KRA and GAA to Tseikuru, Mwingi district.

3. Methodology

This report is based on literature studies, statistical analysis of precipitation data, and a Minor Field Study in Tseikuru Division, Mwingi District in Kenya. The methods chosen were interdisciplinary from both social and natural sciences, in order to describe rural conditions and the impact of rainwater harvesting systems as holistically as possible within the scope of this paper.

3.1 Interviews

To determine the water situation in terms of demand, use, quality and availability, semi-structured interviews with stakeholders at implementation sites were performed. A questionnaire was also passed to 4 appropriate officials and technicians involved with the implementation of rainwater harvesting systems in Tseikuru. Semi-structured interviews were performed with participants who were beneficiaries of different rainwater harvesting schemes. No household interviews were done in relation to this study since the target groups of the implemented schemes were at community level rather than household level. Time issues further influenced the feasibility of performing household interviews in the sparsely populated low land of Tseikuru. Instead interviews were held at the location of the various constructions.

The target groups were diverse and consisted of six head teachers of primary schools, one assistant chief of the area Kaningo just north of Tseikuru town, one parent group consisting of 62 people, and a total of 34 stakeholders connected to various rainwater harvesting schemes. The most reliable field data was derived from interviews with head teachers and technicians owing to the presence of earlier records at schools and extensive knowledge on water status and water management in the area of Tseikuru.
Results from stakeholder interviews tended to be more subjective and varying. The derived information will give a general overview of present conditions concerning water resources (with implemented rainwater schemes) as well as previous conditions (without rainwater schemes). Future expectations on the schemes reliability will be discussed as a combination of social factors (obtained from interviews) and natural factors (precipitation variability). Interview structures can be found in the appendix.

3.2 Observation
To establish rainwater harvesting yields and capacity, implemented sites were visited in the company of technicians of the NGOs German Agro Action and Kenya Rainwater Association. The technicians held informal in situ lectures on the nature, construction, and potential of the schemes. The observations involved water harvesting techniques such as roof catchment tanks, shallow wells, sand dams, and a rock catchment.

3.3 Statistical analysis
Statistical analysis was performed on acquired rainfall data over two local neighbouring stations with a range of approximately 30 years. Interesting variables were, mean precipitation and over-all variability over a monthly, yearly and decadal period. In graphs and models derived from the data years that included missing data have been omitted, to present a picture that is as accurate as possible.

4. Results
In Tseikuru there are a number of rainwater harvesting projects that have been implemented and some that are currently in the process of being implemented. The GAA and the KRA aim to construct 29 subsurface dams/sand dams with adjacent shallow wells, 6 shallow wells in areas of non-saline groundwater, 1 rock catchment, and 20 school roof catchments in various locations in Tseikuru and the neighbouring semi-arid area of Nuu (German Agro Action 2006). The focus of this study is Tseikuru where all of the aforementioned schemes are represented, however roof catchment tanks are in majority of observed and surveyed schemes, largely because they were locally situated and the reliability of collected data high due to organized earlier records.

4.1 Interview targets
Interviews at implemented rainwater harvesting sites were divided accordingly:

1. Roof catchment tanks; 6 semi-structured interviews with head teachers of the following primary schools: Kathungu primary school, Ikathima primary school, Kakunguu primary school, Kinolu primary school, Nzazeni primary school, and Ithoka primary school.

2. Shallow wells; 1 semi-structured interview with local stakeholders (11 persons) at the site of Kwakaka shallow well and 1 semi-structured interview with the chairman of the shallow well and sand dam group of Kyuluku (sand dam under construction at the time of interview).

3. Sand dam; 1 semi-structured interview with local stakeholder (18 persons) at Unyaleni sand dam site.
4. **Rock catchment;** 1 semi-structured interview with 5 randomly selected stakeholders at the construction site of Kavuvu rock catchment.

5. **Parent group;** 1 open* group interview with parents at Nzanzeni primary school (62 persons).

6. **Officials;** 1 semi-structured interview with the assistant chief of Kaningo area, and 4 structured interviews with technicians from KRA/GAA in the form of a questionnaire.

### 4.2 General findings from interviews

#### Roof catchment tanks

Six primary schools were visited upon for an interview with the head teachers concerning water management at the locations Ikathima, Nzanzeni, Kathungu, Kakunguu, Kinolu and Ithoka. All schools had recently (between 2009 and 2010) had a roof catchment tank of the size 50 m³ installed, with a capacity of 50 000 litres when full. The schools had all previously had other tanks of different materials and capacity, some bought, and some donated through various help organisations. These were all younger than 10 years and in half of the cases the tanks were still being utilized alongside the newer tank as a form of back-up scheme. In situations where the older tanks had been rejected the reason was either that they were of poorer quality, or that the gutters from the roofs could only serve one tank at a time.

Despite being recently implemented, most of the newer tanks had harvested water at the time of interview save the tank at Ikathima primary school which was completed after the short rains of October-December in 2009. Water was primarily being used for drinking but in some schools also for cooking, watering seedlings and hand washing. Before there were any tanks at the schools pupils and parents would provide water which they fetched on a daily or weekly basis. The quality of this water varied and illness amongst pupils were not uncommon. Presently the harvested water is generally regarded to be of good quality, and sufficient for the needs of the schools. Withdrawals are generally loosely monitored and differ at a range of 0.5 litres per pupil/day to 2 litres per pupil/day. This range is a product of factors such as water use, number of enrolled students and high expectations on the tank; the available water was anticipated to be sufficient pending the long rains of March-June 2010. Water use has in most cases increased after the implementation of the tanks (Table 1).

