# RAINWATER HARVESTING IN SEMI-ARID KENYA: PRACTICES AND PROSPECTS

By

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## COMMITTEE APPROVAL

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**Abstract**

The aim of this research was to investigate the practices that constrain or facilitate effective rainwater harvesting in semi-arid Kenya. At 647 cubic meters per capita water availability, Kenya is considered water scarce yet with an average rainfall of 500mm per annum the country has great potential to be water sufficient and address water insecurities in marginal lands, such as Makueni County, through effective management of rainwater. Using a case study of rainwater harvesting in Makueni County, Kenya, the research identified and described rainwater harvesting practices, successful and unsuccessful rainwater harvesting projects, barriers and shortcomings as well as avenues for improvement. The literature reveals several factors contributing to the failure to meet the potential for rainwater harvesting to promote water security in semi- arid Kenya including technological, policy, institutional and governance and financial, behavioral and attitudinal. The study found many deterrents to effective rainwater harvesting in Makueni County, including poor technical designs for rainwater capture and storage, inadequate investment, failure to apply water supply standards, perceptions about the non-potability of rainwater, and poor linkage and coordination of efforts at local through national levels of social organization. The research also identified some key factors responsible for successful rainwater harvesting projects which included: social capital, local knowledge and capacity, and establishment and enforcement of property rights. The study concluded that efforts to promote effective rainwater harvesting should therefore include building capacity of project groups at the local level, designing effective RWH policies and institutions and creating RWH coordination networks at local through national and international levels. The study

recommended that, in order to scale up rainwater harvesting efforts there is a need for vertical and horizontal linkages across sectors and levels.

*Key words*: natural resource management, water security, rainwater harvesting, water supply, institutional designs, governance.

## Dedication

*To Jeff, Michelle and Bertha, may you grow to follow your dreams to the full*

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## Abbreviations

| | |
|---|---|
| AFRHINET | ACP-EU Technology Transfer Network on Rain Water Harvesting |
| AMREF | African Medical Research Foundation |
| CASELAP | Center for Advanced Studies in Environmental Law and Policy |
| CBS | Central Bureau of Statistics |
| CSOs | Civil Society Organizations |
| DANIDA | Danish International Development Agency |
| GIS | Geographic Information Systems |
| GoK | Government of Kenya |
| ICRAF | International Centre for Research in Agroforestry (World Agroforestry Centre) |
| IPPC | Intergovernmental Panel on Climate Change |
| FAO | Food and Agriculture Organization |
| KMD | Kenya Meteorological Department |
| KRA | Kenya Rainwater Harvesting Association |
| MCICDP | Makueni County Integrated Development Plan |
| MCSS | Ministry of Culture and Social Services |

| | |
|---|---|
| MDG | Millennium Development Goals |
| MDAs | Ministries, Departments and Agencies |
| MENR | Ministry of water and Natural Resources |
| MoA | Ministry of Agriculture |
| MWI | Ministry of Water and Irrigation |
| NESC | National Economic and Social Council |
| NGOs | Non -Governmental Associations |
| NWCPC | National Water Conservation and Pipeline Corporation |
| RoK | Republic of Kenya |
| RRU | Royal Roads University |
| RWH | Rainwater Harvesting |
| WRUAs | Water Resource Users Associations |
| SEARNET | South and Eastern Africa RWH Network |
| SIDA | Swedish international Development Agency |
| UNEP | United Nations Environmental Programme |
| UNFCC | United Nations Forum for Climate Change |
| UNICEF | United Nations International Children's Emergency Fund |

| | |
|---|---|
| USAID | United States Agency for International Development |
| WTF | Water Trust Fund |
| WARREC | Water Research and Resource Center |
| WHO | World Health Organization |

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# Chapter 1 - Introduction

## Increasing Water Scarcity in Kenya

"Water is critical for human survival, yet world over, the overarching challenge is the increasing freshwater scarcity given that the projected worldwide water demand exceeds supplies" (Gleick, 2009, p. 1). "One of the regions vulnerable to water scarcity in the coming years is the Horn of Africa covering Ethiopia, Eritrea, Sudan, Somalia, and Kenya" (Sachs, 2008, p. 127). Kenya has been experiencing declining water availability per capita over time, from 1853 cubic meters in 1963 to the current levels of 647 cubic meters (Ministry of Water and Irrigation (MWI), 2012). These levels are predicted to fall to 359 cubic meters per capita by 2020 (Republic of Kenya (RoK)/MWI, 2004; RoK/NESC, 2007; RoK, 2004). Causes of the decline include reduced precipitation brought about by climate change coupled with environmental degradation triggered by human encroachment on watersheds (RoK/ MWI, 2010), hydrological variability and trans-boundary issues surrounding water resources, as Kenya shares some of its water sources (rivers, lakes and aquifers) with her neighbors (MWI, 2010). As a result, the country experiences food crises and resource conflicts due to competition over dwindling supplies of water, pasture and arable land (MWI, 2010)

In 2003 the Government of Kenya (GoK) introduced measures to reform water governance institutions through the Water Act of 2003 which provided for public-private partnerships in order to allow alternative service providers to supply water to unreached populations such as slum and rural dwellers (Obosi, 2011). Such alternative service providers

included small companies, vendors and community based organizations (K'Akumu, 2007). Even though the Water Act 2003 was to revolutionize the water sector, much focus was laid on surface and underground water development. However, the desired levels of universal access to water for all have not been achieved (UNICEF/WHO, 2012) and this situation is being exacerbated by impacts of climate change (Mogaka, Gichere, Davis & Hirji, 2006).

Regardless of the deteriorating water situation, Kenya continues to rely heavily on surface water and ground water to meet her water needs even though records indicate that surface water and groundwater are being over-extracted (Malesu et al., 2007, ). On the contrary, the country receives 500mm mean annual rainfall (KMD, 2007) which, according to experts, if sufficiently captured and stored above the present levels which fall below 100cubic meters, is able to increase water availability to address the water insecurities in the marginal lands ( Kenya Rainwater Harvesting Association (KRA), 2009; Malesu, 2017). Inadequate rainwater harvesting is responsible for extreme water scarcity in semi-arid parts of Kenya as noted by RoK/ NESC (2007). As observed by KRA (2010), it is indeed paradoxical for many in a country to suffer water shortage while run-off, often causing destruction to property and lives, is not captured for use.

Such is the outcry for a shift of approach to water security in Kenya that for instance, following the heavy rains in April 2015, Okeyo ( 2015) lamented the endemic failure to harvest rainwater adequately which in turn means that Kenya has persistent water shortages. This sentiment has also been echoed by Rainwater Harvesting (RWH) experts in Kenya (Black et al., 2012; KRA, 2009; Ngigi, 2003; Malesu et al., 2007).

This study undertook to understand practices that facilitate or constrain effective RWH and ways of improving rainwater exploitation with a view to enhancing water security in semi-arid Kenya. It sought to investigate the causes of failure of RWH to achieve its potential and what improved practices, policies and institutions could encourage effective RWH so that there is more replicability, scaling up, and uptake, of effective rain water harvesting in semi-arid Kenya, through a case study of RWH practices in Makueni County, an area selected for the study because it falls in a semi-arid region, has a variety of rainwater harvesting technologies due to its geo-physcal characteristics and was more accessible to the researcher as compared to many other semi-arid regions.

**Problem Statement: Untapped Potential**

With a 500mm mean annual rainfall (KMD, 2007), Kenya has the potential to be water sufficient and address the water insecurities in the marginal lands through exploitation of rainwater harvesting ( KRA, 2010; Malesu at al., 2007, p. 20 ). For instance, for rural households, an area receiving just 200 mm annual rainfall has as much potential for roof water harvesting as one receiving 2,000 mm. Simple arithmetic assuming per capita rural water consumption at 20 litres per day shows an annual water demand of 7.3 cubic metres per person per year, which could be supplied by a roof catchment of 36.5 m2, if only 200mm of rainfall per annum were available (Malesu et al., 2007 p.17). Kenya's rainwater potential through domestic roof catchment is estimated to be more than 350 cubic meters. If captured and managed this water is enough to support 233 million people or close to five times the current population of Kenya (Kairu, 2017, Malesu 2017). However, as noted by Malesu et al. ( 2007b) understanding rainwater potential constitutes more complexities ( some of these are discussed in later chapters) and these potential depends on many factors other than the catchment size, which include , the average annual rainfall, the catchment type, the population density (for roof catchment) and slope gradient. However, as emphasized by KRA (2009), this rainwater potential has not been tapped and a great proportion of rainwater in Kenya drains away as run-off.

Unfortunately, as noted by MWI (2012), there is lack of adequate statistics on the rainwater use in the country even though RWH technology is not new to Kenya as observed by Kinyua (2005) and Black et al. (2012) who state that the practice has been in Kenya for a long time, in fact, since pre-colonial times. In view of inadequate data on rainwater use it is possible

to assume that , rural Kenya, holding a majority of the population (RoK/ Central Bureau Statistics, 2009) with diminishing springs and underground water sources, and largely underserved by piped water (RoK/ (CBS), 2009) could be depending on mostly rainwater (Kinyua, 2005*)*.

This thesis addresses the question of why rainwater has not been harnessed to levels that could minimize water shortage in the country. Considering the availability of a variety of technological options, what are the barriers to effective rainwater harvesting (Black et al., 2012; KRA, 2009; Oguge & Oremo, 2014)? Is it possible, as stated by UNEP (2005) that the lack of adequate rain water harvesting policies, institutions and governance framework could be responsible for the dismal exploitation of rainwater in Kenya? Mutua (2010) says that lack of RWH specific policy and operational guidelines could be partly responsible for the poor RWH status, and emphasizes that despite Kenya's long standing tradition in RWH, Kenya did not have policies that comprehensively stipulate implementation actions for RWH. For instance, despite its intention to revolutionize the water sector in Kenya, the Water Act of 2003 did not explicitly address RWH strategies but merely recognized the need to invest in RWH, while specific measures, policies, levels of investment and operational details were lacking in the legislation (Oguge & Oremo, 2014). As a result, RWH has not been accorded priority in GoK planning and it was mostly limited to and dependent on special government or donor funds (Malesu et al., 2007b). However, there is enthusiasm for the Water Act 2016 which has been deemed a great improvement in addressing RWH priorities such as provision for a national water storage authority to facilitate RWH activities even though it is not yet fully implemented (Oguge & Oremo, 2014).

In a survey in sub-Saharan countries, UNEP (2005) indicated that there were many, often isolated successes in the practice of domestic rainwater harvesting. But, a major mechanism for legal and policy issues, and thus for the mainstreaming and integration of RWH in public water supply was missing. UNEP further stated that knowledge of the water sector organizations about the spread of RWH was weak and there was little experience in establishing legal instruments to promote that spread. Kenya's National Water Sector Strategic Plan 2010-2015 also noted that the potential for rainwater use had not been fully taken into consideration in national water planning and therefore there was no clear framework for managing rainwater harvesting (MWI, 2010; RoK/MWI, 2012).

Poor articulation of RWH priorities within the National or County level water strategies is a major barrier in RWH as explained by Hartung and Partshull (2001) who observe that RWH was often being implemented outside the legal water resources management framework, on a project level, which therefore, implied many limitations because, while individual village-level projects succeeded in the short term, their long terms sustainability could be severely tested in the absence of an appropriate institutional and legal framework at all levels. Moreover, it was also unlikely that extensive replication of appropriate technologies and community-based implementation strategies would be achievable in the absence of supportive institutions at higher levels, even if isolated project success at the local level may be possible (Hartung & Partshull, 2001).

Lack of supportive policies to guide how lessons learned were applied and how further investments could be directed to promote growth were fundamental and urgently needed in the

RWH sector. For example, the progress report on the development of the national Water Master Plan 2030 recognized the lack of data on the contribution of rainwater to the national grid (MWI/JICA, 2012). This made coordination, and integration of RWH activities in mainstream water management plans difficult as the baseline information was lacking. Most rainwater collection was therefore carried out haphazardly with little or no linkage and coordination among projects and among actors, which, in most cases, led to duplication of efforts and little or no replication. Furthermore, due to poorly designed capturing and management systems, much of the water was wasted through evaporation and percolation (KRA, 1999).

A RWH governance framework would entail policy statements, procedures that guide how and what rain water harvesting activities would be implemented, by whom and where including resource allocation for RWH (Mutua, 2010, p.17), and establishment of relevant community support agencies for RWH (UNEP, 2005). The study therefore, sought to investigate RWH practices, constraining and enabling factors and to ascertain or identify any new institutional arrangements that might promote more effective RWH management in semi-arid Kenya.

**Research Objectives**

The overall research objective was to explore, investigate, identify, and describe rain water harvesting practices in semi-arid Kenya. The study focused on two locations(Ka;lanzoni and Kikumini) of Makueni County. The study sought to investigate barriers to RWH, and ways in which those barriers could be overcome to promote effective RWH management byinvestigating RWH practices in one county, Makueni. The potential of rainwater to avert

water shortages in semi-arid Kenya having been reported by Malesu et al. (2007) in a study to establish RWH potential in African countries, it is the position of this research that effective RWH management could promote water security in semi-arid regions in Kenya. The research investigated and identified current RWH practices, rainwater management organizations at community level and other levels of social organization (regional and national), and the linkages or interplay with other mainstream water services, water resources governance institutions and other actors or sectors. Through a case study of twenty community RWH projects in kikumini and kalanzoni locations in Makueni County, coupled with discussions with RWH experts as well as participant observation and document analysis, the researcher identified barriers to rainwater harvesting as well as areas for potential improvement and made recommendations on institutional and social measures to be adopted to increase rainwater harvesting in semi-arid Kenya.

**Objectives**

The specific objectives in this study included:

I. To investigate rain water harvesting challenges and successes in Semi-arid Kenya.

The literature review showed that the potential for rainwater was underexploited (Black et al., 2012; KRA, 2009; Ngigi, 2003; Malesu et al., 2007). This called for investigation so as to discern the shortcomings and successes of current practices and improvements needed to for more effective RWH. Through one on one interviews with key informants and group discussions with community RWH project members the research was able to generate

understanding on RWH implementation modalities, the past and current trends, the actors and promoters, as well as the enablers and barriers to effective RWH.

II. To identify and describe local and national water institutions, legislative and policy frameworks.

Having established through literature review that lack of a RWH governance framework was a contributing factor to poor rainwater exploitation in Kenya, it was important to investigate the policies supporting RWH and establish existing gaps in the policies, the structures through which RWH implementation was carried out and coordination avenues among various actors. This was done, through an extensive literature review of key government development strategies, policies, plans and reports in relevant sectors including the ministries of water and irrigation, agriculture, environment and arid lands management. In addition, focus group discussions with project members provided valuable information regarding modes of operation. Some of the key informants involved in project implementation gave accounts of project implementation structures they applied and technologies adopted in various contexts.

III. To investigate changes that would improve rainwater harvesting institutional design and water security in semi-arid Kenya.

At the end of every discussion, whether informant interviews or group discussions, participants had ideas on how to improve RWH management in Kenya. This information included how to better coordinate, implement, upscale, network and finance RWH.

**Research Question**

The overall research question of this thesis is: Which practices facilitate or constrain effective rainwater harvesting in semi-arid Kenya?

I sought to understand institutional, structural and process factors that could affect effective rainwater harvesting in semi-arid regions of Kenya through a study of two locations in Makueni County. It was my aim that the study results generate proposals of possible improvements in RWH management in Kenya and identify factors that would make a significant difference in RWH.

Furthermore, this research was guided by the following sub questions:

1. What are the existing rainwater harvesting practices?
2. What are the existing local water institutions that govern rainwater harvesting?
3. What are the shortcomings, barriers to effective rainwater harvesting?
4. How could rainwater harvesting management be improved?
5. What linkages exist among local, regional, and national rainwater harvesting institutions?
6. Could existing institutions be improved or new institutions be designed to promote rainwater harvesting?

**Clarification of Terms**

In this section, some of the terms used are defined as applied in this study.

### Rainwater Harvesting

There exists a variety of definitions of RWH based on catchment, and /or storage, among other factors. For instance, Rockstrom (2002) defined RWH as collection and conservation of run-off water originating from ephemeral streams during storm. Ngigi (2003 p. 21) defines rainwater-harvesting as the collection and concentration of run-off, while Mati (2012) used floodwater harvesting rather than rainwater-harvesting, ascribing RWH to 'rainwater collection' and storage only. Critchley and Siegert (1991) used water harvesting to mean the collection of run-off and divided it into: rainwater harvesting as the collection of run-off from roofs or ground surfaces and floodwater harvesting as the collection of discharges from watercourses.

For purposes of this study, RWH includes all methods of collecting, concentrating, utilizing and managing run-off for productive purposes such as domestic water supply, crop, fodder and livestock production (Malesu et al.; 2006, Ngigi, 2003, p. 21). Rainwater harvesting falls into two categories depending on the mode of collection and storage: in-situ and ex-situ (Hatibu and Mahoo, 2000; Ngigi, 2003). In-situ RWH techniques are those that increase the amount of water in the soil profile by trapping and retaining the rain right where it falls (Hatibu and Mahoo, 2000; Malesu, et al., 2006). It may include open-sky RWH systems such as terraces, pitting methods such as zai pits, which are holes dug on the ground to capture and retain rainfall, or bunding which entails earth/stone mounds across contours of a slope to slow run-off and prevent soil erosion (Black et al., 2012) and large external catchment systems such as trapezoidal bunds (Kahinda et al., 2007). Ex-situ is where the catchment area is separate from the target area and harvested water is transported through channels to the target area (Kahinda et al., 2007).

Kahinda et al. (2007) also explained that in the ex-situ rainwater was collected on rooftops or other compact surfaces and stored in underground tanks (UGTs) or above ground tanks (AGTs) for domestic uses and other small-scale activities. Kinyua (2005) added sustainability to the definition by indicating that such rainwater was diverted, collected, stored, used, and managed through various schemes and as sustainably as possible. Kinyua (2005) further stated that in practice, RWH would include, for example, managing water in dams, shielding soils to prevent extensive evaporation, storing rainwater in tanks, or collecting and storing rainwater from rooftops, land surfaces (steep slopes, road surfaces and rock catchments) using simple components (pots, tanks, cisterns) or more complex methods (underground tanks).

**Effective Rainwater Harvesting**

According to the dictionary, "effective" refers to "being successful and working in the way that was intended" (Longman Dictionary of contemporary English, 2010 p. 542). Therefore, when something is effective, it means it identifies and achieves an intended outcome. My study used "effective rainwater harvesting" to refer to a situation where the realized benefit of RWH in semi-arid Kenya and in the country at large was commensurate with the achievable potential. Malesu et al. (2007) in a study to map the RWH potential in Africa reported that an area with mean annual of 200mm rainfall has adequate potential for RWH. Most semi-arid lands in Kenya have a mean annual of 200 to 400mm rainfall, while the country has a mean of 500mm (KMD, 2007) hence showing the underlying potential. Qualitatively, however, effectiveness could be discerned by observable attributes such as existence of and trends in water availability.

**Institution**

Institutions in this study included national and county level laws, constitution and policies, government agencies, the local customs, property rights groups such RWH project groups and their sets of conduct, Civil Society Organizations and RWH networks.

**Governance Framework**

In this study governance framework is applied to refer to mechanisms, policies, procedures that guide and direct how, when, where and what activities and programs would be implemented with a view to promote effective RWH.

**Key Informants**

Key informants comprised those who took part in the expert discussions and interviews. These were experts and opinion leaders who were engaged in structured interviews. The term "informant" was used to distinguish the key informants.

**Project/Community Groups**

The term community group has been used interchangeably with project group to mean the management entities that implement community RWH projects. They are also called project management committees. In some instances they were simply known as "common interest groups."

**Performing/ Successful and Nonperforming/ Non successful**

The projects under study were grouped in two categories based on criteria of reliability and impact. "Performing projects" were those RWH projects perceived by the community as

meeting the intended outcomes of consistent and sustainable water supply for [all] the intended uses and hence could be termed successful while "nonperforming projects" were those falling below the intended outcomes and are described as unsuccessful. For instance, some dams had water but it was contaminated, they were full of silt and obviously neglected and the managing group was not functional. Such a project was deemed to be "non-performing".

**Outcomes of the Study**

The research aimed to investigate RWH practices in semi-arid Kenya. It further, sought to identify and describe the RWH institutions, linkages among institutions, challenges and improvements needed in order to achieve effective RWH in semi-arid Kenya. It explored the social aspects of rainwater harvesting building on the work of ecological resilience and New Institutional Economic perspective theorists (Ostrom, 1990; Young, 2002) on management of common pool resources. Knowledge generated by the study would help inform existing theories on natural resources as far as rainwater management is concerned. The findings comprising the RWH practices, existing management structures, linkages with water governance institutions, constraints, proposed solutions to the existing challenges and actions for various stakeholders would inform RWH interventions. A summary of policy briefs will feed into policy-making arenas for Civil Society Organizations (CSOs) and government.

The participation of community members in the research process elicited and brought to the fore issues and ideas on rainwater management that had remained unrecognized and possibly triggered action in addressing them. During the research, the project research participants reflected on the current rainwater harvesting practices, the constraints to maximum exploitation

of rainwater resources and solutions to the constraints. Some of the solutions identified were actionable by the community with little or no outside interventions and as such could be operationalized as a priority. Finally, the proposed model for rainwater management would facilitate dialogue towards adoption of a nationwide RWH framework that would help advance improvement in RWH in a bid to enhance water security**.**

**Dissertation Outline**

Given the objectives of the study the thesis structures as follows:

Chapter one introduces the study topic and provides background information and significance of the study. The question of "underexploited potential" of rainwater is stated with a view to making a case for exploring probable solutions to realizing that potential. The objectives, research questions and significance of the study are also stated.

Chapter two provides an overview of the history of RWH in Kenya and the current policy and legal framework. The socio-economic and geographical background of the study site, Makueni, is described in order to provide a contextual perspective of the study.

Chapter three presents a review of existing literature regarding RWH in general and management and governance practices in particular. The chapter brings relevant theoretical perspectives to bear on the main research question in order to establish which aspects of RWH successes or failures remain unexplained. The chapter reviews literature related to RWH in Makueni County and Kenya at large, including RWH practices, trends, challenges and water resources governance in Kenya. The chapter gives an overview of theoretical perspectives that could contribute to understanding the research questions including governance of the commons

(Ostrom, 1990; 2001; 2003; 2005; 2008; Bromley, 1991), institutional dynamics and design (Young, King and Schroeder, 2008; Young, 2002, 2003, 2008, 2009, 2010; ), tragedy of the commons (Hardin 1968), and multi-level governance (Berkes, 2007; Folke et al., 1998). A summary of property rights and water resources governance in Kenya is provided.

Chapter four presents the research methodology and design adopted for this study. The chapter includes a restatement of the research questions and objectives and then goes on to discuss the choice of methodology. The research design is discussed including the data collection methods and data sources. The steps and methods applied in data analysis are also presented.

Chapter five presents the results of the investigation of key practices of Rainwater Harvesting, Water access in Makueni and RWH in Makueni County and Kenya at large. The chapter also describes the rainwater harvesting management institutions at both the local level in Makueni County and nationally.

Chapter six describes the methods employed in harvesting rainwater in Makueni County generated from discussions with community members and key opinion informants.

Chapter seven gives a summary of the sub-sets of water projects studied and the major enabling factors in RWH and common characteristics of successful projects. It also provides a summary of non-successful projects, and common factors contributing to those failures. It also summarizes the general challenges in the performance of Rainwater Harvesting projects.

Chapter eight presents a synthesis of the findings and provides conclusions regarding RWH practices in Makueni County, and semi-arid lands and Kenya in general. Institutional

designs for promotion of RWH and theoretical significance of the findings is discussed. The chapter further provides conclusions and recommendations of the study on RWH practices and institutional designs for advancing RWH in Makueni, semi-arid regions and Kenya in general, based on the findings of the study.

# Chapter 2 – Background of Rainwater Harvesting in Kenya and Study Location

## Introduction

In this chapter RWH harvesting is discussed as practiced in the Kenya, covering a historical overview, technologies and the current policy framework based on the existing literature (MWI, 2014; Ngigi, 2004 ; Oguge & Oremo, 2014; RoK, 2002, 2016). The socio-economic and geographical background of the study site, Makueni, County is described.

## Background of Rainwater Harvesting in Kenya

During colonial times, soil conservation incorporating water harvesting was practiced in Kenya, even though after independence, these efforts were generally discontinued due to the oppressive nature of their initial implementation (Lundgren 1993). However, since the 1970s soil conservation, in the form of land husbandry has been on the government development agenda (Lundgren, 1993).

In Kenya, the practice of harvesting run-off water is carried out mainly in the more arid and semi-arid regions with support from Civil Society and Government (Kinyua, 2005). The most common methods are the collection of rainwater falling on rooftops, land surfaces and the collection of floodwater from watercourses for domestic use (Ministry of Water and Irrigation(MWI), 2010). Typically, the harvested water is stored in tanks or dugout water pans (which are ponds used for storing water that runs off fields and roads) or used directly for crop production (MWI, 2010.).

The adoption rate of RWH has been found to be lower because of poor understanding of the technology by many farmers and by agricultural extension officers (Kinyua, 2005; Malesu et al., 2007). Due to the inadequate attention to the potential of RWH and insufficient capacity for training or implementation of RWH, the practice of RWH is limited to isolated projects (UNEP, 2005).

Over the last thirty years, RWH has rapidly gained importance as a valuable alternative or supplementary water source, along with more conventional water supply technologies in many countries (Black et al., 2012; Malesu et al., 2007). The increasing interest in RWH is partly due to declining global fresh water supplies from conventional sub surface and underground sources and growing evidence from studies and researches pointing to the fact that water shortages can be reduced if rainwater harvesting is effectively exploited (Malesu et al., 2007a). In Kenya, the reduction in water levels is partly associated with climate change impacts intensifying water scarcity in the country (Mogaka et al., 2003). Development projects, national and international organizations, government ministries, and other agencies have continued to explore rain water harvesting as a decentralized solution to Kenya's water needs (Black et al., 2012) hence the increasing advocacy for the government to scale up investment in the sector (Ngigi, 2004; 2009)

**Rainwater Harvesting Technologies in Kenya**

Most RWH projects are implemented in schools, communities and households (MWI, 2014). Normally, the RWH system is composed of three components, namely; the rainwater

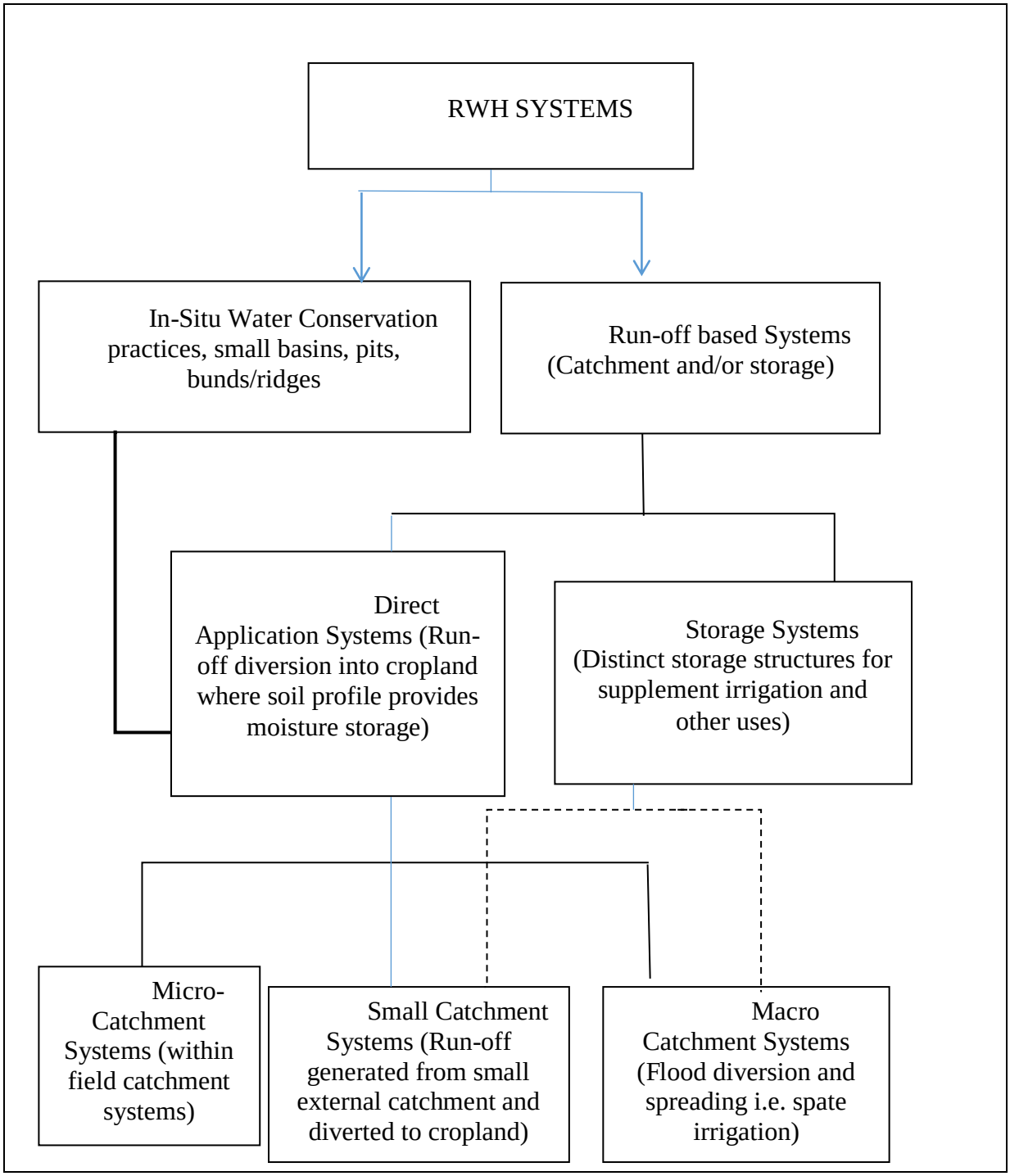
catchment subsystem, the water conveyance subsystem including gutter and pipeline, and the storage subsystem (MWI, 2014; Ngigi, 2004 pp. 22). This is illustrated in the case of a domestic roof catchment:

> A roof (made of galvanized steel sheet) for instance, comprises a catchment surface while the gutters and pipelines are used for conveying run-off from the roof into the storage usually in the form of tanks (can be plastic tanks, underground reservoirs, ferro-cement tanks). (MWI, 2014 p.16)

RWH can be classified depending on the run-off source or storage type. Run-off is collected mainly from ground catchment as well as ephemeral streams (floodwater harvesting and road/footpath drainage). Other examples of catchment include natural surfaces, gullies, rills, croplands, pasture, roofs and hill slopes (Ngigi, 2004). The storage is either in separate structures (ex-situ methods such as tanks, reservoirs, dams and water pans) or soil profile (in–situ methods like terraces, etc). Examples of ex-situ storage structures include underground water tanks composed of sunken pits lined with ultraviolet resistant polythene lining (Ngigi, 2004). Others include rock catchments, sand dams and subsurface dams (barriers constructed across sandy riverbeds, especially in arid and semi-arid areas) (Gould & Petersen, 1999; Petersen, 2000).

A variety of RWH techniques are practiced in the country depending on among other factors, geophysical characteristics like rainfall amount, soil texture, nature of the landscape and intended use of the collected water. Some examples of the various types of technologies categorized in two main types of RWH systems, ex-situ and in-situ, are explained and presented in Figure 1 and Tables 1 and 2 below.

*Figure 1*: Rainwater Harvesting Technologies




*Source*: Ngigi, (2003)

**Run-off Based Systems/ Ex-situ**

Ex-situ systems include rooftop RWH and storage into above or below ground tanks. An area receiving a mean annual rainfall of 200mm is considered to have potential for roof catchment. Therefore all that is required is the presence of roofs to provide the necessary catchments (Malesu et al., 2007). This means that most of Kenya has potential including semi-arid regions with 0-200mm mean annual rainfall. Type and size of roof (related to socio—cultural factors) are limitations, however, since the pastoralist communities mostly reside in temporary structures called "manyattas" whose mud roofs are not very conducive to roof catchment.

Surface run-off collection from open areas and storage in ground-based structures e.g. water pans, earth dams, ponds, rock catchment, underground tanks refers to collection of run-off from open surfaces, such as roads, home compounds, rock outcrops hillsides, open pasture lands and may also include run-off from watercourses and gullies. This technology is viable anywhere as long as geophysical conditions permit (Malesu et al., 2007). Some of these geophysical conditions include soil texture which would determine whether a farm pond is lined or not, slope gradient which would affect location of dams, presence off sandy river beds for sand dams, rock out crops for rock catchment and amount of rainfall.

Flood run-off harvesting from watercourses (ephemeral streams) and storage in sand and subsurface dams (this includes also possibility of weirs, small earthen dams and on-stream ponds) depends on availability of sand rivers, topography that allows construction of weirs, geology to suit storage structures and the presence of a population to make use of the water (Malesu et al., 2007).

Table 1 below presents the most common technologies utilized in Makueni County and the country in general including where they are most applicable and cost implications.

**Table 1: Run-off Based RWH Technologies and their Viability**

| Technology | Features | Viability, and Prevalence | Cost |
|---|---|---|---|
| Domestic roof catchment | Involves the collection of rainwater falling on roofs of homes or any other structures, which is then diverted through a gutter system to a storage structure ( Black et al., 2012).<br><br>Started in Kenya around 1900 ( Black et al., 2012).<br><br>Storage could be a tank, or a jar.<br><br>Tanks could be placed on the surface or sunk underground.<br><br>Constructed using stones, bricks, ferro-cement, or plastic.<br><br>Ferrocement tanks are more popular than brick tanks though recently PVC tanks are most popular | Found throughout the Country (Black et al., 2012).<br>Suitable in areas with at least 200mm rainfall (Malesu et al., 2007).<br>Suitable in areas with population density of over 10 people per kilometer square.<br>The amount of catchment would depend on the size of the roof and amount of rainfall. Resources allowing the volume of a water tank will be based on the potential which is a product of the annual rain x roof size x rainfall coefficient for corrugated roof (0.8).<br><br>Therefore where annual rainfall is 200mm and the roof surface is 36 square meters the potential will be equal to (200/1000) m X36x 0.8= 5.76cubic meters or 5,760 litres (Nissen Petersen, 2007)<br>A household(8 members) would require 8 people x14 litres=112 litres per a day and 112 litres x 365 days = 40,8800 litres per | A 46 cubic meter (46,000litres) Ferro cement tank would cost about 1083 USD about 10 years ago ( Nissen-Petersen, 2007).<br>The rainwater potential estimates therefore indicate that for a tank costing 1083 USD, the annual rainfall given, an average household could access water for domestic purposes(40,880 litres per year) but not sufficient to cater for livestock and farming as well.<br><br>Estimates by Nissen-Peterssen (2007) indicate that a family would need 183,500 litres for thirty five livestock and 183,500 for farming on one acre per year Hence, there will be need for a complimentary source of water for the other activities. |

| | | | |
|---|---|---|---|
| | | year for domestic purposes alone | because the roof catchment alone would be insufficient and too costly. |
| Farm ponds | - KRA upgraded farm pond include various sizes between 50 to 100 cubic meters lined with UVR plastic and roofed with metallic structure and shade net. It also entails a hand pump that lifts water about 1m high for drip irrigation ad a silt trap to control siltation (Oguge and Oremo, 2014). | -Ponds are suitable in areas with average rainfall of 200 mm and above, a slope less than 2% and may include areas with low population and clay soils (Malesu et al., 2007). Ponds conserve water more because they are covered /shielded to reduce evaporation and contamination. | A 100 cubic meter (100,000litres) capacity pond would cost around 1000 USD (KRA, 2009) while a polyester tank of the same volume would cost four times the cost. For example, an average rural household (8 members) would need 112 litres of water per day for domestic needs for livestock 500litres per day and91250 for a season ) and farming, 500litres, per day and 91,250 for a season . Therefor a family would require 224,380 litre capacity pond for a season of (182.5 days) given bi-annual rainfall pattern. This would cost 2000 USD (Mati, 2015) |
| Earth dam Weirs, pans | Consist of raised dam walls (usually 2-5m high) made of compacted earth that retain water in a reservoir (Ngigi, 2004). | Suitable locations include natural depressions in steep sided valleys- (Ngigi, 2004). Water lasts longer where the soils are clay. | Dams are expensive to maintain because of siltation and pollution from animals and rodents (Ngigi, 2004), |

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|---|---|---|---|
| | Pans may occur naturally as shallow depressions and are often used for livestock or wildlife (Nissen-Petersen, 2006) | Normally constructed with a spillway and auxiliary structures such as cattle troughs. Conservation of catchment is necessary to control siltation (Ngigi, 2004). Dams are more suitable on public land for communal access. Construction of dams should take into consideration loss of water due to evaporation and seepage in estimating capacity vis-à-vis the water demand ( Nissen-Petersen, 2006). Size of the dam most often depends on the surface area of the catchment which can be determined through GIS and the resources available, since a larger one implies more cost. | However, they form a source of large amounts of water depending on their capacity (Ngigi 2003). In order to improve water quality, filters and water points would need to be installed. This increases the cost two fold. According to Nissen-Petersen(2006) cost of a small dam( 4,500,000 litres) minus the tanks and distribution system, would be around 10,000 USD. Dams would , therefore be needed in large volumes to meet water demands for domestic and productive purposes for a community. |
| Sand dams | Masonry water barriers built across seasonal streams (Ngigi, 2004). First ones built in Kenya during the colonial era (Ngigi, 2004) | Found mostly in Kitui, Machakos and MakueniRequires ephemeral sand riverbed that floods during the rainy season, sites free of saline rocks and presence of coarse sand (Gould &Petersen, 1999. | Sand dams are less expensive and requires less maintenance compared to boreholes and conventional dams. They are less expensive to construct than earth dams because required raw materials are locally available (Ngigi, 2004). |

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| Subsurface dam | -Similar to sand dams but subsurface are below the surface of the river bed (Ngigi, 2004). | Found mostly in Kitui, Machakos and Makueni<br><br>Requires ephemeral sand riverbed that floods during the rainy season, sites free of saline rocks and presence of coarse sand (Gould &Petersen, 1999). | Subsurface dams are less expensive and requires less maintenance compared to subsurface dams boreholes and conventional dams. They are also less expensive to construct because required raw materials are locally available (Ngigi, 2004). Even though they collect less water than sand dams they are cheaper and several of them can be built along the river course (Nissen-Petersen, 2006). |
| Rock catchment | -Reservoirs with masonry walls located on a bare rock surface with sufficient catchment area to capture enough rain water (Ngigi, 2004).<br><br>Construction of a rock catchment entails erection of the masonry wall and gullies to direct water to a reservoir.<br><br>Collected water could be directed to storage tanks. | Common in areas such as Kitui, Machakos and Makueni.<br>Most suitable rocks include those with low permeability and resistant to weathering such as granite (Ngigi, 2004).<br>- A rock catchment with an estimated capacity of 5000 Cubic meters can serve a population of 10,000 (Ngigi, 2004).<br><br>Rock catchments are prone to pollution because of their open nature | Rock catchments are not expensive to construct but where reservoirs like ferro cement tanks are built, much more resources would be invested. |
| Road run-off | Involves small | Can be accomplished by | Negligible financial |

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| | channels directing run-off from roads, footpaths and cattle tracks (Ngigi, 2004). Soil compaction on roads results in high run-off coefficient (Ngigi, 2004) | rural land-users with little technical support(Ngigi, 2004) | input required. |

Table by: J. Mang'era

Going by Nissen-Petersen (2006, 2007) estimates, a typical household would need about and 405,880 litres for domestic, livestock and farming per a year. To pcapture 405,880 litres of rainwater would need a large roof surface areat and several tanks which would be costly. From the analysis above ponds could hold larger volumes of water for a household at a lesser cost than tanks. Otherwise both ponds and roof catchment tanks would be applied so that the tanks supply water for domestic purposes while the ponds are utilized for farming and livestock needs. However, more discussion and pictures of the above RWH technologies are contained in latter chapters based on the findings of the study.

Makueni County is uniquely placed, in a favorable position for RWH, because of its landscape and physical conditions which make the technologies analyzed above suitable in many parts of the County. For instance, the county receives an annual average rainfall ranging from 200 to 400mm and has a population density of more than 10 people per square kilometer making it suitable for roofcatchment, the landscape consists of gentle slopes and depresions that favour dams, plenty of ephemeral seasonal streams for sand dams and , extensive outcrops in some locations which are useful for rock catchments.

**In-situ Rainwater Harvesting Methods**

In-situ rainwater harvesting methods differ from the ex-situ methods in that these are technologies that retain rainwater right where it falls in the cropped area or pasture (Ngigi, 2003). Table 2 below describes some of the commonly used in-situ methods in Kenya and also in Makueni County as well.

*Table 2*: In-situ- RWH methods

| Method | Description | Photo |
|---|---|---|
| **Zai pits** | Zai pits also known as infiltration pits or planting pits, are a simple and effective form of RWH. They are small holes dug in the ground to capture and retain rainfall. The pits allow little water to escape and therefore enhance rainfall productivity (Black et al., 2012). |  *Figure 2*: Zai Pits Source: (World Agroforestry, 2012) |

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| **Fanya juu**<br><br>**Fanya chini** | Fanya juu, implying 'throw it up' in Swahili, is the process of digging ditches and throwing soil upslope to form an embankment. The bank prevents run-off while the furrow, which is dug along the contour, retains water. Over time, well-formed and flat terraces develop naturally (Black et al., 2012; Ngigi, 2003; Tiffen et al., 1994). Fanya chini is the opposite of Fanya juu because here the soil is thrown down slope instead of up slope but still works the same way. |  <br><br>*Figure 3:* Fanya Juu, Source : (weADAPT, n.d.) |

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| **Contour Earth ridges** | Small earth bunds with a furrow usually on the upper side of the mound. The furrow, which can be narrow and deep or shallow and long, provides a concentrated area for water to be retained. The ridges are used to capture and store rainwater falling between each bund or from a larger upslope catchment as well. Cross-ties, which are small mounds located on the upslope side and perpendicular to the ridge, can be used to further trap water and prevent erosive cross-flows. |  <br>*Figure 4*: Contour ridges with cross ties<br>Source: FAO (Shaxson, n.d.) |
| **Stone and earth bunds** | Stone bunding is the laying of stone mounds across the contours of a slope to form a semi-permeable barrier in order to slow run-off and prevent soil |  |

| | | |
|---|---|---|
| | erosion (Black et al. 2012) | *Figure 5:* Stone and earth bunds, source: FAO, (Barbern, n.d.*)* |
| **Trapezoidal buds** | Earth bunds built in their respective shapes with the tips situated along the contours. The size and spacing of each structure is dependent on crop choice, soil types, climatic conditions, and personal preferences. This allows for creativity and innovation in its design (Black et al., 2012). |  *Figure 6:*Trapezoidal buds, Source*:* Rainwaterharvesting.org |
| **Nagarims** | Regular square earth bunds turned 45 degrees from the contour to concentrate run-off at the lowest corner of the square(Hai, 1998; Ngigi, 2004) |  *Figure 7: (*Critchley, 1991b) |
| Trash line/vegetative strips | A form of contour bund RWH that utilizes the placement of | |

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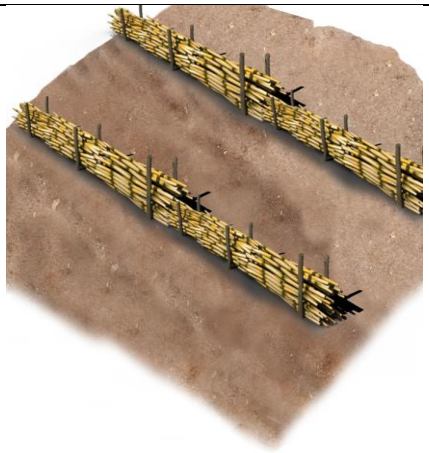
|---|---|---|
| | crop residue along the contour to form a semi-permeable bund. Residue stalks from sorghum and millet, branches from trees, or even piles of weeds can be used. Often these are coupled with soil, stones, or stakes to form more stable structures. (Critchley et al. 1994).<br><br>Vegetative Strips are composed of live strips of vegetation along the contour instead of residue stalks. Vegetative strips are also semi-permeable barriers that slow run-off, capture sediment, and can lead to the formation of terraces (Black e al 2012) |  <br>*Figure 8:* Trash line/vegetative strips<br><br>(Critchley et al. 1994) |

*Table By*: J. Mang'era 2016

The methods described in Table 2 above are applied in many parts of the country , especially in the semi-arid areas. Even though, the researcher was not able to observe all of them

in the study location because of the limit in area covered, a number of these methods are practiced in Makueni County.

**Cost of Rainwater Harvesting Technologies**

Adoption of RWH technologies depends on the suitability of the technology to the social, economic, cultural and physical characteristics of the region (Ngigi, 2003). However, most often financial constraints pose an overriding factor in the uptake of these technologies even where potential of rainwater is high (Ngigi, 2003). As explained in Table 2 above, roof catchment is applicable in many parts of the country with annual precipitation of 200cubic meters and above. However, the cost is prohibitive to the extent that many households use small containers that can only store negligible amounts of water . Below is summary of the cost various RWH technologies in Kenya (Nissen-Petersen, 2005).

Table 3 below shows comparable cost of selected common RWH technologies in Kenya. It is interesting to note that the most commonly used plastic tanks, at USD 160 per cubic meters are most expensive as compared to sand dams which would cost USD 0.8 per cubic meter. Ordinary Kenyans in rural areas with 51 % of the population living below the poverty line which is estimated at Ksh. 1562 (16 USD) per adult per month against the national average of 45 % ( RoK/KBS, 2009) shows that majority may not be able to afford a sizeable roof catchment tank. Furthermore, Makueni County has 62 % of its population living below the poverty line (RoK/KBS, 2009) which shows that affordability water harvesting facilities for most of the inhabitants is indeed a challenge.

Table 3: Typical Costs of Rainwater Technologies

| Technology | Typical example | Cost | Unit |
|---|---|---|---|
| Under ground tanks | Concrete dome shaped tank | 7 | US $/m³ |
| | Brick dome shaped tank | 9 to 14 | US $/m³ |
| | Bottle shaped tank | 4 | US $/m³ |
| | Ferrocement tank | 12 to 15 | US $/m³ |
| | Ball shaped plastic tank | 160 | US $/m³ |
| Above ground tanks | Brick tank | 93 | US $/m³ |
| | Ferrocement tank | 30 to 70 | US $/m³ |
| | Plastic tank | 130 | US $/m³ |
| Runoff open reservoir | Plastic lined | 3 | US $/m³ |
| | Cement lined | 5 | US $/m³ |
| | Unlined | 100 | d/ha |
| | Lined oval tank | 8 | US $/m³ |
| Runoff closed reservoir | Concrete dome shaped underground tank | 7 | US $/m³ |
| | Brick dome shaped underground tank | 9 to 14 | US $/m³ |
| | Bottle shaped underground tank | 4.0 | US $/m³ |
| | Ferrocement underground tank | 13 | US $/m³ |
| | Hemi-spherical underground tank | 23 | US $/m³ |
| | Sausage shaped with cement lining | 16 | US $/m³ |
| In situ | Human land preparation | 113 | h/ha |
| | Draught Animal Power land preparation | 53 | h/ha |
| Sand or sub-surface dams | Sand dam | 0.8 | US $/m³ |
| | Sub surface dam | 0.7 | US $/m³ |
| Rock catchments | Open rock dam with stone gutters | 71 | US $/m³ |
| | Closed rock dam with stone gutters | 89 | US $/m³ |
| | Open rock dam with tank | 110 | US $/m³ |
| | Rock catchment with stone gutters | 46 | US $/m³ |
| | Stone gutters | 2 | US $/m³ |

*Source*: (Malesu et al., 2007)

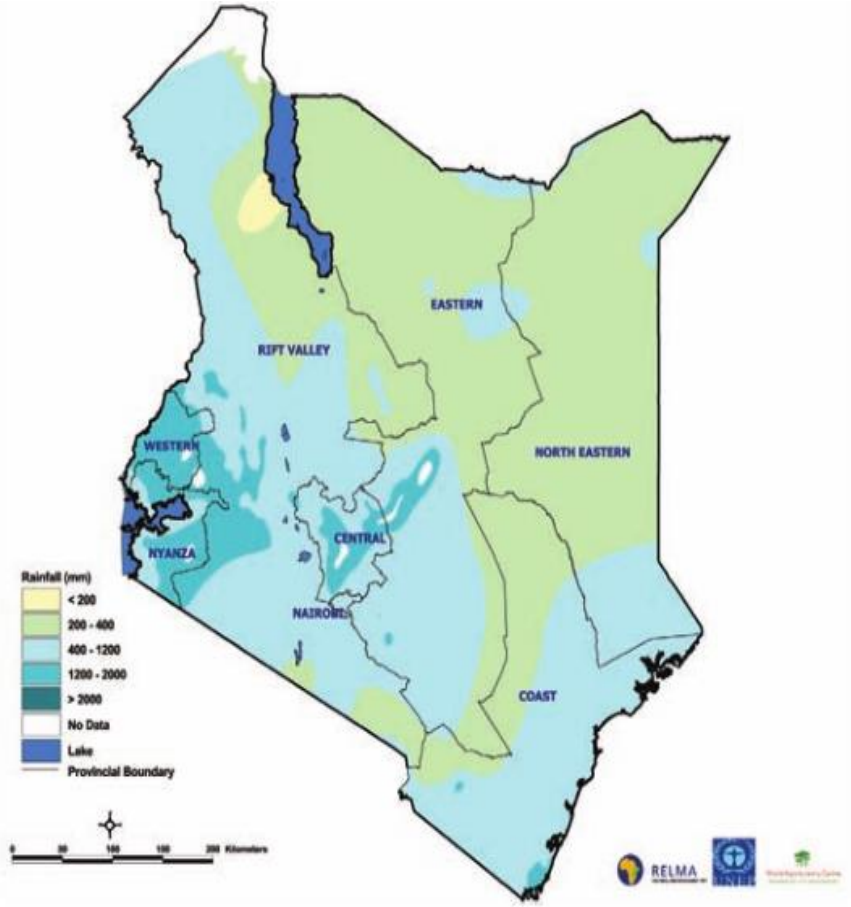
**Estimating the Rainwater Harvesting Potential in Kenya**

According to Nissen-Petersen (2006) water demand estimates could be established through simple calculations based on water needs per use. For instance, the water use per person if estimated at 14 litres per day and a typical African household is taken to consist of eight members, for a season (182.5days) the water requirement would be 20,4400 litres (8people x14 litres x182.5days). Water requirement for thirty-five animals for a season would be estimated at 90,000 litres, while for farming on a quarter acre the water need would be 91,250litres. The total estimated water demand for a household would be estimated at 202,940 litres (202.9 cubic meters). By applying these estimates contractors could determine the capacity of structures based on the number of households in the locality, which were expected to use the facility. Nissen-Petersen (2006) further advised that, in determining the capacity of open reservoirs such as dams, it was important to take into account loss of water through seepage (estimated at 25% of the water in the reservoir) and evaporation (estimated at 50% of the water in the reservoir) even though this depends on whether the dam is lined or not, the soil texture and whether the location is shielded or not.

Even though currently there are no integrated national statistics that could give an elaborate picture of the rainwater potential in Kenya , researchers have been making effort towards this goal with the aim of generating data for enhancing advocacy for RWH (Malesu et al., 2007a). Malesu (2017) indicates the estimated potential for RWH in Kenya through roof catchment to be over 350 billion cubic meters while Mati (2015) gives an example of Nairobi city which has a mean annual rainfall of 1062mm and thus a potential of 596, 485 m3/day assuming 30% rainwater capture. Mati, therefore asserts that Nairobi city could meet 86 % of

water needs if 30% of rainwater was captured. Malesu et al. (2007a) in a mapping of the rainwater potential in 10 African countries, Kenya included, used base maps to illustrate these potential. According to Malesu et al. (2007a) any area with annual rainfall of 200mm and above has a potential to capture as much roof harvesting water as an area with an annual rainfall of 2000mm. The map below showing the annual rainfall of various regions in the country shows that most of Kenya receives annual rainfall of 200mm and above which means that a greater proportion of Kenya is conducive for roof catchment.

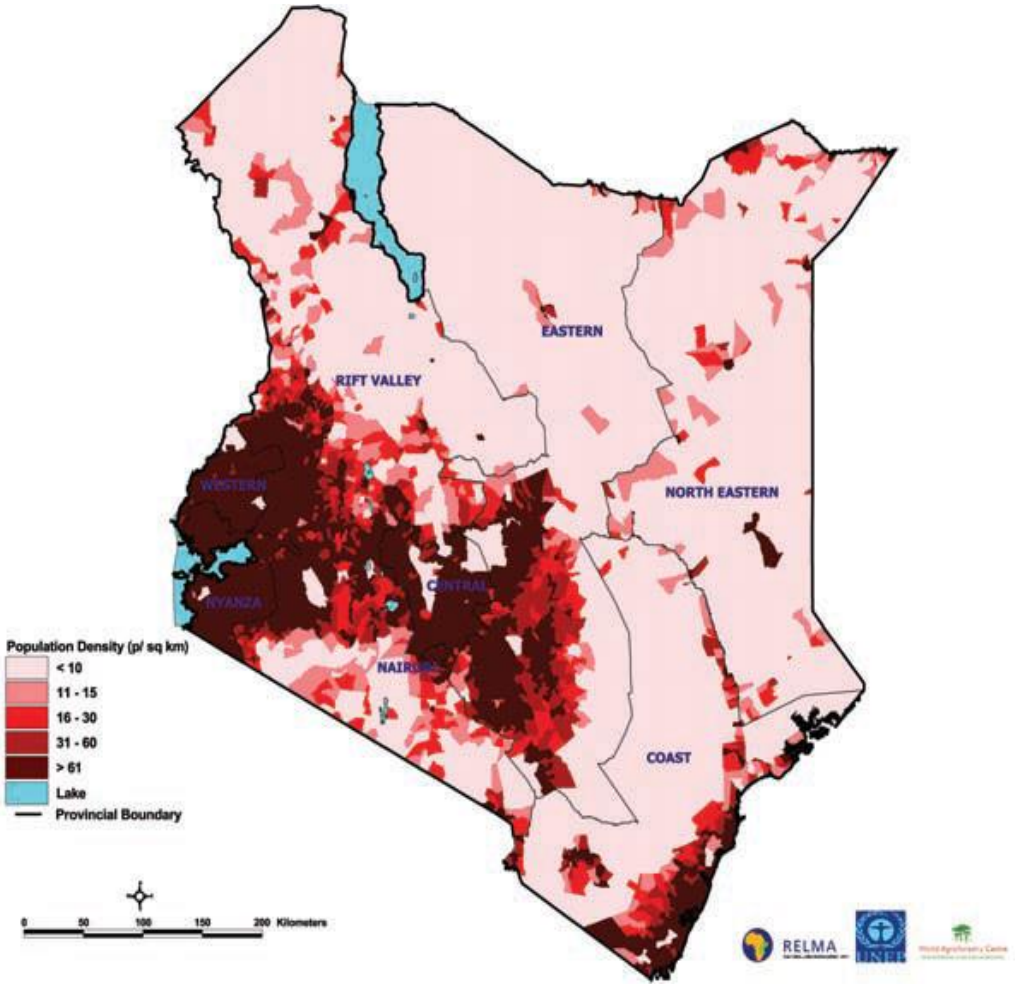
Figure 9: Annual Rainfall Map




*Source:* Malesu et al. (2007a)

However, the amount of roof top catchment would depend on population density. An area with high population density would have more catchment areas due to more structural roofs than in sparsely populated areas. The map below shows that even though most of Kenya has a roof top catchment potential, especially due to rainfall levels, many areas, especially, the North Eastern parts of the Country are very sparsely populated. Therefore this would affect the estimated catchment.

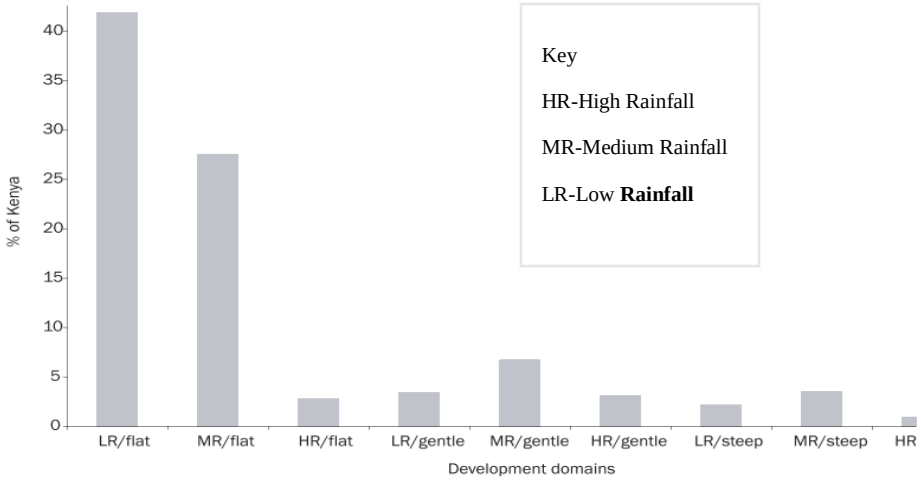
Figure 10: Population Density Map




*Source*: Malesu et al .(2007a)

On the other hand in estimating the potential for runoff RWH, the gradient has been used as a basis in addition to the annual rainfall. The chart and accompanying table below show that the harvestable rain water based on gradient and annual rainfall in regions across the country ranges from 0.52 to 38.96 cubic kilometer.

Figure 11: Possibility for Runoff Water Harvesting




| Area of Kenya | LR/flat | MR/flat | HR/ flat | LR/ gentle | MR/ gentle | HR/ gentle | LR/ steep | MR/ steep | HR/ steep |
|---|---|---|---|---|---|---|---|---|---|
| In Km | 246318 | 162256 | 16187 | 20034 | 39339 | 18103 | 12836 | 20708 | 5430 |
| In % | 41.9 | 27.6 | 2.8 | 3.4 | 6.7 | 3.1 | 2.2 | 3.5 | 0.9 |
| RD coefficient | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Rainfall min (m) | 0.2 | 0.4 | 1.2 | 0.2 | 0.4 | 1.2 | 0.2 | 0.4 | 1.2 |
| Rainfall max (m) | 0.4 | 1.2 | 2.0 | 0.4 | 1.2 | 2.0 | 0.4 | 1.2 | 2.0 |
| Volume min (Km) | 9.84 | 13 | 3.88 | 0.8 | 3.16 | 4.36 | 0.52 | 1.64 | 1.32 |
| Volume max (Km) | 19.72 | 38.96 | 6.48 | 1.6 | 9.44 | 7.24 | 4.96 | 4.96 | 2.16 |

*Source*: Malesu et al. (2007a)

Malesu et al. (2007a) estimates for in-situ RWH showed that the harvestable rainwater for medium rainfall regionsranges from 2.3 cubic kilometers in low rainfall areas to 30.8 cubic kilometers in high rainfall areas(which constitute 5.2% of the total area in Kenya) as shown in the table below.

Table 4 : Development Domains for In-situ RWH

| Area of Kenya | Low Rainfall | Medium Rainfall | High Rainfall |
|---|---|---|---|
| In Km | 22555 | 36623 | 30771 |
| In % | 3.8 | 6.2 | 5.2 |
| RO coefficient | 0.5 | 0.5 | 0.5 |
| Rainfall min (m) | 0.2 | 0.4 | 1.2 |
| Rainfall max (m) | 0.4 | 1.2 | 2.0 |
| Volume min (Km) | 2.3 | 7.3 | 18.5 |
| Volume max (Km) | 4.5 | 22.0 | 30.8 |

*Source*: Malesu et al. (2007a)

The base maps portray RWH potential, even though they are limited in detail.

**Summary of Laws Relating to Rainwater Harvesting in Kenya**

The Constitution of Kenya 2010, Article 21 stipulates that the state should pursue legislative and other measures including application of standards to achieve progressive realization of economic and social rights. Sector strategies and policies such as agricultural

policies have articulated RWH in advancing social rights. For instance, the Water Act 2016 has also aligned with the constitution in promoting RWH ( Oguge & Oremo, 2014).

The Water Act 2016 recognizes the critical role that water resources development plays in the development of the country and takes into account the increasing population and demands. Therefore appropriate water resources and water services strategies have been developed (GoK, 2015). The National Water Harvesting and Storage policy which promotes RWH, storage, conservation and management at the counties and National is being finalized (GoK/MWI, 2012)

The Agriculture Sector Development strategy emphasizes shifting from rain-fed agriculture to irrigated agriculture which can only be achieved by encouraging stakeholders to invest in RWH infrastructure to store and access water upstream while stabilizing river flow downstream (Oguge & Oremo, 2014).

According to Oguge and Oremo (2014), various Policy Papers and Development Plans contain irrigation development plans and strategies which also entail promote water harvesting. Examples include Sessional Paper no. 1, 1994, Sessional Paper No. 2, Sessional Paper No. 4, 1981, Economic Recovery Strategy Paper 2003-2007, Strategy for Revitalizing Agriculture 2004-2014, Irrigation and Drainage Master Plan, which states that irrigation through water harvesting, is key to reducing climate risk and achieving food security among other goals.

Oguge and Oremo (2014) also indicates that RWH is articulated in Kenya Vision 2030, National Policy for Development of ASALs, National Land Policy, Climate Change Adaptation Strategy and National Climate Change Action Plan, all of which recognize the role of reliable water supplies in spurring agriculture and National growth. The National Climate Change

Action Plan calls upon Government and other stakeholders to implement interventions to increase capture and retention of rain water enhance campaigns for water harvesting and scaling-up of surface run-off water harvesting and roof RWH technologies (GoK, 2013) but as explained in Table 5 some of these policies have not had the requisite commitment to foster RWH due to lack of specificity and poor coordination.

Inadequate financing and unspecified articulation of activities has seen most of the proposed activities in the above stated strategies go unimplemented (Oguge & Oremo, 2014). Inconsistency of past policies to support RWH comprehensively is also pointed out yet the potential of a city such as Nairobi was enough to meet its water supply deficits. However, in 2008, a ministerial declaration to include RWH infrastructure in all new city buildings seemed to reverse this situation.

Table 5, delineates the past and present policies adopted by the successive governments of Kenya and their implications in the development of RWH in the Country over the years.

**Table 5: Water Resources Policies and their Implication on RWH in the Country**

| Policy | Provisions for RWH | Implication on RWH Outcomes |
|---|---|---|
| Municipalities and City by-laws chap,265, cap (138) of the Local Government Act (RoK, 1963) | Prohibited RWH in the Central Business Districts for fear of pollution( Mati, 2015.) | Flooding in the cities due to non-capture of run-off or improper direction of run-off. |
| Presidential decrees and ministerial declarations 1980, 2008 (Berger, 2011, Mati, 2015; oire,2009) | In 1980s , president declared that all public schools install Rooftop water harvesting tanks. In 2008, the minister for Nairobi Metropolitan, declared that all upcoming buildings should have provisions for RWH. | Both declarations gave impetus to RWH, even though there was no policy to fall back on and |

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| | | stagnated but the latter one has coincided with policy shifts in support of more proactive RWH. |
| The National water resources management policy 1999( Gok, 1999) and Water Act 2002 (GoK, 2002) | The GoK sought to institutionalize the water governance and established various institutions that were to manage both water resources and water services provision.<br><br>Involved non-state actors in water resources management and water supply provision.<br><br>Relegated water resources development to Ministry of Water (MWI) and ministry of Agriculture (MOA), whereby water storage rested under MWI whereas irrigation rests in MOA. | Created room for community water projects to be recognized water suppliers but lacked explicit measures to up-scale RWH.<br>- It did not include RWH as part of national water resources management. It only recognized water only surface and ground water resources(Oguge & Oremo, 2014). |
| Kenya Vision 2030 Statements on Water promise( ROK /NESC, 2007) | Some of the proposals in Vision 2030 are that Water and Sanitation are available and accessible to all, improving water resources management, storage and harvesting capability constructing multipurpose dams<br>enhancing disaster preparedness and improving the capacity for adaptation to global climatic change.<br>Increase irrigation from 140,000 to 1.2 million ha.<br>Improve water harvesting and storage capacity as one of the | Recognizes that RWH is an option for increasing water security, however no solid commitment on financial ramifications. |
| Water storage draft bill, 2012 ( MWI, 2012) | Outlined specific measures and targets for RWH in the country | Has not yet been implemented, has been in draft |
| Kenya Constitution (RoK, 2010) | Article 43(c) states that "every person has a right to be free from hunger and to have adequate food of acceptable quality and to clean and safe water in adequate qualities" ( | - Implicitly stipulates the need to water security. |

| | | |
|---|---|---|
| | RoK, 2010).<br>Devolved water governance to 47 counties. | -Emergency of trans-boundary water issues, in particular, relating to the mega dams. |
| Water Act 2016 (GoK/MWI, 2015) | Recognized RWH as a viable solution to water scarcity in Kenya (Oguge & Oremo 2014).<br><br>Establishes creation of National Water Harvesting and Storage Authority that will set a framework for expansion for national water storage from 130 million cubic meters to 4.5 billion cubic meters. | Aligns RWH with the constitution recognizing water security as a right and promotes RWH as an option for water security (Oguge & Oremo, 2014) |
| National land reclamation policy and strategy(RoK, 2013) | Recognizes the need to build community resilience to changing climate. | |
| Agriculture sector development strategy2010-2020 ( RoK, 2010) | Reiterates need to shift from rain-fed to irrigated agriculture. | |
| National development plans ( Gok, 1981, 1994, 2003) | Sessional Paper no. 1, 1994, Sessional Paper No. 2, Sessional Paper No. 4, 1981, Economic Recovery Strategy Paper 2003-2007, Strategy for Revitalizing Agriculture 2004-2014,<br>They state that irrigation through water harvesting is key to reducing climate risk and achieving food security among other goals. | Low or no structural or operational implementation (Oguge & Oremo, 2014). |
| Sessional Paper No.8 of 2012 on National Policy for the Sustainable Development of Northern Kenya and other Arid Lands(RoK, 2012) | States the need to promote water harvesting to ensure food security in collaboration with the regional development authorities and investing in water harvesting, water supply and irrigation infrastructure (Oguge & Oremo, 2014). | |
| National climate change Adaptation Strategy (GoK, 2009) and Climate Change | Recognizes water harvesting such as sand dams as a climate change adaptation strategy and encourages building of dams for water storage to support irrigated agriculture. | |

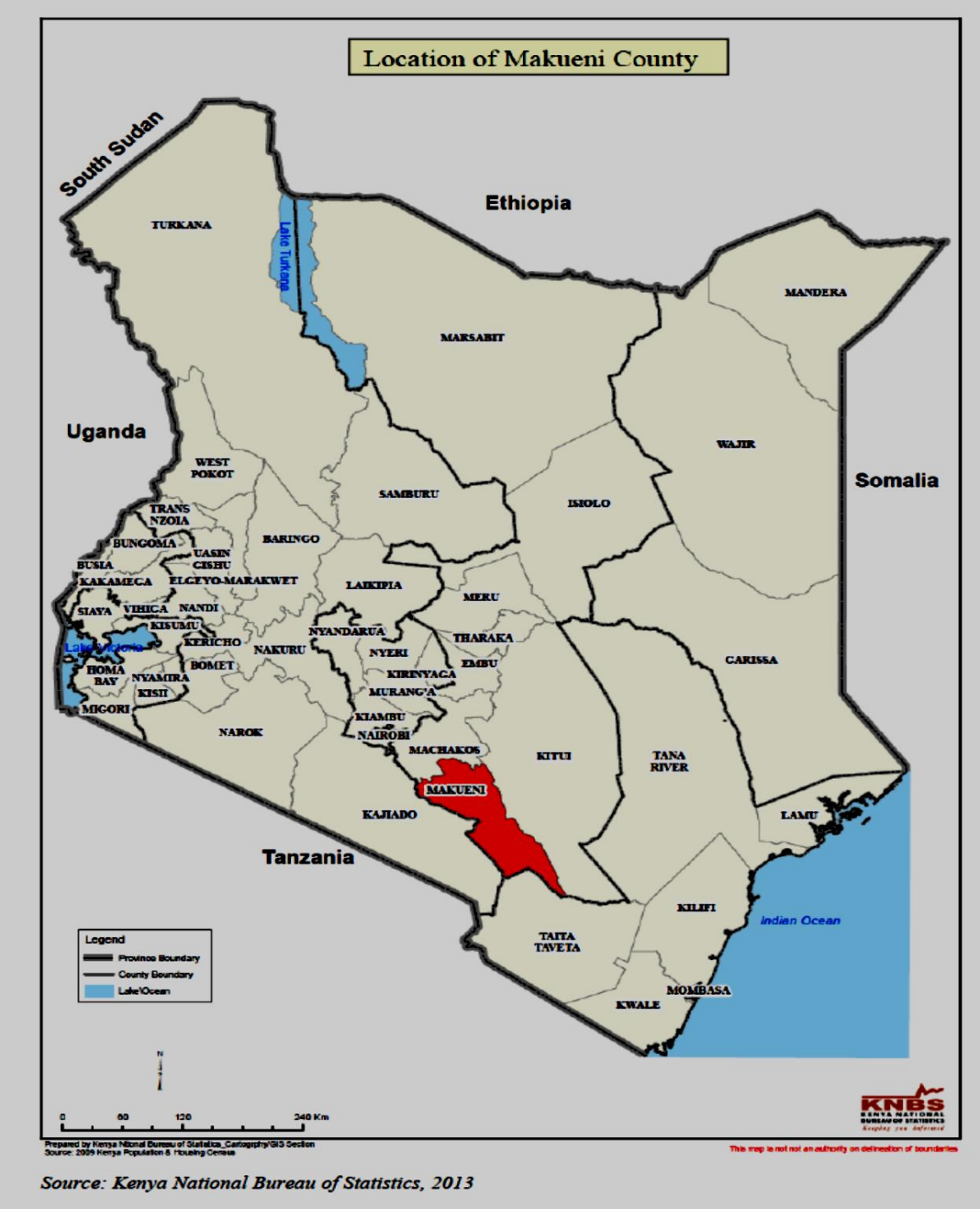
| | | |
|---|---|---|
| Action Plan | Action plans include increasing capture and retention of rainwater, enhancing campaigns on RWH, and up-scaling run-off and rooftop harvesting | |
| National Land Policy ( RoK, 2010) | Supports development and implementation of RWH. | Lack of clear land ownership delimitation inhibits implementation of communal projects. |
| Irrigation Act ( RoK, 1966) | Establishes irrigation boards and regulates irrigation activities | |

*Table By*: J. Mang'era

Table 5 shows that prior to 2012 there were no specific RWH policies except for recognition of the necessity of RWH and integration of some RWH activities in various sectorial strategies and policies. This lapse in policy has been associated with the poor performance of RWH in the Country (Oguge & Oremo, 2014). Efforts to develop a comprehensive RWH policy started with the water storage policy in 2012 and subsequent Water Act 2016 both of which are elaborate on RWH priorities in the country.

**Makueni County**

*Figure12:* Location of Makueni County in Kenya




*Source: Kenya National Bureau of Statistics, 2013*

This study aimed to investigate RWH practices in semi arid lands, hence, Makueni County, happened to be a suitable site since it falls within the semi-arid region. Other reasons that favored Makueni County for this study were its geophysical conditions that favor RWH. For instance, an average annual rainfall` that ranges from 200mm to 400mm is harvestable through a number of technologies. This enabled accessibility to varied RWH technologies that were studied in this research. These factors are discussed further in subsequent chapters.

Makueni County covers an area of 8,034.7$Km^2$and is currently divided into nine sub-counties and twenty-five divisions (Makueni Integrated Development Plan (MIDP), RoK, 2013). The sub-counties are Makueni, Kilungu, Mukaa, Kolwezi, Kathonzweni, Makindu, Mbooni East, Mbooni West and Nzaui (MCID, 2013). The population is estimated at 884,527 (Kenya Population and Housing Census, 2009). The county is largely arid and semi-arid and prone to frequent droughts with the low lying South Eastern region, which is very dry, receiving little rainfall, ranging from 300mm to 400mm (RoK, 2013). The decreasing rain in the southern part of the County cannot sustain the major staple food of maize and beans, hence livestock raising is a major economic activity.

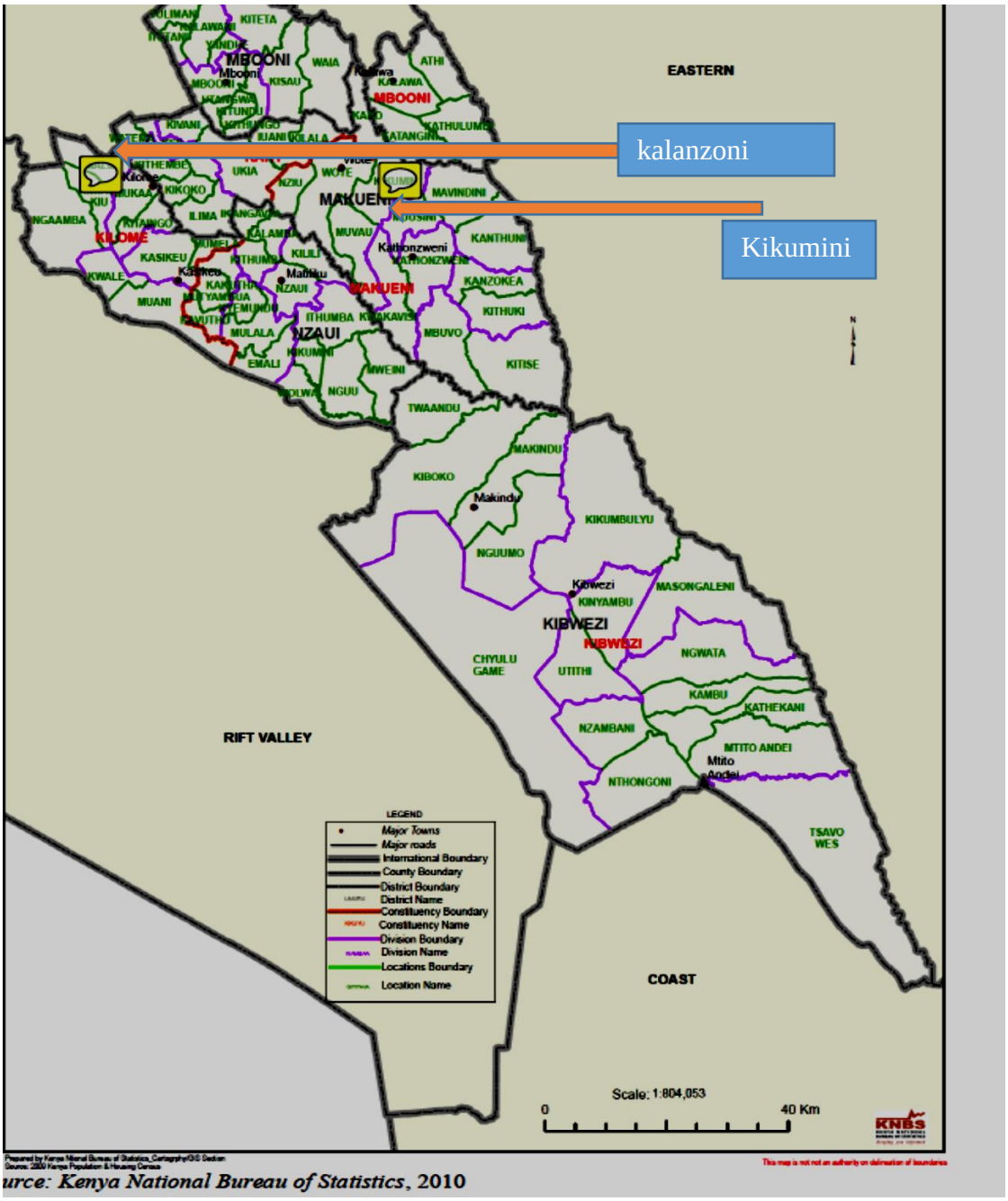
According to the MCIDP (2013), the county experiences two rainy seasons, the long rains occur from March to April while the short rains occur from November to December and the dry period is between May and October. The hilly parts of Mbooni and Kilungu receive 800-1200mm of rainfall per year. High temperatures of 35.8 C are experienced in the low-lying areas causing high evaporation which exacerbates the dry conditions. MCIDP (2013) further indicates that climate variations and extreme differences in temperatures can be explained by difference in altitude so that the areas to the north such as Kilungu an Mbooni hills are usually cool with

temperatures ranging from 20.2 C to 24.6 C, while the low-lying areas of the South such as Kitise are usually hot). The northern part of the county is hilly with medium rainfall ranging from 800mm to 1200mm (MCIDP ,2013) has high potential for food crop production and has few natural and planted forests; the area is therefore suitable for horticulture and dairy farming (RoK, 2013).

One of the clusters of study was Kalanzoni location, which falls under the former Konza Ranch. Konza Ranch was established during the colonial time, first as a grazing scheme under the 1954-59 Swynerton plan. According to Masai (2011), after independence the Government of Kenya encouraged the formation of co-operative societies and land buying companies to acquire white-owned ranches and farms. Konza Ranching and Farming Co-operative Society was formed in 1964. Masai goes on to explain that most farms in the area which were purchased under those terms have since been sub-divided. These include Ngaamba, Kalembwani, Malili and Aimima Kilungu. Public utility land includes roads, hills, dams, boreholes, zero plots, cattle dips, water tanks, schools, hospitals, administration plots and quarries all of which have since been handed over to the residents.

Another study cluster was Kikumini location, which constitutes one of the five locations in Wote division of Makueni County. Wote divisioon holds the county headquarters (Wote Town) with a population of 10,299 people accounting for 28 per cent of the total urban population in Makueni County. However the projects studied in this cluster were outside the urban area.

Figure13**:** Makueni County Administrative Units/ Political Units and Location of Study Sites




Source*:* Kenya National Bureau of Statistics (2010)

**Socio- Economic Context of the Study Population**

According to the Makueni County Integrated Development Plan (2013), the estimated population in the county was 922,183 consisting of 449,036 males and 473,147 females. This is an increase from 884,253 persons in the 2009 Kenya National Population and Housing Census (RoK, 2009, MCIDP, 2013). The annual population growth rate is 1.4 per cent while the male-female sex ratio stands at 100:105. The main language is Kamba with Kiswahili and English used to a smaller extent (MCDIP, 2013).

Of the total population, 471,451 persons constituted the labor force including 247,321 females and 224,129 males(MCDIP, 2013). This is about 51.1 percent of the total population. Most of the people in the labor force were either unskilled or semiskilled. Most of the inhabitants are engaged in agriculture which was the main source of income in the County (MCDIP, 2013). In 2013, agriculture accounted for seventy-eight percent of the total household income followed by wage employment at ten percent while rural and urban self-employment contributed eight and four percent respectively. Due to the arid nature of the county, agriculture, which is the main economic activity, has been performing poorly. This situation has limited the sector's capacity to create much needed job opportunities (MCICDP, 2013).

The Mombasa-Nairobi highway has enhanced the income from trade. However, trade and well as other sources of income are limited, which has led to overreliance on poor performing agriculture. As a result the poverty rates in the county have risen in the recent decades. Rural and urban self-employment contribute eight and four percent of the household income source. Some of the people in Makueni County are involved in light industries especially in the *jua kali* sector which they produce for the local market. This includes dye making from tree barks & roots,

ciondo, mats, baskets and wooden carvings. The county has seven *jua kali* associations employing 1,000 artisans (MCICDP, 2013).

Sand, in the rivers and streams, is the major mineral resource available for the people of Makueni. Sand harvesting, however, remains illegal in the county and this makes it difficult to obtain data on amount harvested and personnel employed in this informal sector. Sand harvesting has also contributed to soil erosion of river banks. Due in part to environmental degradation and climate change, the county is experiencing increasing dry spells. (MCICDP, 2013).

## Chapter Summary

RWH has been practiced in Kenya since pre-colonial times, and a variety of technologies have been in use. However, there is poor coordination of policies and scaling-up investment levels towards RWH from the GoK. The policy environment was found to be improving in terms of support to RWH activities with the enactment of Water Act 2016 which is more explicit in facilitating RWH. Water scarcity in Makueni with depleted surface and underground sources due to the erratic nature of rainfall, has negatively affected livelihoods (MICDP, 2013). With a 200mm mean annual rainfall the county has potential in rain water to address the water scarcity. However this has not been harnessed due to various factors that will be explored in subsequent chapters.

# Chapter 3 - Literature Review

## Introduction

The chapter reviews the literature relevant to the study under the following themes: why rainwater harvesting, climate change and the need for RWH, water governance framework and RWH management, (and existing gaps) as well as theoretical perspectives that shed light on governance issues of RWH. The theoretical perspectives with potential to contribute to the study include: tragedy of the commons (Hardin 1968), governing the commons (Ostrom, 1990, 2008), institutional dynamics including the concepts of fit interplay and scale (Young, 2002) and multilevel governance (Berke &Folke, 1998; Folke et al., 2005; Holling, 2002). In this chapter, I thus, discuss the theoretical issues that were introduced by these authors, and which shaped analysis in various ways. While little research has been conducted on social aspects of RWH in Kenya, the last five years have seen a growing interest in the topic (Oguge & Oremo, 2014).

## Why Rainwater Harvesting

Researchers, Civil Society Organizations and scholars envisage that effective RWH will contribute to enhanced water security and resilience to the impacts of climate change for communities in arid and semi-arid regions of Kenya and may have generalizable benefits for other African countries (Malesu et al., 2007a; Ngigi, 2003, 2004; RoK/ NESC, 2007 p.97).

Worm and Hartum (2006), observe that dwindling levels of groundwater and surface waters, coupled with overall increased demand for water resources due to population growth, has seen

many communities all over the world approaching the limits of their traditional water resources. Therefore, communities have to turn to alternative or 'new' resources like rainwater harvesting. Worm and Hartum (2006) also emphasize that, globally, RWH has thus regained importance as a valuable alternative or supplementary water resource. Consequently, utilization of rainwater is an option along with more 'conventional' water supply technologies, particularly in rural areas, but increasingly in urban areas as well. In their opinion, Worm and Hartum (2006), RWH has proven to be of great value, especially, for arid and semi-arid regions.

According to the strategy for revitalizing agriculture 2004-2014, the Government of Kenya (GoK) recognizes that surface water and groundwater are depleting very fast because they are being over-extracted, and it is therefore vital to promote water harvesting technology on farms to reduce reliance on river water resources (GoK/Ministry of Agriculture and Ministry of livestock and Fisheries, 2004). Malesu et al. (2007b) explains that, "this strategy would include increasing the use of RWH techniques such as roof catchment, pans, water holes and run-off diversions, all of which are now being employed in limited ways in different regions of Kenya" (p. 196). This is also reiterated in the Water Sector Strategic Plan 2010-2015 (MWI, 2010), which states that the country needs to reflect a major paradigm shift in its focus from "extraction and distribution of water" to overall objective of "replenishment, conservation and development of water resources"(MWI,2010). This would depend largely on how water capture and storage is managed. For instance, Weismann et al. (2000), has outlined the sensitive situation of the highland-lowland system of Mount Kenya, where the overutilization of river water in the dry season by upstream users leads to conflicts with downstream users because of reduced flow downstream. Therefore, as explained by Ngigi (2003), application RWH would avert such crises

by reducing overreliance on the streams hence easing pressure on the stream flow of the entire watershed.

Finally, rainwater has been considered cheap as compared to piped water, it is also non-exhaustible and can help ameliorate water stress among the most affected in the arid and semi-arid lands (Malesu et al., 2007). In fact, Ahmed, Mustafa, and Nasir (2011) reveal that RWH technology is a viable, profitable, women-friendly and sustainable source of water supply, while Lehmann et al. (2010) points out that, the adoption of RWH made some significant contributions to achieving the "Millennium Development Goals" since it promoted access to water, improved health (Garrett et al., 2008), enhanced food security (Ngigi, 2004) and lessened burden of searching for water by women, hence contributing to empowerment of women.

## Climate Change and the need for Rainwater Harvesting in Kenya

Climate change is one of the most serious threats to sustainable development facing the globe (MEMR, 2010). In fact, one of the findings of the Intergovernmental Panel on Climate Change (IPCC) is that, millions of people will be exposed to increasing water stress, which will render food security in many African countries severely compromised implying that adaptation would be critical (IPCC, 2007). IPCC (2001), states that, "adaptations, which can be autonomous or policy-driven, are adjustments in practices, processes, or structures to take account of changing climate condition" (p. 89)

In Kenya the phenomenon of climate change is already unmistakable and intensifying at an alarming rate as evident from countrywide temperature increases and rainfall irregularity and intensification (Ministry of Environment and Mineral Resources (MEMR), 2010). Extremes of climate accelerate the degradation of environment through increasing heavy flooding and

prolonged droughts (MWI, 2010). The results are loss of property and lives, siltation of dams, rationing of water and power and increased difficulty in environmental restoration such as reforestation (MWI, 2010). Continued worsening of the country's water shortage situation which, at 647 cubic meters per capita per annum, was considered water scarce (MWI 2010) is expected as climate change affects overall precipitation patterns (IPCC, 2007).