#### Shallow wells

The account of the two shallow wells Kwakaka and Kyuluku presents observable similarities as well as some interesting differences. Both are owned by a community based organization of circa 20 members and supply between 40 and 50 local households with an average of 8 family members with freshwater. Previous to the implementation of the wells, community members (particularly women and children) walked varying distances to collect water which was generally scooped from dry riverbeds, thus facing
Table 1. Findings of the interviews at the primary schools

<table>
<thead>
<tr>
<th></th>
<th>Ikathima</th>
<th>Nzanzeni</th>
<th>Kathungu</th>
<th>Kakunguu</th>
<th>Kinolu</th>
<th>Ithoka</th>
</tr>
</thead>
<tbody>
<tr>
<td>50m³ tank established</td>
<td>2010</td>
<td>2009</td>
<td>2009</td>
<td>2009</td>
<td>2009</td>
<td>2009</td>
</tr>
<tr>
<td>Roof dimensions (m²)</td>
<td>347</td>
<td>318</td>
<td>279</td>
<td>264</td>
<td>250</td>
<td>136</td>
</tr>
<tr>
<td>Water harvested (litres)</td>
<td>Empty*</td>
<td>25 000</td>
<td>25 000</td>
<td>37 500</td>
<td>37 500</td>
<td>10 000**</td>
</tr>
<tr>
<td>Other tanks in use</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Water withdrawal (litres/day)</td>
<td>No water withdrawal</td>
<td>1200</td>
<td>400</td>
<td>100</td>
<td>400</td>
<td>Presently no water withdrawal</td>
</tr>
<tr>
<td>Withdrawal limit (litres/day)</td>
<td>-</td>
<td>No official limit</td>
<td>No official limit</td>
<td>0.5</td>
<td>No official limit</td>
<td>-</td>
</tr>
<tr>
<td>Student enrolment</td>
<td>370</td>
<td>600</td>
<td>260</td>
<td>203</td>
<td>300</td>
<td>280</td>
</tr>
</tbody>
</table>

*Tank was not finished in time to harvest the short rains
** 10 000 litres is past withdrawal point for the 50m³ tank

considerable contamination risks from livestock faeces. However, presently there seems to be a consensus over the reliability of the wells as adequate regardless of annual fluctuations in groundwater tables. Water is considered of good quality (though there were remarks on water salinity at Kwakaka), and furthermore maintenance does not seem to present an issue to the communities. Water is mainly used for domestic purposes such as cooking, washing, and drinking and rarely for irrigation/cultivation or livestock upkeep. In both cases there has been an increase in the consumption of water – in Kwakaka water withdrawal has in some cases increased as much as 4 times compared to prior practices. Kyuluku shallow well has been operating since 1999, and is thereby senior to Kwakaka by 10 years. Even so, recent improvements such as the implementation of a hand pump in 2008, along with the current construction of an adjacent sand dam to raise groundwater levels can be observed at Kyuluku.

The two wells also differ in a few ways; at Kwakaka shallow well water withdrawals are limited to 4 × 20 litres jerry cans per household/day, whereas Kyuluku, despite having no official withdrawal limit, only supports an outtake of 2 × 20 litres jerry cans per household/day. The shallow well community members at Kwakaka have additionally found economic benefits by charging a fee of 5 Kenya shillings (0.06 US dollars) per jerry can for non members. This enhancement was not seen at Kyuluku. Although there were improvements in regards to previous situations and both communities appreciated their wells, a general wish for more water was still prevalent.

Sand dam

Unyaleni sand dam and off-take well has been operating since 2009 and delivers water to approximately 45 households with an average of 6 people. Water withdrawal is ordinarily limited at 4 × 20 litres jerry can per household/day. Water is used for both domestic purposes and for small scale agriculture and livestock watering. Maintenance
is satisfactory. Previously, water was mainly collected at sites of dry riverbeds and was regarded scarce, and contamination by livestock faeces in connection to water sources was common. Today cattle are kept away from the well by circumferential fences and are instead drinking from water troughs implemented in the vicinity. The time spent for collecting water has decreased while the general health of the community is thought to have improved. Water is regarded to be of good quality, and the source is deemed reliable, although there are concerns that water levels may fluctuate due to climatic variation and unpromising rains. As with the shallow wells, more water is desired yet at the same time, water consumption has increased.

Figure 8. Stakeholder interview at Unyaleni sand dam, and donkey carrying jerry cans, woman in background is collecting water from dry river bed in Tseikuru. Photo by N. Aroka (February, 2010)

**Rock catchment**

Kavuvu rock catchment was at the time of interview still in the building process with around 100 people involved with construction labour. The finished structure will have conduits leading to two 150 m³ tanks with a capacity of 150 000 litres when full. These tanks will further be connected to an adjacent water kiosk for local consumption. Five randomly selected workers were chosen for an interview concerning the local water situations in Tseikuru and expectations for the future. It was found that boreholes and dry riverbeds were the common water sources. However, the water retrieved from boreholes was considered salty in some locations. Dry spells were acknowledged as a threat to water security and in general water was deemed a scarce commodity. Water withdrawal in situations of drought was limited to around 1-2 jerry cans of 20 litres per household/day. There were positive expectations on the rock catchment within the group. Anticipated changes were shorter distance to water source, more water of good quality, increased access as well as consumption of water, revenues from selling water at the water kiosk and the development of small scale cultivation. Health progresses and improvements in livestock keeping were also sought.