Since Kenya's economy is dependent on agriculture which is mostly rain-fed, reduced and sporadic precipitation affect both crop and livestock production and consequently leads to disintegration of livelihoods especially in the moisture stressed ASALs which are considered vulnerable and therefore more susceptible to impacts of climate change (Ngigi, 2004, p. 230). Vulnerability is defined as "the extent to which a natural or social system is susceptible to sustaining damage from climate change" (IPCC, 2001, p. 89). Vulnerability is viewed as a function of diverse historical, social, economic, political, cultural, institutional, natural resource, and environmental conditions and processes (IPCC, 2012). Therefore, to address vulnerabilities associated with impacts of climate change on the water sector and strengthen community resilience and adaptation, appropriate measures such as RWH are needed to improve the community adaptive capacity (Ngigi, 2003). This is especially critical for communities in marginal lands which are considered very vulnerable to climatic changes (Ngigi, 2003). Resilience, on the other hand, is defined as:

> The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a potentially hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions. (IPCC, 2012, p. 883)

Kahinda et al. (2010) states that, in the IPPC report 2007, RWH was listed among the specific adaptation measures that the water sector in Africa needed to undertake to cope with future climate change because of its high potential for addressing the impacts of climatic change on water security but that there has been little progress towards this end, in Kenya. In addition, approval and implementation of the -draft national RWH policy and strategy was also required in order to increase application of RWH in the country (MWI, 2012). Ngigi (2003) further notes that, RWH is one of the most appropriate and inexpensive technologies to reduce the level of vulnerability to water scarcity shocks and enhance sustainable livelihoods in moisture stressed ecosystems.

**Water Resources Governance Framework in Kenya**

In a quest to identify the issues in the management of RWH in Kenya, it is important to understand the general water resources governance structure. The history of the water and sanitation sector in Kenya was characterized by institutional fragmentation that led to numerous inefficiencies and subsequent attempts at reform (WHO/UNICEF, 2014). According to Obosi (2011), since independence (1963) to 2003, GoK had undertaken the responsibility to supply water to its citizens through the Ministry of Water Development. The government did this through Local Authorities, especially in urban centres whereby the government would sell water in bulk to the Local Authorities who would in turn sell it to its customers. Each local authority in Kenya had distinct Department of Water and Sewerage. Where it was felt there was no viable water service provider (Local Authority), GoK supplied water to the local area directly through the National Water and Conservation & Pipeline Corporation (NWCPC). Through the Water Act

2002, the GoK sought to institutionalize water governance and established various organizations that were to manage both water resources and water services provision (K'Akumu, 2005).

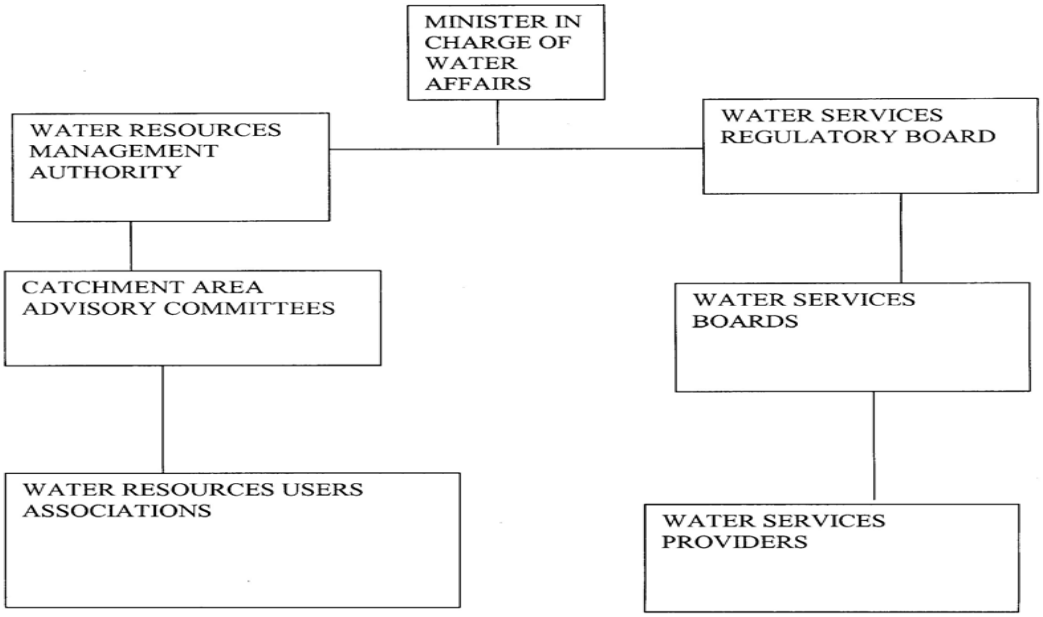
Alternative and Independent water suppliers to supplement the supplies of water to urban and rural dwellers that get unsatisfactory or no services from the conventional piped water network were engaged in the form of water kiosks and private vendors (Obosi, 2011). The "private" component could be a private company but also a group of citizens united in a community-based organization (CBO) and either supported (or not) by one or more NGOs (K'Akumu, 2007). Water kiosks are a form of public-private partnership whereby the government provides water to the kiosk where it is re-sold to the local customers. Private water vendors are "informal" and/or small-scale operators who provide water (and sanitation) services in mostly low-and middle-income neighborhoods (K'Akumu, 2007).

This was one way of Government attempting to introduce public participation in water resource governance similar to structuring of property rights (Bromley, 1991) by assigning property rights over water supply to private individuals to improve governance of water services. However the drawback with the Water Act 2002 was that it was not explicit on RWH activities as most of the focus was on surface and ground water development and therefore did not have much impact in the promotion of RWH in the country (Oguge & Oremo, 2014).

WHO/UNICEF (2014) in the joint water and sanitation monitoring report, further observe that, the Kenyan water sector underwent far-reaching reforms through the Water Act No. 8 of 2002. After the passage of the Water Act 2002, service provision was gradually decentralized to 117 Water Service Providers (WSPs). These were linked to 8 regional Water

Services Boards (WSBs) in charge of asset management through Service Provision Agreements (SPAs). The Act also created a Water Services Regulatory Board (WASREB) that carries out performance benchmarking and is in charge of approving SPAs and tariff adjustments. The Ministry of Water and Irrigation, (MWI) was charged with formulation of policies for water supply in the country, while the Water Resources Management Authority (WRMA) was relegated to water resources governance (MWI, 2012). See Figure 11 below for a diagrammatic overview of Governmental water governance in Kenya (not including non-governmental actors and other water institutions in Kenya).

**Figure 14: Kenya Water Governance Framework**




*Source:* MWI (2012)

In a bid to create room for public participation in water resource management, the Act also created the Water Resource Users (WRUAs) avenue. This was aimed at enabling community based water resource management. If the policy had been adequately explicit, it is through this channel that community based RWH projects could be championed and registered as water service providers but this opportunity has not been actualized due to low awareness (Oguge & Oremo, 2014).

## Rainwater Harvesting Organization and Management

According to the Water Quality Regulations of the legal notice No. 721, the Water Resource Regulatory Authority (WRMA) is mandated to regulate the management and use of water resources. As per the Constitution of Kenya 2010, every water resource is reviewed and held by the National Government in trust for the people of Kenya (RoK, 2010). The Ministry of Water and Irrigation (MWI) is responsible for directing and guiding rainwater harvesting in the country (MWI, 2014). However, at present, the MWI has focused its work on large-scale water supply projects, such as construction of reservoirs and paid less attention to community based rainwater harvesting (MWI, 2014). Policy guidance documents for water resources development in Kenya, such as, the Water Act 2002, Strategic Plan of the Ministry of Environment and Natural Resources 2005-2009, the Strategic Plan of the Ministry of Agriculture 2008-2012 and the Agricultural Sector Development Strategy 2010-2020 and Vision 2030, have not adopted RWH as an approach for achieving water security other than for developing supplementary irrigation (MWI 2014).

MWI (2014) indicates that, it is only recently (2012) that the city by-laws in Nairobi were reviewed to promote RWH as a source of water and also as a way of reducing flooding. So far there has been no specific laws, regulations and technical codes in Kenya relating to using rainwater for water supply and supplemental irrigation. However, the Water Act 2016 provides for a water storage authority and it is considered more aligned to the need to adopt RWH as a strategy for water security as compared to the previous legislations (Oguge & Oremo, 2014). Alongside the GoK agencies, CSOs supplement in the management of RWH in Country. For instance, the Kenya Rainwater Association (KRA), a local non- governmental organization (NGO), spearheads implementation of rainwater harvesting in Kenya (MWI, 2014). KRA is affiliated with the Greater Horn of Africa Rainwater Partnership (GHARP) and is the main local NGO focusing mainly on the organization and development of rainwater harvesting in Kenya.

Construction and implementation of RWH projects is mainly sponsored by international organizations, enterprises and individuals (MWI, 2014). Although recently rainwater harvesting projects in Kenya have received funds from international aid and cooperation programs as well as reserves from government budget of consolidated funds, MWI also indicates that the statistics of the total capital investment for RWH in Kenya has not been done by authorities so it is hard to discern the amount of investment in RWH (MWI, 2014).

At the local level, RWH is carried out at individual households' level or as a joint community venture (Malesu et al., 2007). The selling point is the technology's simplicity in terms of construction, usage and maintenance coupled with a reasonable price (Malesu et al.,

2007). For rural populations living in a scattered way, the main target groups served by RWH projects are schools, communities and households (MWI, 2014).

**Review of Related Research: Rain Water Harvesting Governance Gaps in Kenya**

MWI (2012) in a baseline study leading to the development of the National Water Master Plan (2013-2017), notes that there is lack of an institutional coordination framework for the development of RWH in the Country. Berger (2011) in his thesis research, reviewed existing policies in Kenya and concluded that the policy environment was not supportive to RWH, as the policies did not address RWH in a manner to propel growth in the sector. For instance, the community land tittles made it difficut for private projects to be implented. KRA (1999), also notes that the ministry in charge of water resources in Kenya had no mechanism of approving the construction of a ferro-cement tank or water jar since they did not have design standard drawings, and even some donor agencies lacked policy guidelines in support of rainwater harvesting.

UNEP (2005), in a study covering several countries in East and Central Africa, including Kenya, showed that that water laws did not deal with RWH as the direct collection of run-off and storage for later use but rather as a form of disposal of flood water. Even though Kenya had had a long tradition of RWH, no specific RWH policies had been in place to spell out measures to be implemented to advance the practice (Mutua, 2010). But as explained by Hartung and Partshull, (2001) lack of RWH policy impaired governance of RWH activities and because RWH operated without a governance framework, there were bound to be many limitations because while individual village-level projects might succeed in the short term, their long term

sustainability may be severely tested in the absence of an appropriate institutional and legal framework at all levels that fosters linkage, exchange and growth. The national water resources management policies, strategies and plans show that even though RWH was part of a national water strategy, it has not been duly prioritized (Malesu et al., 2007a) as shown by limited budget lines allocated from the consolidated funds for RWH as opposed to surface water or ground water development investments, which is attributed to attitude and poor understanding of the technology. Even though the Government of Kenya declared RWH compulsory for all public primary schools in 2006, Kenya's policies have not been explicit about rainwater as compared to for instance India and Sri Lanka where there have been successful RWH practices due to explicit RWH policies ( Berger, 2011; Mutua, 2010).

KRA (1999), in a survey of 6 districts (Bungoma, Kiambu, Taita Taveta, Siaya, Kakamega and Kajiado) on low cost individual and or small community based water projects i.e. springs, shallow wells and rainwater harvesting, found community-based water supplies much more efficient than centrally controlled large piped water schemes. KRA (1999), attributed this to a sense of ownership, community participation and contribution in the management of community based water projects which differed from government projects in which the water managers had little or no enthusiasm for including community members in the management. KRA (1999) also identified various managerial issues in community based rain water projects including, limited use of local resources, inadequate community participation and contribution, inadequate project management skills by community organisations, poor financial management and bookkeeping resulting in financial loss, lack of proper water usage and control measures, lack of awareness

and unwillingness to obtain legal status due to taxation, donor dependency syndrome and political interference within the community projects.

In order to improve this situation KRA (1999), suggested that legally formulated by-laws and registration of self-help water projects, improvement of financial and management skills through local training would enhance effective performance of RWH projects through guiding group operations and project management. For example, registered groups were bound by GOK laws on accountability and were more likely to attract development partners as formal entities. Furthermore, existence of group by-laws reduces conflicts or provides avenues for conflict resolution and promotes transparency in the appropriation of benefits. Kinyua (2005) in her evaluation of RWH projects in Njoro, Kenya, also observed that the adoption of rainwater harvesting was found to be poor because there was insufficient understanding of the technology by many farmers and extension officers, hence many who could otherwise benefit from RWH did not because of inadequate information (Ngigi, 2004).

Nilssen (2006) in his thesis on the history of urban water systems in East Africa, suggested that the improved water access data displayed by the United Nations is deceptive in that in most cases it entailed recording of access to an improved source that could as well be a communal stand pipe whereby people had to queue for hours to fetch a gallon of water. He advocated adoption of nested enterprises (multilayer institutions),such as advanced by Ostrom (1990) in extending water systems to unserved rural areas. According to Nilssen,this system worked successfully in Europe especially, Sweden, to enable water access in the rural areas.

Cain (2010) talked about the failure of large scale development projects to meet population water demands, and the fact that even where they were feasible they had large negative social and economic impacts. The writer emphasized a different path entailing efficient and sustainable community scale projects. He illustrated the success of small scale rainwater harvesting in India and lessons drawn by many scholars who have studied rainwater harvesting in India.

## Theoretical Perspectives

In trying to understand RWH practices, and what practices influence effective rainwater harvesting, it was important to understand how and in what circumstances communities are able to exploit and successfully manage the resources at their disposal. This literature review explores theoretical perspectives that help to explain community natural resource management including the Tragedy of Commons (Hardin, 1968) and Governing of the Commons (Bromley, 1991; Ostrom,1990, 2003, 2008) as well as institutional dynamics and design((Young 2002; 2003, 2008, 2009, 2010;Young et al., 2008) environmental governance (Biermann et al., 2009) and in particular multi-level governance (Berkes and Folke, 1998; Berkes et al., 2007; Folke et al., 1998) which seems especially important in the light of local to global water governance.

### Institutions and Water Resources Governance

According to Bromley, (1991) Institutions are made up of formal constraints (rules, laws, constitutions), informal constraints (norms of behavior, conventions, and self-imposed codes of conduct), and their enforcement characteristics; thus they shape incentives in human exchange, whether political, social, or economic. Institutions, such as property rights (the structure of rights

to resources and the rules under which those rights are exercised) are mechanisms people use to control their use of the environment and their behavior toward each other Thus institutions in this study are viewed as "Social practices that are based on the rules of the game but also include common discourses in terms of which to address the issues at stake, informal understandings regarding appropriate behavior on the part of participants, and routine activities that grow up in conjunction with efforts to implement the rules" (Scott & Richard, 2002 p. 62). Institutions, in this study, included national and county level laws, constitution and policies, government agencies, the local customs, property rights groups such RWH project groups and their sets of conduct, Civil Society Organizations and RWH networks.

Review of institutional dynamics literature shows that the new institutionalism movement that has gathered force in the recent decades in the field of social sciences has been facilitated by the need to understand the role that institutions play as determinants of the outcome of interactive human behavior or the links between micro motives and micro-behavior in various social settings (Schelling, 1978 p.138-166). In this regard, institutional design makes sense so long as it concerns understanding the ways institutions are likely to work in practice (Young, 2002 p. 5). Apparently, as explained by Young (2002) most contributors to the new institutionalism are comfortable with a point of departure that treats institutions as a set of rules, decision making procedures and programs that define social practices, assign roles among the participants in these practices and guide interaction among the occupants of individual roles .

This approach to institutions from a social practices perspective is relevant to RWH governance in Kenya because it indicates that institutions are more than sets of rules and

includes understandings, relationships, and trust as well as social norms in which case both formal and informal rules are fundamental. As observed by (Bromley 1991; Ostrom, 1990) formal laws governing resources might exist but the state might not get cooperation from the communities in their enforcement. However, in a structure of property rights where the state is in partnership with communities in governance of local resources such as where the community is accorded some decision making rights, collective action is highly likely. This important because in investigating effective management of RWH will involve the roles of the community and national and county level governments.

This thesis sought to build on the works of institutional theorists to understand how practices influence effectiveness of RWH in semi-arid Kenya. It is assumed that vibrant institutions would promote effective RWH. Ostrom (2008) refers to "robust institutions" in this regard. "Robustness" is construed to refer to a measure of the capacity of an institution to survive various pressures intact in the sense of withstanding the impact of destabilizing forces without suffering collapse or experiencing transformative change (Hasenclever, Mayer, and Rittberger 1999). Other scholars have argued that effectiveness of institutions to perform depends on their fit and match with surrounding the biophysical environment (Young, 2002, 2010; Young et al., 2008) and their ability to devolve functions across levels ( Folke et al., 2009).

This paper adopts the definition of an institution to include both informal and formal rules that guide water governance operations given that when communities come together and organize themselves to manage their resources, there is much more going on among them and are not only following directives or formal contracts by higher authority but have rights to make

decisions about issues affecting them. Moreover they are able to set their goals and their participation, views and decision making are accorded a central role. But, formal rules also have a fundamental role in governance of water resources, hence the need for linkages between communities and state and other involved stakeholders.

**Tragedy of the Commons and Water Resources Development**

The tragedy of the commons perspective (Hardin, 1968) describes how people could overexploit natural resources to the detriment of the entire community. Hardin (1968) stated that independent actors, each performing rationally and in their own self-interest, would deplete a shared resource to the point that the resource becomes degraded and unproductive for the entire community.

Hardin (1968) asserted that, the social arrangements that produce responsibility in the management of resources are those that create coercion. Such coercion, Hardin states, might come in the form of privatization of resources, forcing the exploiter of the resources to bear the cost of negative externalities or government regulation, including fines or imprisonment for nonconforming behavior. Hardin termed this system "mutual coercion, mutually agreed upon."

This meant that communities were not able to act independently to salvage their situation unless prevailed upon by external forces, for instance the Government enacting legislation rules to help the communities. Gleick (1993) stated that water has vital social, cultural, and ecological roles to play that cannot be protected by purely market forces, even though certain management goals and social values require direct and strong government support and protection. In line with

this direction, lack of supportive policies, regulations and operational guidelines for governing RWH has been cited as one of the factors behind poor performance in RWH (Hartung & Patschull, 2001; UNEP, 2005) even though this sort of framework doesn't infer coercion but guidance and coordination. However, contrary to Hardin's claims for "need for coercion", Kenya Rainwater Association (KRA) (1999, 2009) stated that community-based water supplies are found to be much more efficient than centrally controlled large piped water schemes.

Similar sentiments are held by Cain (2011) who also emphasizes on the sustainability of small scale community RWH projects as opposed to mega government projects. This could be attributed to the fact that rainwater is cheap and inexhaustible as explained by Malesu et. al. (2007). KRA (2003) also attributed success of small scale community based projects to the feeling of ownership among community members. This could be what Long (1990) alludes to in his work on actor-oriented approach when he asserted that human reaction and consciousness play a central role in engaging in collective action. He says that, even where structural conditions and types of external impulses are constant, behavior of actors can take diverse forms.

In the light of Hardin's argument it is possible to say that if there are legal guidelines provided and enforced by the government for exploitation of rainwater, there is bound to be better performance because this will stipulate responsibilities and entitlements. For instance, a policy will state how and what extension service will be provided, technology options available and what concessions will be applied to promote RWH, for example, subsidies on inputs, and the sort of implementation structure to be used. However, policy itself is not enough and does not

really guarantee sustainability. There are other attributes of institutions, other than the legal aspects, to be considered as we shall see below in the "nested institutions" perspective.

### Governing the Commons: Design Principles for Robust Property Institutions

Ostrom (1990, 2008) states that overtime communities have successfully managed resources using models that are neither market nor state like. According to Ostrom (1990, 2008) empirical evidence suggests that considerable variance in performance existed and many more local users self-organize and are more successful than it is consistent with conventional "tragedy of the commons" perspective. Ostrom (1990, 2008) observes that in the tragedy of the commons, appropriators are assumed to be homogenous in terms of their assets, skills, discount rates, and cultural views and are also assumed to be short-term, profit-maximizing actors who possess complete information. In this theory, anyone can enter the resource and appropriate resource units. Appropriators gain property rights only to what they harvest, which they then sell in an open competitive market. "The open access condition is a given" in which the appropriators make no effort to change. Appropriators act independently and do not communicate or coordinate their activities in any way.

Ostrom (2008) contended that, users of a common resource are not hopeless and that they can define their property rights. A property right is defined as "...a set of actions and behaviours that the possessor may not be prevented from undertaking in relation to a benefit (or income) stream" (Bromley, 1991; p. 2-3). According to Ostrom (2008), property-rights systems are viewed as *bundles* of rights rather than a single right.

These rights include access, which is a right to enter a defined physical property, and withdrawal, referring to a right to harvest the products of a resource such as timber, water, or food for pastoral animals (Ostrom, 2008). When related to RWH projects, access and withdrawal will relate to, for instance, rights to draw water from a project, like a dam, for domestic and production purposes. A withdrawal right can be attained through daily or monthly payment for drawing water.

Other rights include, management, which refers to a right to regulate the use patterns of other harvesters and to transform a resource system by building improvements (Ostrom, 2008). In relation to RWH projects, this entails the right of members to determine who draws water from their projects and the costs tied to that. On the other hand, exclusion refers to a right to determine who else will have the right of access to a resource (Ostrom , 2008). However, the right to exclusion in the RWH situation in Kenya may not necessarily be vested on individuals but collectively. Exclusion and transfer of rights is a collective decision by the management committee. Nevertheless there are exclusive situations in project management groups where members who are indisposed can be replaced by a family member. Lastly, alienation is a right to sell or lease any of the above rights (Ostrom, 2008).

Ostrom (2008) stated that the likelihood of participants engaging in collective depended on the size and heterogeneity of the group involved and how individuals were linked, the type of production functions users were facing, the type of transaction costs that a group faced, how easy it was to get good information about the results of past actions, and how valuable solving the problem was to participants.

Ostrom (2004), further defined the design principles of a robust institution as "the maintenance of some desired system characteristics despite fluctuations in the behavior of its component parts or its environment"(p. 6). Such an institution will have: defined boundaries which relate to who can enter, harvest, manage, and potentially exclude others; proportional equivalence between benefits and costs relating to the likelihood that participants will feel that the rules they are using are equitable; collective choice agreements meaning that most of the individuals affected by a resource regime are authorized to participate in making and modifying their rules; monitoring system which referred to the ability to monitor patterns of harvesting by other appropriators; graduated sanctions relating to the capacity to notice infractions and sanction conflict-resolution mechanisms and minimal recognition of rights to organize (Ostrom 1990, 2008).

In light of Ostrom's assertions, therefore, some of the defining characteristics of a strong community of RWH project management groups would include ability to define the boundaries of their RWH project, establish who was authorized to draw water and at what cost, penalties for breaking group rules, conflicts resolution systems and mechanisms for appropriating the proceeds from the water sales. This would be supported by creation of effective stewardship mechanisms for local rainwater resources and creation of multiple layer polycentric network of operators that can be dynamic, adaptive and effective over time (Ostrom, 2008). Such multi-level governance networks would link local water groups horizontally, link groups to nationals entities/promoters, link promoters to promoters, link groups to government agencies and other players. According to Young et al. (1999, p. 49) "the success of an institution depends not only on its own performance, but also on its interactions with other arrangements that have

overlapping jurisdictions." In addition to the above characteristics, the strength of the project group would emanate from their ability to work as a team and Ostrom (1990, 1998, 2001, 2005, 2008) found that establishment of trust and reciprocity was fundamental in cultivating the social capital needed for developing functional property right.

Other perspectives reviewed in contextualizing this study included those of institutional dynamics (Young, 2002, 2008, 2010) and multilevel governance (Berkes and Folke,1998; Folk et al., 2005; Holling et al., 1998).

**Fit, Interplay and Scale**

In explaining natural resource governance, Young (2002) and Young et al. (2008) applies the of institutional fit, interplay, and scale theoretical perspective. He showed how institutions interact both with one another and with the biophysical environment. Interplay involves "interactions occurring between institutional arrangements operating at different levels of social organization (vertical interplay) and between institutions at the same societal level (horizontal interplay) (Young, 2002, p. 23). Young and Underdal (1997) asserted that the effectiveness and the robustness of social institutions are functions of the fit between the institutions themselves and the biophysical and social domains in which they operate. These views were important in understanding effectiveness of RWH as it relates to linkages such as those between projects groups and government agencies, Civil Society Organizations and between projects conception and social customs and culture of the communities.

**Multilevel Governance**

Holling et al. (1998) states that in efforts to increase adaptive management and nestedness of institutions to enhance the resilience of ecosystem, not all centralized management institutions could be replaced by community-level institutions." Folke et al. (2005) stated that, governance issues have to be tackled simultaneously at several levels. Therefore, the role of centralized management agencies would not be eliminated but would be partly redistributed to local-level institutions and balanced. According to Young, King, and Schroeder, (2008), the management power and responsibility should be shared across different levels of social organization across-scale, among a hierarchy of management institutions, to match the cross-scale nature of environmental problems and to solve problems of overlaps and gaps.

The institutional dynamics and multilevel governance scholars identify the need for institutional linkages across sectors and levels. Vertical and horizontal interplay are important for ensuring institutional "fit" with social ecological systems. The RWH projects for instance would not be sustainable without linkages to the national level actors like the government agencies that provide policy direction and technical guidance, to the banks for credit, to the market for equipment and sale of produce and to other projects for exchange of ideas and solidarity.

**Common Property Rights and RWH Governance in Kenya**

Institutions could be contextualized defined as clusters of rights, rules, and decision-making procedures occurring at all levels of social organizations (Tanguilig & Tanguilig, 2009). According to North (1990), properties rights are institutions. Property rights can be divided into

private property rights where property rights (all the elements of a property right) are vested with an individual, common property rights where all property rights are assigned to a group of individuals collectively and every member of the group does not possess the rights individually but jointly with the other members of the group and open access in which property rights are held by no one in particular.

Property rights can also be structured in some resources where, for instance, in RWH governance, the state retains policy setting role while the community takes up management rights. According to Bromley (1991) and Ostrom (2008), this was considered to reduce cost of managing the resource by increasing the likelihood of cooperation. Bromley (1991) further noted that most often, the state laws defining property rights are not sufficient and rarely does the state have sufficient resources to enforce formal property rights. According to Bromley (1991) therefore, by resource users establishing appropriate property rights (not necessarily private or state) the transaction costs could be lowered sufficiently to enable cooperation and the dissipation of resource rent could be reduced. Ostrom (1990) suggested that enforcement is effectively undertaken within the collective, and in some cases intervention by the state may cause the cooperation to suffer. In light of Ostrom and Bromley's arguments, to a certain degree, when formal institutions exist to support enforcement of property rights, private property rights may be more effective but when these institutions are lacking, common property rights may be superior to private property rights.

In this study, community projects groups were analyzed as institutions that define and enforce property rights. The linkages between the project groups and institutions in the RWH

sector such as, the national and county level laws and policies, government agencies, CSOs, financial institutions, academic and research institutions and markets were also considered.

## Theoretical Model

The theoretical model illustrated in Figure 3 below describes the research problem in a model which posits that effective RWH could be achieved through improved management, particularly through establishment of effective governance institutions. The model is designed to analyze the existing RWH situation summarizing the opportunities and issues problems. For instance starting from the left the vulnerabilities indicate the existing gaps. These gaps included water scarcity, negligible water storage and reliance on surface water, inadequate knowledge and skills on RWH (Ngingi, 2003) and lack of RWH governance framework (Oguge & Oremo, 2014). The opportunities or assets that existed and could help transform the situation included RWH technology, good amounts of rainfall, RWH sponsors, and presence of local institutions in the community (Black et al., 2012).

Therefore given the factors stated above that constitute potential, it is assumed water scarcity is attributable to lack of policy and policy enforcement in RWH. However, if these opportunities were realized there should be effective RWH and water sufficiency. The research therefore, investigated the reasons why the RWH potential had not been utilized to promote water security and why Kenya continued to experience severe water shortages, especially in semi-arid lands. Hence the research investigated the RWH practices including the extent to which this situation was caused or exacerbated by the lack of an effective institutional or governance framework to foster RWH. The term “institutions” in the model was used in a sense

of capturing relationships and structures as described by Young (2002) and Scott and Richard (2002) in their definition of institution as:

> Social practices that are based on the rules of the game but also include common discourses in terms of which to address the issues at stake, informal understandings regarding appropriate behavior on the part of participants, and routine activities that grow up in conjunction with efforts to implement the rules. (p. 62)

The third box describes factors that could that could facilitate interplay between box one and three in the transformation of the situation in box one to box four. Box four represents the anticipated situation in which there are strong RWH institutions, which support effective RWH.

Figure 15*:* Theoretical Model of the Study

1 2 3 4

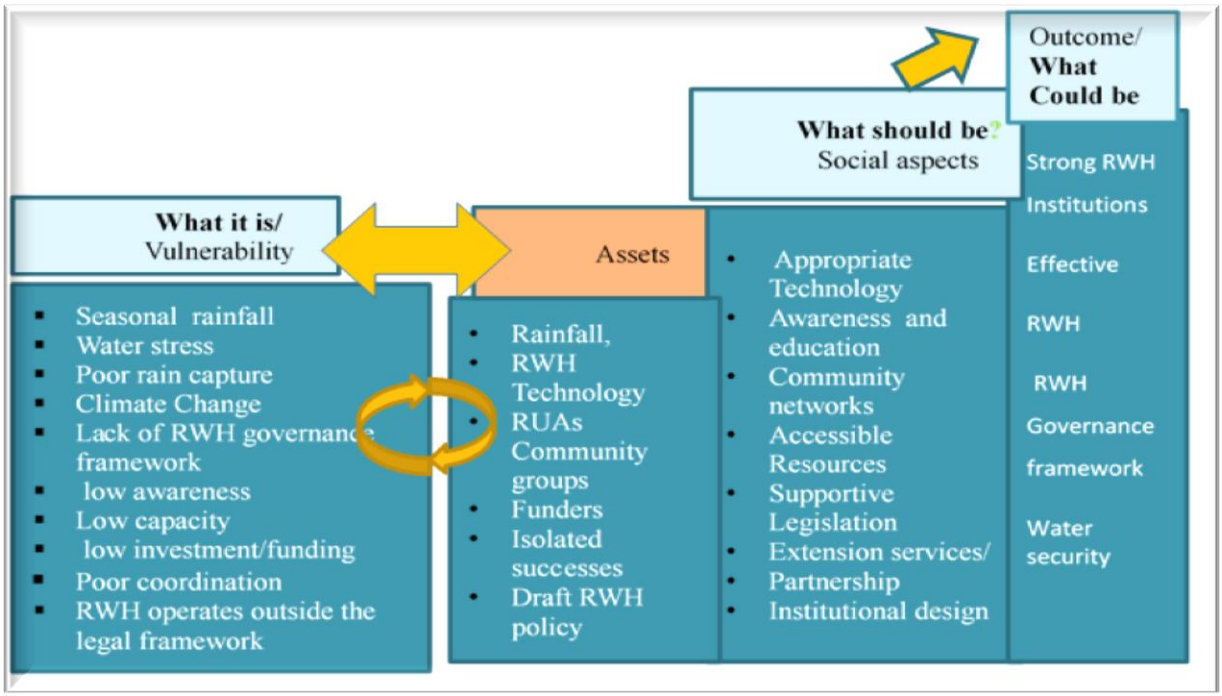



Figure By: J. Mang'era, 2017

**Chapter Summary**

The literature review in this chapter revealed that, even though RWH in Kenya was increasingly being considered as an option for water security, especially in semi-arid areas, there had been inadequate policy in the country to advance the growth of the practice. However, this was expected to improve with the enactment of the Water Act 2016 which was considered more favorable to RWH as compared to the Water Act 2002. An analysis of the theoretical perspectives that relate to management of resources, such as water, showed that institutions were critical in the management of natural resources. Whereas community based institutions, such as, property rights, were better placed to manage community natural resources, the role of the state and higher authorities was fundamental. The importance of linkages and interplay across

institutions was also viewed as critical, significant for effective governance, in this case water governance.

# Chapter 4 -- Research Methodology

## Introduction

This chapter presents the research methodology and design adopted for this study. The chapter includes a restatement of the research questions and objectives and then goes on to discuss the choice of methodology. The research design is discussed including the data collection techniques and the sources. The steps and methods applied in data analysis are also presented. The chapter ends with a statement of the process of upholding research ethics in this research and how both rigor and trustworthiness were assured.

## Research Objectives

The overall research objective was to explore, investigate, identify, and describe the rain water harvesting practices in semi-arid Kenya.

The study to investigate and identify current RWH practices, rainwater management organizations at community level and other levels of social organization (regional and national), and the linkages or interplays with other mainstream water services, water resources governance institutions and other actors or sectors.

## Objectives

Specific objectives of this study included:

i. To investigate rain water harvesting practices, challenges and successes in semi-arid Kenya.

ii. To identify and describe local and national water institutions, legislative and policy frameworks:

iii. To investigate changes that would improve rainwater harvesting institutional design and water security in semi-arid Kenya.

**Research Questions**

My main research question was: What practices facilitate or constrain effective rainwater harvesting in semi-arid Kenya?

Furthermore, this research was guided by the following sub questions:

1. What are the rainwater harvesting practices in Makueni County, Kenya?
2. What are the local water institutions that govern rainwater harvesting?
3. What are shortcomings and barriers to effective rainwater harvesting?
4. How could rainwater harvesting management be improved?
5. What linkages exist among local, regional, and national Rainwater Harvesting Institutions?
6. Could existing institutions be improved or new institutions be designed to promote rainwater harvesting?

**Research Design**

Iapplied a qualitative research methodology approach in this study. I used a case study of RWH practices, policies, technologies in Makueni County, Kenya. Given that the purpose of this research was to investigate practices facilitating or constraining effective RWH, there was need to understand the connection between community water harvesting practices and water security issues. This entailed a detailed study of the wider and local contextual factors influencing management and exploitation of rainwater at both national and local levels. At the national level, secondary data documents including GOK policies, strategies Plans and reports from relevant agencies like the MWI, MENR, MoA, NEMA, County of Makueni Development Plans and CSO reports, policies and strategies, combined with key informant interviews provided an in-depth picture on the policy focus, investment priorities and trends, whereas at the local level primary data collection in the form of interviews and focus group discussions provided the bulk of the findings.

**Methodology - Case Study**

A case study is "an empirical inquiry that investigates a contemporary phenomenon within its life context especially when the boundaries between the phenomenon and the context are not very defined" (Yin, 2008 p. 1). Feagin et al. (1991) defines case study as "an in-depth, multi-faceted investigation, using qualitative research methods, of a single social phenomenon" (p.2). The study is conducted in great detail and often relies on the use of several data sources." The case study approach has been known to be particularly useful in practice based problem where the experience of actors is important and context is critical (Galliers 1991).

Yin (1994) distinguishes three types of case studies: exploratory, causal and descriptive. A causal case study approach was applied in this study to look for cause and effect relationship and search for theories of explaining the RWH practices.

My choice of case study method was in line with the reasons for viability explained by Benbasat et al., (1987, p. 370), whereby he indicates that case study method is viable because it is necessary to study the phenomenon in its natural setting and the fact that researcher can ask "how" and "why" questions, so as to understand the nature and complexity of the processes taking place. I chose case study over survey method because whereas a survey would have been applicable it would not have yielded the indepth information that was required in this study. Action research method would have worked but would have needed much longer time than the researcher could afford.

Despite its suitability for this research, I am conscious of the fact that the case study method has faced criticisms: what Flyvbert (2001, p. 221) referred to as five misunderstandings or oversimplifications about the nature of case study research:

> General, theoretical (context-independent) knowledge is more valuable than concrete, practical context-dependent) knowledge; one cannot generalize on the basis of an individual case therefore, the case study cannot contribute to scientific development; the case study is most useful for generating hypotheses; that is, in the first stage of a total research process, whereas other methods are more suitable for hypotheses testing and theory building; the case study contains a bias toward verification, that is, a tendency to confirm the researcher's preconceived notions; and that it is often difficult to summarize and develop general propositions and theories on the basis of specific case studies.

However, Flyvbjerg (1998, 2001), alongside other researchers like Campbell (1975), Ragin (1992), Geertz (1995) and Wieviorka (1992) who have conducted intensive, in-depth case studies managed to convincingly show that these criticisms do not hold ground. These researchers for instance, report that, "their preconceived views, assumptions, concepts, and hypotheses were wrong and that the case material had compelled them to revise their hypotheses on essential points" (Platt, 2007). In addition, "validity of case study is derived from an epistemological stance based on plausibility and cogency of the logical reasoning applied in describing and presenting the results from the cases and in drawing conclusions from them" (Walsham, 1993, p. 15). Moreover, case study also allows for thick description (Yin, 1994) which gives the researcher access to subtleties of changing interpretations (Walsham 1995b) which would otherwise have been lost in quantitative and experimental approaches (Yin 1994). In light of the above discussion, I therefore found the case study method appropriate for this study. I selected Makueni County for the case study for the reasons which I discuss in the following section.

**Case Study of Rainwater Harvesting in Makueni County, Kenya**

Makueni County lies in the arid and semi-arid zones of the eastern region of Kenya and is usually prone to frequent droughts. Most parts of the County experience between 300mm to 400mm of rainfall per annum and hardly have enough to sustain food production (MICDP,

2013). Over time, the county has experienced climate change and increased variability which includes insufficient rain and prolonged dry spells among others. Human activities such as farming on hill tops, charcoal burning and sand harvesting have contributed to this scenario (MCIDP, 2013) As a result, there has been crop failure affecting food security and thus economic activities status (ROK, 2013). Water scarcity has also become worse as climate change impacts intensify while population increases put pressure on land and other resources (MCIDP, 2013). To mitigate the effects of water scarcity, the community, with help of mostly CSOs, has taken up RWH (MCIDP, 2013).

As an area with water scarcity problems and with potential for RWH (Kimani et al., 2015), a number of CSO sponsored and to some extent GoK funded RWH projects have been undertaken in the County. It was therefore, an excellent location for this study because the County had many RWH projects, different technologies and different management structures and strategies. Furthermore, because of my prior experience working in the County, it was more familiar to me and I benefitted from the help of existing contacts in conducting the study.

Moreover, in selecting the two locations (Kalanzoni and Kikumini) in Makueni County, for the study, I considered the density of projects, ease of access and logistical support. For logistical purposes, it was important to go through development agencies working in Makueni County so as to get access to the projects they sponsored. Two locations in the county emerged suitable as per this criteria and were therefore, chosen. This included Kikumini and Kalanzoni locations. Both locations had a higher number of RWH projects and were within accessible distances, compared to other locations in the county as guided by KRA.

**Study Sample**

The population of the research comprised people involved in RWH in the semi-arid lands of Kenya, and in this case, Makueni County. The study thus involved 167 participants from 20 RWH projects in two locations in Makueni County and 10 key informants involved in RWH in Makueni County such as CSO workers, GoK officers, RWH contractors and consultants, academicians and researchers and suppliers of RWH equipment. The research participants comprised male and female, youth, and the elderly. The participants of the focus group discussions were accessed at their locations through the Chiefs and the community mobilizers.

**Project Classification**

Prior visits to the study area required courtesy calls to the chief in each of the two locations. This was part of protocol but also necessary in obtaining support that would promote cooperation and trust from the residents during these visits the researcher held short meetings with some project groups and piloted the study tools. These meetings were also used to establish criteria for distinguishing successful and non-successful projects. Thereafter, the community mobilizer visited the officials of each project who helped rally group members to meetings.

According to Ritchie et al. (2013) sample size depends on heterogeneity of the population, number of selection criteria, extent to which nesting of the criteria is needed, special interest group to be considered, data correction methods to be used and budget. Through preliminary visits to the field sites using networks and contacts I made during my professional work and with the help of Kenya Rainwater Harvesting Association, I surveyed a number of community water projects to get a grasp of the situation. Based on discussions with the

community members during the pilot visits the defining characteristic identified was reliability and perceived impact. These were differentiated as in the following table.

*Table 6*: Criteria for Project Grouping

| Criteria | Successful | Non successful |
|---|---|---|
| Reliability | Project supplying water Up to potential | Supplies<br>Substantially below potential |
| Maintenance | Project well maintained | Project shows signs of neglect |

It was based on the above criteria, and with the help of the mobilizers, that I selected the two specific locations in Makueni County (Kalanzoni and Kikumini).

**Data Collection Methods**

Data were collected from the sampled study projects through four main techniques which included key informant, focus groups discussions, participant observation and document analysis, each of which is discussed below. Key informant interviews were administered to opinion leaders, experts in the subject matter like Government Agency representatives and Non-Governmental Organization (NGO) workers. Focus group discussions were organized around projects were conducted with the use of focus group discussion guides. Participant Observation and document analysis of secondary sources of data were also applied. The tools used were key informant schedules and focus group discussions guides.

As required by law, I had acquired a research permit from the National Commission of Science, Technology and Innovation for a study in Makueni. I also got one permitting study in Nairobi Counties because I knew that some of the key actors in Makueni reside in Nairobi, so while interviewing them about their work in Makueni, I would find them in Nairobi.

### Key Informant Interviews

Semi-structured expert interviews were undertaken using developed interview schedules. Experts in this context were "persons particularly competent as authorities in the field of RWH ( (Flick 2006 pp. 165). They included experts on RWH from various walks of life: government agencies, Non-Governmental Organizations (NGOs), universities and research institutions and community leaders. A total of ten key informant interviews were carried out from October 2014 to November 2015. This number was considered adequate to generate sufficient information that was manageable (Ritchie et al., 2014) in terms of analysis, bearing in mind that more information was being gathered through other data collection methods. The choice of semi-structured interviews was to enable deeper understanding of participant's perceptions and to facilitate development of rich thick descriptions of experiences (Creswell, 2009, Merriam 2009) presented in the subsequent chapters.

Key informants were sampled from the researcher's contacts and leads provided by knowledgeable people in the sector. Having worked in the water sector, I had made contacts with people involved in the RWH sector. In recruiting the interviewees, I considered the experience and knowledge of the respondents in RWH and involvement or familiarity with RWH in Makueni County. This was easy to make out going by the occupation of potential informants,

training and at times recommendations from others. Being a small sector, the people who were actively involved in it knew each other. It was therefore, possible to get recommendation from interviewees about others that the researcher needed to talk to.

I also managed to attend RWH conferences that took place in the Country: one of such was discussing development of a RWH policy for the Kenya and took place in February 2015 and the other one was experience-sharing workshop for stakeholders in Kenya in May 2014. Through these workshops, I made contacts that were helpful in accessing informants. Some of the discussions held with participants were important in gauging validity of the study topic.

Key informants were recruited by the researcher through telephone and email. In recruiting interviewees, various sub-sections of RWH sector were considered to ensure that the many angles of the sector were represented. As such the researcher sought to interview at least one informant in each area conversant with RWH policy framework. Though at the beginning it was felt that those in government were better placed to answer these questions, it later became apparent to the researcher that informants from CSO ( both donors and local implementing organizations) were quite informed on policy issues and were even able to critique certain aspects which made the discussions very rich. I also strived to ensure that all interviewees were involved with water harvesting in Makueni County. Some of the respondents were engaged in RWH projects in County as donors, implementers, technical advisors /consultants, contractors and as researchers.

I had used most of the period preceding the field work holding consultations with colleagues in the sector and had established most of the promoting entities/actors. Therefore, in recruiting informants, I strived to accommodate representation from a cross-section of these

actors. These included the CSOs, academic and research institutions, industrialists/retailers, contractors, local opinion leaders in Makueni County, financial institutions, county government and national government departments and ministries of water, agriculture, environment and specialized agencies like National Environmental Management Authority and Water Resources Management Authority. I had also to consider the gender aspect. Having realized that most of the people in the field of RWH were males, yet women are ones adversely affected by water scarcity, I sought to involve as many women key informants as possible. I was given three names but was only able to meet up with one as the other two could not be contacted.

Apart from difficult in assessing female informants explained above I did not meet resistance in recruiting other interviewees, though in some big organizations I had to request interviews through the organization structure using emails or personal visits and that took some time to get responses. This also posed a challenge because the organization decided who they felt was the right person to be interviewed. On one occasion I had to abandon an interview and rescheduled with the the relevant informant an interview, a month away. Other informants were recruited personally through phone calls and meetings set up.

In addition to the questions in the interview schedule, qualitative in-depth discussions were held with key informants including subjects such as historical trends, policy trends perspectives around rainwater, current governance institutions and possible improvements or additional institutions to be implemented, management practices, challenges, recommendations and solutions

The interviews took place at a place convenient to the respondents but conducive for the interview to go on uninterrupted. Most of the interviews took places in the key informants'

offices, in quiet boardrooms and when not possible, in other places apart from the offices such as quiet restaurants. The interviewees were all recorded using a Sony digital recorder, even though the researcher took notes in her field diary for crosschecking. None of the informants expressed a problem with the researcher using a recorder. However permission to record was sought at the introductory stage. The researcher was not able to have the interviewees sign the consent form. The researcher had been advised that this could be a source of discomfort given that Kenyans view signatures with mistrust and could affect the genuineness of the responses. During the first interview when I asked the informant to sign, I noticed a change of mood and thereafter I decided to get the consents verbally.

**Focus Group Discussions**

A focus group has been described an informal discussion among a group of selected individuals about a particular topic (Wilkinson, 2004). According to Kitzinger (2005, p. 57), "the focus group method is an ideal approach for examining the stories, experiences, points of view, beliefs, needs and concerns of individuals". Focus group discussions (FGD) provided the researcher with a great opportunity to appreciate the way people saw their own reality and hence "to get closer to the data" (Ivanoff & Hultberg, 2006, p. 126).

Twenty focus group discussions were conducted based on the 20 RWH projects in the study. A group consisted of 5 to 13 members resulting in 167 participants. Each of the groups targeted was involved in the management of a RWH project ranging from dams, farm ponds, rock catchment and water pans. Some members of the group also had roof catchment in their homes. Since FGDs require a conducive environment to support free discussions (Liampttong, 2009), the researcher, with assistance from community mobilizers, in liaison with project group

leaders, identified appropriate locations. Meetings were held in neutral places, which were safe and accessible to the participants and conducive for discussions without interruption or intimidation, mostly next to the project sites. The object of the discussions was to harness the participants' perspectives about the practice of RWH. The full guide sheet for the focus group discussions isin the appendix, however the topics included the following: What were the goals of their groups as far as RWH and water supply was concerned? Were they making progress? What structure were they using to implement the projects? What support were they accessible to? What were the challenges in individual projects and RWH in general, and What improvements did they feel could enhance RWH performance?

Through pilot field visits, the researcher was able to review the focus group discussions guide as well as the style of initiating and moderating discussions in order to cultivate lively discussions. The community mobilizers in liaison with leaders of community projects, partners and the researcher were able to compile lists of RWH projects within the two locations. An initial meeting with mobilizers, community groups' representatives and the researcher was used to select projects for the study and divide them into two sets. One set comprised projects that were considered to be successful based on criteria set with the help of participants, while the other set comprised projects considered not successful. Some partners would also give opinions as to the status of project. However, the researcher took note of such views but made sure this did not obscure the reality from the group discussions. I made comparisons between the two sets, namely, non-successful and successful, in order to note the various comparable attributes in both sets and diagnose striking common characteristics of successful projects.

A community mobilizer was assigned to mobilize participants to attend meetings based on a pre-agreed schedule. The researcher used the lists of members provided by the groups to ensure inclunsive representation of males, females and youth. The community mobilizer was an individual identified due to familiarity with local community and terrain. The group discussions were guided by a moderator (mostly the researcher and in some instances hired assistants, due to language and familiarity considerations). The research assistants were particularly useful because of the vastness of the terrain and language barriers.

In composing the groups, attention was paid to social and cultural issues and context. Selection of group participants was based on shared background (Flick, 2009), mainly involvement in the RWH projects. Particular attention was paid to gender though this was not a problem as most groups were well balanced in terms of males, females and youth representation. The researcher avoided meetings during community events as much as possible such as market days since this would affect attendance. In one location, the meeting coincided with food aid distribution which necessitated a reschedule to the next day.

The researcher recorded all the discussions actively taking note of non-verbal communication as well. Because no voice recording of FGDs was done, the notes were taken in detail by two people. Even though most of the discussions were conducted in "Kiswahili"[1] some of the participants chose to emphasize points in the local language [Kamba]. The researcher ensured there was an interpreter in the groups.

After I had all the group discussion reports done, I organized two feedback meetings on 22nd -23rd August 2015 to confirm with the community whether recorded views were a true

[1] Kiswahili is Kenya's national language, Even though most communities can do basic communications in Kiswahili, communities in rural areas tend to use their vernacular languages. Kenya is composed of 42 tribes.

representation of what they said. One meeting was held in Wote for all the groups in this location and another in Malili for the groups interviewed in this location. This exercise was appreciated by the community. The plea from the community was for support towards enhancing RWH especially for the non-performing projects.

The researcher also took photos of the participants to include in the report. The participants' permission was sought for photo taking and no objection was encountered in all the projects. Photos of participants, and projects were taken in the sites.

### Participant Observation

Direct observation was carried out by the researcher in the course of the research. I took note of physical and observable attributes such as state of water projects and non-verbal communication symbols. My impressions were noted and highlighted in the form of field notes in the researcher's diary (Flick, 2009) and alongside verbal reports for further probing or to add a critical look at informants' answers. Documentation of notes was done right after contact at the field site (Flick, 2009, p. 297). At the project site photos of RWH projects were taken and used for illustration in writing this thesis.

### Document Analysis

The researcher undertook extensive review of (Flick, 2009, p. 48). Some of the available literature was accessed from scholarly articles online, from academic institutions' libraries, Civil Society Organizations'(CSO) libraries, RWH experts' and Government offices. In addition to the published literature, I analyzed reports, strategic plans, publications and websites. Government agencies provided the bulk of the documentation for review.

At the national level documents included policy papers, relevant Acts of Parliament, reports, organization strategies from NGOs and government agencies, and unpublished books and monographs. Combined with key informant interviews, these documents were helpful in providing a broad picture of the RWH situation in the country in general and the the case study region in particular. Such data were accessed at the institutional offices and much of it was also available online. Visits were made to government ministry offices, university libraries and to CSO offices. The researcher was provided with hard copies of documents like policies, strategic plans, technical papers, research reports, and other forms of inventories for reference. In some instances, the respondents offered to send soft copies of documents through email and in some the researcher was given guidelines for accessing more documents online. Secondary data were useful in providing insight into government policies, major events, players and roles and aided exploration of particular responses during the field interviews as well as filling gaps.

**Data Analysis**

Data were analyzed by identifying themes in the data generated by the interviews and focus groups. These themes emerged from the data and were relevant to the research questions. The data generated were analyzed using the QSR software package Nvivo. Nvivo acts as a secure virtual storage tool for qualitative data. All the field notes were labelled and documented. The key informant interviews were transcribed in a given format that allowed the researcher ease of analysis. The scripts were then sent to the informants for confirmation but only five of the ten made comments and sent them back while the others said they had no comments; they were

satisfied with the scripts. The scripts were filed while the photos were all downloaded, grouped per project, labelled and then both soft and hardcopies were filed.

The researcher developed Nvivo files in which all the data were transferred to and coded. Sets of data were disaggregated into subfolders for key informants transcripts and focus group discussions reports. At the beginning the researcher browsed through the notes, followed by a more thorough reading. Notes and highlights were used in sections to indicate experiences during the field visits such as uncovered biases and date of interviews or note associations with other sections. According to Richards (2009) good quality data should include "accuracy, notes on context, thick description, usefulness, and reflexivity" (p. 57). Key sentences, word and phrases were labelled and codes assigned. This resulted in what Flick (2009, p. 307) referred to as "open codes." The researcher did this by documenting the phrases that were frequently mentioned, surprising phrases and those relevant the research questions. The codes were listed and re-coded by eliminating some codes and combining some, hence reducing the list of codes. Further analysis included grouping the codes into categories (Flick, 2009). About 11 categories were created including, key enablers, key barriers, methods, promoters, institutions, recommendations, water sources, policy, general challenges and others. Folders for these categories were created in Nvivo. Having classified data into these categories, through Nvivo, the researcher was able to carry out thematic analysis.

The categories generated were relevant to the research questions that guided the study. Therefore, this enabled the researcher to present the findings coherently and carry out further synthesis of the findings. For instance, the first study question was to find out the rainwater harvesting practices. This comprised utilizing data gathered on methods, policy trends,

promoters and water sources whereas the study question on existing institutions and linkages was answered using data under the category labeled institutions. The study questions on shortcomings were analyzed with data under the category of enablers, barriers and general challenges. To analyze the study question on improvements for effective rainwater harvesting, the researcher tapped onto the information categorized as recommendations and as well as the rest of the categories. However, the researcher noted and analyzed the interconnectedness among the themes.

The focus of this study was to investigate the practices that facilitated or constrained effective RWH. The questions utilized were generated from the literature review about the relationship between RWH practices and effectiveness of the RWH in semi-arid and the entire country at large, while establishing the question of what role and design of institutions for effective RWH. Hence the data were analyzed within this framework. The researcher followed thematic analysis because it was appropriate, as the approach to data collection was based on the research questions. The findings are discussed in the subsequent chapters and common themes highlighted.

**Ethical Concerns**

The study proposal was reviewed by the Royal Roads University Ethical Review Board and was approved. In Kenya, a study permit was obtained from the National Council for Science Technology and Innovation (NACOSTI) upon presenting an ethical review certificate. In the course of the data collection, steps were taken to ensure mutual consent by reading out the consent to participants and orally obtaining their consent. Due to the social –cultural context,

obtaining a signed consent was considered an obstacle to smooth flow of interviews due to local perceptions about signatures. Signatures in the Kenyan context are viewed with suspicion to an extent that it could inhibit free discussion. To uphold participant confidentiality, no names were linked to the quotes from participants in this report.

**Rigour and Trustworthiness**

In efforts to ensure rigor and trustworthiness of the research, I committed to a research that was methodologically planned, based on principle and reflection (Flick, 2009 p. 309). For instance, I reflected on the choice of theory, methodological approach and methods before deciding which one to apply and for what reasons. Credibility was taken into account through application of reflexivity, for instance, taking into consideration my background, perceptions and interests (Krefting, 1991); member checking by cross-checking with respondents the collected data to avoid misrepresentation (Lincoln & Guba, 1985); peer examination to trigger deeper reflexive analysis as suggested by Lincoln and Guba (1985) and employing effective interviewing techniques to generate more information so as to avoid errors due to what Krefting (1991, p. 219) called "preferred social response."

Furthermore, I undertook wide consultations among the academic community and colleagues in the water, environment and natural resources sectors in addition to extensive literature review in a quest to establish validity of my study topic.

As advised by Flick (2009), triangulation is used as a strategy for improving the quality of qualitative research by extending the approach to the issue under study. Triangulation means that "researchers take different perspectives on an issue under study or –more generally

speaking- in answering research questions" (p. 445). In applying triangulation in this research, I used different sorts of data and more than one theoretical perspectives to study the practices that facilitate or constrain effective RWH in semi-arid Kenya.

Transferability was actualized **t**hrough ensuring choice of a sound sampling technique to enable adequate study population to generate sufficient data that could support logical and coherent conclusions and collection of information that provides dense description (Lincoln & Guba, 1985 ). Dependability was developed by ensuring dense description of rainwater harvesting practices as experienced by the community. Other measures I took included ensuring conformability through keeping an audit trail of all my field notes and journal. The raw data I collected in this study also ensured conformability.

## Chapter Summary

In this chapter the researcher stated the research methodology. A qualitative study using case study method was carried out in two locations in Makueni County. The researcher undertook 20 FGDs based on 20 RWH projects, comprising 167 participants and interviewed 10 key informants. Other methods used in collecting data included direct observation and review of secondary data. In upholding research ethics, the research proposal underwent ethical reviews while in the field measures such as seeking consent before interviews were applied. Various measures like triangulation, reflexivity and member checking were adopted to ensure rigour and trustworthiness in this study.

# Chapter 5 – Results and Discussion: Rainwater Harvesting Practices

## Introduction

This chapter presents the first set of findings of the study. The study aimed to investigate practices facilitating and constraining effective RWH and was carried out in two locations in Makueni County which lies in a semi-arid area. In this chapter the findings of the study are presented in detailed descriptions of the accounts of participants and based on themes of the study. The themes covered here include: Perception of Government of Kenya's RWH policy trends, water access in Makueni County, RWH in Makueni County, and sponsors of RWH.

## Perceptions on Government of Kenya's Rainwater Harvesting Policy Trends

The study established from most of the key informants that, historically, RWH in Kenya had progressively developed both by policy and practice. One key informant tracing the history of RWH in Kenya said that: "In the past the practice of RWH has been ahead of policy" ( KI10, 15-01-16). The informants explained that this situation exists because people have always undertaken RWH out of need rather than due to policy direction. The research data indicated that in the pre-colonial times, RWH was not valued because the population was low and surface water was sufficient. In fact, most of the RWH at that time was for domestic consumption. However, the post-independence period saw an upsurge in population and increased stress on natural resources like water and water scarcity set in.

The Key informant further explained that, as population expanded, people started moving to drier areas which meant that RWH was necessary to meet the water needs in these drier lands. The key informant further reported that: "Increased water scarcity saw people

starting to engage in gainful RWH despite the policy dispensation prohibiting rooftop water harvesting for use especially in the urban areas" ( KI10, 05-01-16). On crosschecking this assertion with another informant I learnt that this dispensation was reflected in the city by-laws that prohibited RWH. During this period, there was fear of health risk from asbestos contained in roofing materials. Roofing materials containing asbestos however, have been phased out by and large and modern roofs are considered safe.

Three of the key informants reiterated that by the time the government was realizing the need for proactive water harvesting there was already a lot of opportunistic RWH devoid of policy guideline. At first RWH was mainly targeted for domestic use but later it was extended to livestock production and then much later for irrigation and since then the practice has grown over time though not to the expected levels. A key informant working with an NGO reported that despite dismal performance in scaling up RWH great strides had been made in technological innovation:

> Kenya is one of the leading countries in RWH, not only in Africa but also globally. Some of the techniques that are unique to Kenya but gaining popularity globally include the trapezoidal bunds-which originated in Kenya, particularly in Turkana-, and the farm ponds and sand dams. ( KI10, 05-01-16)

As noted by all the key informants and some of the community members in the group discussions, the long standing tradition in RWH and availability of numerous RWH technologies in the Country in contrast to the low level of RWH was a concern by practitioners, researchers and the citizenry. This finding was in consistent with the literature, (Hartum and Partschull, 2001 p. 259 -266; Malesu et al., 2007; Ngigi, 2003) who attribute the status to the lack of a legal

framework and commitment from the GoK. All the the informants identified lack of suitable policy in the past as a causal factor, even though other factors emanated from both the informant interviews, and group discussions. These included issues like inadequate resources, low capacity and coordination gaps.

Moreover, even though RWH is widely practiced in the Country, scaling-up to other levels and widespread adoption is limited by inadequate knowledge and apathy as explained by most of the informants. This was recounted by a water engineer working for the GoK agency expressing surprise at the status quo:

> In Western Kenya and Nyanza I was surprised that I could not find roof catchment tanks… though the rainfall is high. They don't harvest rain water [laughs]. Try to go there. They rather go to a pond or a river… and you see there in Western Kenya or Nyanza it rains, but yes [laughs] so they don't have that idea of rain water. They don't have a problem or they don't perceive to have a problem. ( KI01, 20-02-15)

It was noted in the literature that perception and attitude was a key issue associated with the low uptake of RWH (Kinyua, 2005). As it emerged from all the focus group discussions in the study, many people believed that it was the duty of the GoK to deliver services like water supply. And even though this was true, the GoK might not manage to deliver water to all as expected due to constrained resources. So, due to perception people would wait and keep blaming the government for their anguish and not take action to change their situations. Other reasons given by informants and focus group participants included poverty, culture which influences for example the mode of building which consequently determined the catchment

surface, gender and mismanagement of RWH projects by community members due to low capacity.

Eight of the informants explained to the researcher that the government revised the Water Act in 2012 to accommodate recent changes in the political governance and social-economic environment. Among the changes to be taken into consideration included on one hand, the promulgation of a new constitution dispensation leading to devolution of governance systems in the country (MENR, 2012) and on the other, the increasing impacts of climate change on the already stressed water resources (GOK, 2010; MENR, 2012). A key informant from one of the local universities emphasized the change in policy and goodwill by the Government: "The Water Bill 2014/2015 seeks to establish Water Storage and Harvesting Authority. This is trying to identify that there is a water crisis and one way of addressing it is through RWH" ( KI04, 15-05-15).

The revision of the Water Act to include RWH was viewed as one of the explicit policy directions and most referred to by many actors as a positive support of RWH, climate change adaptation and environment conservation (This view was expressed even by informants who earlier felt that RWH was being hampered by unfavorable or lack of supportive policy). This study also found that that even though, currently, the GoK encourages RWH, the GOK mainly focuses on construction of major dams and water recharge. Some of the examples of such mega dams cited by informants include the Ndakaini Dam in Muranga County which supplies water to Nairobi City. Even though the catchment of this dam lies in Muranga County the water is channeled to Nairobi County/City by gravity. This has also seen the County of Muranga enter

into a legal tussle with the County of Nairobi on trans-boundary water issues, as explained by one of the key informants privy to issues pertaining to state projects.

The researcher was also informed about ways in which GoK implementation of RWH projects was influenced by politics and hence reduced effectiveness. One of the informants who was a staff member of an international NGO involved in RWH expressed dismay at, for instance, the recent move to implement a dam per ward which he felt was not necessarily informed by feasibility studies or biophysical viability but rather was intended to gain political mileage. Given that dams are very expensive, this is a case of misplaced priorities. He said: "In fact the amount of resources spent on the construction of one dam in this manner can effectively support several farm ponds which are more suited and gainful to the communities" ( KI10, 05-01-16). Politicization of development has often exposed the government to critics who feel that the problem in slow progress in development is not lack of resources but the way the resource are allocated, hence the poor performance in water harvesting is associated with misinformed priorities.

While most of the informants were positive about the recent developments in policy, however, they associated the low advancement in RWH to unfavorable Government policy in the past. They explained that a glance at past government development plans and policies reveals that RWH has not been considered as a viable option for dealing with water scarcity except as an option for irrigation in agricultural policies. In fact, informants decried the fact that prior to 2012, the Ministry for Water had no formal policy dealing with RWH. Efforts to include RWH provisions explicitly in the Water Act started with the draft Water Storage Policy, post 2010. Informants gave an example of the City Council by-laws which only allowed RWH for effective

disposal of water from roofs to avoid dampness and drainage problems but not to collect for beneficial purposes. They said that there have been policy changes in the recent citing review of the City by-laws in some urban centers and the requirement by the Ministry of Public Works for landlords to install RWH tanks for every new premise built, even though this is only for domestic uses. The researcher was also informed that the manifesto of the current ruling party (Jubilee Coalition) also emphasized RWH. The manifesto included proposals to establish a national water harvesting policy and a RWH project in every village and or estate as part of the 5-year investment plan and oblige all new developments to include water harvesting facilities (Jubilee Coalition, 2013, p. 54-55).

According to most of the informants, the National Development blueprint vision 2030 Medium Term Plan 2013-2017 (ROK/NESC, 2012) has talked about harvesting run-off for productive purposes but has not been included in many Counties' development Plans. Furthermore, some informants informed the researcher that although RWH has been mentioned in some of the policies mentioned above, on the ground RWH in practice is often uncoordinated and haphazard and that RWH has not been dealt with decisively. Some of the informants also reported that because of this "impasse" there is now a consistent campaign by a number of actors including Civil Society Organizations, academics, researchers and others for changes in RWH and that as a result the government enacted the Water Bill of 2015. Some also expressed the conviction that water security is a legally given right that should be guaranteed by the GoK as this was echoed by one of the informants from the Civil Society Organizations:

> Let us look at our constitution, its guarantees that everyone should have access to food and sanitation. This implies that our constitution recognizes that food security, water

> security is important for our development. The constitution requires that this food security and water security should be implemented through other legislative frameworks. From the constitution, food and water security is implicitly provided. The Water Bill 2015 presents the first attempt to provide this requirement. ( KI04, 15-05-15)

One of the reasons given by informants for rampant water insecurity despite its enshrinement in the constitution as mentioned above was poor prioritizing of RWH by the government. Informants explained how water insecurity doesn't equate to tap water in every region but mapping what is feasible in various regions by existent resources. This is consistent to the literature especially in regard to what Nilsson (2006) referred to when he proposed that governments should focus on nested enterprises to attain water security in rural areas instead of endeavoring to connect all to water which is not feasible. Nested enterprise refer to a situation where institutions are multilayered across levels to enable devolution or replication (Ostrom, 2008).

Some of the glaring gaps in policy reported by all the key informants and some of the group discussion participants included for instance the fact that the Ministry of Water and Irrigation (MWI) had no mechanisms for approving installation of RWH structures. While one key informant noted that in the Ministry of Agriculture, RWH was narrowed to conservation agriculture hence RWH activities in this ministry were not recorded alongside other RWH activities.

At least two informants noted that even though in the past policy was inadequate, there were isolated developments that were never complemented with other measures or monitored to ensure full-scale operations that would promote meaningful RWH. For example, in the late

1980s the President of the Republic of Kenya made a declaration that all primary schools should install RWH infrastructure. “This could be that reason why you will find RWH tanks in many schools in the rural areas” [emphasis added]. Later in 2003 the Minister, Ministry of Water also made a declaration that all new buildings should include a rainwater harvesting tank. These uncoordinated developments which were in no way supported by a policy framework underscore the perception that RWH activities have been undertaken very haphazardly which is also observed in the literature (Hartung & Patshull, 2011; MWI, 2014).

**Rainwater Harvesting in Makueni County**

In this section I delve into RWH as it is practiced in Makueni County. Dissecting the RWH practices in Makueni entails recounting and elaborating the perceptions of the informants as to the status of RWH in the Country and in Makueni County, including the facilitating and constraining factors.

As emerged from both the field findings and literature,as a semi-arid region, Makueni County has had a long experience with RWH. Because of unreliable rainfall and scarce surface water sources, coupled with heavy capital outlay required for groundwater investment the residents look to rainwater as cheaper and more accessible. Focus group participants on the ground described the situation as dire. For instance a young lady participating in a group discussion explained the needy situation:

> Sometimes this place can go for 6 years without rain, water shortage is acute. With people having corrugated iron sheets houses, they could be assisted with tanks to

> supplement water harvesting activities but the government has not contributed to water harvesting in the area. (PASHG 16-04-16)

Unlike the other actors like CSOs who could identify favorable changes, especially in policy and resource allocation, taking place nationally in RWH, almost all the community participants in Makueni felt the Government was doing nothing on RWH to relieve their suffering. As some of the group participants explained, the government can possibly meet them halfway, for instance, through supplying water tanks which many of the residents are unable to afford or subsidizing the RWH infrastructure to ensure affordability.

All the informants interviewed decried the inadequate investment made in RWH in the area despite its potential to alleviate the water scarcity in the County. Many residents trekked long distances to water sources (seasonal rivers mostly) and during the dry spell the situation was disastrous. Furthermore many RWH projects which would ease this situation did not function as expected due to poor workmanship and maintenance. A participant from one of the project groups, for instance, had this to say:

> The sand and earth dams' water is usually contaminated by cows, donkeys and other animals since there is no other water source and these dams are not protected anyway. In addition many of them leak and do not hold water for long. ( PTSHG, 15-04-16)

A number of dams observed during the study were silted, broken and not well kept, therefore, could only retain minimum water quantity. Nevertheless, a variety of techniques have been deployed in harvesting rain water in Makueni County. As reported by the key informants

and group participants alike, projects ranged from sand dams to subsurface dams, earth dams, water pans, roof catchment and several in-situ technologies.

**Promoters of Rainwater Harvesting**

The researcher learned from all the informants and group discussions that RWH was mostly implemented through the support of the NGOs. Most RWH projects were donor funded, and to a lesser extent the government funded, through provision of incentives for some of the water harvesting products. For example, for construction of a water pan, the government would eliminate some taxes even though this was still haphazard. And also through the National Drought Authority the Government supported implementation of earth dams in semi-arid areas for pastoralist communities. The findings indicated that the government had not been a big player in RWH as expected. A key informant involved in RWH advocacy summarized the Government's efforts saying:

> The government thought of providing piped water to everybody, so when that dream was not realized, then the CSOs seemed to fit in those gaps. The CSO comes and looks at what is the most appropriate solution in a given area. So some of them will say water harvesting. In fact, the Government is learning from us. ( KI03, 25-04-15)

The findings resonate with the literature that since Kenya attained independence, in 1962, it had been the intention of the successive governments to supply water to all as shown in the country development plans (K'Akumu, 2007). In the Development Plan 1970-74 the government aimed to supply acceptable water to all rural areas by 2000 and in the Development Plan 1974-78, the aim was universal access to safe water for all by 2000 (Gok, 1969,1966).

Clearly, this had not been achieved since water access was about 62 % nationally and 55% in the rural areas (WHO/UNICEF, 2014). Furthermore, even the MDG Goals of Universal access to safe water by 2015 was not met. It is following this scenario that many actors especially CSOs have been lobbying the government to apply realistic measures to achieve water security. For instance, instead of struggling to connect rural areas the Government could adopt a community based approach and support small scale community RWH projects which are community based and sustainable (Ngigi, 2003; Nilsson, 2006).

According tone key informant, academic institutions had also contributed substantially to RWH through some courses they offered. The researcher was informed that the University of Nairobi, Jomo Kenyatta University and Egerton University were offering courses in Agricultural Engineering which prepared some of the graduates' skill to design and implement RWH interventions. However, the shortcoming of some of the courses was regarded as a setback in ensuring the right skills to foster RWH as emphasized by a male informant involved in a RWH consultancy in one of the universities: "There are inadequacies in the universities because there's more emphasis on theory than the practical though" (, KI04 15-05-15).

The practicality of many university programmes has always been a concern to stakeholders who feel that the reason for inadequate capacities in many technical fields is due to failure to match university courses with the market requirements (Mutula, 2002; Obasi & Olutayo, 2009). It is therefore no wonder that most of key informants considered inadequate technical skills a challenge to RWH and most of the community participants complained about poor workmanship in RWH projects.

The researcher was also informed by the key informant that universities have also developed interventional programmes focusing on promoting Rainwater Harvesting. For instance, the University of Nairobi, under the Center for Advanced Studies on Environmental Law and Policy (CASELAP), a department or faculty unit of the University of Nairobi, trains and develops senior managers on environmental policy focusing in three key areas: Environmental Law; Environmental policy and Environmental Diplomacy. Under CASELAP they run the AFRINET, a 3 year program which is focused on fostering knowledge and use of Rainwater Harvesting Technologies for supplemental irrigation in rural dry lands of sub-Saharan Africa (CASELAP, n.d.). Jomo Kenyatta University of Agriculture and Technology (JKUAT) had the Water Research and Resource Centre (WARREC) set up in conjunction with the Ministry of Water to become a national center of excellence in research, innovation, science and technology for the broad water sector issues which had been promoting RWH (WARREC, n.d.).

Other key informants and group participants also mentioned the banks like the Kenya Women Finance Trust and KRep Banks who advance loans for buying tanks. However, group participants expressed skepticism, noting that banks offer loans to people with assets and when they failed to pay the loan, the banks repossessed their tanks and the assets used to secure loans. They were disenfranchencized that the GoK had not intervened. Manufacturers of RWH equipment like water tanks (kentank) and pumps (kickstart) were also among actors mentioned by the some of the key informants.

The major CSOs supporter of RWH mentioned by the informants and group participants during the research included Kenya Rainwater Harvesting Association (KRA), the World Vision, and Action Aid, USAID, Welt Hunger Hilfe, SASOL, Caritas, Danish Development Agency

(DANIDA), Swedish International Development Agency (SIDA) and World Agroforestry Center (ICRAF). The Government Agencies involved with RWH included the Ministry of Water and Irrigation(MWI) in charge of water policy and coordination matters, the National Drought Recovery Programme under the Ministry of Agriculture, the National Water Conservation and Pipeline Company (NWCPC), the Water Trust Fund (WTF), and Ministry of Agriculture. The counties had set up water departments as well as agriculture departments which also dealt with the same.

According to the informants, some of the promoters were known for particular technologies. For instance, KRA was known for farm ponds, Welt Hunger Hilfe for rock catchment and SASOL for sand dams. Some of the informants also felt that, to a large extent, the community was a promoter because some of the community members individually installed RWH systems.

## Local Rainwater Harvesting Governance Institutions

A large body of information and insights regarding the institutional complexities of managing RWH projects emerged from this study. This section aims to understand whether and what institutional design facilitates effective RWH. It brings together the various responses from participants about RWH institutions. Currently there is no distinct unified and interconnected RWH framework on the ground or national level or connecting the two levels, instead only isolated efforts to create functional structures for individual projects or specific actor/donor implementation. Some of the needed or desired components of RWH institutions emerging from the research included: implementation structure, project installation design, organizational structure, governance and identity, revenue generation and resource access model, and coordination and networking structures and processes.

### Implementation Structure

An implementation structure refered to the functional and operational organization put in place to ensure activities planned in a project are carried out as envisaged. The implementation structure proposed here emanated from descriptions by actors on how they operated and how they would prefer to operate. It therefore included actors in a project, at different levels (national, local, international), their functions and how they related to one another. From the interviews with both key informants and group discussion participants four modes of RWH project implementation structures were identified: private, communal, combined communal and private and institution based.

1. Private: In some instances implementation was found to be private in the sense that the project was owned by a household. This was very common for projects like roof catchment, and farm ponds whereby individuals installed RWH projects in their homesteads, with or without assistance from donors, for their own use and with or without selling surplus water to the community members.

2. Communal: This is where a project was implemented by the community jointly. This was the structure utilized by many of the donor and government-funded projects. Most of the assessed projects in this research fell into this category. As explained by the informants, in such cases land was donated by the community or a community member and the project was erected. The community would then nominate representatives to a management committee to oversee the project in trust. However, this was also found to be a setback when projects were implemented on private land without implementers proceeding to seek change of ownership. Later this would affect sustainability or expected outcomes as owners of the land ended up claiming ownership of the project. Earth dams, sand dams, and subsurface dams and in some cases farm ponds were implemented this way.

According to some of the informants, the way of implementing communal projects depended on the donor approach. Some donors would hold consultations with the community and facilitate formation of management committees, whereas others would survey existing/ registered groups and choose the one to partner with to implement the project. As reported by one key informant, the outcomes from the two approaches depended on perceptions, though in the latter, the group owned the project and the direct beneficiaries were the group members. In the former the host community members were considered direct beneficiaries but most often

because of ambiguity in boundaries it was very difficult to identify the exact membership. Commitment was a challenge in such cases because of inability to clarify entitlements.

3. Combination of communal and private: According to an informant fromthe CSO sector, KRA had adopted a model whereby each sub-location (local administrative unit) of targeted districts or regions had a RWH group and all these sub-locational groups amalgamated into one umbrella RWH group at the locational (higher level local administration unit) local level. Through the umbrella group KRA implements the projects. The umbrella group elected officials to form a managing committee. All the rest are members through the umbrella group. According to this model, each member was supposed to contribute a given amount of money in order to get the farm pond in his or her compound. The amount tagged for a member was considered subsidized based on the actual cost of the farm pond. In this model the project ownership could be at a private level. However, at the group level capacity building and monitoring is done. The first project that was implemented communally served as an example for illustrative purposes. After implementation of the communal project, members were supposed to emulate and implement similar ones at private level or even at group level. KRA trained the members at the beginning of the project on RWH, group constitution, operations and maintenance, agribusiness and marketing. The groups were expected to coordinate to ensure there was no overlap in activities.

Figure16*:* Combined Communal and Private Implementation Structure

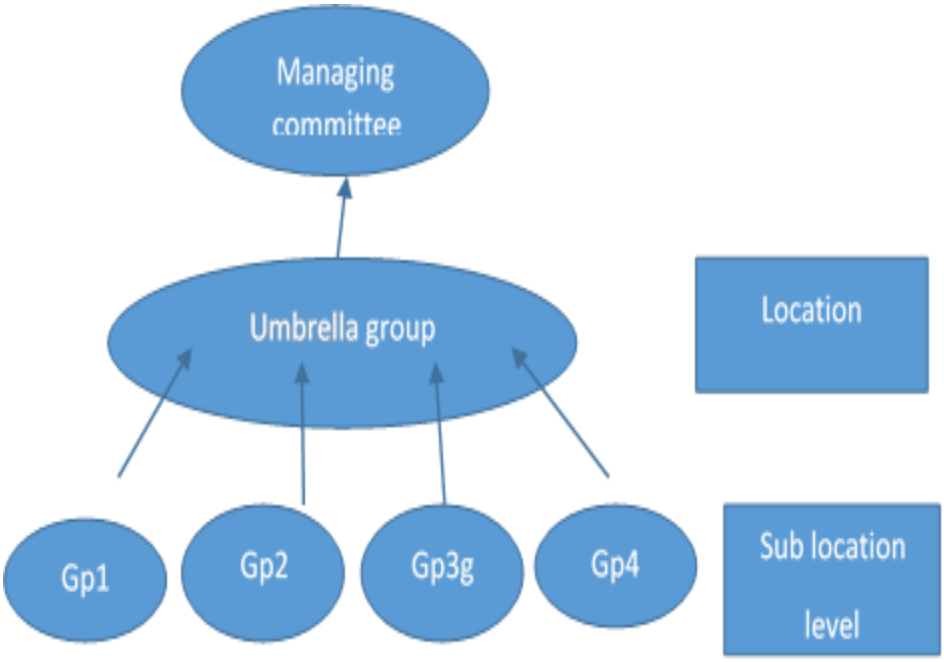



Figure By J. Mang'era

4. Institution based: In this approach, as explained by one key informant, the projects were implemented in institutions like schools and churches. The institution became the implementation partner. The community had access rights to water but at a fee. The school or church nominated a committee to oversee the project, for instance a school would appoint some members from the Board and from among the staff members to form a committee to manage the project.

The above approaches were applied as per the prevailing circumstances. For instance, depending on donor preferences, or where there were feuds in the community a project couldbe handed over to an institution. Based on observation during the study and discussions with

informants, most sustainable projects were the privately and institutionally managed projects. This was attributed by informants to the high level of ownership and presence of governance systems for the institution. Nevertheless, as per the observations made by the researcher, well managed communal projects showed a higher level of impact. Therefore, the researcher concluded that combined communal and private structure, which also reflected a nested enterprise or multilayer structure (Berkes, 2003; Ostrom, 2008, 1990; Young, 2002) would be more beneficial to the community if adopted in a nested manner the way KRA was applying it. The groups that were part of this research using this model comprised part of the performing cases.

**Project Organization, Governance and Identity**

Project organization, governance and identity were applied in this study to describe the horizontal and vertical relations at the local, regional and national project management levels and legal conformity required in order to be recognized by the government and other agencies. All the projects involved in the study had management committees. The difference among them was the level of functionality. This was explained by an informant, NGO worker in Makueni County:

> During the development of a project, in most cases there will be a community leadership team, that's what we call the water committee. This water committee would have been trained on how to manage the water system because in most cases the rain water harvesting project implementation and management would involve a number of things…. All these require a kind of maintenance… (KI09, 20-09-15)

The findings show that the project donors ordinarily instituted project committees to manage projects. Some donors or funding agencies trained such committees while some did not.

The project committee, once in place, would then elect officials including the chairman, secretary, and treasurer. It was the role of the chairman to chair meetings and ensure meetings were held. The secretary invited members for meetings, took the minutes at meetings, while the treasure took care of the group accounts. The executive committee composed of the three officials was also in charge of dispute resolution and disciplinary issues. However, cases needing resolution were communicated to all the members during general meetings for endorsement.

At formation, some agencies facilitated project groups to develop constitutions that would spell out how the group operations and functions would be carried out. All the groups studied reported having a constitution though some no longer adhered to it. Almost all of the groups were registered under the Ministry of Culture and Social Services as self-help groups. However according to the opinions of the experts, these project groups also needed to register as water service providers (WSPs) given that the Water Act 2002 and 2015 provides for those in the business of water supplies to be recognized as water service providers. This was well articulated by a key informant working in Makueni County with an NGO:

> The government has come up with what is referred to as water service providers. These water service providers are put in a group such that they can be a water association or a water provision group registered and issued a permit to provide water to the community. So, [pause] there is that structure which allows these small groups managing a water system, whether it is roof catchment or a rock catchment or even a borehole to form the water users association. This water users association is linked to the government as a water service provider. They are able to pay some little money so that whenever they

> have a technical issue they can go to the offices of the Ministry of Water and Irrigation, technical office, that is the District Water Officer and then they get some assistance there. ( KI07, 20-09-2015)

This excerpt implies that that there were avenues for RWH to be included in the national water resources governance framework but that knowledge was lacking on the ground. Another reason given by an informant for the low level of interaction with government water agencies was because RWH was not considered important and hence could be handled locally as explained by the same informant :

> The reason is that to the Water Resource Users Associations (WRUAs) or the government structure, in most cases rainwater harvesting is considered to be a small scale water provision, which brings about little money. So the registered water service providers would not want to engage in this as they assume the community would run such small water provision systems. It is assumed it will never go to a level where they will require a specialized person from the Ministry of Water to come because even his coming requires some resources. (, KI07, 20-09-2015)

Based on the discussion emerging on the governance, organization and identity of RWH project management structures, the researcher deduced that this was very much a donor or project sponsor oriented process to initiate but community driven in terms of maintenance. Therefore, as a third party, the sponsors had a role to ensure the requisite organizational, governance and legal capacity to manage a project while the community had responsibility to take up and maintain community RWH projects as agreed and as befitting. Where there were disconnects in actualizing these responsibilities and roles, cases of low performance in RWH

projects were apparent especially on donor exit. Since most donors funded projects over a period, the community group was expected to have attained requisite capacity and control to manage the project sustainably by end of the funding period. If this had not happened, then the project was at risk of failure as the donor wound up at the end of the funding period.

**Coordination and Networking**

The terms "coordination and networking structure" in this research were used to describe the ways in which actors interacted across different levels, functions, roles and interests in the RWH sector. Interplay also included interaction with other sectors recurrent in many discussions during the research was the lack of coordination in RWH activities to ensure harmony, sharing of information and knowledge. A key informant from a local university involved in RWH consultancy cited poor coordination in the sector: "During the baseline, we noted that although there were many organizations pushing RWH agenda, their activities remained uncoordinated. What one group was doing was unknown to other groups. Lack of coordination is breeding chaos in this area" (, KI04, 15-05-15).

All key informants and some group discussion participants indicated that coordination was poor. Coordination was also lacking among the government agencies that deal with RWH, for instance, between the Ministry of Water and Irrigation, and the Ministry of Agriculture as well as with the County Government and agencies like Water Resources Management Authority. A key informant from an NGO involved in RWH project implementation provided a detailed analysis of poor coordination in the GoK projects:

> We have heard of billions for water for irrigation, water harvesting and supply….
> Funding has increased substantially for the last five or six years. The only thing there is,

> is confusion because you find funds given to water and irrigation [ministry], funds given to agriculture [Ministry], sometimes do the same things in the same district. So in terms of synergy and in terms of scale, the biggest problem is doing too many small things everywhere which do not have an impact. It is not channeled into one huge project that will have proper impact. Even if it is two departments, which are almost doing the same thing (irrigation and agriculture) they do not work together. So there is still a problem of inter- sectorial coordination and working together to achieve good synergy. ( KI05, 20-09-2015)

One of the grey areas identified by a majority of the key informants and reported by some of the focus group participants in the management of RWH projects, was poor coordination among actors, especially the funders, and poor linkage and synergy within sectors. At least 8 key informants highlighted poor coordination as a major challenge. This finding is consistent with the literature (Black et al., 2012, p. 35; Malesu et al., 2012; Ngigi 2004, 2009) who have emphasized on the need for improved coordination in the sector. Asked who bore this responsibility most of the focus groups pointed to the government though many again reported that though the main promoters of RWH were CSOs there was competition rather than cooperation among the CSOs. Some informants felt that the RWH networks were there but were not effective because of fragmentation, poor representation on the ground, under-exploitation of the network potential, overstepping of mandate and lack of clarity of network functions. This meant that those in charge had not been able to map out the focus and operationalize the roles of the network effectively. An informant working with an academic institution noted the following:

> Besides the legal framework there is need for a National Rainwater Harvesting Network. KRA is there but it mainly run as a business model. There is need to work closely with other actors in this sector. In my opinion, having a viable National RWH Network which also has links with regional and international networks is the first step towards development of standards and certifications in RWH. ( KI05, 15-05-15)

A proposal from most of the key informants was the need for a coordinated pool of technicians, engineers, consultants and contractors who would be certified by a recognized body to undertake RWH projects implementation. Therefore, a RWH network could be given the mandate of establishing a pool of these experts and certifying them in installing RWH structures to guarantee quality assurance to the beneficiaries. As such, the function of a network linking all the players would be to set standards, certify contractors and projects, issue operation guidelines and sample structure specifications or designs, and promote capacity building through information sharing and training among actors. The actors would include, community projects members, CSOs, academic institutions, government agencies, retailers, industrialists and individual experts.