**Parent group**

At Nzazzeni primary school an open interview with 62 parents was held. Again the purpose was to determine the local water situation and further understand coping mechanisms in times of dry spells in arid/semiarid rural areas such as Tseikuru. Unsurprisingly women were usually responsible for the water supply of their families,
which were commonly large households of between 6 and 12 members. Water withdrawals vary depending on distance to water source, the availability of water and on the access to donkeys for carrying heavy loads. The range of withdrawal could span 2-8 jerry cans of 20 litres per household/day. Regular water sources include dry riverbeds, shallow wells/bore holes and rainwater harvesting roof tanks if the household can afford tanks and have tin roofs. The water quality varies depending on the source, and water from wells and roof tanks is regarded to be of best quality. Interestingly water is not generally used for cultivation (although it occurs in some areas). Instead the use is centralized around livestock keeping and domestic uses. In cases of dry spells women would walk further distances to fetch water, even as far as the Tana River that runs about 10 kilometres north of Tseikuru.

Officials
Four officials associated with the KRA/GAA (2 technical assistants and 2 university lecturers on soil and water management) were given a questionnaire on rainwater harvesting in Tseikuru. The survey discussed the potential of implemented schemes, the challenges and future expectations. Furthermore an interview with the assistant chief of Kaningo (an area in Tseikuru with high birthrates and dry conditions) was carried out on the same topics. To begin with there was an accord over rainwater harvesting as a positive initiative with high potentials in rural livelihoods. It was regarded a practical technology and a cost-effective option for water supply in areas where there are limited alternatives and varying rainfall patterns. Concerns existed over the negative effects that rain scarcity and variability has on yields and reliability of rainwater harvesting schemes. Too little rain would leave schemes unproductive, while too much rain in a short period of time would lead to loss of water. Climate change is thus a worrying factor. When economically feasible an abatement strategy could be to supplementing rainwater harvesting methods with run-off and groundwater harvesting schemes. However this is very costly and would require more contributions from donors. Generally, rainwater harvesting was regarded to be relatively reliable and sustainable.

At present, rainwater harvesting is not very common in rural areas where many live in poverty and mostly use grass for thatching their roofs, instead of roofing with plates of tin. This is the case in Tseikuru. The region was chosen for rainwater harvesting implementation because it was found to be among the most vulnerable areas with serious water shortages problems – a true constraint to development. The implementation challenges have mostly concerned communal mobilizing and creating an understanding and sense of responsibility towards the different schemes. In some cases such difficulties have caused mismanagement of maintenance of implemented structures.

Generally, however, the effects of rainwater harvesting on the communities have been encouraging, as the accessibility to clean and safe water has improved and water quantity has been amplified. There is shorter distance to collect water, which is time and energy preserving, and some small scale farming is sprouting in the region. Livestock production, livelihoods and health have improved. Experience has shown that people are ready to participate in rainwater harvesting and are open minded to new technologies. Community contribution and participation as well as rural capacity building is a key point for project sustainability.
4.3 Statistical analysis results

In order to appreciate the variability of precipitation, data was attained from two stations in Mwingi, namely St. Joseph’s Seminary and Mwingi Agricultural Station. The data have a scope of approximately thirty years, but unfortunately they are not continual. Figures ... and ... give a picture of the large variations of rainfall in the region during the periods of 1961 - 2009. The graphs show that the average yearly variations of rains are high. For example, maximum yearly precipitation for St Josephs Seminary was over 1800 mm, while minimum yearly precipitation was barely over 400 mm during the past 30 years. Observed levels at Mwingi Agricultural Station had a rainfall peak 1300mm while the lowest was 200 mm. Comparing the years 1961 and 1962, the difference in rainfall is as much as 50 %. Even though the two stations follow roughly the same curve, there is little consistency throughout the decades, making changes in rains rather difficult to predict. Even on a monthly basis there are substantial differences throughout the year.

Figure 9. Yearly rainfall for the two stations in 1961 to 2009. Some years have been omitted owing to lack of data. Average yearly precipitation is 806 mm (σ 351) for St. Joseph’s Seminary, and 714 mm (σ 273) for Mwingi Agricultural station.

Figure 10. Average monthly rainfall for the two stations (1961 – 2006). Years without data have not been included in the calculations.
In the case of rainwater harvesting by roof catchment tanks at the primary schools in Tseikuru that was mentioned earlier, the average rainfall during the long rains of March-May (which is about 100 mm) would fill all of the 50 m$^2$ tanks to a maximum despite the varying roof dimensions. However from the period of June-September there would be little or no replenishment and daily withdrawals over 330 litres would lead to the tanks drying out before the short rains of October-December. In this scenario, with the present water withdrawals, at least half of the schools would run the risk of running out of water before the short rains of 2010. As for other schemes it is possible that their capacities would be met also, but depending on water demands and evaporation/filtration they may still dry out during the dry period of June-September.

5. Discussion
The Tseikuru experience shows that despite apparent benefits, implementing rainwater harvesting is not always easy. Rainwater harvesting in different locations may yield entirely dissimilar results, and due to various factors it is not unproblematic to determine which area will meet expectations for rainwater harvesting or not. Some factors that may affect the reliability of rainwater harvesting schemes are listed below.

5.1 The community factor
In Tseikuru a factor manifested itself as a difference in drive and motivation of different communities during construction or after the implementation of a system. This had two consequences: where management and maintenance was unsatisfactory there would be some type of malfunction of a scheme, but where communities cared well for the implemented scheme the opposite situation, i.e. a local success story, would be more likely to occur. One theory could be that previous donor aid investments in the area had lead to somewhat apathetic attitudes where communities expected help in the form of hand outs. This mind-frame could potentially undermine the communities’ sense of ownership and responsibility towards the newer schemes, which in turn would negatively affect the schemes’ ability to yield water.

Another problem related to the community was the difficulty in rallying members for planned schemes. There may be a myriad of reasons for this, ranging from the community having inadequate understanding concerning rainwater harvesting, general lack of interest or more pressing priorities. Women are traditionally expected to be the suppliers of water in Tseikuru and thus typically held the majority as executive members of schemes and as unskilled labour during their implementations. These activities were an addition to regular water fetching duties and had to be budgeted into the every day schedule.

5.2 Precipitation variability
Seasonal rainfall variability has been mentioned previously as a concern to securing yields through the use of rainwater harvesting methods. It is fair to reiterate the problems of unreliable precipitation both spatially and temporally. In Kenya this means that two locations may receive more or less rains than expected and during unexpected time periods. In Tseikuru rains may vary in quantity from one area to another, meaning that some tanks can fill more than others, and, similarly, water tables may raise more in some wells than in others. Here there is a need to consider the capacity of the scheme. The roof dimensions of for example Ithoka Primary School was more than 100m$^2$ smaller than the dimensions of other school roofs. Hence, Ithoka Primary School has
less harvesting potential than all other schools, and the rainwater harvesting scheme implemented there stands greater risk of failure during dry spells. To abate problems caused by natural rainfall variations schemes must be constructed so as to retain water over such lengths of time as to keep communities with a constant supply.

5.3 Water demand increase
Throughout the field study in Tseikuru it was evident that water consumption had increased in response to the extra yields from implemented schemes. No matter what scheme or what target group, from school roof tanks to shallow wells and sand dams with an off-take well, stakeholders confirmed that they were using more water than previously, often more than twice as much. The same scenario has been seen in Botswana, where rainwater harvesting systems have nearly doubled household consumption of water (Gould 1995). The development is not surprising; as a matter of fact it was expected and sought for. More water use would lead to more and better agricultural and livestock productivity, a healthier population and a spark to development. However, where water use is not restricted, and considering the high population growth of Kenya, there may be a risk for future overuse of the systems. In such a case the capacity of a scheme would not be enough to satisfy demand.

An example of a rainwater harvesting scheme that did not quite meet expectations can be found in Makanya in north-eastern Tanzania. The scheme in question is locally called Ndiva and collects run-off water from the Tanzanian highlands into minor dams where water is taken to supplement irrigation for agricultural lands (Enfors 2009). Ndiva did have indirect benefits to local communities, but owing to overuse there was little effect on the coping capacity as drought struck the area (Enfors 2009).

An interesting question in connection to increasing water demand is the effect this may have on communities’ resilience in times of drought. With seasonal rainfall variations being unpredictable, would droughts affect communities in Tseikuru harder when the threshold for water demand has gone up due to more water availability? In light of the short time during which rainwater harvesting has been employed in Tseikuru, it is difficult to answer that question. As yet, few activities related to the increased access to water have been implemented. Should, however, irrigated agriculture increase in importance, which would be a logical adaptation to increased water availability, then crop failures caused by droughts and failing rainwater harvesting schemes, could become a threat to the communities.

Most of the stakeholders that were interviewed were aware of climate change and the risks of escalated unpredictability in regards to rains and droughts in the future. The general response to the apprehension was to go back to the older ways of coping with drought. This included rationing water/decreasing consumption, and looking for water further off. The communities did not seem to be completely dependent on the implemented schemes, but rather regarded them as additions and alternatives to existing water sources. This is in line with other studies of rainwater harvesting (Gould 1995). Many stakeholders wished for additional schemes despite – or maybe because of the improvements that had been witnessed. Generally rainwater harvesting seemed more like an alleviation to drought rather than a cure.

5.4 General findings
Despite the risks, a lot of the benefits that were expected have been seen. Thanks to rainwater harvesting schemes there is more water available closer to communities,
meaning less time and energy spent on gathering water from distant and possibly unsafe water sources. The increased availability of water in schools has resulted in healthier students, and some of the schools visited in Tseikuru had seedlings that were being irrigated as a means of abating soil erosion through afforestation.

Sand dams and subsurface dams with adjacent off-take wells/shallow wells have a good potential for extracting water, as water infiltrates easily through sand and as there is also a cleansing effect when water is filtrated through the sand. As these structures store groundwater, the water resource is also protected against excessive evaporation and the water can be used for long periods without drying up. However, owing to the geology of some areas in Tseikuru, groundwater in some locations is considered salty.

Despite the salinity of the groundwater in some areas shallow wells are not discouraged in Tseikuru. They are appreciated by the neighbouring communities as a reliable water source and natural fluctuations of water tables does not seem to pose a problem. Maintenance appears to work in an exemplary manner, and there is opportunity for the owners of shallow wells to gain revenues from selling water to the public at affordable prices.

Rock catchments are generally quite sizeable structures thus creating large reservoirs. The water is relatively clean and water loss to evaporation is kept at a minimum if a large storage tank is built in connection to the rock catchment. Maintenance is usually unproblematic, but these constructions are rather expensive and unfeasible for communities to engineer without economic and technical assistance. Rock catchments are in general located at some distance away from the homes of the communities using them.

Roof tank catchments give good quality water but are mostly implemented at schools since most households in Tseikuru lack tin roofs. The reliability of the roof tank catchments depend on good rains and on water consumption at the schools. The schools mentioned in this paper generally did not have very strict water withdrawal limitations, which could result in water yields not being enough to satisfy demands from one rainy season to the other. It is therefore important that some sort of regulation is adapted to ensure the schemes sustainability.