Important linkages for coordination also included those of the project groups and government agencies for technical support. For instance, it was well established that during community group elections, the Ministry of Culture and Social Services and the Department of Provincial Administration sent representative to oversee the process. But this can only happen if the groups are legally registered and kept the ministry abreast within formation about their operation.

A national network would add value to the local institutions on the ground by providing avenues for continued interaction and communication. For instance, if the umbrella model (nested enterprise) used by KRA is applied on the ground then the national network complements the local networks to ensure there is linkage from local to national levels.

**Project Installation designs**

During focus group discussions, it emerged that to ensure efficiency and effectiveness, it was important to have a design of project installation that incorporates elements of sustainability, socio-economic and environmental factors. For instance, it was apparent that most of the roof catchment surface areas in the homes were limited and thus, it was not possible to capture adequate amount of water to cater for all uses (domestic, agriculture and livestock). Even if the surface areas were large enough, it would require voluminous tanks which most people in rural Makueni County could not afford. It was therefore proposed that successful RWH should feature a combination of methods for effectiveness. For instance access to a dam (pond, pan, sand dam) for agricultural and livestock purposes and a roof catchment for domestic purposes. A key informant working with an international CSO advocates for availability of large amounts of water:

> …I prefer either a sand dam or a big surface dam or a combination because at the end of the day though the roof catchment tank gives clear drinking water, for it to be able to sustain enough to take people throughout the year you will need many more tanks if you do estimates. People don't do estimations. ( KI08, 21-10-15)

As explained by another key informant, the model promoted by KRAfor dams was meant to cater for conservation, control siltation, contamination and improve efficiency in general:

> The big dams initially done by the Ministry, the Constituency Development Fund and all this integrated development programs, are left open to all users so that livestock goes direct and people go direct…. Ours we have actually eliminated that. We are making sure if you have a water reservoir nobody or no animal goes in. You fence it [pause] you have a dyke that goes below the wall with a membrane filter then you are able to get water downstream. And downstream you have a water point for livestock, that is the cattle trough and a water point for human beings, that is what we call community water point… We put an underground intake chamber then the pipe, outlet pipe will go below the dam wall then you have the water being collected downstream by gravity. Yeah that is the technology we are using. And we also found another thing that is normally left out is the issue of sanitation..… If the users don't have anywhere to go and bath, they will come and bathe inside the dam at night. So we have also put in the sanitation facilities in the design. We normally have a bathroom and a toilet separate for men and women. ( KI03, 25-04-15)

The components for the design model for various RWH methods, as it emerged from the discussions with the almost all the key informants in the study can be summarized as follows

1. Lining for earth dams, pans, and farm ponds where the soil is non-clay to control seepage

2. Shade net (85% shade) for ponds to control evaporation contamination and prevent accidents or even insects breeding in the reservoir.

3 Intake well sunk below the surface of dams serviced with a pump to enable people fetch water without getting into the dam and contaminating it or an intake chamber that is sank below the surface and connected to a tap for residents to tap water. Furthermore, the water accessed this way will have been filtered a bit to reduce turbidity.

4 Cattle trough for animals to access water and not get directly into the dam/pan/pond.

5 Sanitation facility to reduce open defection in the surrounding and bathing within the dam/dams/ponds and consequent contamination of the water.

6 Fencing of the dam/pond/pan for safety.

7 Conservation of the catchment. It was noted that conservation of catchment in most cases was reduced to mere planting trees on the embankment of dams or pans. It should entail thorough mapping of the catchment using GPS prior to installation of the dam and undertaking several conservation activities like terracing, that would improve the quality of water that goes into the dam.

*8* Water tank and distribution: In some instances a tank could be installed where the water is pumped into the tank and treated before being tapped. If the capacity of the dam is high, distribution to more water points can be done. If water treatment is not possible at the central point, then residents should be trained on treatment at household level using best affordable methods. One of the informants who has been involved in RWH for over 40 years as a contractor and consultant reminisced about some of his experiences:

> …..on the river bank we dig a well and then we can build a pump house, then a pump (so because there is no electricity so they use a diesel generator to make electricity to pump it up)… Now then its [water] is pumped 5 km up the hill into an elevated tank that has chlorine. Then gravity takes it down. It is the best project I have done…. I take many people there. It pumps 16$cm^3$ of water per hour six hours a day all year. ( KI08, 19-09-2015)

Many of the experts interviewed agreed that the way most RWH projects were constructed was not successful because either they lacked standard technical requirements or they were not well equipped to ensure potability. Some of the reviewed literature was in agreement with this finding and reiterates that there was need to do quality control in RWH to guarantee good service to users (Black et al., 2012, p. 40). Even though the successful projects did not exhibit all the listed components studied it was demonstrated that this was necessary in that promoting quality, quantity and ultimately sustainability. Therefore it was important that project groups and sponsors access information about accredited technicians and designs.

## Chapter Summary

The main institutions for RWH governance in Makueni County were the community water management committees or groups on the ground, also known as "common interest groups" while at the national level it was the GoK agencies and NGOs like KRA. SEARNET, a network, hosted in the World Agroforestry Centre, coordinated RWH activities in East and Central Africa. Except for occasional collaborations, there were glaring gaps in coordination

and cooperation among the various actors. Many of the issues raised in this research therefore, pointed to the need for more linkage, coordination, networking and standardization in RWH.

# Chapter 6 – Results and Discussion:

# Rainwater Harvesting Methods in Makueni County

## Introduction

RWH methods in Makueni County and the entire country vary. All The key informants and group discussion participants appreciated that RWH technology is not new to the country, neither was it new to Makueni County. The practice has been in Kenya for decades and a variety of technologies have been adopted based on geophysical conditions and end use, as explained by an informant, a civil engineer engaged in RWH:

> Particularly communities in arid and semi- arid areas have been using RWH technologies since time immemorial. They had to adapt to the impact of unreliable rainfall. Currently, because of climate change and global pressure, there's need to adapt and to evolve modern technologies to become more resilient. ( KI03, 25-04-2015)

In line with this findings, Kinyua (2005) indicates that even though RWH is practiced nationwide, it is more common in arid and semi-arid lands (ASALS) because of water scarcity. These regions are also the hardest hit by climate change impacts (IPCC, 2007). Most of the ASALs receive around 0-200mm of rainfall per annum (KMD, 2007) yet most of these areas are far from getting piped water from the GoK because of past governments fiscal policies, and fast distance (Ngigi 2004). Furthermore, even areas with a thin the rainfall belt lack adequate access to piped water for various reasons like poor government policy. And therefore for these communities, the available options are either ground water source if available or rain water. Five key informants, especially from the CSO sector, reported that underground water (bore

holes, wells) is costly to install and maintain as the pumps break down frequently or water levels recede with time thus making rainwater the cheapest and most sustainable option in ensuring community resilience to external shock.This finding was also reiterated in the group discussions who said that most of the bore holes experience breakdowns often as well as water recession.

The key informants further explained that the RWH technology application depended on physical and geological characteristics of a place. For instance a key informant from one of the RWH agencies said:

> The technologies adopted depend on the uses and locality. For instance, in Kambalani [Kitui, Makueni, Machakos] and Isiolo where you have the sandy river beds, sand dams and subsurface dams are very common for all purposes i.e. domestic, livestock and micro irrigation. ( KI03, 25-04-2015)

The key informant also explained that on the other hand, roof catchment is widely practiced in almost all parts of the country. According to the group discussion participants, a majority of the population in Makueni County utilizes roof catchment and one of the most limiting impediments to roof catchment had been socio-cultural factors. For example, the Maasai community traditional homes are made of mud which is not conducive to RWH. Many group discussion participants said that poverty prevents them from implementing roof catchment given that many houses in the rural areas are grass thatched which inhibits RWH as opposed to those that are iron- roofed. Even some of those with iron roofs still had either a small catchment surface or a small capacity tank hence could only capture small amounts of water at a time.

The researcher was informed by a key informant that in areas characterized by livestock production, water pans and earth dams were very common but they had problems like siltation because these areas were characterized by high soil erosion in the highlands, the source of much of the runoff . The rain fall intensity in these areas was high and lasted very short periods yet the soils were loose. This facilitated erosion and consequently siltation of the dams. However, rock catchments systems were specific to areas with open rock catchment or extensive rock outcrops that form rainwater catchment surface like Makueni, Kitui, Kajiado, and partly in Turkana.

## Macro Rainwater Harvesting

### Dams and Ponds

The key informants involved in technical aspects of RWH explained to the researcher that farm ponds, earth dams, water pans, subsurface, sand dams and roof catchment constitute macro RWH in contrast to the micro modes. Farm ponds and pans were described by the informants as the diversion, collection and storage of water from some external catchment area to a natural or constructed basin structure and that these structures varied in makeup and size, ranging from small manually dug farm ponds to large community earth and sand dams.

#### Farm Ponds

The researcher learned from the group discussion participants that farm ponds had recently been introduced to Makueni County targeting mostly small-scale farmers though their uses were normally not restricted to micro-irrigation and livestock production. They were also used for domestic purposes. A key informant reported that KRA, for instance, was implementing the “upgraded farm pond.” It was being referred to as upgraded because it had all

the components that reduced water loss, by reducing seepage, siltation, evaporation, and improving water management. The pond, according to a key informant from one of the leading RWH agencies, was an integrated system. The system started from the catchment for harvesting water which was mainly road side or within the farm, the sill trap, screen sill filter, excavated pond and the roof. Technical specifications for the pond technology had evolved overtime in a bid to make ponds better suited to the socio-economic and physical environment as narrated in the excerpt below by the same respondent:

> Initially what we used to call the first generation farm pond, we were roofing with iron sheet, and you will find that in schools to date we are still roofing with iron sheets to avoid children going in. But then, the cost was very high…. We were challenged sometimes in 2009 by UNDP…. We had a project we were doing with UNDP and then they said the cost of which we were doing one pond was very high…. They said, the technology is good but could not be adopted by most farmers because of the cost, so can you try to reduce the cost by half? And then if you can reduce by half, what you are requesting we will double [pause]. So we actually looked around and said yes, all we needed to do was to look at the trade-off between [pause] losing some water through evaporation. So we actually realized we could use some net instead of the iron sheet. Then again... when it came to net, we had the net from 50-90% shedding. We were like if we go for the 90% one, the water would not be able to go through. So it could not collect direct run off, so we went for the 80% that allowed water to go in, and then there was a trade-off of lossing 20% water through evaporation, which actually has not been happening[laughs]. So we increased the size a bit to actually cater for that 20%

> anticipated loss and then we were able to actually come up with a reduced cost. Back then that was roofed by timber, because around Mt. Kenya there are a lot timber, so we did not have a problem with wood for that. But when we tried to take the same technology to Ukambani, the first thing, since we also discuss with the community… they told us "look, here in Ukambani our termites eat even metals." [Laughs]. Moreover, the cost of timber was expensive, so we went back to the drawing board and that is how we thought about the simple metallic roofing for the farm ponds, which actually now seems to be the best and which still cuts the cost further if you consider the cost of wood and the cost of setting up because with the metallic everything comes as pieces and they are all fixable so you could actually fix it within a very short time. So we were able to reduce the cost and come up with something the community felt was more appropriate....Yes, this is what we have and that's what we are calling the 3rd generation farm pond. Because the 1st generation we were roofing with iron sheet… we moved from iron sheet to greenhouse… with wooden, then the net, the shade net, with wooden structure then we realized the wooden structure could not work everywhere but now we have realized the metallic structure can work in a variety of environmental contexts. ( KI03, 25-04-2015)

As in other development sectors, many dynamics underlie RWH phenomena that influence the outcomes. The respondent quoted above clearly showed that implementers, especially local NGOs are sometimes caught in between balancing the demands of donors and those of beneficiaries. Sometimes these demands could be divergent, sometimes mutual. The case above is mutual and adding value to the beneficiaries in the sense that the donor was

supporting development of locally suited technology. This was highlighted by majority of the group discussion participants and some some of the key informants as a major challenge because most often NGOs implemented projects using imported technology which on one hand was expensive and on the other unsustainable because of poor compatibility with the social, ecological and cultural environment. This incompatibility was partly to blame for failure of many RWH projects (Black et al., 2012). One key informant explained that where the soils were clay it was possible not to line the ponds and retain water for a long time. In this case one only needed to excavate and have a farm pond. However, where the soils were very sandy without the lining you could not harvest and retain the water for long. It was crucial for communities to understand the technology so that they could determine where to do lining and where not to line ponds.

The researcher further learned from the key informant that the ponds needed the roof not only to control evaporation and loss of water but also to prevent mosquito breeding and accidents especially for children. They were durable so long as animals were kept away to prevent piercing and tearing.

*Figure 17:* Farm pond implemented by the ASHG project in Makueni, photo by J. Mang'era

The key informant further illustrated that cost of a complete pond was about $1000 which may seem expensive, but, for instance, if it was being used for small scale horticulture farming for

sale, the pay back was possible within two to three seasons. This he said, was based on his experience implementing farm pond technology in Kenya.

*Figure 18:* More sophisticated pond using the greenhouse roof and ground as catchment, photo by J.Mangera

Farm ponds are a technique unique to Kenya that was being propagated by SEARNET and KRA as reported by two other key informants. This technology had widely gained popularity especially in the drier regions and the whole country in general. According to these

informants, farm ponds were more economical than most methods because they could be used for both farming and domestic purposes and do not require extensive space to install. In fact, some of the neighboring countries were using Kenya as a reference point as they replicated the technology. It was therefore the opinion of most of the informants that Kenya should take advantage of such innovations available locally to upscale RWH.

### Sand Dams, Subsurface Dams Earth Dams and Water Pans

A key informants informed the researcher that sand dams and subsurface dams were found in terrains with sandy riverbeds of Eastern Kenya, for instance, Isiolo, Kituiand Makueni. From the literature Sand dams are described as follows:

> … Steel reinforced concrete (or technically speaking, rubble stone masonry) wall built across a seasonal sandy riverbed. During the rainy season, a seasonal river formed and carried soil (made up of sand and silt) downstream. The heavy sand accumulates behind the dam, whilst the lighter silt washes downstream over the dam wall. Within one to four rainy seasons the dam completely fills with sand. However, up to 40% of the volume held behind the dam is actually water stored between the sand particles. The water can be abstracted from the sand dam in three main ways: Traditional scoop holes; an infiltration gallery either leading to a tank behind the dam and/or piped through the dam leading to a tap; an infiltration gallery leading to a sealed shallow well in the valley side – topped with a hand pump. (Excellent Development, n.d.)[2]

[2] http://www. 2016excellentdevelopment.com/articles/people-amp-communities/what-are-sand-dams, Accessed on -06-15 15:07:40

The researcher was informed by participants that populations in semi-arid environment like Makueni and Kitui, had been using sub-surface dams and sand dams to harvest rain water. This was the most common method for which the Government had done some small investments in semi-arid areas to provide water for domestic use and livestock. A Key informant involved in RWH projects implementation recounted his experience with sand dams:

> In Makueni, we actually considered the water pollution… and weighed how to reduce water pollution. Installing an access well and hand pump, so that, instead of people going to scoop water from the sand, you have a well equipped with a hand pump for easier access, we found out that was helping so much in reducing pollution. ( KI03, 25-04-2016)

*Figure 19* : Syiuni subsurface dam, photo by J. Mangera

*Figure 20* :Matiani sand dam
Source: Kimani et al. (2015*)*

From the respondent's description of the technology, it is apparent that once a well was installed, it was important that a hand pump is erected to assist in drawing water from the well in a more hygienic and safe manner. In addition, an animal trough was put on the side so that livestock can access water from this point instead of going directly to the dam. This prevents

contamination from animals. Generally, according to the key informants, equipping a dam this way improves the quality of water making it safer for domestic use. This was also emphasized on in the literature because one of the challenges facing RWH projects, especially dams, was contamination and subsequent quality compromise (Black et al., 2012).

A key informant explained that the difference between a sand dam and a subsurface dam lay in the fact that the sand dam was on surface of the river bed while a subsurface dam was below.He said: “The sand dam is above the level of the sand whereas the subsurface dam is below the level of the sand on a river bed.” ( KI06, 19-09-15).

*Figure 21:* Makueni Earth dam project group members during a discussion , photo by J. Mang’era

On the other hand a water pan was described by another key informant involved in water engineering: "A water pan is where using a tractor or a bull dozer you impound the soil without much compaction hence creating a reservoir. Water pans have no regular shape, however, they are less intensive in terms of effort in excavation" (KI07, 20-09-2016). In the case of a pan as detailed by the informant, water will be available to be used by the community and most cases it will not go round the season, so that after three months the pan had dried up. According to the informant pans were normally smaller than dams and much shallow than ponds. One of the challenges reported by almost all the informants across the board regarding dams and pans was that they were not considered as sources for potable water. Three of the key informants noted that this was so because of the way such projects were implemented. Many sponsors would try to cut down the expenses so they installed projects halfway. For instance, dams and pans became an issue of just excavation whereas there was much more to do after excavation to meet required portability standards. This was narrated in detail below by a keyinformant working with a leading international NGO involved in RWH in Makueni:

*Figure 22:* Kwa kaledu water pan in Malili, photo by J. Mang'era

If you construct a water pan in order to provide clean water to the community, you are supposed to put what we call a filtration system on the upper side of the whirl, that is, the wall and that filtration system is composed of ground material of rocks, small and big rocks and then sand. They are put in layers such that when the water is going through it is purified. This system has proved not to be very effective if the water is very turbid. So now to ensure that the community can get clean water from this turbid water beside the filtration system which is put on the upper side of the reservoir or the whirl now there is another system where you construct what we call the slow sand filter which is a big system where water goes…enters into that and its composed of materials almost like the ones that I have talked about.... There is sand, there are boulders, there is ballast ground such that water will go through that and the volume is big. By the time it comes out now

> its water that is actually clean. So that one has been done by some Civil Societies, but it is expensive. That's why some of them don't go out and talk about it. Because the water pan or the dam may cost about KES 4 million and then the sand and the filter to treat that water in a good quality manner it would also require like another KES 3 million to construct that. So you will realize, that is expensive. So, what happens is that the water comes from the reservoir, comes through the sand and filter then the water is taken into a storage tank.… Then now communities fetch from that storage tank [pause] so it is a model which works but it is not popular since it is expensive and also because of lack of knowledge. ( KI07, 20-09-2016)

One key informant commenting on the design of RWH infrastructure said the success and sustainability of RWH interventions like earth dams depended on identification of suitable sites. Apart from a site being technically suitable for a certain intervention one must also take into account the social economic and technical requirements. A site could be suitable for a dam but far away from a settlement. Thus, there was a need to integrate the technical requirements with the socio-economic conditions of the beneficiaries because it was the people who would manage and utilize these structures. Integration of the technical requirements with the socio-economic condition of the beneficiaries would therefore indicate optimal site for such interventions.

*Figure 23*: Contamination due to lack of drawing points, Photo by J. Mang'era

**Roof-top Catchment**

All key informants and focus group discussion participants cited roof-top catchment as the most common of all the RWH methods, practiced everywhere in the country, in both urban and rural areas. Roof catchment water was often used for domestic purposes. Based on the observation by the researcher in the field various types of containers were used to tap water from the roof including clay jars, drums tanks and under/ground reservoirs. In Kenya this technology had evolved overtime as explained by an informant who was a contractor and consultant on RWH. "Now I have trained so many foundational engineers in building different types of roof catchment tanks using bricks, ferro- cement, concrete blocks but now nobody is using it because they all have PVC tanks" ( KI06, 19-09-15).

The key informant informed the researcher that in the 1970's and 1980's, tanks made out of corrugated galvanized iron sheets were promoted. However, most of these tanks were quickly abandoned due to leakages resulting from corrosion. Several NGOs also promoted rainwater

harvesting ‘jars’ during this time, which utilized sticks and branches for a framework and reinforcement to the structure. After a few years, termites consumed the sticks, and most of the jars subsequently fell apart. Ferro-cement tanks then began to gain popularity in Kenya in the 1980s and 1990s. However, according to the informant, many problems were experienced with these initial ferro-cement tanksbecause many tanks were constructed poorly using poor sand and inadequate curing, which resulted in porous walls that gave way to seepage. The literature also reiterates that ferro-cement tanks were the most popular material for construction due to its affordability and quality and Successful examples of its implementation were found throughout Kenya (Nissen-Petersen, 2007).

The key informants discussing roof catchment appreciated that its evolution had been due to the quest for efficiency and effectiveness even though inadequate implementation skills affected the overall impact of the technology on water security. To date one would find many Ferro cement tanks that leak and were unutilized in homesteads due to poor workmanship. A key informant emphasized that the limiting factor to roof catchment was the size of the catchment, the capacity of the harvesting container and awareness**.** An informant, water engineer working for a government agency explained this in-depth:

> Nowadays, the average people have iron roofed houses. It is only that the house could be small and the tank small. The need is to increase the size of the tank and rectify those tanks not build properly, you know haphazard building [Pause] it is like “trial and error”, it does not really help. Like I found in Magadi, UNICEF, which is a very big organization or AMREF, could give tanks to every household, but, what capacity? 100 litres. 100 litres for harvesting rain water is not enough. Whereas from the research I did, an average

family will need about 20,000 litres for six months. And 20,000 litres in Magadi translates to 5 ‘mitungis’ (jerricans) that’s, 100 litres per day. ( KI01, 20-02-2016)

According to one key informant a well-constructed roof catchment tank consisting of a fowl flash (the first 1 % of the volume), and a well-insulated tank will provide safe water for domestic use. A fowl flash ensures no dirt particles gains entry into the tank. If the tank is completely closed up and shielded from the sun then the microbes are not able to grow and the water remains very safe.

*Figure 24:* Simple basic roof catchment – Malili, Photo by J. Mang’era

*Figure* 25 : Ferro-cement tank for roof catchment Source *:* Aroka (2010)

While most of the key informants believed that provision of potable water was most important some expressed the view that availability of large amounts of water was most important so that there was enough for all purposes. One key informants said thatonce large quantities were available then water treatment could be done at household level. In this regard, the roof catchment should be supplemented with some other method like a dam or pond. The key

informant working with an NGO running RWH projects in ASALs went to lengths to analyze roof catchment:

> So now [pause] my problem is that whenever I think about rainwater harvesting, if I am doing audit in the field I don't like the idea of constructing a tank because a tank is very expensive. I prefer either a sand dam or a big surface dam or a combination because at the end of the day, these tanks keep clean drinking water but to… have water that would be enough to take people throughout the year, you will need another source. …You do the calculation and see how many tanks we will have. Many people do not do estimates, they just go construct a tank and then harvest from the roof. You need to know the surface area of your catchment. You need to know the demand per day and then relate to that storage and then you will see the number of times it will rain so that you can estimate whether it can keep the community or the school going for a full year. ( KI08, 21-10-2016)

Considering the feedback from other Key informantduring the research, there were concerns regarding lack of matching the capacity of roof catchment tanks with the household water demands. And even so, an emerging dimension was whether one mode of RWH was sufficient and whether there was need for combining methods to ensure sufficiency. This concern will be discussed in next chapters.

**Rock Catchment**

As informed by a key informant, a rock catchment is a gathering system with a concrete wall built on top of a rock. This normally happened where there was a big surface area of rock

However, often this water did not last long, it was likely to have been exhausted within two to three months after the rains due to evaporation. Hence collected water was channeled through a sand and gravel filter to a tank. The key informant further explained that the rock catchment required a system of maintenance. This included erection of a fence so that animals such as goats and cows don't climb the rock and cause contamination. During the dry spell dust gathered on top of the catchment. Therefore, the management group or caretaker of the project had to be trained to be on the lookout so that the first rain is not allowed into the tank in order to clean the surface and get rid of the dusty water.The key informant compared rock catchments to other methods:

> Though rock catchment is limited in site availability, rock catchment can collect significant water within small showers just like roof catchment but it is also limited in use ( to domestic use) as compared to open reservoirs like dams unless the water is distributed [chanelled] to points where it can be used for irrigation and livestock. ( KI07, 20-09-2016).

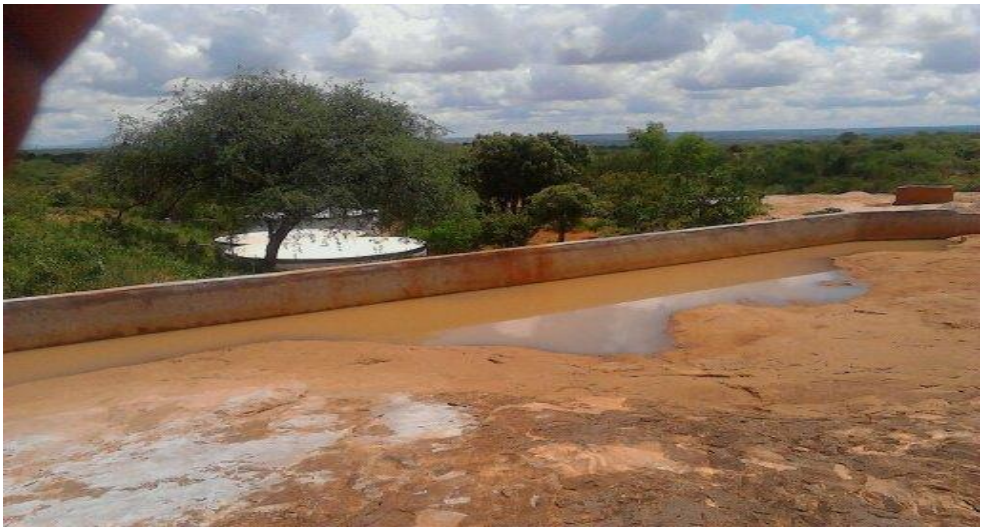


*Figure 26:* Rock catchment managed by Vololo self-help group with tanks together with distribution , Photo by J. Mang'era

*Figure 27:* Muliluni Rock Catchment in Makueni County showing distribution tanks ( USAID/ Welt Hunger Hilfe,2009 *)*

As explained in the excerpt above because of exposure, rock catchment could not hold water for long due to evaporation. The water quantity collected was smaller compared to a dam

hence could not, in most cases suffice for farming. It was thus mostly used for domestic purposes.

**In-situ Rainwater Harvesting**

As explained by a key informant, an agricultural engineer, in-situ water harvesting technologies referred to trapping rain water where it falls on the ground so that there is maximum soil filtration. This was done through techniques like terracing, pits and redges. In most cases, two or three in-situ technologies were used at the same time, for example, terracing plus zai pits, contour ridges plus zai pits to ensure maximum filtration. Another key informant asserted that For a long time in-situ RWH was considered conservation agriculture hence it was relegated to the Ministry of Agriculture (MoA). It was therefore not captured as a mode of RWH. However this had since changed as experts had maintained that the process involved was actually collecting and storing rainwater within the soil and therefore should be considered RWH.

*Figure 28*: Zai pits, Anyanyae project Source: Photo by J. Mang'era

As explained by most of the informants in-situ methods were numerous and although the concept was the same, they were implemented in a variety of ways in different regions.

**Chapter Summary**

Informants reported that even though there were a variety of technologies being utilized to harvest rain water in Makueni County, sustainability and general impact on water security was impaired by low investments in the sector as opposed to the estimated potential of RWH in the region, due to lapse in policy and implementation and management problems. Physical conditions, intended use and cost determined the method to catchment applied. Main types of technologies assessed in this study included, earth dams, water pans, domestic roof catchment, farm ponds, rock catchment and in-situ methods such as terraces and zai pits. While informants reported isolated cases of success both in institutional design and technology, and GoK policy to RWH was becoming more favorable, issues such as poor technical designs, capacity and coordination all seemed to hinder progress. In the next chapters these factors are discussed in detail.

# Chapter 7 – Results and Discussion: Success and Non-success Factors

## Introduction

The purpose of this chapter is to characterize successful and non-successful projects, and to identify and describe the factors that facilitated success or non-success of projects in the study area. To compare performing (successful) and non-performing (unsuccessful) projects, at the onset of the fieldwork I developed evaluation criteria to identify factors that contribute to success or non-success and obstacles across all of the RWH initiatives in the study area ( see above in the \methodology chapter). I was then able to group all of the projects into the two groups. The criteria included benefits/impacts and reliability. Reliability was used to refer to consistence in output, in this case water supply or any other expected outputs, while benefits were the perceptions of the people as to the effectiveness of the project and the benefits they received from the project. In the first section all projects that were grouped as successful are listed and discussed. The non-successful projects are also discussed in the following section and an analysis of the crosscutting themes between the two groups is made.

## Successful Projects

The findings identified the following projects with attributes of success for performing RWH projects in the study area. The projects are summarized below and thereafter common success factors are discussed.

*Table 7*: Successful RWH Projects

| **Group** | **RWH project and other activities** | **Group Governance** | **Success Factors** | **Project State** | **Success/Impact** |
|---|---|---|---|---|---|
| ASHG/ 011 | Farm ponds in-situ, roof catchment. Also engaged in agri-business, water selling, and table banking. | Registered in MCSS, and have a constitution. They hold frequent meetings. | Group members work as a team, trust and respect one another. Members had believe in the group vision and goal ( Farmpond for each member). Group members were trained by KRA and MCSS, The group Networked with the MOA. Members were aware of their roles. | Well maintained | The group had Bought 20 water tanks for members, and Installed 2 other farm ponds. The group had managed to Diversify income from water sales other activities using the RWH projects. |
| NYMSHG/ 012 | Farm ponds, Roof catchment, in-situ, fish ponds, horticulture, water selling | The group was registered by MCSS, they had a constitution in place, and group functions were carried out in line with the | Members had a common vision- to reduce poverty amongst them. There was trust among the group members. There was a shared aim to buy a posh mill. The Group was trained on project management and some members trained on in-situ RWH by MoA. | Well maintained | Diversified income and alternative livelihoods created. Water availability for group members and for community. |

| | | | | | |
|---|---|---|---|---|---|
| | | constitution. | | | |
| KKSHG/013 | Farm ponds, insitu, fish pond , roof catchment, horticulture water selling, merry go round | The group was registered by MCSS, had a constitution in place and adherence to the constitution observed. | Members trust each other, their leadership and goals, Discipline among members enhanced and roles distributed among members. Group trained on project management and on conservation agriculture | Well maintained- Problems with animals damaging. The embakments | The group had achieved a reduction in distance to water source, and had access to steady supply of water though still not to the expected level. |
| TWWSHG/ 014 | Farm ponds, in-situ RWH and roof catchment. | Registered by MCSS and had aconstitution in place. | Unity among members reported and noted. | Well maintained | The group had Improved water availability, implemented additional ponds on their own, and managed to link with market/manufacturer for passion fruits processing. |
| WWM SHG/015 | Farm ponds, in-situ, roof catchment, Agribusiness-passion fruit, and merry go round. | Registered by MCSS, and had a constitution in place. | Discipline among group members practiced through adherence constitution. Executive management was in place. Group trained on project management, conservation agriculture and agribusiness by | Well maintained | Increased availability of water and food, and made income from water sales, and from agribusiness. |

| | | | | | |
|---|---|---|---|---|---|
| | | | the ministry. | | |
| VYSHG/016 | Rock catchment with three distribution tanks of 45,0000 litres, roof catchment, tree nursery and water selling. | Registered by MCSS, and had a constitution in place , | Group unity was a strong point as emphasized by members. Stability was ensured through commitment by members. Executive management was in place and functioning as required. Trained on project management by USAID. | Well maintained although not fenced. Water tanks with distribution points enabled easy access to users. | Water availability at reduced distance and improved income for members. |
| TMSGH/ 017 | Farm ponds, in-situ RWH, roof catchment and water selling | Registered by MCSS, constitution in place | Unity of purpose in the group. Adherence to the constitution confirmed. Regular group meetings (monthly) ensured. Trained on RWH and project management. | The project was fairly well maintained although not fenced. The members complained of problems with rodents. | The group had managed to access loan from a local bank for project expansion. Members reported increased self-esteem apart from improved water availability. |
| TUSHG/ 018 | Farm pond and roof catchment | Registered by MCSS, and had a constitution in place. | Group unity was attested to by members Good Documentation of group matters The constitution was shared among members and followed-members confirmed constitution guides their interaction | Well maintained | Water availability |

| | | | | | |
|---|---|---|---|---|---|
| KISHG/ 019 | Farm ponds, in-situ RWH, roof catchment, water selling and agribusiness. | Registered by MCSS and had a constitution in place. | Group unity,trust and shared vision helped enhance stability. Members acknowledged that good leadership was their strength. Good record keeping shown and noted. Group benefitted from training on project management and business management. | Well maintained | Improved water availability and access to more nutritious food farmed using harvested water. Income generation. The group managed accessed loan from a local bank for project expansion. |
| KASHG/ 020 | Farm ponds, in-situ, roof catchment, merry go round, farming | Registered by MCSS, constitution in place , affiliated to the AIC church | Group is intact and focused<br><br>Group trained on RWH, conservation agriculture and project management | Well maintained | Water domestic, livestock and farming' accessed loan for increasing Farm ponds Accessed/loan credit as a group |
| MPS/21 | Roof catchment composed of a Ferro cement tank, one iron sheet roofed farm pond and conservationagriculture. | Governed by the school board rules. | Management committee was intact, and oversaw the project on behalf of the school.<br><br>Project management training was done by New Life- a Faith Based donor. | The project was in goodcondition, partly attributed to school /institutional based management. | The project provides water for use in the school and for subsistence farming (kitchen garden). |

**Existence of a Recognized Management Entity**

One of the common factors observed by the researcher in the projects studied that were considered successful in the perception of communityparticipants was the existence of membership organized as a self-help group and registered with the Ministry of Social Services at the national level. However, some key informants informed the researcher that with the coming into effect of the Kenya Constitution 2010, registration of such groups could be done at county level. Two of the Key informants also said that, based on the Water Act 2016, these groups could also register as Water Services Providers under the Water Resource Management Authority. A key informant working with an international NGO suggested the financial advantage of registration: "It is very good for the groups to register as WSPs for they can even access money from the Water Trust Fund" ( KI07, 20-09-2015).

As explained by the Key informants, registration of groups was very important for accountability and compliance with the law. It also made it easier for such groups to partner with funders and government as they became recognizable legal entities. One key informant explained that since the Water Trust Fund was a government agency set up under the Water Act 2002 to offer credit facilities for water resources development (GoK/MWI, 2012), when community groups were registered as WSPs they could form WRUAs and hence be eligible to access these resources. They were also able to request capacity building assistance from relevant GOK agencies. Capacity building was important because during the study, it emerged that almost all the groups that were considered successful/performing, had had their capacity enhanced through training.

Most of the group discussion participants reported that many of the community groups came together voluntarily out of common interest, for example, to solve a pressing need. A female participant in one of the focus groups discussions, recounted water hardship that gave rise to the formation of their group: "We used to walk long distances especially as the seasonal rivers used to dry most of the times but we don't walk anymore." (ASHG 011, 14-04-15).

The participants reported that the need to solve the water problem and overcome poverty motivated them into joint action. The literature ( Ostrom,1990, 2001, 2005, 2008; Berkes, 1989, 2007) who assert that users of common resources are not usually helpless and are able to organize in order to solve their problems is in agreement with this finding. In general self-motivation emerged as a contributing factor to group and project sustainability.

The researcher was also informed through the group discussions that groups were also formed through facilitation by a third party rallying community members towards addressing a concern. Such third parties could be Civil Society or Government workers. A male key informant working for a RWH network emphasized this by saying that : "….The software is where the project must have very well trained Water Users and a Community Management Committee that will especially manage that dam" ( KI03, 25-04-15). Once in place the group nominated their executive committee guided by the constitution which also spells roles of the executive. In addition, maintaining an identity through registration also helped the groups to freely collaborate and enter into partnerships that are important for project sustainability such as liaisons with GoK agencies. These collaborations were a very important part of institution building, promoting linkages and positive horizontal and vertical interplay.

**Existence of Enforceable Rules and Guidelines**

From the Focus group discussions, it emerged that, for the projects to work out successfully, the group had to come together and work as a team, as explained a female participant: "We have kept the group together by following group rules and constant consultation" (NYMSHG 012, 16-04-15*).* At the formation stages the groups were required to develop a constitution that would govern their behavior and operations. In fact, it was mandatory for the groups to have a constitution in place before registration. The constitution gave guidance to members regarding governance matters, for example, how to elect officials, the officials' roles and responsibilities, how to resolve conflicts and how to share benefits accrued. A male key informant working for a RWH network emphasized the CSO role in project group constitution formation:

> .....They will be trained to understand that we need to enhance by-laws, because we need by-laws to know how you will be getting money for maintenance and operation…. In fact most of them will employ watchmen on their own because they don't want anyone to come and vandalize their property or they don't want people who are non-members to come and use. They also set a certain cost, how much they will they charge for livestock, for instance and that is what they will use to pay the watchman and for operation and maintenance." ( KI07, 25-04-2016)

The excerpt emphasizes the need for project groups to have and exercise their rights over common pool resources, for instance, the right to withdrawal and access resources as also noted in the Literature (Ostrom, 1990, Schlager, 1994). This means that attaching cost implication to a

resource use generated income for the group but also ensured that the group was able to access resources for maintenance of the project. The group was also able to control who uses the resource through the right to access by appointing a caretaker. Therefore, project groups who identified their rights well at formation and enforced them were able to build stronger, vibrant and sustainable institutions, hence promoting project sustainability.

All the groups visited emphasized the importance of not only rulemaking but adherence to the rules in ensuring the success of the project. The participants said that project donors organized training for members to be sensitized on the constitution so that they were aware of the penalties, obligations and rights. A male participant explained the usefulness of rules to the group:

> ….This has helped us maintain discipline as well as safeguarding members' interests since they are assured of their roles and benefits. During elections, the Ministry of Culture as well as the provincial administration send representatives as observers. (ASHG 011, 14-04-15)

Arising out of the conversation with the group participants and as highlighted in the excerpt above were issues of transparency. Transparency and individual integrity were the basis of the group constitution. So long as group matters were dealt with in a transparent manner there would be cohesion and project progress. Examples of projects that had crumbled because of lack of openness were said to be numerous and some of the members involved in the discussions reported having been victims of such groups which they had long abandoned.

This discussion with members of community groups also highlighted the need for authorities to recognize the right of appropriators to devise their own institutions and supporting them as also noted in the literature (Murrow & Hull, 1996, Gautum and Shivakoti, 2005). For instance, by the Ministry of Social Services cooperating with the groups on demand meant giving space for group independence and growth while adding value. Most of the project groups performing well also indicated some collaboration with government agencies.

In the strong knit project groups, ensuring participation was a priority and deliberate efforts were made to achieve this. For instance, all members participated in all cycles of project life and there were regular consultations among members. Consideration was given to members who were deemed vulnerable because of their social-economic or physical state, by, for instance, giving waivers on certain contributions such as allowing in-kind contributions instead of cash.

**Clear Member Benefits and Benefit Sharing Strategy**

It was also apparent from the group discussions that for a group to stay together, they had to have a common vision as articulated by a female participant from one of the project groups in the study: **"**We are targeting to raise kshs 200,000 and install a posho mill as an extra income generating project" (ASHG 01114-04-2016). But also the project had to be seen to add value to the lives of the members. Performing groups had a way of sharing the proceeds of their joint efforts. Resources would be pulled together and invested in assets for members in turns. An illustration is ASHG, as narrated by a female participant member of the group.

*Figure 29*: Focus Group Discussion with ASHG, Photo by J. Mang'era

> The group came together in 2010 as an environmental group…. Their aim was to carry out environmental conservation activities like conservation agriculture and tree planting to improve their lives. They were deeply concerned about the high levels of poverty in the area, youth unemployment and environmental degradation. They were trained by KRA who also supported them with a farm pond. They used the farm pond for micro irrigation and also applied in-situ-RWH techniques. They also had a merry go round, planted trees and sold water from the farm pond. They had been trained by the ministry of agriculture on conservation agriculture.
>
> From the proceeds they made from selling water and farm produce as well as through table baking, they aimed to buy 1000litre tank for every member. So far they have bought for 20 members. They also want to replicate the farm pond in each member's homestead. They have also been buying furniture for members (through merry-go-round)

As exemplified in the case above, groups that were successful were able to control access to the resource. Charging a fee for water access meant that they were able to direct how the resource is used and also generate income to maintain or develop the resource further. About half of the groups studied had levied a charge on water withdrawal from the community projects whereas for the other half, open access was the norm except for domestic roof catchment. Water was sold at 5 Kenya shillings per 20 litre jerrican, and for livestock, residents were required to pay a flat rate per month. After taking care of the operations income from group activities would then be re-invested or profits shared among members on an agreed enterprise such as installing

private farm ponds for individual members. This triggered commitment, vibrancy and sustainability.

**Sense of Ownership**

Ownership in this study was used to refer to the perception of members regarding to whom the project in question belonged. It is ironic,as observed by the researcher, that in some places the projects would be referred to by the name of the agency that funded them while in some cases members would indeed speak proudly about their projects and their ownership of them. The reasons for this difference as explained by both the key informants and the group participants included factors such as the way in which the project was conceived, whether it was community generated or imposed by the donor**.** A participant from one of the performing groups explained: **"**Most of the RWH projects are community run. This is because the communities initiate the projects as a felt need and seek assistance later" (KKSHG 013, 13-04-15).

Sense of ownership was apparent in performing groups. In cases of communal projects which were sponsored by donors, some of the project sponsors encouraged the community members to also make some contributions towards the cost of the project. This was to encourage ownership and commitment to the project. An informant working with a local NGO in Makueni explained how they promote ownership in project groups: "So to promote ownership the community members make contribution in everything that we do… We insist that it is either cash or kind, but even in kind we translate it to cash" (KI 03, 25-04-15).

Most of the Key informants also affirmed that member contributions towards communal projects was important in addressing the problem of drop-outs and group disintegration which

was observed to be a major issue in most of the nonperforming groups. In emphasizing this a male participant from one of the projects said: “Lack of quick returns makes groups disintegrate” (WWSHG,015 15-04-15). Some members joined projects groups hoping to attain some quick benefits and when this did not happen they abandoned the groups. As explained by the participants, having a share in the investment ensured that members stayed together even during hard times and this contributed towards the success of the project. This had aided in building strong social ties and institutions.

Another contributor to ownership was ensuring that the project if non-private, was built on public land. Members indicated that whenever an individual had donated land for a community RWH project they ensured that the land was transferred to the group so as to prevent situations where the initial owner of the plot took over the project.

**Clear Business Model/Value Chain**

Groups that were functioning well had very clear business models, as explained by most of the informants. In particular a male expert involved in RWH consultancy gave an example of one project he had been part of:

> In Kisasi in Kitui, we built a subsurface dam in a river bed a big pump house, pump, diesel generator, 30 km of pipeline and all that. That was in 2005, 10 years later, it is still functioning and they have a turnover of more than 1 million shillings in a year. They sell the water in the kiosks and they have 12 kiosks where they sell the water. The money goes to pay the staff working in the project, maintain the generator, pump, and the pipeline. ( KI06, 19-09-2015)

As exemplified above, conceptualizing of RWH as a business and crafting a business model to work by was said to breed success. Some of the groups with performing projects were utilizing the harvested water for irrigation and taking part in agribusiness while some would make income from selling water and the proceeds, apart from catering for repair and maintenance of the projects also was allocated as dividends to members. An informant with long experience supporting RWH projects in Makueni with an international NGO in underscoring the need for value chain addition in RWH projects said:

> I am just from an ICRAF meeting and we were talking about a billion dollar business plan for water harvesting. One of the things we agreed, was that it has to be linked to a value chain. It could be dairy production, beef production, planting trees or including domestic use. So domestic to me is a very small part of the demand system. The biggest problem is that when we push technology to the community we assume that there is a very good business the farmer can do with this water, and they will not do anything. We think that if we can provide water, the farmer will be able to do ABCD. But in reality, it is not the case. ( KI05, 05-08-2015)

The excerpt above illustrates that through value chain addition, projects were able to sustain themselves and generate more impact than in instances where RWH projects were utilized solely for domestic water supplies. This was helpful in triggering scaling up as well as giving rise to development of more RWH projects. The study did indeed reveal that all the performing groups were operating on a business franchise model either selling water itself or utilizing water for farming or using proceeds from water for other investments.

**Capacity Building of the Project Members**

For the RWH projects to function effectively, the group members ought to have the requisite capacity to manage the project. Capacity of the members was vital in ensuring sustainability of the project and project sponsors who were keen on this component actualized it in a variety of ways. A Key informant involved in consultancy and construction of RWH projects explained how they undertook the task of building group members' capacity:

> So we took a committee for each project for a one week training course before we started to construct the structures…. And then when we were about to complete, about 15 months later, we took them for another one week training course again on accounting, management, by laws and things like those. And out of the 6 projects we implemeted, I think one is not working but the others are working very well. We look for success stories, although we also take them to see what has failed, so that they avoid ABCD. We try to expose them to communities that are similar to them culturally, that have similar lifestyles, livelihood systems, similar environments and things like that. (KI06, 19-04-09-15)

As explained above, the group discussion participants members' capacity was built through vertical learning by actual training and horizontally through exposure to other groups. The informants said that combining the two strategies this way helped the members to internalize and apply the learnings better. The members needed skills on team building/ group dynamics, operations and maintenance which included repairs, servicing, finance and accounts management, crosscutting issues like gender and HIV/Aids and on RWH. For instance the

project group needed to understand how to ensure that specific project infrastructure was in good condition and operating well and how to add value with a view to growth, for example, through undertaking business ventures. Apart from the crosscutting trainings that groups said were mandatory for all members (or in some instances the entire management committee) the groups nominated different members for different types of trainings. The trained individuals became resource persons in the topic of training and could go round training other group members on the same. For instance, one of the groups (ASHG) that had a farm pond for irrigation, had three of the members trained on in-situ RWH. The trained members visited other group members to train them on how to use the in-situ RWH techniques in their farms.

However, one time training was not sufficient because groups evolved and the members needed their capacity refreshed to accommodate or address emerging issues/interests as the project progressed. For instance, once some groups had a water project which enabled them to farm productively, they would at some point want to engage in agribusiness and hence needed skills on microenterprise development or marketing. Participants reported that project sponsors exited at the end of the project periods which were as short as a couple of months. If at the point of donor exit the project members had inadequate capacity to manage the project, chances of the project failing were high. Thus as a principle, some donors, as part of a networking or exit strategy, encouraged project groups to establish linkages with the government agencies on the ground to ensure so that the groups accessed technical support from these departments, especially after the sponsor's departure.

Most of the performing groups confirmed that they had had capacity building and that this training was instrumental in their management of the project. They also reported collaboratory links with government departments like Ministry of Social Services, Local Administration and Ministries of Water and Agriculture. A key informant working with a local RWH network explained networking between the groups they supported with the GoK agencies:

> …Like agriculture [Ministry of Agriculture] is because we work with them. Actually on the ground we engage with them, we liaise with them as long as the project is going on even for the big dams. The officers from the water department, we engage them and give them some facilitation, what we call allowance because we are working with USAID, and they prohibit payment to government officers. So we give them facilitation for transport, to actually supervise the work. For the big dams we don't design on our own we have to follow the government standards. We engage them for the survey, and all through process, including supervision and handing over. (KI03, 25-04-15)

Based on the discussion above, capacity building was therefore associated with good performance in RWH projects but also fundamental in building and sustaining strong RWH management institutions. Some network based partners like KRA, would invite project entities to be part of their membership. This, ideally, would create an avenue for continued interaction and capacity building.

**Presence of a Monitoring Information and Communication System**

Ability for group members to do peer review among themselves was a source of motivation and was fundamental for project progress. Among the performing groups studied,

members emphasized the encouragement from follow up by fellow members. They reported that they monitored each other to ensure that they were implementing what they agreed in meetings. A female participant from one of the projects reported: "We do rotational tasks within the group and it is very easy to know whose piece has been done or not. The books of group accounts are read out to members every end of year" (TWSHG 014 14-04-15). In contrast a member from one of the non performing groups in Malili said: "Although we are united by sharing similar water problem, we rarely work together thus, nothing to monitor" (MEDSHG 05 05-02-15).

Literature revealed that , "When members/users of a resource are able to monitor each other, the resource conditions were themselves better than when local users/members do not monitor each other" (Ostrom, 2008, p. 9). This resonates with the discussion above. "Monitoring was important to gauge progress or determine what needed improvement, and to be of greater use to future projects" (Black et al., 2012, p. 46). Critchley (1991a) also reiterated that development projects in Sub-Saharan Africa lagged at monitoring, evaluation, and reporting regardless of the underscored importance of these processes According to Critchley monitoring was important in taking stock and informing decision making.

Participants reported that one of the avenues to ensuring that information was shared promptly and effectively was through frequent and regular meetings and consultations. This was done through scheduled monthly meetings and annual general meetings. For the annual meetings government officials from the Ministry of Social Services were invited as observers or as resource persons. All members were given an opportunity to give views, opinions and ideas on how to move the group forward as well as review past activities and plan for the next year.

Various reports and information were shared during meetings and members were free to ask any question. All office bearers gave a report on the group performance during the past year including group accounts status as well as resource people contributing to the member's way forward. All outgoing office bearers also gave exit reports. This was deemed important for continuity and averting occurrence of conflicts. Information sharing enabled all members to participate in monitoring and owning group progress. Groups where information was not shared effectively were characterized by suspicion and consequently conflicts leading to projects' degradation.

**Social Capital**

Social capital was used in this research to refer to the shared values and understandings in the group that made it possible for members to trust each other and so work together. Coleman (1988) defined social capital as "anything that facilitates individual or collective action, generated by networks of relationships, reciprocity, trust, and social norms" while Sanders (2006) defined it as "the collective value of social networks (who people know), and the inclinations that arise from these networks to do things for each other (norms of reciprocity)." Social capital, in this view, emphasizes "specific benefits that flow from the trust, reciprocity, information, and cooperation associated with social networks."(Sanders,2006). Social capital has also been viewed as "a necessary condition for community engagement in collective action in development in that the greater the level and salience of the potential joint benefit and the existence of a supportive political system, the higher the probability that collective action will be undertaken" (Ostrom, 2002, p. 199).

Common among the performing groups discussions as per the group was the fact that the members had trust in one another and looked out for one another. A member from one of the projects which had been in operation for almost 10 years said "we stay and work together because of the trust we have with one another" (ASHG 011 14-04-15). They reported that this was one of their strong points in keeping together. However, as the participants said, this trust was an element built over time and based on strong foundation of enforceable rules and transparency and accountability. Using results of a household survey in Tanzania, Narayan and Pritchett (2000) showed that villages with more social capital were also more likely to have undertaken community road building activities, and to have adopted more modern agricultural practices. Thus, RWH groups that indicated to have built some level of social capital in this view were able to achieve more because members stayed committed to the group goals. Furthermore, the participants indicated that the pulling factor which was water scarcity and poverty was a growing concern hence there was benefit in staying and working together.

In discussing the key common practices across projects in the case study, some factors emerged as positive and some as negative to RWH. The study identified and described some key commonalities in successful projects which facilitated sustainable RWH projects. These included: capacity of the management group, identity, ownership, social capital, enforced rights and rules, benefit sharing strategy, value chain addition, presence of monitoring mechanism and jointly owned financial plan.

**Factors Underlying Poor Performance**

**Non-successful Projects**

About half of the projects studied by the researcher were characterized as non-successful based on the set criteria of reliability and felt benefits. It was important to study this kind of projects to discern if there were any common aspects that led to projects falling much below their planned outcomes. In this section, I discuss some of the crosscutting attributes that seemed to characterize low performance of projects as explained by the participants and experts.

Literature shows that one of the challenges that 21st century development has to address in order to ensure progress has to do with sustainability of development projects ( Fricker,1998). According to Fricker (1998) sustainability means "to hold together with tension", showing the constant work and attention needed to make such a system succeed. In spite of the growing interest and knowledge, and number of RWH systems being implemented with success, there are also a large number of challenges associated with RWH projects in Kenya. It is evident that many projects in developing countries, whether old or new, have faced difficulties in creating sustainable mechanisms (Critchley 1992; Lindqvist 2005,). Unfortunately, it has been too common in Kenya to see RWH systems rapidly degenerate and become completely dysfunctional after a project implementation period has ended. Below are some of the common failure factors in most of the non-performing projects. The projects that were termed non-performing are summarized below followed by a discussion of the common factors associated with unsuccessful projects.

*Table 8:* Non-successful RWH Projects

| **Group** | **RWH project and other activities** | **Group governance** | **Factors contributing to poor performance** | **Project state** | **Success/impact** |
|---|---|---|---|---|---|
| KYSHG/ 01 | Concrete dam and roof catchment using small polyester water tanks | The group was registered and had a constitution developed at formation. | Low commitment to the project noted.<br>Disintegrated group, no unity observed.<br>Unclearmanagement structure.<br>Lack of shared vision<br>No training done at all for members,<br>No mention of networking links except occasional visits by local leaders during campaigns to pledge support.<br>The group members said they rarely held meetings unless there wass an event requiring them, no records. | Dam capacity was greatly reduced by silt, and as observed the water was very turbid, The project had not been protected with a fence, and had no water points'<br>It was highly in needing repair. | Dam supplies water,( though very contaminated) for livestock, farming and some domestic chores like washing. |
| MEDSHG/ O2 | Earth Dam and roof catchment | The group had a Constitution developed at formation.<br>Non-functional management. | Poor participation by members in group matters unless coerced.<br>Lack of clear management structure.<br>No training done for members regarding project management<br>They never held meetings.<br>No record keeping observed.<br>Group had minimal linkages to | Based on observation the dam had very turbid water.<br>Project had no fence or water points'<br>Open access observed.<br>The spill way had | Dam supplies water- though very contaminated - for some needs like livestock, |

| | | | | | |
|---|---|---|---|---|---|
| | | | other actors in RWH sector even though<br>some members concerned about the state of the project had been seeking support from county to repair the dam. | broken, Siltation observed | |
| KSHG/03 | Dam and roof catchment. | Constitution developed at group formation, Group registered with MCSS | No management structure noted, No focus or shared vision.<br>The members received no training on any of the relevant topics regarding the management of the project.<br>group rarely meets except when there are visitors. | The dam had broken embankments, turbid water, no fence and had no water points. | |
| KKSHG/04 | Dam and roof catchment. | Group was registered with a constitution developed at group formation. | Conflicts among group members reported showing lack of trust, shared vision and goals.<br>Members complained about leaders' failures, selfishness and corruption.<br>No training done for the group on RWH or project management. No consultations and networking noted except with chief /local leaders who looks for the groups when there is need. | The project had turbid water and was not equipped to conserve water whereas the roof catchment tanks in member homesteads were of minimal capacity tanks.<br>open access for animals and community members noted. | |
| MEDSHG/05 | Dam and roof catchment | Group registered with MCSS and had a constitution. | Lack of teamwork noted and reported.<br>Divisions among members, each seeking self-interests<br>No functioning management structure, or common vision | Needs fence to protect the dam, turbid water, or watering points | |

| | | | | | |
|---|---|---|---|---|---|
| | | | No training done for members regarding management of the project. | | |
| KKASHG/06 | Water pan and roof catchment | Constitution developed at group formation. | No sense of ownership to the project noted among members.<br>Group rarely met<br>The management committee not functional.<br>Group lacked project management skills as they had not been trained.<br>No records of group activities produced. | Lacks protection, turbid water observed, project not protected by fencing and no water points seen. | |
| KKSHG/07 | water pan , roof catchment | Constitution developed at group formation, group rarely meets unless there is an event requiring them, no records | Poor sense of ownership noted,<br>The group had poor track of members management committee is not functional.<br>The members have not received necessary trainings to help them manage project.<br>No linkages mentioned except with chief's office. | No fence, no catchment protection and no water points.<br>Turbidity noted | |
| KTED SHG/08 | Earth dam | Group registered by MOCSS and constitution developed at group formation, | Management committee is not functioning as only a few of the committee members were traceable. | A lot of erosion on the edges needing terraces, causing turbidity .<br>Project not protected and no water points | |

| | | | | | |
|---|---|---|---|---|---|
| WWKSHG/ 09 | Farm ponds and roof catchment | Registered group with a constitution. | Constitution existed but not followed and most members were unaware of what their constitution says.<br><br>Conflicts in the group reported due to divergent interests,<br><br>Project hijacked by one member indicating corruption.<br><br>Frustration among members due to lack of information on available conflict resolution avenues observed.<br><br>The Group lacked internal conflict resolution mechanisms as noted.<br><br>Group trained on project management at the beginning but no impact of the training noted.<br><br>Some members already abandoned the group indicating frustration. | | |

**Degraded Projects**

Well-intentioned interventions often turned out to be "white elephants" due to lack of a holistic approach. Several areas of Kenya were notorious for having a history of short-lived projects (Critchley, 1991a; Hogg, 1986) and RWH projects in Makueni were no exception to this. Moving around in the county, the large number of RWH projects that were not performing to the expectation or not at all because of neglect or due to poor inception and implementation was apparent. Based on the observation by the researcher, one of the signs of a degraded project, especially for pans and dams, was siltation, breakages and disorganized use. Siltation occurred due to poor conservation of catchment because the erosion that took place in the surrounding ended up in the dam or pan. This reduces the water volume in the reservoir and also contaminates it.

Two key informants explained in detail that there were many factors attributed to siltation, however, the main one was inadequate effort during initial phases and afterwards to conserve the catchment. Donors, most often did not budget for this in a quest to reduce cost. A key informant working with an NGO explained how this poor approach to project design couldturn disastrous:

> …..Now there is a question about catchment protection, if you do a project without catchment protection, soil erosion will bring back the costs…. Going to construct many terraces, dykes and all, the cost per beneficiary becomes very high and because cost per beneficiary is very high then the donors will not be funding this project and that is the problem. Because the donor asks for cost per beneficiary, so people will just go and excavate a dam and will not take care of catchment because it will take a lot of money …

then you can say you are doing conservation by asking people to plant some trees or to dig some terraces. ( KI08, 21-10-2015)

The majority of Key informants blamed poorly done projects on inadequate funding but also indicated that degradation also occurred because the management committees did not have capacity to conduct operations and maintenance. If the project was not fenced for instance, animals would destroy it as they accessed water and contaminate it as well. Besides, if the management had no capacity for financial management, they were not able to plan revenue collection or generation to finance repairs. Most of the non-performing projects I observed especially dams, were full of silt, the embankments were broken, riparian areas were not protected and there were no watering points so both animals and human beings got into the dams to draw water, drink and bathe as well as defecate in them. Some ponds, tanks were dry because of leaking hence could not hold water.

*Figure 30*: Empty pond with silt due to poor siting and leakage, photo by J.Mang'era

*Figure 31*: KKEDSHG dam not protected or fenced no water points hence contamination, photo by J. Mang'era

**Lack of Benefit Sharing Strategy and Harvesting Controls**

Operations and maintenance were hampered not only by lack of skills but also inadequate control of access. Most of the projects not functioning as expected had not levied any access fee and no revenue collection was being done. There was no charge for drawing water. This meant that there were no resources generated to take care of repair works. For instance, when siltation took place, a grader was needed, or a contractor was needed to repair a broken wall. Other minor servicing operations normally required the group to have capacity to allocate roles among themselves to carry out operation and manteinance activities. For instance, a female participant from one of the projects talking about the lack of teamwork in their project retorted: "Although we are united by sharing similar water problem, we rarely work together thus nothing to monitor" (TWSHG 014 15-04-2015).

Members from some of the non-successful projects said that because there was no teamwork there was nobody to rally the rest into action unless an outsider feels their predicament and intervenes. Empowered groups would not only apply financial costs to the resource use but also applied other forms of payment for drawing water like providing labor, or giving an asset in exchange, for those who had no cash money. An NGO worker who has been in charge of RWH projects in Makueni explained how groups generate revenue:

> They charge for water, any use for water they have a small cost which they actually decide on they own. They will say livestock will be Ksh 5, and for drawing water for example a 20liters jerrican will be Ksh. 2. They say, since all of us own livestock and we don't want to start counting we will all be contributing ksh. 500 per month. And then they all contribute. (, KI03, 25-04-2015)

The excerpt above portrays the dynamics in project groups showing that many activities meant for project progress required collective decision making which was not possible when members lacked teamwork. Given that all groups interviewed affirmed having constitutions, it was surprising to see how others were using the rules to enhance teamwork and others not adhering to the rules at all. One of the notable responses among non-performing groups was lack of capacity building, hence, even application of the group constitution was limited. Hence, the research was able to conclude that the existence of rules on paper without training was not helpful in institution building and that training was important for the group to understand and own their constitution and project.

**Weak and Corrupt Leadership**

In some instances a project group was able to generate revenue from water sales but due to poor accountability they ended up with no resources to cater for maintenance. As reported by participants from the focus group discussions, accountability issues were partly due to low capacity and partly to poor leadership characterized by corruption. A male participant frustrated by the lack of integrity on the part of their executive committee recounted:

> We know poorly managed projects, ours is a good example… We started as communal but turned into private. Eventually the project has collapsed because the dejected members vandalized the project as a revenge measure [shakes head] Yes we had rules but they were not being followed. In essence some members were bribed with food during election of the group leaders so no one questioned the leaders. The leaders, we elected were paid [bribed] by the chairperson to leave the project to him alone. Today it's a private project not communal and the donor has left we don't know what to do. We need

> to be profiling the leaders, not electing leader because they are rich or educated. We would like the police to arrest the original group leaders because they dumped us, they used our names to get the project from the donor then expelled us once the donor left. (WWSHG 09 14-04-2015)

In some projects, even though training had been done and group members were aware of the rules, personal interest and low integrity sabotaged group interest. The excerpt shows how corrupt leaders took advantage of the impoverished situation of other members to suppress dissent and divert projects to their own use. Disregard for rules that were supposed to bind them together was a sure sign of failure. In most non performing projects members lamented the failure of some members, mostly, the executive committee, to abide by the rules. In such cases as shown above a clique of the management manipulated the rules to their advantage and continued to benefit to the disadvantage of the rest. Given that Makueni County is a hunger prone area, dependent on food relief during the dry spells, bribery with food could effectively corrupt group processes such as election of the executive committee. The researcher was informed that there are well to do individuals who used community groups to get projects for their own interest. It was even explained how some people mobilized members for projects and once they got the project they kept away those members and took possession of the projects.

The issue above touches on the concept of "development brokers" in development arena. The literature (Neubert, 1996) talks about the concept of local "development brokers" to refer to individuals who were a necessary intermediate, in bringing people together or acting as a kind of catalyst. Neubert (1996) further said that these brokers were also mistrusted as people who sought their own interest first because they misused their special position and cheated one

or even both of their clients. According to bottom-up development approaches, the people themselves have to solve their own problems using resources at their disposal ( Neubert, 1996). Neubert (1996) also says that the development agencies would want to play the role of a supporter or a facilitator only. They cannot deal with every individual, but groups could be supported. In practice, the initial phase of self-help projects is different. The development agencies are not dealing with all group members but with representatives of the groups who are called "peasant leaders" or even with local administrators or notables. "Peasant leaders", administrators and notables act as brokers. Neubert (1996) concluded that mostly the development agencies do not reflect the special role of these brokers and that sometimes they do not even notice that brokers are involved. Moreover, the agencies take the existence of self-help groups for granted.

This initiating phase of the projects includes two tasks, the organization of the group and the installation of a linkage between groups and the development agency. Simple brokerage is not sufficient to initiate a project; the groups must be founded and organized. The clique of individuals who seem to be in many projects fall in this category and some of the white elephant projects are a result of involvement of these brokers. (Neubert, 1996 )

**Poor Teamwork**

One of the differences between the performing and non performing projects was the level of commitment and teamwork. Drop out of members was reported in the non-successful projects. For most of the non performing projects, participants indicated that they did not meet often and it was hard to trace some of the members. Drop out was also triggered by lack of transparency by those in charge which made members not to attend meetings and other group

activities. Lack of transparency and accountability by the leadership meant that the rest of the membership was unclear on objectives or what each member's entitlements were. Informants said they chose to stay away or stayed loosely connected just in case some third body came to intervene or some changes occurred. This study assessed two projects which had become a "one man show". Such projects made minimal impact since they were not benefitting the community as initially targeted.

**Conflicts**

Some of the groups grappling with poor performance of projects experienced conflicts which were caused by disregard of rules and operational procedures. As reported by participants, in some cases members were unclear how to go about resolving the underlying issues and disgruntlement resulted**.** In some seemingly performing projects members were disgruntled due to failed promises from the donor. One participant who lamented the failure of the donor to fulfil promises said: "They told us that were to get a farm pond each, where are they?" (NYMSHG 012 14-04-2015). While this affected motivation to some extent, common interest prevailed and the project became successful. Another source of conflict was internal dynamics such as when participants said you would find members not happy for example, with lack of accountability by leadership. A participant from one of the groups facing internal problems said: "The leaders we elected were paid by the chairperson to leave the project to him alone, today it's a private project not communal and the donor has left we don't know what to do"(WWSHG 09 14-04-2015).

Although almost all the groups indicated they had group rules (constitutions) which most often had provision for conflict resolution, it seemed that they were either ignored or not understood. The literature (Gare & Feldman 2009), indicates that conflicts are part and parcel in

human relationships because it naturally arises from diversity in goals, needs and ways of thinking, and competition and therefore , project design and implementation at the local community level were characterized by problems and conflict (Gyan and Ampomah, 2016). It has also been noted that several technically and economically well-planned projects have failed because of conflicting stakeholder interests as stakeholders fights result in many projects not achieving their set targets or, being abandoned in midstream (Field 1997). A survey in Tanzania by Mnaranara (2010) also found that community development processes are burdened with formidable constraints that stem from differences in stakeholder interests. Unless such conflicting interests and rivalries were managed properly, the benefits of community development may not be achieved. Isham and Kahkonen (2000) in their study of effects of participation and social capital on community-based water projects in Sri Lanka and India showed that the two key variables identified to ensure this collaboration in community groups include the accountability of leaders and all stakeholders having a voice in the decision-making process. They concluded that projects were more likely to succeed in communities with cohesive community groups and regular civic activities.

Gyan and Ampomah (2016) conclude that the relationship among the various actors and their ability to have a common or shared vision, goal, or interests were the major preconditions to project success overriding capital investments. Therefore project managers should devote more time towards mobilization and strengthening relationships to ensure communities move from interests to common goals. Conflict resolution should be structured in community development programs, to enable communities build effective alliances during community development

processes. The researcher noted that the projects with conflicts were mostly those that had had no training. It was therefore, necessary to have capacity building for these groups.

**Poor Participation,**

One of the underlying causes for setbacks in project progress identified by group discussion participants was poor participation or lack of it by the local communities. In the case of Malili, with most of the non- successful projects, almost all the projects, even though handed over at different times to local groups, lacked participation of the communities right from inception. Some of the he participants said that: "This was a project of the colonial white settlers that was sold to the society and later handed over to us to manage" (KYSHG01 05-02-15). Once the projects were handed over there was no training to guide the groups managing the projects on what to do. They were guided to develop group constitutions and to register with the Ministry of Social Services and that was all. A key informant explained, the reason for poor commitment by members to projects:

> This is the much taunted strategy termed 'top down development. When you go to the community and ask if they need a pond and they will say yes. You put up a pond and in reality it is because you asked them if they needed one. "Did this community really need a pond?" (KI09, 05-08-2015*)*

The majority of the focus group participants explained that this has been a major problem for many projects because some NGOs would come to the community and initiate projects they imagined the community needed instead of letting the community identify their own needs. In most cases it is because the NGOs raised funds for specific interventions without

involving the communities. So when they had the money they would go to the communities to implement.

Most of the non performing groups reported inconsistent meetings and low attachment to their project. They also reported having no common vision and felt they lacked capacity to manage the operations and maintenance of the projects. However, due to changes in the Kenyan constitutional dispensation and availability of funds at the county level for projects, some of the groups have been regrouping to access funds for repair of the dams.One of the recommendations from group discussion participants across the board, especially from the non-performing projects, was the need for training on project management.

**Comparative Analysis of Non-successful and Successful Projects**

While providing a snapshot of the status of the groups contained in Appendix 2, Table 7 and 8 portray certain trends and dynamics between susccessful and non-successful projects. Some of these factors are discussed below:

**Technology**

From Table 7 and 8 above, the researcher realized that most of the projects that fell in the unsuccessful category were dams and pans. On the other hand Table.7 shows that farm ponds and roof catchment fell in the success category. It happened that pans and dams were mostly community based because they required much more space and resources for installation. This meant that the dams were managed communally. Both the key informants and focus group discussion participants reported that most of these dams were poorly installed and not sufficiently equipped to provide potable water. This was explained by a key informant: “The big

dams initially done by the Ministry, the Constituency Development Fund and all these integrated programs are left open to all users so that livestock and people go directly into the dam…" (KI03, 25-04-15). In addition due to inadequate capacity of to manage them, such projects were neglected to an extent that the water was contaminated by animals and erosion. As seen from findings, communal projects were also characterized by group dynamic issues like conflicts and this could affect project performance. On the other hands farm ponds were in some cases owned privately, and being a more recent technology the implementation style tended to prioritize capacity development of the project group. Furthermore, farm ponds were being implemented in a way that there was value chain addition, attached to the projects, such as using the farm pond for farming to enhance food security as indicated by this responded:

> One of the things we agreed was that it has to be linked to a value chain. It could be dairy production, beef production, planting trees or including domestic use. So domestic to me is a very small part of the demand system. The biggest problem is that when we push technology to the community we assume that there is a very good business the farmer can do with this water, and they will not do anything. (KI05, 5-08-15)

Hence value addition would likely promote project sustainability because it promotes associated livelihoods.

It was also noted by the researcher that where communitieswere accessible to more than one means of RWH technology the success was more, for example, in instances where a house hold had roof catchment and access to a dam or a pond. This observation was reiterated by a key informant who advocated for the combination model in oreder to ensure that communities had adequate amonts of water:I prefer either a sand dam or a big surface dam or a combination

…."(KI08 21-10-2015). In such cases communities were able to allocate uses for particular sources of water, for example roof catchment water would serve domestic purposes whereas dam or pond water would be used for irrigation and livestock purposes.

**Time**

In comparing successful and non-successful projects, it emerged that time was a determinant of project performance. Younger projects were more vibrant in performace as compared to older projects. Most of the projects included in the successful category in the study were five years old and below whereas the non-successful ones were beyond five years. However there were isolated cases, for instance the rock catchment project (vololo) which was over a decate old but was still performing well. Analysis revealed that the the project members were trained in project management. Moreover, the group engaged in value addition activities such as farming which diversified their income and contributed to sustainability of the project. One of the group participants said: "we have diversified our group income by introducing table banking, by offering credit at low interest and we also do farming" (VSHG 016 16-05-15).Value chain addition in RWH projects featured prominently from Key informants who felt that lack of it in many projects is a major reason for failure.

Another reason why time was a crucial element was in regard to donor exit. Most of the group discussion participants reported that projects performance declined after donor exit. This was especially so where the group's capacity hadn't been strengthened to be able to manage for instance, operations and mantainence.

## General Challenges Facing Rainwater Harvesting in Kenya and Makueni County

Even though there was increasing interest in and knowledge of RWH, its growth and the potential for scaling up within and beyond Makueni County as well, sustainability of RWH projects was impeded by many challenges (Black et al., 2012). A number of issues which were raised by the key informants from a national perspective were also raised by the local people involved in everyday RWH processes. These challenges are discussed below.

### Lack of Feasibility Studies

Feasibility studies are a crucial stage in the design of a development intervention because they help in assessing the viability of a planned project. Unfortunately, it appeared that many players in the sector went to install RWH projects like dams without ever undertaking a feasibility study. A RWH expert working with a local academic institution explained the importance of feasibility studies:

> The success and sustainability of RWH interventions like earth dams depends on identification of suitable sites. What you find is that an earth dam is constructed in a place that does not have the bio-physical requirements which include soil type, and rock type required. In Kenya some of the projects taken by the Constituency Development Fund (CDF), for instance, don't look at some of these factors. They just look at a site; somebody provides the land, then come up with a tractor and scoops the earth. ( KI04, 15-05-2015)

Consequently, some of these projects ended up abandoned because they were not able to yield the expected outputs and outcomes. If, for example, a dam was located in an area without

assessing the catchment potential, it might not be able to capture adequate run-off expected to meet the local demand. According to Black et al. ( 2012), part of this assessment should entail a comprehensive search of past projects implemented in the area that could provide clues about what may work and what must be avoided in a target area. Most of the key informantsdiscussing the need for RWH projects to be based on feasibility studies said that most CSOs avoided the feasibility studies because of inadequate funding as opposed to government projects that most often prioritized self-interest and gaining political mileage which overrode feasibility study recommendations.

**Technical Designs**

Apart from situating a RWH project in the appropriate site, the design of the project also had to be conducive to users. This included considering the users' safety, and health dimensions. Many projects became redundant soon after construction because of poor technical outlay, as reiterated by informants. A participant from one of the project gave an example of these challenges experienced in RWH: "There was a water project of brick tanks built through assistance of SIDA but they all leaked and thus were rendered useless" (KKSHG 04 15-04-2015).

Some of the key informants explained that most contractors failed to integrate the project with the social-economic and cultural environment so as to promote effectiveness and hence, poor project sustainability resulted. Many rainwater harvesting water tanks, especially those made of cement, ended up leaking if the contractor didn't follow standard guidelines. This normally happened due to utilization of incompetent artisans. In line with this finding, the literature (Black et al., 2012) explained that it was crucial to utilize known and competent

artisans since many problems associated with RWH projects originated from shoddy construction work, which was frequently encountered. Problems often arose due to poor cement concentrations in an effort to save money, lack of curing time to speed up the process, or simply poor knowledge of proper tank construction methods. A solution to this would be the standardization or certification of RWH tank construction. Group discussion participants also reported that a number of dams were redundant because of poor craftsmanship. An informant who was assisting evaluation of government sponsored dams that were not performing explained the process of designing a dam:

> …When you design an earth dam and you plan to get water for domestic, livestock and Agricultural, use there's need to come up with a design that will provide for different purposes: Where the livestock will get water, where the community will get water for domestic uses and where they can access the same water for small scale irrigation. The most important thing that comes next apart from technical design is management. "Who is managing this?" What you do is you can have the dam, then some pipe will take water out to a designated place for livestock use, another pipe to a designated place for domestic use and another pipe to a particular place to be used for irrigation. But the most important thing is you must come up with a design on capacity, and how you will be able to reduce water loss, seepage and evaporation. ( KI07, 20-09-2015)

In view of the above excerpt, informants reported that many sponsors did not take into consideration all these factors in designing RWH projects. This view was also highlighted in the literature (Black et al., 2012) who explains the need to provide for water points during design of ponds and dams so as to promote longevity of such structures and water quality. He said for

example, that allowing livestock access to the pond will cause tearing of the lining because the livestock walk down to the water level to drink, they thus often rip the lining material with their feet and this leads to seepage. Using a bucket and rope for extraction whereby a rope is attached to the handle and thrown into the pond to collect water was also detrimental because when the bucket is pulled back to the user, it often dragged along the side of the lining, especially when the water level was low. As a result, tearing is often seen in one corner of the pond. To prevent this from happening Black et al. (2012) suggested that fencing of dams and ponds should be included in the design to prevent livestock access. Ngigi (2004, p. 84) stated that water drawing points ought to be included in ponds and dams either through pumping, piping and setting up of water kiosks as well as auxiliary structures like cattle troughs. Catchment protection should be done to hold siltation whereas capacity training of management to de-silt which ought to be carried out every dry season before the rains is thus recommended for the long-term productivity of a pond system. Again, this highlights the importance of appropriate technologies and also of technical capacity training in projects' management.

In designing projects, the kind and source of materials used was said to be important. A RWH consultant and contractor had this to say about sourcing of materials:

> I use as much local materials as possible and as much local skills as possible to keep down the price [cost] and people understand what I am doing, because I am doing something they are used to…. Like when they are building houses, they use local *fundis* [artisans], I use local materials, I don't import anything. If you build water harvesting systems for farmers or for people out there and install a pump made [bought] in Denmark

> or Japan, how will they get spare parts? How will they repair it? That's why you will see many pumps not working. (KI08, 19-09-2015).

The researcher was informed that sometimes donors and contractors used imported materials in the construction of RWH projects and because of that it was very hard to find spare parts to service the project when there was a breakdown. Imported materials also made the projects very expensive. Some of the project components that were imported include water pumps, shade nets, lining, and filtration chambers. Informants indicated that this was a major cause of redundancy in RWH projects. They said that even though there were efforts to innovate more customized products by entities like Kick Start who supplied a variety of water pumps, there was need for more innovation to bring down the costs of such materials. Moreover, there was need for more linkage with the private sector like the manufacturers, banks and researchers for more product varieties.

**Rainwater not Considered Potable**

It was generally reported that agencies on the ground did not consider rainwater from dams, pans and ponds potable; rain from roof catchment could be. A water engineer informant working with an international NGO explained the attitude of actors in the RWH sector towards rain water:

> The Civil Society including Faith Based Organizations and other NGOs, most of them will provide water through construction of water pans… that is rainwater harvesting. When they want to provide what we call potable water or [clean water], they use water tanks which collect water from the house roofs. But, when it comes to harvesting

> rainwater through water pans [dams] they consider that water not potable. So for them, that is not considered as clean water. They give that one for general use like making of bricks, watering of animals doing all other chores like washing clothes. ( KI08, 20-09-2015)

It was explained that most agencies supported RWH projects but they did not complete the projects in a way to ensure potability of the water. This happened because it proved to be costly. In order for the dams' and pans' water to be considered potable a filtration facility ought to be installed. As well, the facility has to have water points for various uses: where people fetch, livestock trough and even a point for irrigation. The filtration mechanism was meant to reduce turbidity. However, treatment of the water could be done through installation of a water tank where treatment was done centrally before distribution or through training users to do household level treatment. Water from a sand dam could also be accessed through a well which was equipped with a pump, in a cleaner manner.

However, since most agencies did not want to incur additional expenses, they just excavated reservoirs and considered their work done. The question of sustainability also came in as the majority of the informants explained that installing a filtration mechanism could backfire because the communities were not able to maintain it. For instance the filtration membrane was supposed to be changed from time to time but communities were rarely able to do this.

**Capacity**

Capacity in the management of RWH was reported by all the key informants as a grey area because many of the failed projects were associated with inadequate knowledge and skills to run them. The issues therein ranged from the capacity of the contractors to install the project, to

the community groups having insufficient skills and knowledge to adopt the technology, run and maintain RWH projects. It was bewildering to some informants to observe that even where there was a lot of rain some communities never bothered to harvest rainwater because of apathy or ignorance. Once the projects were implemented the management of the project was affected by dissension among members due to poor group cohesion and inadequate operations and maintenance skills. An informant who was working with an international NGO implementing RWH projects in Makueni said:

> ..Inadequate technical know-how is because they lack information on how to access the water or rather to store some. They are not able to demand yet our government extension is demand driven. So if you are not aware of what you want, you can't go to that irrigation or Agricultural department and demand that, look, "I am able to finance up to this extent, can you help me to make it right?" When you talk of water harvesting, the water conservation aspect of the agricultural department, is still water harvesting. Putting up proper terraces, putting retention ditches, being able to mulch and so on is part of it. Without that knowledge or awareness they are not able to demand or even if they know a little bit, they will do it in such a way that it is not effective. (KI05, 20-09-15*)*

The excerpt above reflects the situation prevailing on the ground where people lack information about what is available in terms of technology and service. Even in situations where they were aware of the technology they did not know where to ask for assistance on how to install it. Ngigi (2003) argued that RWH seems to have a low status among the water engineers and technicians who were normally trained in design of complicated and expensive water supply systems. RWH did not seem "glamorous" enough to specialize in. Where RWH projects had

been implemented they have focused on institutional domestic consumption, targeting institutions like schools and health clinics. In addition, informants said that RWH was dependent on mainly the CSO, most of whom were ill-equipped to deal with technical aspects of RWH projects.

Some of the projects on the ground especially those initiated by the GoK had no management structure or if there was, the managers were not trained. For instance, in all the projects assessed in Malili which were non-performing the members had not had any sort of training. According to some of the informants, training of management groups on institution building, financial management, operations and maintenance, conflict resolution and entrepreneurship should be included in the RWH project implementation process.

Most of the participants also expressed the need for increased awareness noting that even though the public had some information it was still not enough and most people did not have useful information. For instance, informants suggested that there was a need for simple do-it-yourself manuals that would enhance awareness and uptake. This research revealed that capacity building was fundamental in building RWH institutions, sustainable projects and promoting uptake.

**Ownership**

Ownership in this research was found to be a significant factor of success. For instance many projects had been built on private land donated by community members. If such land was not transferred to the group name in a timely manner, issues of access and control come into play as explained by an informant:

> Because communal things were quite difficult to manage, we again start with even the ownership of the land. We always tell them we are putting this pond here, if it is on an individual farm you must get that to be transferred to public land to acquire the project title that will be held by the water committee or the CBO or self-help group that will be registered under that self-help group. (KI02, 25-04-2015)

Almost all the informants expressed the need for project managers and sponsors to understand the social and cultural aspects of the communities before implementing RWH projects because most often when these factors were overlooked project ownership was impaired. For instance it was important to understand land ownership systems, to know what the implications of projects being implemented on private land were. During the study the researcher came across cases where an individual donated land and later possessed a project that was otherwise meant to be communal. Informants explained that it was normally the failure of project groups to follow up and transfer private land to group ownership after project implementation.

Another factor that affected ownership was poor mobilization and involvement of the community in decision making. As explained by informants, this lack of participation in decision-making was common in GoK projects and some CSOs who never invested adequate time in planning, mobilization and involvement of beneficiaries. Such projects were perceived by the informants to be imposed on the community.

**Focus on Mega Projects**

In the RWH circles the Government is known for its mega projects. A water engineer working with an international NGO explained:

> Currently the government encourages rainwater harvesting but they only come-in in terms of constructing major dams. In terms of community level and at household level, it is the individuals and the NGOs. But the government normally comes in terms where a big dam is supposed to be constructed. Especially, what we call earth dams and the concrete dams, the government comes in…. and it doesn't specify whether that water will be used for domestic or agricultural use. So you can identify specific examples like the Aruba dams in Machakos, the Ndakaini dams in Thika and we have many…. But specifically they are large big holes. ( KI07, 20-09-2015)

According to some of the informants the government invested resources in mega projects which had not been very effective in facilitating water security because of poor implementation processes. A key informant conversant with the water sector explained how some of these macro dams were also facing trans-boundary water issues because they were used by the national government to supply water to other counties other than the source county. Trans-boundary issues had become common with the implementation of the Kenya constitution 2010 that saw the country divided into forty-eight (48) counties. Therefore, as each county was trying to protect their resources, disagreements over what resource belongs to which county ensued:

> ….The ones done by the government are mainly community [based]. The government always wants to emphasize on large infrastructure. Something that has a capacity of 40-50,000 cubic meters. In fact they have not succeeded. What I am doing right now is a consultancy for National Drought Management Authority. They have been implementing earth dams in different areas and these earth dams often fail. They are requesting me to

help in designing some of the technical requirements to ensure these dams last. (, KI04, 15-05-2015)

The failure of many government supported RWH projects, especially dams, was attributed by some of the Key informants to the failure by government project managers to undertake adequate mobilization to create social cohesion necessary for project management upon completion. Government projects were also poor in community involvement in project planning and implementation which impaired the level of impact as most of them did not take into account the concerns of the community. Furthermore, the projects were characterized by poor ownership as the communities never felt attached to them due to low involvement. As explained by a key respondent involved in the revamping of some of these government supported projects, they also failed because of poor technical designs which was ironic since government was supposed to be providing guidelines on technical aspects of RWH infrastructure. This raised the need for better coordination and building of institutions that can govern RWH in the country.

**Politicized Development**

Some informants recounted how some of the RWH projects implemented by the Government were sited without proper assessment of locations (feasibility studies). In addition they were not focused on impact but on political leverage. A key informant working with a local NGO explained his experience with government approach:

> Because of the recent constitution dispensation and consequent devolution of service provision to counties we have central government doing water pans in the counties independent of the counties, and I said, if you want to do a 1000 water pans there, work with the county government, and give them the supervisory role. They said, "how will the people know that president is doing something?" I find the whole thing a bit crazy, because they are saying for us to be felt on the ground we must also do this. ( KI03, 25-04-2015).

The Key informants explained that government had initiated a programme under which they allocated money for dams and pans including specified number per county without carrying out feasibility studies to find out where there were favorable catchment conditions and regardless of the local priorities. Their intention was for the community to see a project that had been implemented by the government regardless of its efficiency and effectiveness. The government projects were equated to more votes for the incumbent in the next election. This focus on political influence other than impact was therefore a setback in the scaling-up of RWH and contributed largely to increasing the list of non-performing projects. The scenario above

underscores the need for enhanced governance of the RWH sector through implementation of institutions that could offer improved coordination.