Tseikuru is a sparsely populated area that apart from having problems with water supply, poverty and sanitation also lack proper road networks. This obstructs development work since it is difficult to reach stakeholders and transport goods or materials for constructing rainwater harvesting schemes. Improvements in infrastructure are considered to be important to further advance development in Tseikuru. This is in line with previous studies that argue that rainwater harvesting is most effective in rural areas if they are broad based, i.e. promotes indirect benefits such as revenue from selling water, increased agricultural yields etc, and accompanied with investments in infrastructure, markets and institutions (Enfors 2009).

6. Conclusions
This paper has dealt with rainwater harvesting and its impact on rural communities in arid-semiarid regions of Tseikuru, a region of poverty and water scarcity in eastern Kenya. The study has had three main focuses: firstly, to present some of the various rainwater harvesting schemes in Tseikuru through observations, literature studies and
field studies; secondly to assess the potential of the schemes, i.e. the yield in times of
drought, by evaluating the capacity of schemes in relation to precipitation variability;
and thirdly to study the coping strategy of stakeholders during times of water scarcity
before and after the implementation of rainwater harvesting systems. The overall
objective of the paper is to investigate and draw conclusions on the reliability of
rainwater harvesting systems in times of unpredicted climatic variations such as drought
and to assess whether the schemes affects the coping capacity of the communities.

The rainwater harvesting schemes in Tseikuru diverse and include structures such as
Roof catchment tanks, shallow wells, sand dams and rock catchments. These schemes
are increasing water quantity and availability at the implemented sites. In the cases of
the roof catchment tanks, shallow wells and the sand dam the potential of the schemes
have been reached in a satisfactory manner and there is confidence that the same will
apply for the rock catchment of Kavuvu.

In addition, water quality has improved. This has led to an increase in water
consumption and water is used mainly for household purposes, drinking and sustaining
livestock. In Tseikuru water is not commonly used for irrigation in order to enhance
agricultural yields. After the implementation of rainwater harvesting, women and
children travel less far to collect water and have more time for resting, and/or household
chores. Children have more time to focus on their education.

Rains are persistently erratic and variable and may affect the reliability of rainwater
harvesting schemes. Further effects on the reliability of schemes are changes in water
demand and the level of personal investment that the community is prepared to show.
Lack of adequate infrastructure combined with sparse populations hampers
implementation and prolongs the construction stage.

Rainwater harvesting schemes are used alongside traditional water sources and is an
appreciated complement to household water supplies. As of yet the dependency towards
the schemes seem moderate, this is probably because the systems are relatively new.
Coping strategies before the implementation of rainwater harvesting schemes include
travelling farther to fetch water, collecting water of worse quality from dry riverbeds
and consuming less water. The communities would most likely return to these strategies
if the schemes fail to ensure water supplies during a dry spell. Hence it seems rainwater
harvesting does not have a significant effect on the coping strategies of the communities
of Tseikuru during drought. Furthermore, because the schemes are designed to preserve
water over a long period of time (unless water demands increase drastically), there is a
confidence that they will be continually replenished by the seasonal rains. In the light of
the short time during which rainwater harvesting has been an option, it is difficult to
come to a decision on the reliability of rainwater harvesting schemes. However, during
water use conditions that do not greatly exceed current levels, rainwater harvesting
schemes have the potential to buffer droughts and are relatively reliable as long as they
are properly maintained.
Acknowledgements
I would like to Acknowledge and give my sincerest thanks to my supervisors Mr. Lars-Ove Westerberg at the Department of Physical Geography and Quaternary Geology at Stockholm University as well as Dr David Mburu, chairman of Kenya Rainwater Association. Their support and guidance was of great importance to this study.

I would also like to thank the wonderful personnel at German Agro Action and Kenya Rainwater Association in Kenya for their assistance, patience and warmth, and for passing on their knowledge and expertise on rainwater harvesting in Tseikuru.

Thanks also to the Kenya Meteorology Department for providing precipitation data over Mwingi area and the Swedish International Development Agency (SIDA) for financing the field study.

Finally I would like to thank Åke Rydell for many insightful coffee breaks and my greatest inspiration, my mother Susan Aroka and family.
Appendix

Interview formula for rainwater harvesting technicians/officials at KRA and GAA

Background
- Could you tell me something about your professional background?
  
  Previous positions and education
  Current position and length of time that position has been held
  Any professional interests (example: development work, resource management, or other)

- How were you introduced to the concepts of Rainwater Harvesting?
- What are your general thoughts on Rainwater Harvesting in rural arid/semiarid regions?
- How did you come in contact with the KRA/GAA?

Rainwater harvesting methods in Tseikuru
- Could you tell me about the kinds of methods that are implemented in Tseikuru, Mwingi District?
- What are the strengths/drawbacks of the implemented methods?
- Are the implemented methods affected by seasonal variations in precipitation?
- Do you perceive the implemented methods in Tseikuru as sustainable/reliable in times of seasonal variations?
- Do you believe that climate change might affect the sustainability/reliability of the implemented methods in Tseikuru?

Implementation process of rainwater harvesting methods in Tseikuru
- How/why was Tseikuru chosen as a region to implement rainwater harvesting methods?
- Were there any criteria for the local actors to meet?
- For how long have the KRA/GAA been active in Tseikuru?
- What role do the local actors have in the implementation process?
- Could you tell me about the funding of the implemented rainwater harvesting methods?

Findings and general experiences in promoting Rainwater Harvesting in Tseikuru
- What effects were anticipated in implementing rainwater harvesting methods in Tseikuru?
- What effects has the implemented rainwater harvesting methods had in Tseikuru?
- What are the anticipated long-term effects of implementing rainwater harvesting methods in Tseikuru?
- Were there any challenges involved in the implementing of rainwater harvesting methods in Tseikuru?
- What have you learned in working with rainwater harvesting in Tseikuru?
Interview formula for local stakeholders in Tseikuru

**Background**
- How many people live in your local area?
- How big is your household? – is this a general average in your local area?
- How was the water situation in your local area before you had RWH methods implemented?
  - Where was water collected?
  - Who collected the water?
  - How much water was collected?
  - What was the general quality of the water?
- What did you know about RWH before it was implemented in your local area?
- How did the local area decide to implement RWH?
- Could you tell me about how your local area came in contact with KRA?
- Were there any costs connected to the RWH method?
- Could you tell me how the maintenance of the RWH scheme works?

**Water quality and quantity before and after**
- For how long have you used this RWH method?
- How much water are you generally collecting in a day/week?
- What happens to the yield when there are seasonal variations in precipitation? – If yields go down how do you react to the change in yield?
- What is this water used for?
- Is the water of good quality?
- Do you feel as though you have more water available now than before the RWH method was implemented?
- Do you feel as though your household is using more water now than before the RWH method was implemented? – If yes, could you estimate how much more water is used every day than before?

**Changes?**
- Have your water routines changed since the implementation of the RWH method?
- Have other households changed their water routines?
- Has life changed in anyway after implementing the RWH methods?
  - Are people healthier?
  - Is there any change in harvest yields?
  - Could you tell me something else that I have not asked for?
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Compilation of interviews conducted with local stakeholders in Tseikuru, 16th – 25th February 2010.

Kathungu primary school, Tseikuru division
Interview with Mr. Nyaa, head teacher
15th February 2010

Background
Implemented scheme: 1 * 50m³ roof catchment tank
Roof dimension: 279 m²
Implemented by: German Agro Action
Capacity: 50 000 liters
Operating since: 2009
Water harvested: At the time of interview the tank was said to be 1/2 full
Water expectancy: ongoing
Water withdrawal: circa 400 liters/day
Enrollment: 260 students + teachers and preschool children
Water use: drinking, cooking, watering seedlings, sometimes for washing
Maintenance: missing key to faucet restricts withdrawal, missing tap

Previous scheme
Implemented scheme: 2 * 10 000 liters plastic tank
Implemented by: World Vision
Operating since: 2006
Current operating status: out of use

Previous water situation
No water at school
Pupils/parents carried water from far (up to 10 Km)
Water source unknown

Changes
Available drinking water for pupils
Student stopped carrying water from far
Water for seedling; anti-desertification

General findings
Roof tank is regarded to be reliable
Water quantity and quality is regarded to be good/reliable
Water use is relatively unmonitored
Maintenance is insufficient
Would like another tank
Kakunguu primary school, Musavani location, Tseikuru division
Interview with Mr. Musgimi, head teacher
16th February 2010

Background
Implemented scheme: 1 * 50m³ roof tank
Roof dimension: 264m²
Implemented by: German Agro Action
Capacity: 50 000 liters
Operating since: 2009
Water harvested: At the time of interview the tank was said to be 3/4 full
Water expectancy: ongoing
Water withdrawal: circa 100 liters/day
Limit: 0.5 liters per student per day
Enrollment: 203 students
Water use: drinking, cooking, watering plants
Maintenance: okay

Previous scheme
Implemented scheme: 1 * 10 000 liters plastic tank
Implemented by: World Vision
Operating since: 2008-2009
Current operating status: out of use, leaking

Previous water situation
No water at school
Pupils/parents carried water from far (3-4 Km)
Water source unknown

Changes
Available drinking water for pupils
Comfort
“Improved life”
Improved performance at school

General findings
Water is enough for drinking
Water is not enough for other uses
Would like another tank
Water is regarded reliable
Water is regarded to be of good quality
Water use has increased
Rainwater Harvesting in Rural Kenya

Kwakaka Shallow Well, Musavani location, Tseikuru division
Interview with stakeholders at Siweta primary school, 11 Shallow Well members, mainly women
16th February 2010

Background
Implemented scheme: 1 * Shallow Well
Implemented by: German Agro Action
Labor: 25 Shallow Well members
Capacity: unknown
Operating since: 2009
Water harvested: unknown
Water expectancy: ongoing
Water withdrawal: 4 * 20 liters jerry-cans per household = 80 liters per household
Beneficiaries: 40 households with an average of 8 people
Water withdrawal total: 80 liters per household * 40 households = 3200 liters daily
Limit of 4 jerry-cans per household
Water use: cooking, washing, drinking
Maintenance: okay

Previous scheme
No previous scheme

Previous water situation
Water was collected at dry riverbed (Karumu river), approx. 5 Km away from location
Water collected was about 1 jerry-can per household/day
Water was unsafe/contamination risk was high

Changes
Revenue from shallow well 5 Ksh per jerry-can used by non members
Time used for collecting water by children and women has decreased
Water available closer to stakeholders – effect: more water collected

General findings
Water quality is good, however regarded salty
Water levels have been adequate
Limit of 4 jerry-cans per household
Water is not enough for irrigation/cultivation or upkeep of cattle
Reliable water source, however water levels fluctuate
Would like another well, or Sand Dam
Water use has increased
Nelly Aroka