**Lack of Adoption of Standards**

Lack of standards in many of the RWH projects was a major concern as articulated by some of the key informants. Many institutions in the RWH sector did not apply standards of quantity, quality, and distance and time when implementing projects. There were International Standards like the SPHERE (The Sphere Handbook, n.d.) which were used by reliefnd development organizations specifying on, for example, how much water per person per day; what is considered potable water; or how far the water point should be from the home. The World Health Organization (WHO, 1997) also had some guidelines on drinking water quality. The researcher was also informed that the GoK Agencies had guidelines for drinking water quality but have not been disseminated widely.

These were standards to be applied to ensure effectiveness of water development interventions. By and large the standards were never applied in RWH. This was attributed by the informants to the low status of rainwater among actors. People regarded RWH as cheap and so, there was no need for intense surveillance. One of the informants working with a GoK agency explained the lack of standards: "Like I found in Magadi, UNICEF, which is a very big organization or AMREF, they could give tanks to every household but which tanks 100litres. 100litres for harvesting rain water is not enough." ( KI01, 20-02-2015).

As indicated above, a majority of the sponsors did not carry out baseline surveys to estimate the water needs or the feasibility studies to indicate the expected output so at to match the needs and capacity of the project. It was therefore found that for this situation to improve, more relevant education and information about RWH harvesting ought to be disseminated to turn

around the prevailing mindset. Regulation to promote standardization was also proposed by the informants.

**Uncoordinated Projects**

Coordination of projects among implementers was advanced by a majority of informants as a major constraint in the scaling up of RWH, leading to many isolated projects that were not complementary in maximizing impact:

> We have heard of billions for water for irrigation, water harvesting and supply. They are doing it….. Funding has increased substantially for the last five or six years. The only thing there is, is confusion because you find funds given to water and irrigation [Ministry], and to Agriculture [Ministry] sometimes do things in the same district. So in terms of synergy and in terms of scale, the biggest problem is doing too many scattered projects everywhere which do not have an impact. It is not channeled into one huge project that will have proper impact, even if it is two departments which are almost doing the same thing irrigation and agriculture. They do not work together so there is still a problem of inter- sectorial coordination working together to achieve good synergy. (KI05, 05-08-2015)

As summarized above there was lack of coordination among the Government agencies involved in RWH. Every agency seemed to do their portion regardless of what the other is doing. The concept of synergy was lacking among the CSOs/NGOs who appeared to be in competition among themselves. This point to a need for a governance framework that incorporates and links all levels. According to most of the informants the CSOs were always critical of each other, reinventing the wheel and wanting to be seen doing something. Given that resources for

development projects are competitive there was always the aim of outdoing the other and this could explain poor coordination. There was also lack of coordination between the Government agencies and the CSOs. For instance the Ministry of Agriculture unlike the CSOs for a long time regarded in-situ RWH methods as conservation agriculture and therefore this was not integrated with other RWH efforts.

Most of the informants explained that, most often, actors plunged into areas for development interventions without surveying to find out who else was working there or what else had been implemented there. It was therefore necessary to have a coordinated data bank that could help harmonize development efforts in RWH.

**Concentration on Drinking Water Rather than Water for Productive Purposes**

Some of the informants said that there was too much focus on water for drinking without regarding the sustainability of the RWH projects. They pointed out the lack of value chain addition in designing RWH contributed to failure in many cases. Value chain addition, as explained by the informants, entailed linking RWH to some productive activity other than domestic use. In this way, there would be generation of income and increased impact. An example is investing on RWH for food security. An informant working with an international NGO with projects in Makueni County explained the need for value chain addition:

> When it comes to looking at water for production at the household level especially in a bigger scale, we are not yet focusing on that….We bring a tap for drinking water and that is the current focus [pauses] personally, I think focus should be more on water for production which you do not need to treat thus it is cheap water. Ideally there should be

> two taps, one for production and one for domestic use. The larger quantity should be for production. Even if one was to avail credit facilities to enable people to do that, unless it is linked to a certain sector or some value chain, it will still be a problem for them to pay. But then also many people don't know how to do things. Like now I am working for a project called 'meta meta'. Where we harvest rainwater from roads for agricultural production…. making burnt bricks, washing cars, for livestock. Many people are not aware that you can use that water from the roof for so many things. This is due to lack of knowledge. These groups are in the bush, they don't buy newspapers, they have no television but they have radios. We could actually talk in the radio about rain water harvesting using the local vernacular stations. And even if they are aware they don't know where to get support to do that job. ( KI05, 05-08-2015)

There were differing opinions among the informants on whether the priority should be on provision of potable water or availability of large quantities of water. There are those who felt that the priority should be water for domestic purposes. They said that at household level, RWH did not have to be tied to a commercial value chain to succeed even though, value chain addition was an added advantage. It also depended on what value chain because health is an added value even though not necessarily commercial. Therefore, others felt that the focus should start with ensuring that there was plenty of water hence the need for combination methods like, roof catchment and dams. A water engineer working for a donor agency made a case for large quantities of water as a priority had this to say:

> I know I care for more of volumes of water because I know volumes of water can change a lot, in my opinion volumes of water if you have enough water, very big volumes

> and people are able to get it people can be able to take care of the water in their homes than when they have very little clean water and nothing but that does not mean that I care not for clean drinking water There should be various ways on how to try to make water clean even if it is from a dam ( KI08, 21-10-2015)

In view of the different opinions among informants, as seen in the excerpts above it is important to note that the focus for many agencies was provision of safe drinking water to all (GOK, 1969, 1976, 2002). This had not been achieved. However, there was a big difference between government water supply schemes and community-based RWH projects. Government supplies were funded through consolidated funds or bilateral aid but maintained with resources from the consolidated fund and water sales whereas community RWH projects even though funded through grants would have no ready source for resources for maintenance. Therefore, it was crucial for these projects to generate resources for maintenance in order to promote sustainability. Apart from water sales, value chain addition is an avenue to generate revenue, and create alternative livelihoods from RWH projects. Thus, in investigating an institutional design for RWH, linkage of RWH projects to other sectors and market would be an important consideration.

**Resources: (Capital Outlay, Materials and Human)**

A concern was raised during focus group discussions regarding the costs of installing RWH projects. Communities felt that equipment such as, PVC tanks, linings, pumps and shade nets were considered expensive and thus derailed the uptake of RWH at a bigger scale. A participant discussed the constraints to scaling up RWH:

> It is very hard to access credit for RWH yet people fear loans due to repercussions of failure to pay, especially property auction. Is it possible to get soft loans for water provision, can we get loans for individuals or groups for water projects. (ASHG 011 14-04-2015)

The researcher was informed that in some instances people resorted to using available materials like drums whose capacity was negligible because they couldn't afford tanks. Some for instance improvised local bamboo wood for gutters. Accessing finances from banks was regarded a big challenge because banks were not very sure about the sustainability of RWH projects and considered it a risky venture. Some of the few institutions that offered credit were reported by the informants to have very strict mechanisms so that upon a default of payment for the shortest period they would take ownership of the property of the person who was given a loan.

*Figure 32:* Improvised local materials in use for RWH. Photo by J. Mang'era

**Chapter Summary**

In view of the discussion above and in identifying common practices in performing and non-performing projects, it emerged that the functionality of project groups to expectations, fundamentally depended on social cohesion or social capital. This could be achieved through mobilization and capacity building to build relationships and forge common interest. Therefore capacity building had a fundamental role in RWH.

In this chapter the major challenges deterring effective exploitation of RWH included: poor technical designs, non-application of standards, lack of guidelines and quality control measures, potability of rainwater, ownership, capacity, focus on mega projects by the government, politicization of development projects, poor coordination of efforts, lack of knowledge, too much focus on domestic water as opposed to water for production, weak and corrupt leadership and inadequate financial resources. Common attributes identified among non-performing groups were degraded projects, conflicts, scuttled membership, and poor participation, corrupt and weak leadership. The chapter also concluded that potability of rainwater depended on the technical design of projects because this determined the cleanliness of the water. For instance, an appropriately designed dam with water points and filtration facilities would produce potable water.

The next chapter provides a synthesis of the results presented in this study including the literature review that led to the conclusions and recommendations about practices and institutional requirements for successful RWH in Makueni County.

# Chapter 8 –Synthesis, Conclusions and Recommendations

## Introduction

This chapter summarizes the research findings related to existing RWH practices , barriers to effective RWH and factors of successful RWH projects in Makueni County and draws the findings together with a view to providing a unified argument for recommendations by the researcher for effective RWH in Makueni County in particular, and ASALs in general. The chapter also relates the findings to existing theoretical perspectives and the literature including "Governing the Commons" as presented by Ostrom (1990, 2008, 2005,) multilevel governance (Berkes and Folke,1998; Bierman, 2007; Bulkeley & Schroeder, 2011; Holling, 2002) and institutional dynamics (Young, 2002, 1999, 2008, Young *et al*, 2008).

Finally, the chapter presents a summary of the arguments and conclusions based on the syntheses of data. It puts together key summaries and the final conclusions based on the study findings and provides recommendations on the way forward in policy, practice and research areas.

## Existing Rain Water Harvesting Practices (Research Question One)

The findings of this study showed that RWH was a county-wide practice and most widely practiced in the arid and semi-arid areas. The study found that domestic roof catchment was the most common RWH method across the country whereas dams and ponds were more common in the arid and semi-arid areas. In-situ RWH which was coordinated by the Ministry for Agriculture and implemented as conservation agriculture was also gaining ground in Makueni

County and other ASALs with increasing water scarcity accentuated by effects of climate change as is also reflected in the literature (Kimani et al., 2015; Kinyua, 2005; Ngigi, 2003; 2004).

The study found that in the past, policy for RWH had not been favorable but there were positive changes in the last few years which had seen more investment in the RWH sector, even though, the investment level was far from being satisfactory. This was supported by the interviwees as observed in their comments on the policy trends in the RWH sector, for instance, an interviewee said: "The water Bill2015 seeks to establish Water Storage and Harvesting Authority. This is trying to identify that there is a water crisis and one way of addressing it is through RWH" (KI04, 15-05-2015). Although RWH appreciation had grown tremendously in the last 5 years, it was still not practiced as an option for water security. This was also observed in the literature (Black et al., 2012; Oguge & Oremo, 2014). However, on the ground, instances where residents could afford to access more than one source of RWH, for example, roof catchment and a pond, there was increased water security.

Widespread scaling-up of effective RWH practices was impaired despite the number of successful isolated projects. This was also noted in the literature (Oguge &Oremo, 2014, Hartung & Patshull, 2001) on RWH trends. RWH was mainly supported by the CSOs although government good will was increasingly being noted through increased allocation of budget from the consolidated funds and bilateral support.

The study also found that, there was overall awareness about RWH in Kenya in general and Makueni County in specific but knowledge that would enable decision making in adoption of RWH technologies was still quite limited, hence the reason for the slow uptake as indicated by

respondents' comments on challenges facing RWH up-take: "inadequate technical know-how, they lack information on how to access the water or rather how to store it" (KI07, 20-09-2015).

Furthermore, advancement in RWH was negated by poor technical designing in the implementation of projects, breakages and poor maintenance, expensive RWH infrastructure, inadequate capacity, non-application of standards, politicization of projects, focus on mega projects by the GoK, poor coordination of efforts and bias towards domestic water supply. This observation was reiterated by interviewees through their comments such as, "What I am doing right now is a consultancy for the National Drought Management Authority. They have been implementing earth dams in different areas and these dams often fail. They are asking me to help in designing some of the technical requirements to ensure these dams last" (KI04, 15-05-2015). These constraints are also mirrored in the literature (KRA, 2009; Kinyua, 2005, Ngigi, 2004) as affecting the development of the RWH sector. The study findings therefore, pointed to the need for networking and creation of links across levels to encourage information sharing that would contribute in addressing some of the noted challenges.

In terms of management, most projects, especially dams, were implemented communally, while others such as roof catchment were privately implemented and some projects were institutionally managed. In some instances, there was a mix of private and communal implementation management. The study found that most of the privately and institutionally owned projects which mostly included roof top catchment functioned more sustainably. This was partly attributed to existence of ownership which was more subtle to cultivate in communal projects as observed in participants' comments such as: "to promote ownership we encourage

the community members to make a contribution in everything we do" (KI02, 13-04-2015), explaining how they foster ownership to ensure ownership.

**Enablers and Barriers to Effective Rainwater Harvesting (Research Question Two)**

The study findings showed that the water scarcity in Makueni County served as a source of motivation to harvest rainwater and therefore a major enabling factor for the community groups to make RWH work. This was indicated in the participants' comments: "We were concerned about the high levels of poverty, youth unemployment, and water scarcity" (ASHG 011 14-04-2016). Literature showed (Kimani et al., 2015;MIDP, 2014) that Makueni county was specifically experiencing worsening water crises with the changing climatic conditions.

The presence of NGOs on the ground that were encouraging people to take up RWH, however, was a key enabler of successful RWH projects. Most of these NGOs and the government had undertaken pilot projects to demonstrate how RWH could help alleviate not only the water problem but also food shortage through micro-irrigation. This was also mirrored in the literature (Kimani et al., 2015; Kinyua, 2005, Black et al., 2012) indicating that RWH in the country was mainly being supported by CSOs who were actively lobbying the government to invest more in RWH and sensitizing the public on RWH.

The study found that there were isolated numbers of successful projects which communities could learn from. This finding resonated with the literature (Hartung & Patshull, 2001, Oguge and Oremo, 2014) that RWH was limited to project level successes due to inadequate or lack of policy guidelines to direct and coordinate RWH activities. Some of the factors promoting effective RWH included: the project group capacity based on training by sponsors and sometimes by the GoK agencies on request; social capital built in the group over time; value chain addition so that the water would be used for agribusiness or other business that brought income; revenue collection from water sales and good financial practices and planning;

and presence group progress monitoring measures. Some of these factors are reflected in the conversation with interviewees on promoting sustainable RWH projects: "We were talking about a billion dollar business plan for RWH. One of the things we agreed, was that it has to be linked to a value chain" (KI05, 05-08-2015). Value chain addition meant that RWH projects are run on a business model (franchises) and the water supplies are also used to support alternative livelihoods such as agribusinesses. This would generate income and promote sustainability of the projects.

The study findings, clearly showed that RWH was hampered by inadequate financing and prioritizing by the government, and given the majority in rural Makueni found the cost of RWH materials expensive, this slowed down implementation of RWH. Access to credit from finance institutions was also constrained by stringent conditions and rampant poverty in the County. Lack of a coordination mechanism to address issues of duplication, poor capacity among community and RWH project management groups, conflicts within RWH project groups, poor project ownership and lack of application of water supply standards to rain water supply systems negatively affected RWH as shown in some of the interviewee expressions: "like I found in Magadi, UNICEF, which is a big Organization or AMREF could give tanks to every household but what tanks? 100litres. 100 litres for harvesting rainwater is not enough" (KI01, 20-02-2015). Standards for water supply existed at national and international levels and examples of such standards included, The Sphere Standards (The Sphere Project, 2011) and WHO standards for water supply (WHO, 2009). Other challenges that were found to hinder progress in RWH included inadequate technical support for the project groups, politicization of projects implementation by the government, focus on mega projects by the government instead of

sustainable community based projects and too much focus on domestic water supply as opposed to value chain addition that could enhance livelihoods.

**Existing local Water Institutions that Govern RWH (Research Question Three)**

According to the study findings the main RWH institutions on the ground were project groups, also referred to as "common interest groups", registered as self-help groups in the Ministry of Culture and Social Services. These groups arose mostly out of common interest based on issues affecting the community. Some were self-motivated while others started out of facilitation by a third party like an NGO. The findings of the study also showed that the project groups had constitutions spelling rights of members though "robustness" of these groups and the projects depended on how they exercised these rights. The study found that that some of the project groups studied had come together voluntarily and developed rules and rights that governed them. They reported to have come together due to a common interest such as to tackle rampant poverty among the members. The rules that governed them were mostly articulated in terms of group constitutions as indicated by the participants' comments such as: "We have kept the group together by following group rules and constant consultation" (NYMSHG 012 16-04-15). However the researcher found that only about half of the groups involved in the study exercised these rights.

The group rules talked about the governance structure, how the group would share tasks, how they would keep their finances, sanctions for misbehavior, conflict resolution and disclosure. Some of these characteristics of the project management groups mirror the literature (Ostrom 1990, 2005, 2008) on property rights suggesting that users of common resources are

able to organize themselves and put in place rights to administer the use of resources. Ostrom (2008) and Murrow & Hull (1992) provided the "design principles for a robust institution." Some of the common principles expected in a functional resource management institution included conflict resolution, minimal recognition of the right to organize, graduated sanctions and proportional equivalence of benefits.

In relation to the non-successful groups, which composed almost half of the project groups studied, the conflict resolution avenues laid out in the group constitutions were not explored much as some of the groups had conflicts. Most of the non-successful groups also did not have a benefit sharing strategy which led to some groups disintegrating because of the lack of transparency in appropriation of group benefits. On the contrary, in the performing groups, sanctions for not adhering to group obligations were applied, there were conflict resolution measures in use, project proceeds were declared transparently and hence the groups were able to re-invest and diversify income sources.

The successful groups also presented higher cohesion and team work as indicated by the comments by the participants such as: "We stay and work together because of the trust we have with one another" (, 16-15-2015). This relates closely to the literature on social cohesion and property rights whereby Ostrom (2008, p. 5), argues that "developing trust and reciprocity was crucial to building the social capital needed to create a notable property right." It was thus, noted that the above factors did influence the sustainability of RWH projects in Makueni County.

Some CSOs on the ground had piloted implementation structures to try and prop linkages among groups and with other actors but they are isolated cases. A case in point is the KRA

model which brought together sub-locational RWH groups to form an umbrella unit at the locational level in a bid to cascade piloted projects.

While the Water Act 2016 provided for the RWH projects to be registered as Water Service Providers and form the Local Water Resource Users Associations (GoK/MWNR, 2015), many of the groups had no idea about this making the links to be non-existent. This would enable them be recognized within the system and also to access funding from the Water Trust Fund(NWTF) provided for by the Water Act, for purposes of financing water provision projects and sanitation to disadvantaged groups. None of the interviewed groups had registered as a water service provider. The study also established that for a project to qualify, it had to supply water of at least 30000 cubic centimeters. None of the study projects had received funds from the NWTF and very few were aware of its existence.

The study found that at the local level, some of the community groups worked with the government agencies including, the water department, agriculture, National Environment Management Agency (NEMA), and Ministry of Social Services. Both the Ministry of Water and the Ministry Agriculture were involved in implementing RWH projects and also providing technical services on demand by the community while NEMA was responsible for carrying out environmental impact assessments before implementation of projects such as dams.

The study also found that, some CSOs had tried to form national and international networks to bring together actors in the RWH sector for coordination purposes. One such network was the KRA which was intended to be a national network even though it was affiliated to a regional level network (GHARP). The other networks found in the ground included, SEARNET which was hosted in ICRAF and incorporated countries in East, Central and Southern

Africa, and AFRHINET which was hosted in the University of Nairobi. However, the study revealed that these networks had not performed the coordination role as expected by the stakeholders and therefore there was need for a functional network.

The study findings also revealed that according to the Water Act 2002 and Water Act 2016, the Ministry of Water and Natural Resources (MWNR) was mandated to be responsible for water affairs entailing policy and strategy formulation and coordination and monitoring ( GoK/MWI, 2002; GoK/MWI, 2015). Water Service provision was then relegated to the Water Services Regulation Board (WASREB) while the Water Service Boards (WSBs) were in charge of regional water services and under them were the water companies based on the eight water basins. Under the Kenya Constitution 2010 and the consequent revised Water Act 2016, each of the 47 counties in Kenya had a water Company. The WSBs were in charge of assets and contracting, coordinating the Water Service Providers (WSPs) and liaising with private, community and civil society sectors. It was the responsibility of the WASREB, WSBs and the WSPs to work in concert with local authorities, CBOs, NGOs, and the private sector, to ensure implementation of the national water strategy (GoK/MWI 2009, GoK/MWNR 2015).

The study further established that the water resource management was under the Water Resource Management Authority (WRMA) under which are the Catchment Areas Advisory Boards (CAACs). Under the CAACs the Water Resource Users Associations (WRUAs) were responsible for water catchments (MWI, 2009; MWNR, 2012). The RWH projects were supposed to be part of the WRUAs because these were the ones who developed plans for development of catchments including conservation, water management and supply. However, none of the interviewed groups linked with the WRUAs in the study location. Because of low

awareness about the Water Act, many catchments in Makueni County did not have functional WRUAs.

The National Pipeline and Water Conservation Management (NPWCM) charged with the responsibility of excavating dams and drilling boreholes. The Water Act 2016 also provides for National Water Storage and Harvesting Authority to facilitate enhanced RWH. But, as per the time of this study this has not been rolled out to the ground.

**Linkages among Local, Regional, and National Water Institutions (Research Question Five)**

As an outreach to communities for service delivery the government agencies were supposed to have extension officers on the ground who provided technical support. The study found that Project Funders/ NGOs tried to link community groups to relevant government agencies on the ground for this reason. However, most often the line ministries were not funded adequately to ensure a proactive supply side, hence they had to peg their service to demand as indicated by interviewee comments such as:

> … Like agriculture [Ministry] we work with them. Actually on the ground we engage with them, as long as the project is on- going. For the big dams we engage the water ministry and give them some facilitation… we call it allowance because we are working with USAID, and they said you cannot pay government officers. So we give them facilitation for transport, to actually supervise the work. For the big dams, we don't decide ourselves; we have to follow the government standards. We engage them for the survey, and all the processes, and also engage them in supervision and handing over. (KI03, 25-04-15)

According to the findings, the only reported visits to project sites were by Agricultural officers, Administration and Social Services. These visits only happened when the community requested for them. For example, during group elections, an officer from Social Services was invited as an observer. Visits and interaction from the GoK agencies also happened when the government was running a programme.

Horizontal linkages were dependent on donor facilitation or type or the implementation model supported by the donor. Some donors organized exchange visits across projects as a form

of networking their beneficiaries and capacity building. Generally vertical linkages from local to national levels were missing, weak or subversive of local success.

**Way Forward: Improvement of Practices and Existing Institutions and Designing of New Institutions (Research Question Four and Six)**

Suggestions for improvements in existing institutions included improved linkage and interplay across levels, sectors and among actors, improved coordination, revamping service provision, rolling out plans on paper and filling in gaps identified in the system. On the other hand, designing new institutions is recommended as necessary to address disconnects. The findings showed gaps in the area of capacity, information, knowledge and skills flow, and coordination at all levels as noted by the comments made by respondents, for instance, ”during the baseline we noticed that although there were organizations pushing the RWH agenda, their activities remained uncoordinated. What one group does is unknown to other groups” (KI04, 15-05-2015).

The findings therefore supported establishment of a RWH network which would link all stakeholders including community water projects, donors, CSOs, banks, GoK agencies, academic and research institutions, private sector such as the industrialists and retailers in RWH. This proposal mirrors the literature, for example, Black et al (2012) states that the coordination network could allow for better communication and collaboration among stakeholders, both at the large organizational level and grassroots level.

The need for interplay at all levels was also underscored by Young (1998, 2002, and 2008) and Young et al., (2008). Holling et al. (1998) stated that environmental and renewable resource issues were neither small-scale nor large-scale but cross-scale in both space and time and therefore, the problems have to be tackled simultaneously at several levels. In this regard the role of centralized management agencies were to be partly redistributed to local-level institutions and balanced and management power and responsibility shared cross-scale, among a hierarchy of management institutions, to match the cross-scale nature of management issues. This viewpoint is also reiterated by Berkes and Folke (1998) who noted the need the locally adapted social-ecological systems to be protected, but not isolated from external driving forces such as macro-economic and trade policies.

What is more, a network would, facilitate linkages not only vertically but horizontally. The local actors will be able to interact with national level actors while also interacting with other same level players as noted by interviewee comments:

> Besides the legal framework there is need for a National Rainwater Harvesting Network… There is need to work closely with other actors in this sector. In my opinion, having a viable National RWH Network which also has links with regional and international networks is the first step towards development of standards and certifications in RWH. (, KI05, 15-05-15)

For instance, there was apparent lack of information on the ground about the water resources governance, role of the community and what the GoK was doing. Furthermore, many

players with key roles, such as manufacturers, were left out or are loosely involved when indeed they had an important a role to play in the mainstream water provision network.

It is for this reason that the government agencies need to work in liaison with the CSOs, academia and the private sector including banks and industrialists to form a national RWH coordination network that will complement the existing water governance framework in order to ensure that development of RWH is adequately supported. Some of the functions of the network would be technological exchange, capacity building, information sharing, monitoring, research, certification, developing manuals and guidelines, advocacy and coordination.

Several suggestions regarding RWH development in the findings included improvements in coordination of resources in the sector to inculcate unity of purpose and avoid duplication and wastage as also indicated in the literature Ngigi (2004) on the need for coordination in the RWH sector. There was also need for enactment of RWH policy to guide implementation of RWH. This was also noted in the literature (Hartung & Partshul 2001) on how the slow progress in RWH is due to lack of requisite policies hence the need for enactment of RWH policies.

The findings also showed that improving RWH management and governance through capacity building of project groups and encouraging their participation in project design was fundamental. Regular networking avenues with government officers would be effected through a functional network. Education and sensitization of the communities to be able to take advantage of the opportunities available in RWH was paramount. Similarly enabling them to organize and participate in designing interventions in RWH through empowering them with skills to make their own collective agreements and manage projects could enhance a sense of ownership and sustainability. This is also advanced by Hull, (1996) and Ostrom (2008). Furthermore, capacity

of the groups needed to be enhanced so that they are able to register as WSPs and be part of the legal national water governance structure.

As result of the findings of this study the researcher proposed a revamped implementation structure. The local institutions needed to be re-energized through creation of horizontal linkages. For instance, the multilayer model used by KRA could be replicated for coordination, so that in every sub-location a rain water harvesting group exists with each nominating a representative to the Locational RWH group which then nominates a representative to the national RWH network. This is the concept of nested enterprises as stated by Ostrom (2008) and Marshall (2008), which recognizes the importance of the principle of subsidiarity. This implies that tasks should be decentralized to the lowest level of governance with the capacity to conduct them satisfactorily. The findings showed linkage across projects mostly out of donor initiative but this was just for occasional trips for benchmarking. However with the proposed kind of linkage, there would be more exchange and stronger links.

The findings showed that only about half of the groups interviewed indicated that they organized themselves out of common interest to address issues like poverty, youth unemployment, and environmental degradation. Nine of the twenty groups studied indicated that they were asked to come together to manage projects that were handed over to them. Almost all the nine groups were considered non-successful based on the criteria set to identify successful and successful projects. This was attributed to the sense of ownership. Ostrom (2008) wrote about the principle of minimal recognition of the right to organize. The right of appropriators to devise their own institution is also hailed by Murrow and Hull (1996) and Gautam and

Shiavakoti (2005). The self-organized project management groups had a vision, higher sense of ownership and were more motivated than the ones that were compelled to organize.

One other change in institutional design emanating from the findings was the need for RWH projects to follow designs that guarantee quality of water. Solomon (2010) advised that RWH techniques have been evolved and improved throughout history, and the most successful civilizations throughout time have adapted RWH techniques to best suit their needs. The models/designs applied should therefore take on board different uses of water including: production comprising livestock and farming, and domestic purposes as seen in some of the comments such as:

> We are making sure if you have a water reservoir nobody or no animal goes in. You fence it [pause] you have a dyke that goes below the wall with a membrane filter then you are able to get water downstream. And downstream you have a water point for livestock, that is the cattle trough and a water point for human beings, that is what we call community water point. (, KI03, 25-04-15)

This would make projects more consumer-friendly, ease maintenance efforts and prevent contamination thus promoting water quality. Such designs should not only focus on quality but quantity as well. It was important for designers of a project to have knowledge of the number of beneficiaries the project aims to serve and the water demands based on the international standards on water requirement per person per day should be based on water demands so that the design is matched with existing demand.

In connection to the approach above is value chain addition also supported by Black et al (2012) who underscores the need for value chain addition in RWH projects. Allowing for utilization of the water for other income generating activities will facilitate livelihoods diversification as well as project sustainability. An example of value chain addition includes, agribusiness whereby RWH is used for irrigation and produce is marketed hence generating income for project members.

Finally the findings also supported the utilization of a combination model in RWH projects whereby beneficiaries should have access to at least two methods of RWH as emphasized by interviewee comments:

> I prefer a sand dam or a big surface dam or combination because at the end of the day though the roof catchment tank gives clear drinking water, for it to be able to sustain enough to take people throughout the year you will need many more tanks if you do estimates. People don't do estimations. (, KI08, 21-10-15)

This meant that a household had one other source of rainwater in addition to domestic roof catchment like a farm pond or dam to achieve sufficiency.

**Institutionalizing Rain Water Harvesting in Semi-Arid Kenya**

The findings of this study indicated that promoting effective RWH in semi-arid Kenya should incorporate various aspects of RWH including capacity building, implementation structure, legal, governance, coordination and networking and technical designing. There is no one institutional design that fits all needs but rather several institutions based on the above

aspects coupled with interplay and linkages across sectors and across levels, as shown in the diagrammatic illustration below.

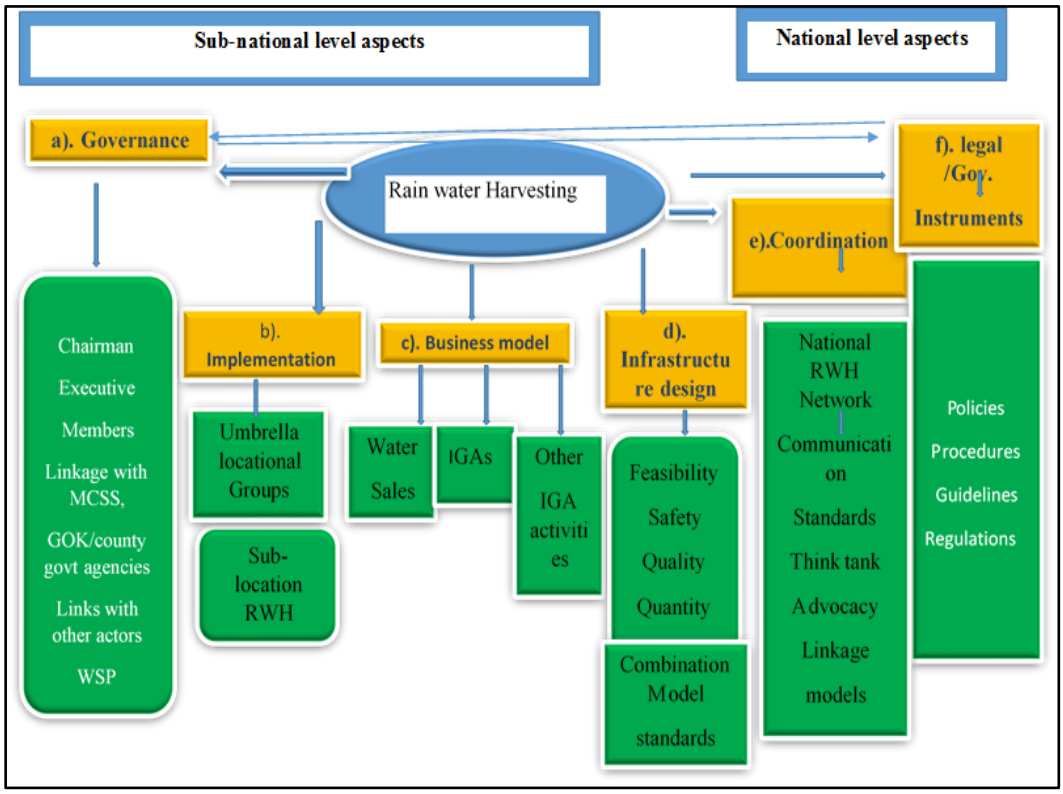



*Figure 33:* Diagrammatic Illustration of the RWH Institutional Aspects

By J. Mang'era

Starting from the left, the subnational aspects include local institutions' governance aspects (box a) which basically looks at the structure of local institutions and how they are governed. The groups need to operate by a system of rules and rights, often contained in the group's constitution. The theoretical perspective on which the study was anchored identified property rights that govern organized common pool resource users as follows: rights of access; withdrawal, management; exclusion; and alienation while the principles include: defined boundaries, proportional equivalence of benefits, nested enterprise, monitoring, minimum

recognition of the right to organize and graduated sanction. This is mirrored in the works of Berkes ( 2007); Ostrom (1990, 2001, 2008) and Young ( 2002). In all the projects studied, the management committees had most of the above rights stated on paper in the name of group constitution.

The research revealed that only half of the groups in the study enforced some of these rights and principles. The right of exclusion was actualized through charging for water services and this was quite central in influencing project sustainability whereas the principle of proportional equivalence of benefits proved to be quite instrumental in group cohesion and project sustainability. Capacities building of the project groups on project management to enable them actualize their rights as spelt out in their constitutions would contribute towards vibrant RWH project management institutions. It was important to ensure that withdrawal of water is controlled through payment which helped the project groups to meet overhead costs and thus maintain the project. Proportional sharing of proceeds and clear understanding of roles was important because without this level of transparency there would be conflicts which would cause the project to stall.

Governance aspects also revolved around organizing the power relations within the project management to ensure good leadership and accountability and addressing legal status of the project management groups. The structure consists of a management committee, executive committee and led by the chairman, all with roles substantiated and differentiated. It would start with strong mobilization activities to marry diverse interests and create common interest and then followed by trainings on topics in relation to project management and group dynamics.

Based on this platform, strong cohesive institutions to manage RWH projects sustainably would be formed.

The existing national water governance framework indicates areas of convergence with community water projects but this has not been operationalized because of lack of awareness or lack of deliberate efforts to implement the framework fully. The Project groups would have to be registered as Water Service Providers so as to benefit from opportunities available in the enactment of Water Act 2016.

Box b) indicates an implementation structure which combines communal and private models also referred to as "nested enterprise" by Ostrom (2008). The findings of this study indicated that this mode of implementation was more sustainable. This is where groups from several lower units coalesce to form an umbrella unit at a higher level and members have both communal and private RWH projects. This would promote replicability and scaling up in RWH. At the umbrella level (location) projects would be piloted and then cascaded to the sub-location level through the constituent groups. Linkages would be fostered through widened reach and ensuring representation at local and national levels. When groups are organized in this way, it is possible to link to national level institutions based on the formidable local constituency being represented. Information dissemination and knowledge transfer would be strengthened.

According to the findings of this study, there is a need to institute a RWH project technical model represented in box d that promotes quality and quantity aspects of water supply based on internationally accepted standards. Such a design would cater for different users of water including: production comprising livestock and farming, and domestic purposes. To allow sufficiency, this design would also be accompanied by a combination model which means that

beneficiaries would have access to two sources of RWH, for instance, a roof catchment and a dam or pond. This would be in order to maximize on the potential and also promote water security among communities. Furthermore the project design needed to meet standards of quality, quantity and effectiveness and be based on sound feasibility study to boost water security.

The study findings also pointed towards the need for application of a business model (c) or value chain addition in RWH projects so as to boost sustainability. This would entail utilizing the collected rain water for a productive purpose other than domestic. An example in point is utilization of rainwater for irrigation to attain food security and generate income through selling the surplus. This kind of approach would contribute towards sustainability of RWH projects because there would be income to meet overheads and for other reinvestments to promote alternative livelihoods.

The findings support as shown on the right side of figure 2, a national RWH network to ensure coordination of available resources and activities so as to limit duplication and promote positive impact. This structure would enable linkages from national level to the ground, support capacity building horizontally and vertically, that supports flow of operations and information, and would consequently facilitate vibrant project management groups on the ground. A RWH network which would link all stakeholders including community water projects, donors, CSOs, banks, GoK agencies, academic and research institutions, private sector such as the industrialists and retailers. This would make it a think tank that would perform the functions of data documentation and lessons learned and facilitate exchange and flow of such information. It would also host a data bank of personnel, especially of approved contractors and develop

guidelines for project implementation. The network would undertake capacity building and education on RWH in liaison with GoK agencies and lobby for favorable policies on behalf of the communities. Identified disconnects in linkage between government agencies on the ground and local RWH institutions on one hand and between local and national RWH institutions on the other, and among local groups themselves, which inhibit access to information, knowledge skills and options will be addressed through creation of an effective national network. These gaps as the findings show also impeded sustainability as also reflected in the literature (Hartung and Partshull, 2001) because the successful cases were not replicated but remained isolated.

Another national aspect level is provision of legal and governance instruments to direct RWH governance (f), which would form another national level institution that would cover development of policies.

## Conclusions

Rainwater harvesting was widely practiced and was a major source of water supply in the study areas of Makueni County. This observation is underscored by assertions from participants on the status of RWH in the county such as, "particularly communities in the rural arid and semi-arid areas, have been using rainwater since time immemorial" (KI03, 25-04-2015). This also resonated with literature (Kimani et al., 2015; Kinyua, 2005; MIDP, 2013) on rainwater harvesting status in the area. RWH technologies varied among users and the bases of these variations included cost, intended use of water and amount of rain received. Additionally, RWH was however being operated below expectations and perceived potential.

The main reason for the low performance in RWH was the absence of an effective RWH policy in the country and the consequential lack of institutional support for innovation, implementation and local management. The lack of RWH policy was to a large extent responsible for the meagre resource allocation by the government and poor coordination in RWH sector. This was supported by interviewee comments such as, "in the past the practice has been ahead of policy" (KI10, 05-01-2016). Literature also reiterated the policy inadequacy affecting RWH progress (Ngigi, 2003; Mutua, 2010; Oguge & Oremo, 2015; UNEP, 2005; Wambua, 2004). However, the policy environment around RWH was becoming more favorable with enactment of the Water Act 2016 which specifically had great focus on RWH development unlike the previous Act and strategies (Water Act, 2002; the Ministry of Agricultural strategy papers, the National development manuscript - Kenya Vision 2030) that lacked serious commitment to RWH yet they were expected to be the guiding frameworks for RWH activities in the country. Nonetheless, a comprehensive policy covering all aspects of RWH including research and development, governance and funding remains a major gap in the sub-sector.

The RWH policy gap meant that government involvement in the subsector was lackluster. In the circumstances contrary to the expectation of community members in the study areas that government would take the lead in RWH, it was Civil Society Organizations that were at the centre of RWH practice. This was pointed out by the interviewees, for instance: "With people having corrugated iron sheets roofed houses they could be assisted with water tanks to supplement water harvesting activities but the government has not contributed to water harvesting in the area" (ASHG,14-04-16). The Ministries, Departments and Agencies (MDAs)

in the water sector acted marginally mainly providing facilities in an uncoordinated fashion with the result that the sub-sector remained weak.

It was the conclusion of the study that capacity building for RWH was needed at all levels in Kenya. However, the capacity of management groups was specifically important for sustainable RWH projects. This was supported by interviewees' comments such as, "Without that knowledge or awareness, they are not able to demand or even if they know a little bit, they will do it in such a way that it is not effective" (KI07,20-09-2015). Promoting effective RWH efforts therefore, needs to start from effective local institutions and to establish effective local institutions, sound mobilization and training was crucial to promote social cohesion that was found to be instrumental in the strength of local institutions. Cohesive local institutions were associated with successful RWH. Literature (KRA, 2009, Neubert, 1996; Ostrom 2003; 2005; 2008) affirms the importance of strong institutions, capacity and cohesion in ensuring sustainability. Even though there was no project group that could be considered to have been functioning perfectly, it was apparent that some of the groups were functioning more effectively than others thus promoting sustainable RWH projects. The characteristics common in these groups included; existence of enforceable rules, clear benefit sharing strategy, sense of ownership, addition of value chain, capacity, monitoring system, and social capital cultivation. These characteristics contrasted with those common to non-successful groups which were characterized by conflicts, weak teamwork, degraded projects, corruption, domination by cliques and unclear ownership rights.

The study also concluded that poor linkage and coordination among RWH institutions resulted in duplication of efforts and lack of scaling up of RWH activities in the country. This

was confirmed by interviewees' statements, for example: "The only thing there is, is confusion because you find funds given to Water and Irrigation [Ministry] and to Agriculture [Ministry] sometimes do the same thing in the same district" (KI07, 20-09-15). There was need for both vertical and horizontal linkages across levels including local, national and international. The study concluded that coordination of resources (skills, finances, learnt lessons) at all levels could be enhanced through creation of a national RWH network which would generate more linkages and synergy. The literature (Black et al., 2012; Holling et al.; Oguge & Oremo, 2015; Young, 2002; Young et al., 2008) also supported networking and creation of vertical and horizontal interplay to address poor communication and duplication challenges. The national network would facilitate information sharing among various actors (experts, donors, consultants, researchers, industrialists, policy makers), capacity building, oversee certification and standardization, address duplication, quality and capacity issues in RWH. To complement this, a multilayer implementation structure that would link local RWH projects' groups from the sub-locations through locations to the national network would be promoted.

**Limitations**

This study constituted a case study of one county in the semi-arid region of Kenya which was chosen as representative of the rainwater harvesting practices in semi -arid Kenya. Even though the case study of Makueni County was undertaken to reflect a wider region, including all semi-arid areas and the country in general, only a number of technologies were involved. Therefore, due to limited time and resources, it was not possible to cover all aspects of RWH. Furthermore, even though substantial information was collected and research rigor applied, the

field observations were carried out in only one season (dry season) because accessibility is difficulty during the rainy season, which meant that the overall picture was limited.

## Recommendations

### Implications for Theory

According to Ostrom (1990) the likelihood that users of a resource will engage in collective action depends on, among other factors, how valuable solving a problem is to the users. Though RWH could be undertaken individually, the socio-economic factors like the poverty levels and scarcity of resources such as land called for joint ventures in order to attain the anticipated levels of impact on water security. Given that these local RWH project institutions were the cornerstone in catalyzing RWH growth by ensuring sustainable replicable projects, it is important that efforts to grow RWH begins with them. In analyzing the dynamics in these institutions that manage RWH projects it was noted that some applied the principles proposed by Ostrom (2008) and institutional diagnostics Young (2002) to a large extent. Young (2002, 2008, and 2010) however implied that since contexts were not the same, every context required institutional diagnostics to identify the problems and most suitable solutions.

It has been observed by other scholars such as Agrawal (2002), Turner (1999) and Cleaver (2000) the issue of defined boundaries as espoused by Ostrom (2008) was hard to discern. For community RWH projects, especially those fully sponsored by donors, accessibility and use depends on distance, and where applicable, affordability but not necessarily on strict membership. Normally donors map likely number of beneficiaries and are happier if more people

are using the project. However, this may work for membership based projects like farm ponds where members have invested their own funds.