Unyaleni Sand Dam and Off-take well, Musavani location, Tseikuru division
Interview with stakeholders, 27 people, mainly women
17th February 2010

Background
Implemented scheme: 1 * Sand dam and 1 * Off-take well
Implemented by: German Agro Action
Labor: -
Capacity: unknown
Operating since: 2009
Water harvested: unknown
Water expectancy: ongoing
Water withdrawal: 4 * 20 liters jerry-cans per household = 80 liters per household
Beneficiaries: 44 households with an average of 6 people =264 people
Water withdrawal total: 80 liters per household * 44 households = 3520 liters daily
Water use: cooking, washing, drinking for cattle
Maintenance: okay

Previous scheme
No previous scheme

Previous water situation
Water was collected at dry riverbed approx. 3 Km away from location
Water collected was about 1 jerry-can per household/day (at most 2 jerry cans with donkeys)
Water was scarce
Water was unsafe/contamination risk from cattle was high
Water was saline

Changes
Since implementation water has been available in the shallow well
Cattle are kept away from water source
People wash more frequently – hygiene improvement
Enough water for small scale agriculture and domestic use
People are generally healthier
Time used for collecting water by children and women has decreased
Water available closer to stakeholders – effect: more water collected

General findings
Water quality is regarded to be good
Limit of 4 jerry-cans per household
Reliable water source, however there are concerns that water levels may fluctuate due
to climatic variation, rains are not promising.
Would like another Sand Dam and well
Water use has increased
Rainwater Harvesting in Rural Kenya

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**Kaning, Tseikuru division**

*Interview with Joseph Muthengi Assistant Chief of Kaningu*

17th February 2010

**Background**

Chief responsibility: mobilization of communities in Tseikuru for water structures

Duration of position: 3 years

Number of coordinated people (to date): ≈ 40 households with an average of 6 people = 240 people

Reason for mobilization: wanted to uplift the standard of life for communities in Tseikuru

How was contact with GAA/KRA established: stakeholder meetings held by KRA and GAA

Challenges: community members did not attend meetings, difficult to engage communities

**Previous water situation**

Droughts are regarded to be common in area

Water was/is commonly collected at various dry riverbeds

Some water sources are prone to contamination risks

**Changes**

Time used for collecting water by children and women has decreased

Children have more time to focus on study

Women have more time to mind households and rest

Water can be put into cultivation/small scale agriculture in some places.

People are less sick

**General findings**

Water schemes are abating droughts

Communities are realizing benefits to organizing and implementing rainwater harvesting

Future goals: continue to get water closer to communities in Tseikuru

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**Kavuvu Rock Catchment, under construction, Kavuvu, Tseikuru division**

*Interview with stakeholders, 5 randomly selected people; 3 women 2 men*

18th February 2010

**Background**

Implementing scheme: 1 * Rock Catchment and 2 * tanks of 150m³ tank

Implementing by: German Agro Action and Kenya Rainwater Association

Labor: over 100 people are in some way involved with construction labor.

Capacity: 150 000 liters per tank

Operating since: -

Water harvested: -

Water expectancy: ongoing

Water withdrawal: -

Beneficiaries: unknown

Water use: cooking, washing, drinking for cattle
Nelly Aroka

Maintenance: -

Previous scheme
No previous scheme

Current water situation
Water is collected at various sources, dry riverbeds and boreholes
Water from boreholes are considered salty
Water is regarded to be scarce with dry spells having a declining effect on water
Water withdrawal in situations of drought is limited to around 1 - 2 jerry cans of 20 liters per day per household

Expectations
Shorter distance to water source
Clean water (rainwater)
More water
Consumption is anticipated to increase
Water is anticipated to be used for cattle, own consumption, household use (cooking, washing), and cultivation
Anticipating revenue from selling water

General findings
Groundwater in area is regarded to be saline
Water is currently insufficient for many stakeholders
Dry spells have declining effects on water sources
Water scheme is anticipated to bring positive development by stakeholders
Water consumption is anticipated to increase
Women outnumber men in construction labor
Maintenance is required for the pipes, taps as well as fencing

Ikathima Primary School, -, Tseikuru division
Interview with head teacher Mr. Mughi
22nd February 2010

Background
Implemented scheme: 1 * 50m³ roof tank
Roof dimension: 347m²
Implemented by: German Agro Action/KRA
Capacity: 50 000 liters
Operating since: 2010
Water harvested: At the time of interview the tank was said to be close to empty
Water expectancy: anticipating rains
Water withdrawal: water brought from home! 2 jerry cans of 20 liters per month is brought by parents and students
Enrollment: 370 students
Water use: drinking only, cooking regime is on hold
Maintenance: -
Rainwater Harvesting in Rural Kenya

**Previous scheme**
Implemented scheme: 4 * 10 000 liters plastic tanks and 1 * 10 000 liter tank
Implemented/donated by: World Vision and World Bank and 1 bought by school
Operating since: 2006
Current operating status: all tanks are out of use – roofing gutters need maintenance!