Though some projects were more effective than others, there were none that could be termed "robust" if analyzed in the light of Ostrom (2008) assertions. This is because there were specific challenges at different levels or locations. The local institutions were found to be at different levels of robustness. Even those considered successful had issues while those considered non-performing also had certain aspects of success. Therefore it implies that sense to institutional designs have to incorporate certain differences in regions and the strength of an institution could only be evaluated on a graduated continuum of success.

**Implications for Policy**

From the foregoing therefore, it would appear that, policy change and prioritization by the government is needed. This would involve a change of approach to water security, for instance, a policy focus on increased investment in RWH. The Government has had intentions to supply water for all, as evidenced in various past development plans, but it might not be possible to supply piped water to all. Instead GoK should adopt a multifaceted approach which would include diversified water supplies depending on available endowments across regions, promoting and scaling up small scale community based projects. Adoption of a community based approach would entail a bottom up strategy which would create room for community participation to enhance ownership. It is also fundamental that government projects are based on impact other than politics.

Water governance should be reviewed in the face of devolution. One of the setbacks in devolving water governance to the counties has been trans-boundary water issues. A number of

cases were pending in Kenyan courts over trans-boundary water issues. A good example was Nairobi County which drew part of its water from Ndakaini dam which was located in Muranga County. As a result there has been a case in court suing the Nairobi County for utilizing another County's resources without compensation. This needs to be addressed in policy.

**Implications for Practice**

Challenges raised and gaps identified revolved around management issues. If an effective coordination mechanism were in place, many of these challenges would be addressed. Constraints were identified in coordination, capacity, technical support, and policy and information flow. Coordination mechanisms would provide linkages to ease some of these constraints.

**Recommendations:**

In view of what is noted above, practices for improvement of RWH should incorporate the following principles:

- Application of a combination model in RWH water supply projects: In all the groups visited inadequacy of water from the RWH project was cited. This was attributed partly to capacity of containers/reservoirs, siltation or disconnect between quantity and demand. It was therefore proposed that a combination model should be adopted, especially where cost is an issue. This for instance, would ensure that a bigger capacity reservoir (dam, pan, pond) is utilized for production while a roof catchment is installed for domestic purposes.
- Application of standards: Promoters of RWH projects needed to adopt standards in their practice, such as, the WHO standards for water supply in schools and

SPHERE project's minimum standards for water supply and sanitation, all through the project cycle so as to ensure effectiveness of RWH interventions. These are internal standards that specify for instance amount of water required per person per day. Installation of projects without adherence to standards was decried as one of the factors behind failure of RWH projects. Standards for RWH projects would start with baseline surveys, feasibility studies which provided data necessary to support adoption of standards on quality quantity, time and distance as far as rainwater is concerned. An initial feasibility study would indicate the viability of an intended project based on anticipated quantity from the mapped catchment whereas baseline survey data would provide details on the status of the intended beneficiaries and the water demand amounts. This information would help ensure that the beneficiaries are able to access the required/recommended amounts of water per day, and at the recommended maximum distance and time taken to the water point.

- Regulation of RWH infrastructure and designs: In order for RWH to be regarded as potable, there would be need to be regulation of the way in which the infrastructure is installed and water handled. For instance water from dams, and pans was regarded as non-potable. Most often this was so because the structures were not installed to completion. Many dams were abandoned after excavation and regarded as complete. However for the dam to provide clean water, more than excavation was needed. For instance fencing, sinking a well or installing a filtration chamber, separate water points for domestic, livestock and production, a

water pump and sanitation facilities in the surrounding, distribution and water treatment facilities. Roof catchment could also be improved through installation of a foul flush system to ensure that only clean water gets into the tank. Treatment of rainwater whether at a central place or at the household would improve the water quality. This in essence, would makes the structures more costly and that is why many sponsors took shortcuts. Therefore, with regulation by the government supported by Civil Society, it would be possible to immensely improve the quality of rainwater. Although the Ministry of water had some guidelines on installation of some structures like dams, these guidelines were rarely adhered to intentionally or unknowingly. Interestingly even some of the projects done by the government were also missing some of the details mentioned above. Consequently existing guidelines ought to be disseminated and those that are missing be undertaken.

- Utilization of Local materials: One of the challenges identified facing RWH projects was inability to take care of operations and maintenance which rendered projects unsustainable. This was caused by factors, such as, utilization of imported materials which made repairs difficult due to inaccessible spare parts and lack of involvement of local people in project planning resulting in failure to transfer knowledge and capacity. Therefore, sponsors of RWH should use locally available materials, or customize imported models using local materials and build the capacity of the beneficiaries to maintain the projects.
- Sensitization and community responsibility: This study indicated that there was broad awareness about RWH in the community and the nation at large. What was

lacking was the technical knowledge and determination to carry out RWH. Recognizing that service provision is not cheap, the community should be empowered to do what they are able to do with available resources and government should support their efforts. It was affirmed that communities are capable but they needed a slight push in terms of information about available options and technical aspects. One of the informants indicated that when they introduced the farm ponds, some of the communities who had money immediately picked it up and were able to start implementing the technology. Therefore, it was felt that the actors in the RWH sector including the government, CSOs, academic and research institutions should embark on a national proactive education of the public on RWH, available technologies, where to get what support, and how to access that support.

- Networking and Coordination: Linkages and synergy: The need for an effective national coordinating network was floated as a strategy to advance rainwater harvesting to the next level. It was noted that there were networks on the ground but none of them had performed the role that a network should perform. Some of these networks engaged in implementation of projects instead of coordination. It is however the opinion of the study that an effective network would bring together actors in the sector including experts on the topic, consultants/contractors, researchers, industries manufacturing equipment, banks providing financial services, and government agencies. An effective network should be able to mobilize not only members but provide supportive linkages to members, such as, mobilizing communities to form common interest groups and link them to donors, experts,

trainers, other groups and government agencies for various services. The network would link researchers to experts and industrialists to promote continued dialogue and conversations on RWH including modeling and remodeling of localized affordable infrastructure for RWH.

- Furthermore the network would work with academic and research institutions to develop curriculum on RWH. An effective network should keep and provide an inventory of lessons learnt, success cases, trainers, experts in particular sections, contacts of various members, models for various technologies, and strengths and weaknesses of various models and approaches. The network would bring together actors for technical conferences and coordinate development of guidelines and standards for RWH. Conferences are necessary for review planning and coalescing of innovations. In view of the above tasks the network should be able to develop tools and certification standards and be able to issue certificates to contractors so as to control quality in RWH. The network should then authoritatively lobby and advocate for development of a suitable legislative framework to govern RWH through working closely with the Government. In liaison with the Government agencies, the network would embark on public education agenda to educate the public about various ways of RWH. In this way a governance framework for RWH could promote linkage and interplay among different levels to support RWH at all levels and to provide a conduit for information and resources.
- Financial Resources: As noted in almost all the projects studied, finance and costs were major handicaps in RWH. It was reported that the equipment was expensive and

beyond affordability of most residents. Due to the average level of income, very few, could afford a water tank. It was therefore, important for the government to subsidize this equipment to foster uptake. Though banks were beginning to support RWH projects, this needed to be advanced so that many of the local people could access credit for such projects. This also underscored the need for RWH projects to adopt a business model which would make them viable for borrowing credit but also promote sustainability**.**

- Institutional design to support RWH in semi-arid Kenya: Institutionalizing RWH in semi-arid Kenya would take on board various aspects of RWH including operational, implementation structure, legal, governance, coordination, networking and technical design. There was no single institution but several institutions based on the above aspects that could function coherently with linkages and interplay**.** The conceptual institutional illustration for RWH governance presented above, is built on lessons learned from isolated practices emerging from interviews and actual project management practices on the ground. These included views from informants on what needed to be put in place, what is provided for by prevailing national water policy, models used by actors/sponsors and how RWH was practiced by the local people.

**Suggestions for Future Research**

Many RWH options have not been exploited and this could be areas for further study:, for instance, Kenya suffers from serious floods especially in the cities due to poor maintenance of drainage. The run-off from roads can be diverted to reservoirs and directed to fields for farming. This would minimize the havoc caused by flash floods. Many residents in the urban centers wash

pavements, cars, and water gardens with clean treated water amidst water rationing. Research into various environmentally appropriate methods of capturing rainwater especially in urban centers should be carried out to resolve some of these uses and ease pressure on potable water. Research on cheaper customized technology for RWH needs to be supported for growth in the sector.

I propose research on the efficacy of government sponsored mega dams in the attainment of water security in the country. This research revealed indifference among stakeholders on the effectiveness of the mega dams in realizing water security for all, however no specific statistics were available hence the need for specific research on the topic. Tied to the dynamics of the mega dams was the issue of trans-boundary waters across countries in relation to mega dams. There is a need to evaluate how such dams should be managed for effectiveness, harmony and fairness.

**Personal Reflection**

The proposals put forth in this thesis are not a panacea but reflect an attempt to generate information driven by the desire to contribute to defining solutions to problems afflicting a vast majority of the populace. Based on a long experience in community development, I believe that, "if you enter a community and manage to put in place workable structures and systems, the quest to solving social issues is halfway achieved". In this regard I trust that strong RWH management institutions in place to govern rainwater harvesting would improve RWH and support sustainable water supply in the semi-arid lands.

Progress in RWH would be anchored in good information flows facilitated by coordination and networking, effective interplay across all levels and among sectors to enable skills and knowledge transfer, and consequent scaling up. Progress would also be anchored in cohesive implementing entities with requisite management skills to support growth and sustainability. This institutional interplay would flourish in an operating environment of favorable policy that sets directions in terms of priorities for investment so as to foster availability of relevant skills, fiscal resources, capital equipment, technical support, guidelines, standards and controls.

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## Appendix A: Research Consent Form

My name is Janet Mang'era. I am a student in Royal Roads University, Canada. This research study constitutes part of requirements towards the fulfillment of a doctoral degree at Royal Roads University. My credentials with Royal Roads University can be established by telephoning my supervisor, Prof. Leslie King through 1-250-391-2600 x 4104.

The research project I am undertaking is titled: Building institutions for effective rainwater harvesting; addressing vulnerabilities and enhancing resilience. The project aims to establish ways of improving rainwater harvesting towards water security in the arid and semi-arid regions. This document therefore explains what the research entails and your signature of the same will constitute an agreement for you to participate in this research project.

This research will last for about nine months. I will carry out interviews with a number of people involved in the field of rainwater harvesting. I will also take photos of some of the projects. Some of the questions I will be seeking answers from you include the main sources of water, rainwater management practices, challenges, type of institutions managing rainwater and how they linked to other water management frameworks and what improvements could be made to improve rainwater harvesting. Collected information will be compiled in a report that I will submit to RRU for the fulfillment of the requirement for a doctoral degree. I may also share the findings of my research in the form of presentations in conferences and publications.

Some of the interviews will be audio recorded and some written. However no information will be linked directly to a particular individual unless with specific permission and agreement has been has been sought prior to the interview. If anyone decides to withdraw from the process before completion, the information collected from them will not be used in the

analysis but will be destroyed. All documentation will be kept in a very secure manner and retained in for a period of five years after this project completion.

Findings from this research will be sent to all those who have participated through email or by post upon compilation, completion and submission of the report to my University

Participation in this research is therefore of your own free will. If at any point you choose to withdraw you are free to do so. Otherwise all information gathered from you during the interview is confidential and will be treated as such. Your name will not be used nor associated with any responses.

By signing this letter, you give free and informed consent to participate in this study.

Name: _____

Signed: _____

Date: _____

## Appendix B: Research Tools

**KEY INFORMANT Questionnaire**

**Interviewer: _____ Date: _____ day/month/year Time:**

**A. Personal information**

1. What is your area of specialization?
2. How long have you been involved in the field of rain water harvesting?

**B. Water situation in Kenya**

3. Kenya is considered a water scarce country, what is your opinion regarding this.

**C. Rainwater harvesting**

4. How do you define Rainwater Harvesting?
5. What is the status of Rainwater Harvesting in the country ( trends, prevalence, methods)?
6. What is your Organization's Policy about rainwater harvesting?
7. What do you think of the prevailing/ Government Policy /legal framework on rainwater harvesting (is there one, is it operational? Effective
8. What Government agencies are concerned with RWH?

**D. Rainwater Management**

9. Which part of the country does your organization implement RWH projects
10. Does your organization have a particular model for implementation of rainwater harvesting projects
11. Do you know of other models applied by other entities
12. What structures/ networks exist to manage RWH projects

13. How is rainwater harvesting implemented privately/communally? Please explain the most common methods and the reasons for adopting those methods?
14. Who are the main promoters/actors in Rainwater Harvesting?
15. What challenges face rain water projects (both communal and private)?
16. Are there any striking common aspects in successful projects?
17. What about common aspects in non-successful project?
18. What support do the Government/ County /water department officers provide to rainwater harvesting
19. What structure exists to govern Rainwater harvesting on the ground?

E. Recommendations

20. In your opinion, how can rainwater harvesting be better implemented?
21. What sort of structures can help support more effective rainwater harvesting?
22. Do we need to better support existing structures?
23. Do we need to develop new structures?
24. How would these structures engage with other water structures, frameworks and stakeholders?

**Focus Group Discussion Schedule**

**Group/Project name ----------location----------Village -------**

**Category ----------**

**Consent (Ref to attachment)**

**Interviewer: _____ Date: _____ day/month/year Time:**

A. Group information

25. When was the project started?

26. How many members are involved in the project?

27. What were the goals of the project? Have you achieved them?

28. How happy are you with the outcomes of the project?

29. What are the good things about the projects?

30. What are the barriers or obstacles to the project achieving its goals?

31. If you were going to give someone advice about starting a similar project what would you advise?

32. How can your project be improved?

B. Water access in Kenya

33. What are the main sources of water in this area?

34. Can you describe the water situation in this area?

35. What are the factors that are responsible for the situation you have described?

C. Rain water harvesting

36. What are common Rainwater harvesting methods in this area?

37. What are challenges facing rainwater harvesting in this locality?

38. Who are the main promoters of Rainwater Harvesting?

39. Does the Government encourage/ facilitate rainwater harvesting?
40. What support does the Government/ County provide to rainwater harvesting?

D. Rain Water Management

41. Are rainwater harvesting projects privately/communally managed? Please explain the most common and the reasons.
42. What are the characteristics of a well-managed water project? What are the characteristics of a poorly managed project? Can you identify some examples of both cases in this area (Makueni)?
43. Does your project have rules that govern who benefits and how they benefit, sanctions for offenders etc? If so how has this helped or not helped the sustainability of your project?
44. What do you do to ensure members are working towards the project goal?
45. How do you monitor individual and group performance?

E. Recommendations

46. How can rainwater harvesting be improved- in this area and in Kenya as a whole?
47. What does the Government/NGOs /Community need to do to achieve improve Rainwater Harvesting?

## Appendix C - Focus Group Discussion Participants

| GROUP | SUBLOCATION | LOCATION | Division | county | total |
|---|---|---|---|---|---|
| T M SHG | kikumini | Kikumini | wote | makueni | 14 |
| TSHG | ngosini | Kikumini | wote | makueni | 14 |
| KiKiSHG | kikumini | Kikumini | wote | makueni | 13 |
| KSHG | kikumini | Kikumini | wote | makueni | 10 |
| WKSHG | kikumini | Kikumini | wote | makueni | 5 |
| Anyanyae | Kaumoni | Kilala | kaiti | makueni | 6 |
| KaKaSHG | Ngosini | Kikumini | wote | makueni | 6 |
| NyMSHG | ngosini | Kikumini | wote | makueni | 11 |
| TWSHG | kikumini | Kikumini | wote | makueni | |
| VSHG | Yikivumba | Kikumini | nguu | makueni | 10 |
| WWMSHG | ngosini | Kikumini | wote | makueni | 10 |
| **GROUP** | **SUBLOCATION** | **LOCATION** | **Division** | **county** | |
| KyED SHG | | Kalazoni | malili | makueni | 9 |
| MatED SHG | | Kalazoni | malili | makueni | 7 |
| KyamED SHG | | Kalazoni | malili | makueni | 7 |
| Kiko ED SHG | | Kalazoni | malili | makueni | 8 |
| Mak ED SHG | | Kalazoni | malili | makueni | 9 |
| KwakaSHG | | Kalazoni | malili | makueni | 10 |
| mapri | | Kalanzoni | malili | makueni | 5 |
| Kwakae SHG | | Kalazoni | malili | makueni | 7 |
| kiti SHG | | Kalanzoni | malili | makueni | 6 |
| Total | | | | | 167 |

# Appendix D - Focus Group Discussions' Report

| Group | objectives &vision | RWH Projects | activities | constraints | successes | strengths | weaknesses | recommendations | comments/observations |
|---|---|---|---|---|---|---|---|---|---|
| Anyanyae | Started in 2010, aimed to reduce poverty among members. Trained by KRA. Every member to have a farm pond and water tank, create youth employment | Farm pond ,in situ RWH(zai pits), roof Catchment, conservation agriculturet | farming, agribusiness, hay selling , water selling , table banking , tree nurseries | Inadequate resources, high cost of RWH infrastructure, unpredictable weather pattern and unreliable rainfall. -water harvested doesn't last long | Installed two farm ponds , 20-5000l- tanks, income from various ventures, planted 10,000 trees so far, buying furniture for one another, contributing 1000, monthly to put up ponds for members | Trust among members, respect for group rules, group constitution, good monitoring and information sharing through meetings, diversified income base | poverty impedes member participation and group progress - high cost of dams and local labour | Government to subsidize RWH infrastructure. Communities to be supported with more farm ponds preferably at house hold level and increase their size modeling Bishop Masika's strategy -avail affordable credit facilities for rain water harvesting projects | projects in good condition, group vibrant and enthusiastic |
| Ngwatanio ya Munyuni | Started in 2011 aimed to harvest rain water and use it to improve their standard of living. Trained by KRA | Farm Pond, trained on rain water harvesting (zai pits) KRA gave materials for construction the members contributed land and labour | | -Unreliable rainfall The water is not enough for all year round farming and household requirements -High Cost of the dam and labour -Night animals ( squirrels and rats) damaging the drip lines and crops. The tank for the drip kit is too small (230L) | They have one farm pond with a capacity of 50,000 litres , income from horticultural farming -diversified income base from tree nursery - increased savings towards buying the posho mill | group cohesion, discipline enhanced by adhering to their constitution, Forum for sharing ideas and information | High poverty levels -unpredictable weather -inadequate skills and knowledge on water harvesting -lack of awareness on the same | -Avail affordable credit facilities for rain water harvesting projects- Increase the farm ponds and their size to individual members Replicate the projects Give tanks and even if its cost-sharing Regular stakeholders meetings and linkage with the same | |
| kanini kas | started in 2010 -aimed at harvesting rain water and use it to improve their standard of living -trained by KRA and every member was to get a farm pond -access vegetables to members -access water for domestic uset | Farm Pond (5000l), trained on rain water harvesting (zai pits) KRA gave materials for construction the members contributed land and labor | fish farming and horticulture farming of tomatoes and vegetables. water selling , merry go round, E5 | Unreliable rainfall Cost of the dam is high Night animals especially squirrels and rats have been damaging the drip lines and crops The tank for the drip kit is too small (230L) and cannot hold a lot of– Water Leakage of the pond thus not storing water for long | They have one farm pond with a capacity of 50,000 litres - income from horticultural farming -reduced walking distance for water drawing in the seasonal rivers thus saving time for other activities | group cohesion and unity of purpose -discipline enhanced by adhering to their constitution, -Forum for sharing ideas, information and other social activities | High poverty levels thus hindering group members contribution -unpredictable weather -high cost of dams and local labor -inadequate skills and knowledge -lack of awareness on the same Discouragement due to KRA not availing a dam per group member as initially promised despite members excavating the dams | Increase the farm ponds and their size to every individual group members Initiate fundraising to replicate the projects Avail affordable credit facilities for rain water harvesting projects Government to -provide more and alternative resources for water harvesting projects | Members are aware of roles and responsibilities -the project is well maintained -adherence to the constitution has ensured there is no pilfering of group funds and enhanced discipline -likelihood of members dropping out due to KRA not keeping the promise of a farm pond per member |
| Thome Witu | The group was started in 2012 -aimed at harvesting rain water and use it to improve their standard of living -trained by KRA and every member was to get a farm pond -access vegetables to members -access water for domestic use | Farm Pond, trained on rain water harvesting (zai pits) The farm pond has a capacity of 50,000 litres KRA gave materials for construction the members contributed land and laour | Horticulture farming of onions and vegetables. water selling , merry go round, Currently doing passion fruit farming under contract farming | , high cost of RWH infrastructure, unpredictable weather pattern and unreliable rainfall. -water harvested doesn't last long | two farm ponds : -the members are doing a second pond from their own resources - income from horticultural farming -reduced walking distance for water drawing in the seasonal rivers thus saving time for other activities -The group is working with a passion fruit company who are providing a market | Group cohesion and unity -discipline enhanced by adhering to their constitution, -Forum for sharing ideas, information and other social activities - initiated a merry go round to cater for other social needs | High poverty levels Income from the -inadequate skills and knowledge -lack of awareness on the same unfulfilled promises by donor breeds uncertainity. | Increase the farm ponds and their sizes Initiate fundraising to replicate the projects - thorough study and survey on the most appropriate water harvesting technology to be adopted. affordable credit facilities RWH -Government consider a multi-agencys/ stakeholder approach to the same | Members are aware of roles and responsibilities -the project is well maintained -adherence to the constitution has ensured the group is stable - Entry of the passion fruits company might give the RWH Projects a new impetus. |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Wendo wa Mang'a oni** | The group was started in 2011<br>-aimed at harvesting rain water and use it to improve their standard of living<br>-trained by KRA | Farm Pond , 50,000ltrs, trained on rain water harvesting (zai pits)<br>KRA gave materials for construction the members contributed land and labor | Horticulture farming of tomatoes and vegetables. water selling , merry go round, | Unreliable rainfall<br>insufficient water<br>'Cost of the dam<br>damage of materials by animals | Income from horticultural farming.<br>-reduced walking distance for water for other activities<br>-Availability of food at homes | group oneness, cohesion and unity<br>-discipline enhanced by adhering to their constitution,<br>-Forum for sharing ideas, information and other social activities | High poverty levels<br>-inadequate skills and knowledge<br>-lack of awareness on the same | Increase the farm ponds and their size.<br>-include water purification gadgets<br><br>Avail affordable credit facilities for rain water harvesting projects | Members are aware of roles and responsibilities<br>-the project is well maintained but the members are not very motivated as the profits are not encouraging<br>-adherence to the constitution has ensured the group is stable |
| Vololo Self Help Group | The group was started in 2003<br>-aimed at harvesting rain water and use it to improve their standard of living<br>-Establish a tree nursery<br>-trained by KRA | This is a rock catchment project, 3 tanks of 450,000 ltrs constructed -trained on rain water harvesting KRA gave materials for construction the members contributed land and labor | Fruit tree nursery and vegetables. water selling , merry go round, | Unreliable and unpredictable rainfall<br>The water is not enough for all year round for domestic use only<br>'Cost of the project and the tanks is high<br>-Project on public land and not fenced hence likely to be vandalized | reduced walking distance for water drawing in the seasonal rivers thus saving time for other activities<br><br>-Availability of water for domestic use and for animals and the tree nursery | group oneness, cohesion and unity<br>-they give water free to weddings and funerals for all community members<br>-discipline enhanced by adhering to their constitution,<br>-Forum for sharing ideas, information and other social activities<br>- initiated a merry go round/ table banking | High poverty levels<br><br>-high cost of construction of the water tanks<br>-inadequate skills and knowledge<br>-inadequate awareness on on RWH | Iinclude water purification technology to assist the community access clean drinking water<br>- Credit facilities for rain water harvesting projects like big water tanks.<br>-the water catchment can serve 10 tanks of 150,000 litres each and only 3 have been built | Members are aware of roles and responsibilities<br>-the project is well maintained but not fenced<br>-adherence to the constitution has ensured the group is stable |
| **Twone Mbee Self Help Group** | Project was started in 2011 initiative of Kenya Rain Water Harvesting Association means to increase food and nutrition security through increased adoption of rain water harvesting and management systems for horticultural production | Farm Pond, trained on rain water harvesting | merry go round that has enabled them qualify to join a micro finance institution | Unpredictable rainfall. and Pond size is smalls compared to the demand.<br><br>Cost of the project is high | reduced walking distance for water drawing in the seasonal rivers thus saving time for other activities<br><br>-Availability of water for domestic use and for animals<br>-establishment of a farm for horticultural crops | group oneness, cohesion and unity which has also increased self esteem and worth<br>-discipline enhanced by adhering to their constitution,<br>-Forum for sharing ideas, information and other social activities<br>- initiated a merry go round/ table banking to | High poverty levels thus hindering group members contribution and projects can be aesily hijacked by the rich in the society<br>-unpredictable weather<br>-Income from the IGA's is not enough to motivate the members to keep going<br>-inadequate skills and knowledge | Increase the farm ponds and their size to every individual group members<br>Initiate fundraising to replicate the projects and force the county as well as the National government ensure there is a pond per family and enhance food security at the household level<br>-Credit facilities | Members are aware of roles and responsibilities<br><br>-adherence to the constitution has ensured there is no pilfering of group funds and enhanced discipline.<br><br>-Project okay but site is not fenced and produce and water are destroyed by birds and likely to be vandalized |
| **Tumatha** | The group was started in 2007 as a sand harvesting group. The RWH project which was started in 2010 being an facilitated of KRA | Farm Pond, trained on rain water harvesting | Agribusiness.<br>Merry go round | Unreliable rainfall.<br><br>'Cost of the project<br>-Project on public land and not fenced hence likely to be vandalized.<br>Fam pond size | | group oneness, cohesion and unity which has also increased self esteem and worth<br>-discipline enhanced by adhering to their constitution,<br>-Forum for sharing ideas, information and other social activities<br>- initiated a merry go round/ table banking to cater for other social needs and qualifying group members to save in a micro finance institution | High poverty levels thus hindering group members contribution and projects can be easily hijacked by the rich in the society-unpredictable weather<br>-inadequate skills and knowledge | Ponds for individual group member and the community at large I introduce greenhouse farming since it is more water usage efficient and could be more productive<br><br>Avail affordable credit facilities for rain water harvesting projects<br>Government to support more and alternative resources for water harvesting projects | Members are aware of their rights and obligations as the group members<br>-the project is well maintained and records well kept<br>-adherence to the constitution has ensured the group remains cohesive and intact. |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Kiimachu self help group** | The group was started in 2009 as a table banking enterprise until 2011 when RWH project was started in partnership with Kenya Rain Water Harvesting Association as a way to increase food and nutrition security through increased adoption of rain water harvesting and management. | Farm Pond, trained on rain water harvesting<br>The farm pond has a capacity of 50,000 litres<br>KRA gave materials for construction the members contributed land and labor | Availability of vegetables and sale of the surplus tablebanking and uplifting other members through credit amongst the members at a low interest. Members have initiated goat keeping and rearing project as an alternative source of income and they are doing well since each members is a goat keeper | inadequate pond capacity<br>Cost of the project and the tanks is high<br>-Project on public land and not fenced hence likely to be vandalized -projects can be -easily hijacked by the rich in the society<br>-inadequate skills and knowledge<br>--unresponsive county government uses non bottom up approach in community development -Politics of water where politicians use water supply promises as a mean to woo voters. | reduced walking distance for water drawing in the seasonal rivers thus saving time for other activities<br><br>-Availability of water for domestic use and for animals<br>-establishment of a farm for horticultural crops | group oneness, cohesion and unity which has also increased self esteem and worth<br>-discipline enhanced by adhering to their constitution,<br>-Forum for sharing ideas, information and other social activities<br>- initiated a merry go round/ table banking to cater for other social needs and qualifying group members to save in a micro finance institution for more credit | High poverty levels<br>Poverty that forces people to be primarily concern with daily meal thus little time is available to engage with government or other stake holders for project support<br>NGOs help to create awareness and facilitate us create a strong advocacy platform for reach the governmen.They should also focus on the domestic water as currently they harvest water for irrigation | replicate the projects.<br>Affordable credit facilities for rain water harvesting projects<br>Having RWH as part of County integrated development program if this was done then there would be resources for all the group members to individually own a RWH facility in their home. This would reduce poverty and stop the food donation. | Members are aware of their rights and obligations as the group members<br>-the project is well maintained and records well kept<br>-adherence to the constitution has ensured the group remains cohesive and intact |
| Kikumini AIC Self Help Group | The group was started in 2012 as a prayer group and in 2013 RWH project was started in partnership with Kenya Rain **Water** Harvesting Association as a way to increase food and nutrition security through increased adoption of rain water harvesting and management. | Farm Pond, trained on rain water harvesting | Availability of vegetables and sale of the surplus | Unreliable and unpredictable rainfall<br>The water is not enough for all year round for domestic use only<br>'Cost of the project is high<br>-Project on public land and not fenced hence likely to be vandalized • Crop diseases that they do not understand and sometimes the recommended seed are not available locally<br>• The prolonged drought reduces the amount of water harvested<br>Poverty that limit peoples capacity to enlarge the farm pond and diversify the products<br>Lack of technical or financial support from the county government | reduced walking distance to water source.<br><br>-Availability of water for domestic use and for animals<br>-establishment of a farm for horticultural crops | group oneness, cohesion and unity which has also increased self esteem and worth<br>-discipline enhanced by adhering to their constitution,<br>-Forum for sharing ideas, information and other social activities<br>- initiated a merry go round/ table banking to cater for other social needs and qualifying group members to save in a micro finance institution for more credit | High poverty levels<br>unpredictable weather<br>-inadequate skills and knowledge high literacy levels and politicians take advantage of the people | Avail affordable credit facilities for rain water harvesting projects<br>Government to -provide more and alternative resources for water harvesting projects<br>Helping in identification of genuine seed suppliers and having them locally available<br>• Building greenhouses with drip irrigation instead of open farming in an open land | Members are aware of their rights and obligations as the group members<br>-the project is well maintained and records well kept<br>-adherence to the constitution has ensured the group remains cohesive and intact. |
| Woni wa Kaseveni | The group was started in 2011 and the RWH project was started in partnership with Kenya Rain Water Harvesting Association as a way to increase food and nutrition security through increased adoption of rain water harvesting and management. | Farm Pond, trained on rain water harvesting<br>The farm pond has a capacity of 50,000 litres<br>KRA gave materials for construction the members contributed land and labor | The project is no longer communal since the chairperson has taken over and it is now a private project | • The leaders that were elected were paid by the chairperson to leave the project to him alone, today it's a private project not communal and the donor has left we don't know what to do .<br>• Corruption of the project leaders , disagreement lack of transparency and accountability<br>poverty<br>The water is not enough for all year round for domestic use only<br>Cost of the project is high<br>• The prolonged drought<br>Lack of technical or financial support from the county government | reduced walking distance for water drawing in the seasonal rivers thus saving time for other activities<br><br>-Availability of water for domestic use and for animals<br>-establishment of a farm for horticultural crops although the project was later taken over by the chairman on unclear terms | • Corruption, disagreements, lack of unity<br>• Bad leaders who do not follow the rule of the bylaws<br><br>the project was poorly managed, and a good example which was started as communal but turn into private eventually the project has collapsed because the dejected members destroyed the project as a revenge measure | High poverty levels thus hindering group members contribution and projects can be easily hijacked by the rich in the society-<br>unpredictable weather<br>-inadequate skills and knowledge high literacy levels and politicians take advantage of the people | avail affordable credit facilities for rain water harvesting projects- Increase the farm ponds and their size to individual members<br>Get more donors to replicate the project<br>Give tanks and even if its cost-sharing<br>Avail affordable credit facilities for rain water harvesting projects<br>Government to -provide more resources for water harvesting projects<br>-Have regular stakeholders meetings and linkage with the same | Disharmonious group<br>-the project hijacked by one member<br>- non adherence to the constitution has kiiled the group. |

| Group | objectives &vision | RWH Projects | activities | constraints | successes | strengths | weaknesses | recommendations | comments/observations |
|---|---|---|---|---|---|---|---|---|---|
| Kyunguni Self Help Group | The project was started by the colonial government white settlers and the group was formed in 1986 to take over the management of the project from Konza Famers society who had bought the (project earth dam) from the said white settlers and the goal was to increase access to water for domestic livestock and farming | Earth dam, water tanks of various sizes at the domestic level | Water for livestock, domestic and small scale irrigation | Inadequate resources , high cost of RWH infrastructure prolonged drought reduces the amount available thus sometimes, they only access water for livestock and domestic use. | The dam supplies water to the people all the year round for domestic use. The ones using the water for irrigation to grow vegetables and foodcrops for domesticconsumption and selling the surplus and serving 10 km radius | An opportunity to meet and agree on how to improve their lives not only by increasing access to water but also fundraising for development thus increasing cohesion and unity of purpose trust among members, respect for group rules, group constitution good monitoring and information sharing through meetings, diversified income base | Poverty<br>- high cost of maintenance.<br>increasing population and demand for water Kenya . Lack | Fencing to control access to water point<br>Have distribution lines to peoples home<br>Separating water point for people and animals<br>Must surround the earth dam with terraces, gabions to reduce silting<br>That the earth dam must be fenced and have water points separate for animals and people | dam supplies water but since rthere are no water points , it is contaminated no sustem to control use. Needs organizational reform and repair |
| Matiliku Self Help Group | The group was started in 1945 by the colonial government white settlers in 2008, the group then was allocated the earth dam by Konza Famers society who had bought the (project earth dam) from the white settlers, for management on behalf of the community the goal was to increase access to water for domestic livestock and farming | Earth dam, water tanks of v | Water for livestock, domestic and small scale irrigation | water is not enough for domestic use let alone livestock and irrigation faming. The dam is drying up and the silting and prolonged dry seasons makes water for use inadequate Furthermore this dam is not fenced and wild animals have free access and sometimes find dead aimals in the water, sometimes the livestock defecates inside the dam and stll have to draw domestic water from it but the quality is not okay due to contamination. | The dam supplies water to the people all the year round for domestic use. The ones using the water for irrigation to grow vegetables and foodcrops for domesticconsumption and selling the surplus and serving 10 km radius | | poverty impedes member participation and group progress<br>- high cost of dams and local labour and an ever increasing population and demand for water Kenya Women Finance Trust and KRep Banks (Micro finance institutions) who advance loans to buy tanks. It should be noted that they offer loan to people with assets and when you fail to pay the loan they reposes their tanks and the asset you secured | Fencing to control access to water point<br>Must surround the earth dam with terraces, gabions to reduce silting<br>That the earth dam must be fenced and have water points separate for animals and people.<br>NGOs and community can help in desiltingand increasing the dams to ensure there is enough water for irrigation Teaching communities on simple water treating technologies<br>The government needs to lead the wayin RWH | Project supplies water for all purposes - contaminated water., group is ethusiastic. Needs repair and mantainence |
| Kyamumba Self Help Group | Group began in 1998 but the project was first constructed by colonial government in 1945 by white settlers who later sold it to Konza Famers Society, the society allocated the dam to this group to manage on behalf of the community the goal was to increase access to water for domestic livestock and farming | Earth dam, water tanks of v | Water for livestock, domestic and small scale irrigation | Inadequate water for domestic use livestock and irrigation faming. The dam is drying up and the silting and prolonged dry seasons The dam is not fenced and wild animals have free access and contaminate the water sometimes . | The dam supplies water to the people for domestic lvestock and agriculture use. | | Poverty impedes member participation and group progress<br>- high cost of dams and local labour and inaccessibility to credit: | Fencing to control access to water point<br>Separating water point for people and animals<br>Must surround the earth dam with terraces, gabions to reduce silting<br>That the earth dam must be fenced and have water points separate for animals and people | Government to invest more RWH infrastructure and Helping communities/NGOs/ and government to enlarge the dam |
| Kikongoni Earth Dam CBO | In 2005 but the project was being run previously by Konza Famers Society who had bought the project (earth dam) from white settlers | Earth dam, water tanks of various sizes at the domestic level | Water for livestock, domestic and small scale irrigation | Inadequate water for domestic use livestock and irrigation faming. The dam is drying up and the silting and prolonged dry seasons The dam is not fenced and wild animals have free access and contaminate the water sometimes Poor leadership and local political interferences | | | | Fencing to control access to water point<br>Have distribution lines to peoples home<br>Separating water point for people and animals<br>Must surround the earth dam with terraces, gabions to reduce silting<br>That the earth dam must be fenced and have water points separate for animals and people.<br>NGOs and community can help in enlarging and increasing the dams to ensure there is enough water for irrigation | Project is not in good condition,<br>the executive committee is not answerable to the members<br>members are not free to voice their grievances and the leadership address their grievances<br>meetings are not regularly held and group records are not well kept and trhe groupis in a crisis |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Makueni Earth DamA7:J9 | The group started in 2012 to take over the management of the project from Konza Famers society who had bought the (project earth dam) from the white settlers and manage it on behalf of the community the goal was to increase access to water for domestic livestock and farming | Earth dam, water tanks of various sizes at the domestic leve | Water for livestock, domestic and small scale irrigation | Inadequate water for domestic use livestock and irrigation faming. The dam is drying up and the silting and prolonged dry seasons Poor leadership and local political interferences Lack of volunteering sprit in the group work Lack of money to hire people and equipment to renovate the dam | supplies water for domstic livestoc | | Silting of earth dam Poverty thus inability secure loan or to purchase rain water harvesting infrastructure Low awareness on potential of RWH in spurring development in this are by government, local leadership and individuals | CSO can help as social entrepreneur in the area of water. Fencing to control access to water point Separating water point for people and animals Must surround the earth dam with terraces, gabions to reduce silting That the earth dam must be fenced | Project is not in good condition, due to leaders not managing to mobilize followers towards a certain goal the executive committee is not answerable to the members members are not free to voice their grievances and the leadership address their grievances meetings are not regularly held and group records are not well kept and trhe groupis in a crisis NGOs and community can help in enlarging and increasing the dams to ensure there is enough water for irrigation Teaching communities on simple water treating technologies The government needs to lead the way and be involved in all the stages and especially the current impasse |
| Kwa Kalendu Earth Dam Self Help Group | The group started in 2013 to take over the management of the project from Konza Famers society who had bought the (project earth dam) from the white settlers and manage it on behalf of the community the goal was to increase access to water for domestic livestock and farming | Earth dam, water tanks of various sizes at the domestic level | Water for livestock, domestic and small scale irrigation | Inadequate water for domestic use livestock and irrigation faming Inadequate resources , high cost of RWH infrastructure prolonged drought reduces the amount available thus sometimes, they only access water for livestock and domestic use.. | The dam supplies water to the people all the year round for domestic use. The ones using the water for irrigation to grow vegetables and foodcrops for domestic consumption and selling the surplus and serving 5 km radius | A social opportunity to meet and agree on how to improve their lives and lobby for more support not only by increasing access to water but also fundraising for development thus increasing cohesion and unity of purpose trust among members,respect for group rules, group constitution good monitoring and information sharing through meetings, diversified income base | Poverty increasing population and demand for wate r inability secure loan or to purchase rain water harvesting infrastructure Low awareness on potential of RWH in spurring development in this are by government, local leadership and individuals environmental degradation especially cutting down the availabletrees for firewood and charcoal burning | Fencing to control access to water point Separating water point for people and animals Must surround the earth dam with terraces, gabions to reduce silting That the earth dam must be fenced as well as initiate soil and water conservation projects | Though the project supplies water , it is still operating below capacity, it is not fenced , and water is rurbid albeit used for domestic purposes |
| • Marwa primary school | Started in 2011 when a a farm pond was excavated to increase arable land for irrigation and produce more food for school pupils | Domestic Roof top catchment farmpond | water for use in school to increase land for food production as well as domesticuse. | Inadequate water for irrigation due to the demand for water for domestic use high cost of RWH infrastructure prolonged drought and the unwillingness of the school parents to contribute to water harvesting projects. | Thefarm pond supplies water for gardening supplies water to the school and the community as well while the tank is utilized for domestic use. | | The poverty levels are high High cost of water harvesting infrastructure Low awareness on potential of RWH in local leadership and individuals environmental degradation The community unwillingness to contribute due to the free primary education policy and expecting the government to put up the water harvesting infrastructure | Government can help by motivating people as well as subsidizing some costsrelated to water harvesting infrastructure, while CSO can help as social entrepreneur in the area of water | Project is in good condition, since it is in a school setting thus being taken care of by the school management. |

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| Kwa Kaeke Earth Dam | Project started In 2011 however originally, the project was constructed by the colonial government white settlers. This was later purchased by the community through Konza Famers Society. In 2011 and this group was allocated the project by the Konza Famers Society to manage on behalf of the community. and the goal was to To increase tree coverage and access to water for domestic livestock and farming | Earth dam, water tanks of various sizes at the domestic level | Water for livestock, domestic and small scale irrigation | Inadequate water for domestic use livestock and irrigation faming Inadequate resources , high cost of RWH infrastructure prolonged drought reduces the amount available thus sometimes, they only access water for livestock and domestic use.. | The dam supplies water to the people all the year round for domestic use. The ones using the water for irrigation to grow vegetables and foodcrops for domestic consumption and selling the surplus and serving 5 km radius | Increasing cohesion and unity of purpose ,trust among members,respect for group rules, group constitution good monitoring and information sharing through meetings, diversified income base | poverty, Low awareness on potential of RWH in spurring development in this are by government, local leadership and individuals environmental degradation especially cutting down the availabletrees for firewood and charcoal burnin | Fencing to control access to water point Separating water point for people and animals Must surround the earth dam with terraces, gabions to reduce silting That the earth dam must be fenced as well as initiate soil and water conservation projects | Potential not maximized . Leaders trying to mobilize members to do repair |
| Katilini Earth Dam | The project was started by the colonial government white settlers and the group was formed in 2000 to take over the management of the project from Konza Famers Society who had bought the (project earth dam) from the said white settlers and the goal was to To increase tree coverage and access to water for domestic livestock and farming | Earth dam, water tanks of various sizes at the domestic level | Water for livestock, domestic and small scale irrigation, tree nursery | Inadequate water for domestic use livestock and irrigation faming , the rainfall pattern is unpredictable Inadequate resources , high cost of RWH infrastructure prolonged drought reduces the amount of water available. | The dam supplies water to the people all the year round for domestic use. and serving 5 km radius | Increasing cohesion and unity of purpose ,trust among members,respect for group rules, group constitution good monitoring and information sharing through meetings, diversified income base the members are acting on the environment and ecouraging planting of trees | Poverty levels are high and reduces participation of members and group progress | Fencing to control access to water point Separating water point for people and animals Must surround the earth dam with terraces, gabions to reduce silting That the earth dam must be fenced as well as initiate soil and water conservation projects Building capacity of the leaders of the groups Tree planting should be a continuous process within the earth dam catchment | Project potential not maximized thoughc leaders mobilize followers towards a watere provision |