**Previous water situation**
No water at school,
Pupils/parents brought water from various sources example shallow wells and Tana River
Water was regarded unclean

**Anticipated Changes**
Available drinking water for pupils
Good quality water
Health benefits
Concerns on water reliability due to climatic variability

**General findings**
Poor attendance at school
Drop out is common, common reasons; girls are married away, boys start working before graduating and parents traditionalism
Water use is probably linked with availability
Performance and enrollment at school is probably linked with water availability
Maintenance is not working
Even though tanks have been previously implemented they are no longer in use

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**Kinolu Primary School, Tseikuru division**
**Interview with head teacher Mr. Joshua Kairu**
**22ND February 2010**

**Background**
Implemented scheme: 1 * 50m³ roof tank
Roof dimension: 250m²
Implemented by: German Agro Action/KRA
Capacity: 50 000 liters
Operating since: 2009
Water harvested: At the time of interview the tank was said to be 3/4 full
Water expectancy: ongoing
Water withdrawal: estimated 400 liters per day
Limits: No official limit but water is restricted
Enrollment: 300 students
Water use: drinking, cooking, washing hands and watering seedlings
Maintenance: okay

**Previous scheme**
Implemented scheme: 3 * 10 000 liters plastic tanks and 2 * 3 000 liter tanks
Implemented/donated by: World Vision and 2 tanks bought by school
Operating since: -
Current operating status: donated tanks are being used
Previous water situation
No water at school,
Pupils/parents brought water from various sources

Changes
Available drinking water for pupils
Pupils/parents do not have to fetch water
Enrollment has increased
Good quality water
Health benefits

General findings
Good maintenance on water schemes
Positive regards towards schemes
Water use is probably linked with availability
Previous tanks are in use

Nzanzeni Primary School, Tseikuru division
Interview with deputy head teacher Mr. James Muchiri
23rd February 2010

Background
Implemented scheme: 1 * 50m³ roof tank
Roof dimension: 318m²
Implemented by: German Agro Action/KRA
Capacity: 50 000 liters
Operating since: 2009
Water harvested: At the time of interview the tank was said to be 1/2 full
Water expectancy: ongoing
Water withdrawal: estimated 1200 liters per day
Limits: No official limit, water withdrawals are poorly checked
Enrollment: 600 students
Water use: drinking, cooking, washing hands and watering seedlings
Maintenance: -

Previous scheme
Implemented scheme: 3 * 10 000 liters plastic tanks and 2 * 3 200 liter tanks
Implemented/donated by: World Vision and 2 tanks bought by school
Operating since: 2005
Current operating status: 1 of the donated tanks is in use

Previous water situation
No water at school
Pupils/parents brought water from dry river beds approx 1 km from location in 2 liter cans
Water from dry river bed is regarded to be unclean, contamination by livestock

Changes
Available drinking water for pupils
Pupils/parents do not have to fetch water
Increased enrollment

**General findings**
Area is considered to be harsh/ dry
Concern for water scarcity during dry spells
Positive regards towards schemes
Not all tanks are connected to roof gutters

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**Nzanzeni Primary School, Tseikuru division**
*Interview with parent group 62 people*
*23rd February 2010*

**Background**
Average household members: varies from around 6 - 12
Water withdrawals: varies depending on distance to water source and the availability of donkey; 2 - 8 jerry cans of 20 liters per household per day
Water uses: washing, bathing, cooking, water for livestock, water is generally not used for cultivation
Water quality depends on water source
Water from bore hole and roof tanks are regarded to be of best quality
During dry times water is taken from Tana River

**Water sources**
Dry river bed (Tana River)
Shallow wells
Bore holes
Rainwater tanks if household can afford tanks and have tin roof

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**Kyuluku shallow well, Tseikuru**
*Interview with Mr. Musyimi chairman of Sand Dam group*
*24th February 2010*

**Background**
Implemented scheme: 1 * shallow well and 1 * hand pump
Hand pump implemented by: German Agro Action/KRA
Capacity: -
Operating since: 1999, hand pump installed 2008
Water harvested: -
Water expectancy: ongoing
Beneficiaries: 20 members in the Sand Dam group and approx 30 other beneficiaries
Total beneficiaries: 50
Water withdrawal: 2 jerry cans of 20 liters per 50 beneficiaries: 2000 liters per day
Limit: No limit for withdrawal
Water use: drinking, cooking, washing
Maintenance: okay

**Previous scheme**
No previous scheme
Previous water situation
Water collected from other dry river beds

Changes
Water consumption has increased
Cultivation of crops
Reliable water source
Good quality water

General findings
Water levels in well fluctuate during the year

Ithoka primary school, Tseikuru
Interview with deputy head teacher Mr. Mwangangi
25th February 2010

Background
Implemented scheme: 1 * 50m³ roof tank
Roof dimension: 136m²
Implemented by: German Agro Action/KRA
Capacity: 50 000 liters however rains only filled 2/5 of the tank
Operating since: 2009
Water harvested: At the time of interview the tank was said to be 1/5 full
Water withdrawal: water is below withdrawal point!
Enrollment: 280 students
Water use: when tank was in operation an estimated 60 liters per day was withdrawn for drinking
Alternative water sources: water is collected from borehole near school - salty
Maintenance: okay

Previous scheme
Implemented scheme: 2 * 2300 liter tanks and 1 * 10 000 liter tank to store water from borehole
Implemented/donated by: -
Current operating status: tank for preserving water from bore hole is in use

Previous water situation
No water at school
Pupils/parents brought water from various sources. 2 * 20 liter jerry cans per week

Changes
Fresh water is available
Pupils/parents do not have to fetch water

General findings
Positive regards towards roof tank though it is not being used
High anticipation for the coming rains
When water availability affects water use; scarcity increases conservation of water
Rainwater Harvesting in Rural Kenya

References


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Nissen-Petersen Erik. 2006. Water from Dry Riverbeds. ASAL Consultants Ltd.
Nissen-Petersen Erik. 2007. Water from Roofs. ASAL Consultants Ltd.
Figure references


